Disha Publication Inc

Target
MHT-CET
ONLINE ENGINEERING TEST 2021
Past (2020 - 2016) + 10 Mock Tests
(7 in Book + 3 Online)

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Get free access to Online Test(s)?

INSTRUCTIONS

1. You can access your test on any Window based Desktop, android tablets or ipads and mobile phones absolutely free.
2. Visit the link below or scan the QR code:
   3 Mock Tests
   http://bit.ly/MHT-CET_2020
3. Click on **"Attempt Free Mock Tests"**, a Registration window pops up, enter all the details in the form & click "Sign UP".
4. User is now logged in the account & all the Mock Tests appears in the grid. User can attempt the Free Mock Test(s) by clicking the **"Start"** button.
5. Contact us at support@mylearninggraph.com for any support.

Contents

(PAST PAPERS)

MOCK TESTS

SOLUTIONS

MHT-CET 2020

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. For the same cross-sectional area and for a given load, the ratio of depressions for the beam of a square cross-section and circular cross-section is

(a) $3 : \pi$ (b) $\pi : 3$ (c) $1 : \pi$ (d) $\pi : 1$

2. If three equal masses *m* are placed at the three vertices of an equilateral triangle of side $1/m$ then what force acts on a particle of mass 2m placed at the centroid?

(a) Gm^2 (b) $2Gm^2$ (c) Zero (d) $-Gm^2$

3. In a reverse biased diode when the applied voltage changes by 1 V, the current is found to change by 0.5 μA. The reverse bias resistance of the diode is

(a) 2×10^5 W (b) 2×10^6 W
(c) 200 Ω (d) 2 Ω

4. Two simple harmonic motions are represented by the equations $y_1 = 0.1 \sin\left(100\pi t + \frac{\pi}{3}\right)$ and $y_1 = 0.1 \cos \pi t$.
The phase difference of the velocity of particle 1 with respect to the velocity of particle 2 is

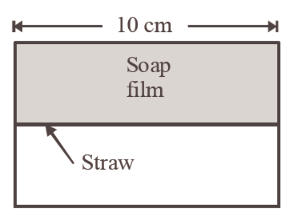
(a) $\frac{\pi}{3}$ (b) $\frac{-\pi}{6}$ (c) $\frac{\pi}{6}$ (d) $\frac{-\pi}{3}$

5. A stretched wire 60 cm long is vibrating with its fundamental frequency of 256 Hz. If the length of the wire is decreased to 15 cm and the tension remains the same. Then the fundamental freuqency of the vibration of the wire will be

(a) 1024 (b) 572
(c) 256 (d) 64

6. A soap film of surface tension 3×10^{-2} formed in a rectangular frame cam support a straw as shown in Fig. If $g = 10$ ms^{-12}, the mass of the straw is

(a) 0.006 g
(b) 0.06 g
(c) 0.6 g
(d) 6 g



7. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the discs coincide. The centre of mass of the new disc is α/R form the centre of the bigger disc. The value of α is

(a) 1/4 (b) 1/3
(c) 1/2 (d) 1/6

8. Two sources of equal emf are connected to an external resistance R. The internal resistance of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then

(a) $R = R_2 - R_1$

(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$

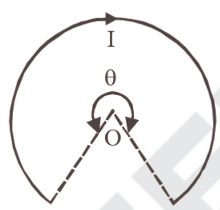
(c) $R = R_1 R_2/(R_2 - R_1)$

(d) $R = R_1 R_2/(R_1 - R_2)$

9. A vessel contains oil (density = 0.8 gm/cm^3) over mercury (density = 13.6 gm/cm^3). A homogeneous sphere floats with half of its volume immersed in mercury and the other half in oil. The density of the material of the sphere in gm/cm^3 is

(a) 3.3 (b) 6.4 (c) 7.2 (d) 12.8

10. A current of I ampere flows in a wire forming a circular arc of radius r metres subtending an angle θ at the centre as shown. The magnetic field at the centre O in tesla is



(a) $\frac{\mu_0 I\theta}{4\pi r}$ (b) $\frac{\mu_0 I\theta}{2\pi r}$

(c) $\frac{\mu_0 I\theta}{2r}$ (d) $\frac{\mu_0 I\theta}{4r}$

11. A broadcast radio transmitter radiates 12 kW when percentage of modulation is 50%, then the unmodulated carrier power is

(a) 5.67 kW (b) 7.15 kW

(c) 9.6 kW (d) 12 kW

12. Two trains are moving towards each other with speeds of 20m/s and 15 m/s relative to the ground. The first train sounds a whistle of frequency 600 Hz. The frequency of the whistle heard by a passenger in the second train before the train meets, is (the speed of sound in air is 340 m/s)

(a) 600 Hz (b) 585 Hz

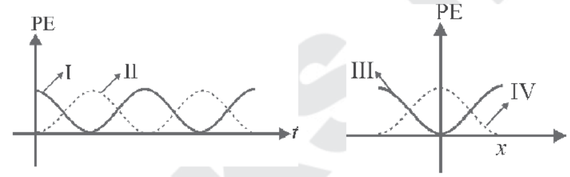
(c) 645 Hz (d) 666 Hz

13. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a. The gravitational potential at a point situated at $\frac{a}{2}$ distance from the centre, will be:

(a) $-\frac{3GM}{a}$ (b) $-\frac{2GM}{a}$

(c) $-\frac{GM}{a}$ (d) $-\frac{4GM}{a}$

14. For a particle executing SHM the displacement x is given by $x = A\cos\omega t$. Identify the graph which represents the variation of potential energy (P.E.) as a function of time t and displacement x.



(a) I, III (b) II, IV

(c) II, III (d) I, IV

15. A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength 20 Vm^{-1} and 0.5 T respectively at right angles to the direction of motion of the electrons. Then the velocity of electrons must be

(a) 8 m/s (b) 20 m/s

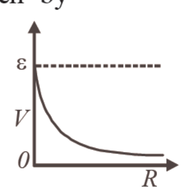
(c) 40 m/s (d) $\frac{1}{40}$ m / s

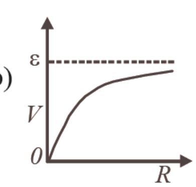
16. The period of oscillation of a magnet in a vibration magnetometer is 2 sec. The period of oscillation of a magnet whose magnetic moment is four times that of the first magnet is

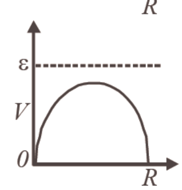
(a) 1 sec (b) 5 sec

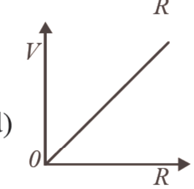
(c) 8 sec (d) 0.5 sec

17. A cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by

(a) 

(b) 

(c) 

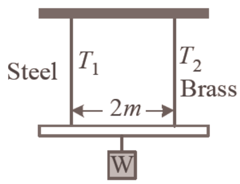
(d) 

18. The transition from the state n = 4 to n = 3 in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from

(a) $2 \rightarrow 1$ (b) $3 \rightarrow 2$

(c) $4 \rightarrow 2$ (d) $5 \rightarrow 4$

19. A light rod of length $2m$ suspended from the ceiling horizontally by means of two vertical wires of equal length. A weight W is hung from a light rod as shown in figure.



The rod hung by means of a steel wire of cross-sectional area $A_1 = 0.1\ cm^2$ and brass wire of cross-sectional area $A_2 = 0.2\ cm^2$. To have equal stress in both wires, $T_1/T_2 =$

(a) 1/3 (b) 1/4 (c) 4/3 (d) 1/2

20. For which angle between two equal vectors $\vec{A}$ and $\vec{B}$ will the magnitude of the sum of two vectors be equal to the magnitude of each vector?

(a) $\theta = 60°$ (b) $\theta = 120°$

(c) $\theta = 0°$ (d) $\theta = 90°$

21. The width of a slit is 0.012 mm. Monochromatic light is incident on it. The angular position of first bright line is 5.2º. The wavelength of incident light is [sin 5.2º = 0.0906].

(a) 6040 Å (b) 4026 Å

(c) 5890 Å (d) 7248 Å

22. The least coefficient of friction for an inclined plane inclined at angle α with horizontal in order that a solid cylinder will roll down without slipping is

(a) $\frac{2}{3}\tan\alpha$ (b) $\frac{2}{7}\tan\alpha$

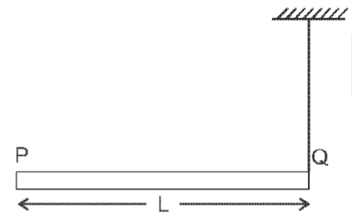
(c) $\tan\alpha$ (d) $\frac{5}{7}\tan\alpha$

23. Two balls are projected at an angle θ and $(90° - \theta)$ to the horizontal with the same speed. The ratio of their maximum vertical heights is

(a) 1 : 1 (b) $\tan\theta : 1$

(c) $1 : \tan\theta$ (d) $\tan^2\theta : 1$

24. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is



(a) g /L

(b) 2g/L

(c) $\frac{2g}{3L}$

(d) $\frac{3g}{2L}$

25. Let Q denote the charge on the plate of a capacitor of capacitance C. The dimensional formula for $\frac{Q^2}{C}$ is

(a) $[L^2M^2T]$ (b) $[LMT^2]$

(c) $[L^2MT^{-2}]$ (d) $[L^2M^2T^2]$

26. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω. The power gain of the amplifier is

(a) 500 (b) 1000 (c) 1250 (d) 50

27. A glass flask is filled up to a mark with 50 cc of mercury at 18°C. If the flask and contents are heated to 38°C, how much mercury will be above the mark? (α for glass is 9×10^{-6}/ºC and coefficient of real expansion of mercury is 180×10^{-6}/ºC)

(a) 0.85 cc (b) 0.46 cc

(c) 0.153 cc (d) 0.05 cc

28. With the increase in temperature, the angle of contact

(a) decreases

(b) increases

(c) remains constant

(d) sometimes increases and sometimes decreases

29. A prism has a refracting angle of 60º. When placed in the position of minimum deviation, it produces a deviation of 30º. The angle of incidence is

(a) 30º (b) 45º (c) 15º (d) 60º

30. A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth's surface is 11 km s^{-1}, the escape velocity from the surface of the planet would be

(a) 1.1 km s^{-1} (b) 11 km s^{-1}

(c) 110 km s^{-1} (d) 0.11 kms^{-1}

31. The fringe width in a Young's double slit experiment can be increased if we decrease
(a) width of slits
(b) separation of slits
(c) wavelength of light used
(d) distance between slits and screen

32. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is
(a) 1 : 4 (b) 1 : 2 (c) 1 : 1 (d) 1 : 5

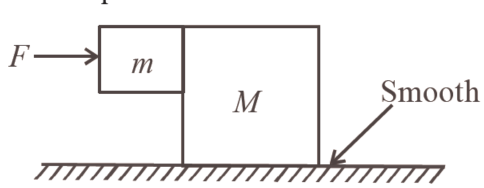
33. An electromagnetic wave going through vacuum is described by $E = E_0 \sin(kx - \omega t)$; $B = B_0 \sin(kx - \omega t)$. Which of the following equations is true?
(a) $E_0 k = B_0 \omega$ (b) $E_0 \omega = B_0 k$
(c) $E_0 B_0 = \omega k$ (d) None of these

34. A galvanometer of resistance 100 Ω gives a full scale deflection for a current of 10^{-5} A. To convert it into a ammeter capable of measuring upto 1 A, we should connect a resistance of
(a) 1 Ω in parallel (b) 10^{-3} Ω in parallel
(c) 10^5 Ω in series (d) 100 Ω in series

35. A spherical ball of iron of radius 2 mm is falling through a column of glycerine. If densities of glycerine and iron are respectively 1.3×10^3 kg/m^3 and 8×10^3 kg/m^3. η for glycerine = 0.83 Nm^{-2} sec, then the terminal velocity is
(a) 0.7 m/s (b) 0.07 m/s
(c) 0.007 m/s (d) 0.0007 m/s

36. A Carnot engine whose low temperature reservoir is at 7°C has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of the high temperature reservoir be increased?
(a) 840 K (b) 280 K (c) 560 K (d) 380 K

37. The two blocks, $m = 10$ kg and $M = 50$ kg are free to move as shown. The coefficient of static friction between the blocks is 0.5 and there is no friction between M and the ground. A minimum horizontal force F is applied to hold m against M that is equal to



(a) 100 N (b) 50 N (c) 240 N (d) 180 N

38. The pressure on a square plate is measured by measuring the force on the plate and length of the sides of the plate by using the formula $P = \frac{F}{\ell^2}$. If the maximum errors in the measurement of force and length are 6% and 3% respectively, then the maximum error in the measurement of pressure is
(a) 1% (b) 2% (c) 12% (d) 10%

39. An electron of mass m and charge e initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is
(a) $\frac{-h}{eEt^2}$ (b) $\frac{-eht}{E}$
(c) $\frac{-mh}{eEt^2}$ (d) $\frac{-h}{eE}$

40. A plano-convex lens is made of material of refractive index 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is
(a) 50 cm (b) 100 cm
(c) 200 cm (d) 400 cm

41. A mass m is revolving in a vertical circle at the end of a string of length 20 cm. By how much does the tension of the string at the lowest point exceed the tension at the topmost point?
(a) 2 m g (b) 4 m g (c) 6 m g (d) 8 m g

42. Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. If $R_1 >> R_2$, the mutual inductance M between them will be directly proportional to
(a) R_1/R_2 (b) R_2/R_1
(c) R_1^2/R_2 (d) R_2^2/R_1

43. If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the unit of b is
(a) km/s (b) kms
(c) km/s^2 (d) kms^2

44. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2 open at both ends vibrating in third overtone are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is
(a) 8/3 (b) 3/8 (c) 1/2 (d) 1/3

45. If one mole of monoatomic gas $\left(\gamma=\frac{5}{3}\right)$ is mixed with one mole of diatomic gas $\left(\gamma=\frac{7}{5}\right)$, the value of γ for the mixture is

(a) 1.40 (b) 1.50 (c) 1.53 (d) 3.07

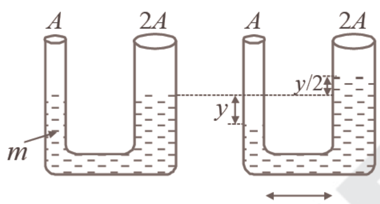
46. In a series resonant circuit, having L,C and R as its elements, the resonant current is i. The power dissipated in circuit at resonance is

(a) $\frac{i^2R}{(\omega L-1/\omega C)}$ (b) zero

(c) $i^2\omega L$ (d) i^2R

Whereas ω is angular resonant frequency

47. A U-tube is of non uniform cross-section. The area of cross-sections of two sides of tube are A and 2A (see fig.). It contains non-viscous liquid of mass m. The liquid is displaced slightly and free to oscillate. Its time period of oscillations is



(a) $T=2\pi\sqrt{\frac{m}{3\rho gA}}$ (b) $T=2\pi\sqrt{\frac{m}{2\rho gA}}$

(c) $T=2\pi\sqrt{\frac{m}{\rho gA}}$ (d) None of these

48. From a supply of identical capacitors rated 8 mF, 250V, the minimum number of capacitors required to form a composite 16 mF, 1000V is

(a) 2 (b) 4 (c) 16 (d) 32

49. An α-particle of energy 5 MeV is scattered through 180° by a fixed uranium nucleus. The distance of closest approach is of the order of

(a) 10^{-12} cm (b) 10^{-10} cm

(c) 10^{-20} cm (d) 10^{-15} cm

50. A moving coil galvanometer has N number of turns in a coil of effective area A, it carries a current I. The magnetic field B is radial. The torque acting on the coil is

(a) NA^2B^2I (b) $NABI^2$

(c) N^2ABI (d) $NABI$

CHEMISTRY

51. KO_2 (potassium super oxide) is used in oxygen cylinders in space and submarines because it

(a) absorbs CO_2 and increases O_2 content

(b) eliminates moisture

(c) absorbs CO_2

(d) produces ozone.

52. Which of the following is a bactericidal antibiotic?

(a) Ofloxacin (b) Tetracycline

(c) Chloramphenicol (d) Erythromycin

53. An ideal gas expands against a constant external pressure of 2.0 atmosphere from 20 litre to 40 litre and absorbs 10 kJ of heat from surrounding. What is the change in internal energy of the system? (given : 1atm-litre = 101.3 J)

(a) 4052 J (b) 5948 J

(c) 14052 J (d) 9940 J

54. In a solution of $CuSO_4$ how much time will be required to precipitate 2 g copper by 0.5 ampere current ?

(a) 12157.48 sec (b) 102 sec

(c) 510 sec (d) 642 sec

55. Which of the following compounds will undergo self aldol condensation in the presence of cold dilute alkali?

(a) $CH_2=CH-CHO$ (b) $CH\equiv C-CHO$

(c) C_6H_5CHO (d) CH_3CH_2CHO

56. An element having an atomic radius of 0.14 nm crystallizes in an fcc unit cell. What is the length of a side of the cell ?

(a) 0.56 nm (b) 0.24 nm

(c) 0.96 nm (d) 0.4 nm

57. 120 g of an ideal gas of molecular weight 40 g mol^{-1} are confined to a volume of 20 L at 400 K. Using

R=0.0821 L atm K^{-1} mol^{-1}, the pressure of the gas is

(a) 4.90 atm (b) 4.92 atm

(c) 5.02 atm (d) 4.96 atm

58. Fluorobenzene (C_6H_5F) can be synthesized in the laboratory
(a) by direct fluorination of benzene with F_2 gas
(b) by reacting bromobenzene with NaF solution
(c) by heating phenol with HF and KF
(d) from aniline by diazotisation followed by heating the diazonium salt with HBF_4

59. Substance used for the preservation of coloured fruit juices is
(a) benzene
(b) benzoic acid
(c) phenol
(d) sodium meta bisulphite

60. Which of the following compounds gives dye test?
(a) Aniline (b) Methylamine
(c) Diphenylamine (d) Ethylamine

61. The correct statement with regard to H_2^+ and H_2^- is
(a) Both H_2^+ and H_2^- do not exist
(b) H_2^- is more stable than H_2^+
(c) H_2^+ is more stable than H_2^-
(d) Both H_2^+ and H_2^- are equally stable

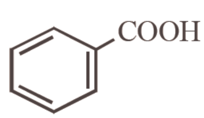
62. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of water for this aqueous solution is
(a) 76.00 torr (b) 752.40 torr
(c) 759.00 torr (d) 7.60 torr

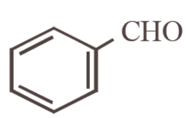
63. Mark the oxide which is amphoteric in character
(a) CO_2 (b) SiO_2 (c) SnO_2 (d) CaO

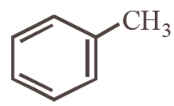
64. The standard EMF for the cell reaction,
$Zn + Cu^{2+} \longrightarrow Cu + Zn^{2+}$ is 1.1 volt at 25°C. The EMF for the cell reaction, when 0.1 M Cu^{2+} and 0.1 M Zn^{2+} solutions are used, at 25°C is
(a) 1.10 V (b) 0.10 V
(c) –1.10 V (d) –0.110 V

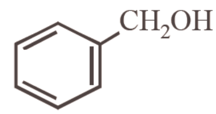
65. The reactant (X) in the reaction

$$(X) \xrightarrow[(CH_3CO)_2O]{CH_3COONa} \text{Cinnamic acid, is}$$

(a) 

(b) 

(c) 

(d) 

66. The brown ring complex is formulated as $[Fe(H_2O)_5NO]SO_4$. The oxidation number of iron is
(a) 1 (b) 2 (c) 3 (d) 0

67. A substance $C_4H_{10}O$ yields on oxidation a compound, C_4H_8O which gives an oxime and a positive iodoform test. The original substance on treatment with conc. H_2SO_4 gives C_4H_8. The structure of the compound is
(a) $CH_3CH_2CH_2CH_2OH$
(b) $CH_3CHOHCH_2CH_3$
(c) $(CH_3)_3COH$
(d) $CH_3CH_2–O–CH_2CH_3$

68. Number of moles of $KMnO_4$ required to oxidize one mole of $Fe(C_2O_4)$ in acidic medium is
(a) 0.167 (b) 0.6 (c) 0.2 (d) 0.4

69. Predict the product C obtained in the following reaction of butyne-1.

$$CH_3CH_2 - C \equiv CH + HCl \longrightarrow B \xrightarrow{HI} C$$

(a) $CH_3 - CH_2 - CH_2 - \underset{\underset{Cl}{|}}{\overset{\overset{I}{|}}{C}} - H$

(b) $CH_3 - CH_2 - \overset{\overset{I}{|}}{C}H - CH_2Cl$

(c) $CH_3CH_2 - \underset{\underset{Cl}{|}}{\overset{\overset{I}{|}}{C}} - CH_3$

(d) $CH_3 - \underset{\underset{Cl}{|}}{C}H - CH_2CH_2I$

70. The vapour pressure of a solvent A is 0.80 atm. When a non-volatile substance B is added to this solvent its vapour pressure drops to 0.6 atm. the mole fraction of B in the solution is
(a) 0.25 (b) 0.50 (c) 0.75 (d) 0.90

71. The electric cookers have a coating that protects them against fire. The coating is made of

(a) heavy lead (b) zinc oxide

(c) magnesium oxide (d) sodium sulphate

72. Chlorine is liberated when we heat

(a) $KMnO_4 + NaCl$ (b) $K_2Cr_2O_7 + MnO_2$

(c) $Pb(NO_3)_2 + MnO_2$ (d) $K_2Cr_2O_7 + HCl$

73. Which of the following solutions will have the maximum lowering of vapour pressure at 300 K

(a) 1 M $CaCl_2$ (b) 1 M NaCl

(c) 1 M Phenol (d) 1 M sucrose

74. Which of the following electrolyte will be most effective in coagulation of negative sol?

(a) KNO_3 (b) $K_4[Fe(CN)_6]$

(c) Na_3PO_4 (d) $MgCl_2$

75. The element which has not yet been reacted with F_2 is

(a) Ar (b) Xe (c) Kr (d) Rn

76. Which is the best oxidising agent among the following ?

(a) S (b) O (c) Se (d) Te

77. Which of the following is correct for a first order reaction?

(a) $t_{1/2} \propto a$ (b) $t_{1/2} \propto 1/a$

(c) $t_{1/2} \propto a^0$ (d) $t_{1/2} \propto 1/a^2$

78. Standard enthalpy and standard entropy changes for the oxidation of ammonia at 298 K are – 382.64 kJ mol^{-1} and –145.6 JK^{-1} mol^{-1}, respectively. Standard Gibb's energy change for the same reaction at 298 K is

(a) -22.1 kJ mol^{-1} (b) -339.3 kJ mol^{-1}

(c) -439.3 kJ mol^{-1} (d) -523.2 kJ mol^{-1}

79. Which of the following polymers do not involve cross linkages?

(a) Melmac (b) Bakelite

(c) Polythene (d) Vulcanised rubber

80. When a metal is to be extracted from its ore and the gangue associated with the ore is silica, then

(a) an acidic flux is needed

(b) a basic flux is needed

(c) both acidic and basic fluxes are needed

(d) Neither of them is needed

81. $A \rightarrow B, \Delta H = -10 kJ\ mol^{-1}, E_{a(f)} = 50\ kJ\ mol^{-1}$, then E_a of $B \rightarrow A$ will be

(a) 40 kJ mol^{-1} (b) 50kJ mol^{-1}

(c) – 50kJ mol^{-1} (d) 60 kJ mol^{-1}

82. At anode in the electrolysis of fused NaCl

(a) Na^+ is oxidized (b) Cl^- is oxidized

(c) Cl is reduced (d) Na is reduced

83. Molarity of liquid HCl will be, if density of solution is 1.17 g/cc

(a) 36.5 (b) 32.05

(c) 18.25 (d) 42.10

84. Which of the following bicarbonates does not exist as solid?

(a) $KHCO_3$ (b) $NaHCO_3$

(c) $CsHCO_3$ (d) $LiHCO_3$

85. P_2O_5 is heated with water to give

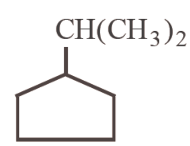
(a) hypophosphorous acid

(b) phosphorous acid

(c) hypophosphoric acid

(d) orthophosphoric acid

86. What is the IUPAC name of the compound ?



(a) 1, 1 – dimethyl – 1 – cyclopentyl methane

(b) 2 – cyclopentyl propane

(c) 1 – (1 – methyl) ethyl cyclopentane

(d) Cumene.

87. Which one of the following reactions is expected to readily give a hydrocarbon product in good yields ?

(a) $RCOOK \xrightarrow[\text{oxidation}]{\text{Electrolytic}}$

(b) $RCOO^-Ag^+ \xrightarrow{Br_2}$

(c) $CH_3CH_3 \xrightarrow[h\upsilon]{Cl_2}$

(d) $(CH_3)_3CCl \xrightarrow{C_2H_5OH}$

88. Among the trihalides of nitrogen which one is most basic ?

(a) NF_3 (b) NCl_3

(c) NI_3 (d) NBr_3

89. Omeoprazole and lansoprazole are used as –
(a) antifertility (b) antiallergic
(c) antibiotic (d) antacid

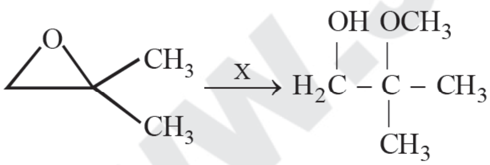
90. Hydrolysis of sucrose is called
(a) hydration (b) saponification
(c) esterification (d) inversion

91. van Arkel method of purification of metals involves converting the metal to a
(a) volatile stable compound
(b) volatile unstable compound
(c) non volatile stable compound
(d) None of the above

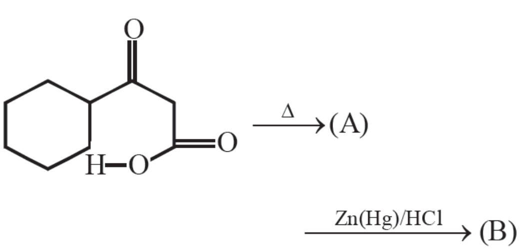
92. When SO_2 is passed through acidified solution of potassium dichromate, then chromium sulphate is formed. The change in valency of chromium is
(a) +4 to +2 (b) +5 to +3
(c) +6 to +3 (d) +7 to +2

93. Which of the following polymer is used for manufacturing of buckets, dustbins, pipes etc ?
(a) Low density polythene
(b) High density polythene
(c) Teflon
(d) Polyacrylonitrile

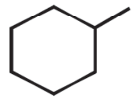
94. What is X in the following reaction ?

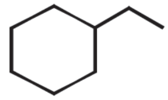


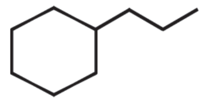
(a) CH_3OH, H_2SO_4
(b) $CH_3OH, CH_3O^- \overset{+}{Na}$
(c) H_2O / H_2SO_4 followed by CH_3OH
(d) CH_3MgBr / ether followed by H_3O^+

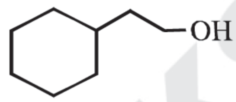
95. 

In the above reaction, product (B) is:

(a) 

(b) 

(c) 

(d) 

96. The compounds $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$ constitutes a pair of
(a) coordination isomers
(b) linkage isomers
(c) ionization isomers
(d) optical isomers

97. Which of the following factors may be regarded as the main cause of lanthanoid contraction?
(a) Greater shielding of 5*d* electrons by 4*f* electrons
(b) Poorer shielding of 5*d* electrons by 4*f* electrons
(c) Effective shielding of one of 4*f* electrons by another in the subshell
(d) Poor shielding of one of 4*f* electron by another in the subshell

98. The polymer used in making synthetic hair wigs is made up of
(a) $CH_2 = CHCl$
(b) $CH_2 = CHCOOCH_3$
(c) $C_6H_5CH = CH_2$
(d) $CH_2 = CH – CH = CH_2$

99. Which of the following is called Wilkinson's catalyst?
(a) $[(Ph_3P)_3 RhCl]$ (b) $TiCl_4 + (C_2H_5)_3 Al$
(c) $(C_2H_5)_4 Pb$ (d) $[PtCl_2 (NH_3)_2]$

100. One mole of an ideal gas is allowed to expand reversibly and adiabatically from a temperature of 27ºC. If the work done during the process is 3 kJ, the final temperature will be equal to ($C_v = 20\ JK^{-1}$)
(a) 150 K (b) 100 K
(c) 26.85 K (d) 295 K

SECTION-B

MATHEMATICS

1. In an entrance test, there are multiple choice questions. There are four possible answers to each question, of which one is correct. The probability that a student knows the answer to a question is 90%. If he gets the correct answer to a question, then the probability that he was guessing is

(a) $\frac{1}{40}$ (b) $\frac{1}{39}$ (c) $\frac{1}{37}$ (d) $\frac{2}{43}$

2. If $\pi/2 < x < \pi$, then $\int x\sqrt{\frac{1+\cos 2x}{2}}dx =$

(a) $\cos x + x\sin x + C$ (b) $-\cos x - x\sin x + C$
(c) $\sin x + x\cos x + C$ (d) $x\sin x - \cos x + C$

3. A rectangle with one side lying along the x-axis is to be inscribed in the closed region of the xy plane bounded by the lines $y = 0$, $y = 3x$ and $y = 30 - 2x$. The largest area of such a rectangle is

(a) 135/8 (b) 45 (c) 135/2 (d) 90

4. If $f: R \to R$ be a function defined by $f(x) = 4x^3 - 7$. Then

(a) f is one-one -into (b) f is many-one - into
(c) f is many-one onto (d) f is bijective

5. $\sim((\sim p) \wedge q)$ is equal to

(a) $p \vee (\sim q)$ (b) $p \vee q$
(c) $p \wedge (\sim q)$ (d) $\sim p \wedge \sim q$

6. With the usual notation $\int_1^2 \left([x^2] - [x]^2\right)dx$ is equal to

(a) $4 + \sqrt{2} - \sqrt{3}$ (b) $4 - \sqrt{2} + \sqrt{3}$
(c) $4 - \sqrt{2} - \sqrt{3}$ (d) none of these

7. The general solution of

$x(1+y^2)^{1/2}dx + y(1+x^2)^{1/2}dy = 0$ is

(a) $\cos^{-1}x + \cos^{-1}y = C$

(b) $x^2 + y^2 = (1+x^2)^{1/2} + (1+y^2)^{1/2} + C$

(c) $(1+x^2)^{1/2} + (1+y^2)^{1/2} = C$

(d) $\tan^{-1}x - \tan^{-1}y = C$

8. If $A = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$, then A^{2008} is equal to

(a) A (b) A^{-1} (c) I_3 (d) 0

9. Three vertices of a parallelogram ABCD are A (3, –1, 2), B (1, 2, –4) and C (–1, 1, 2). The coordinates of fourth vertex D are

(a) (1, 1, 1) (b) (1, –2, 8)
(c) (2, –2, 6) (d) (1, 0, 2)

10. The value of $\int \frac{\sin x + \cos x}{\sqrt{1-\sin 2x}}dx$ is equal to

(a) $\sqrt{\sin 2x} + c$
(b) $\sqrt{\cos 2x} + c$
(c) $\pm(\sin x - \cos x) + c$
(d) $\pm\log(\sin x - \cos x) + c$

11. The equation of the plane containing the line $\frac{x+1}{-3} = \frac{y-3}{2} = \frac{z+2}{1}$ and the point (0, 7, – 7), is

(a) $x + y + z = 2$ (b) $x + y + z = 3$
(c) $x + y + z = 0$ (d) None of these

12. The co-ordinates of the foot of perpendicular from the point A (1, 1, 1) on the line joining the points B (1, 4, 6) and C (5, 4, 4) are

(a) (3, 4, 5) (b) (4, 5, 3)
(c) (3, –4, 5) (d) (–3, –4, 5)

13. $(p \wedge \sim q) \wedge (\sim p \wedge q)$ is

(a) A tautology
(b) A contradiction
(c) Both a tautology and a contradiction
(d) Neither a tautology nor a contradiction

14. Two finite sets have m and n elements. The total number of subsets of the first set is 56 more than the total number of subsets of the second set. Then :

(a) $m = 3, n = 6$ (b) $m = 6, n = 3$
(c) $m = 5, n = 6$ (d) None of these

15. Let f be the function defined by

$$f(x) = \begin{cases} \frac{x^2 - 1}{x^2 - 2|x-1| - 1}, & x \neq 1 \\ 1/2, & x = 1 \end{cases}$$

(a) The function is continuous for all values of x
(b) The function is continuous only for x > 1
(c) The function is continuous at x = 1
(d) The function is not continuous at x = 1

16. The distance of the point (1, – 2, 3) from the plane $x - y + z = 5$ measured parallel to the line $\frac{x}{2} = \frac{y}{3} = \frac{z-1}{-6}$ is

(a) 1 (b) 2
(c) 4 (d) None of these

17. $\int \frac{x+\sin x}{1+\cos x}dx$ is equal to :

(a) $x\tan\frac{x}{2}+C$ (b) $\cot\frac{x}{2}+C$

(c) $\log(1+\cos x)+C$ (d) $\log(x+\sin x)+C$

18. The maximum value of $z = 6x + 8y$ subject to constraints $2x + y \le 30$, $x + 2y \le 24$ and $x \ge 0$, $y \ge 0$ is

(a) 90 (b) 120 (c) 96 (d) 240

19. $\int_{\pi/3}^{\pi/2} x\sin(\pi[x]-x)\,dx$ is equal to :

(a) $\frac{1}{2}+\frac{\pi}{6}$ (b) $1-\frac{\sqrt{3}}{2}+\frac{\pi}{6}$

(c) $-\frac{1}{2}-\frac{\pi}{6}$ (d) $\frac{\sqrt{3}}{2}-1-\frac{\pi}{6}$

20. The general solution of the equation

$\tan\theta+\tan 4\theta+\tan 7\theta=\tan\theta\tan 4\theta\tan 7\theta$

(a) $\theta=\frac{n\pi}{4}$ (b) $\theta=\frac{n\pi}{12}$

(c) $\theta=\frac{n\pi}{6}$ (d) None of these

21. For non zero, non collinear vectors $\vec{p}$ and $\vec{q}$, the value of $[\hat{i}\ \vec{p}\ \vec{q}]\hat{i}+[\hat{j}\ \vec{p}\ \vec{q}]\hat{j}+[\hat{k}\ \vec{p}\ \vec{q}]\hat{k}$ is

(a) $\vec{0}$ (b) $2(\vec{p}\times\vec{q})$

(c) $(\vec{q}\times\vec{p})$ (d) $(\vec{p}\times\vec{q})$

22. Let $f(\theta) = \sin\theta(\sin\theta + \sin 3\theta)$ then

(a) $f(\theta)\ge 0\ \forall\theta\in R$ (b) $f(\theta)\le 0\ \forall\ \theta\in R$

(c) $f(\theta)\ge 1\ \forall\ \theta\in R$ (d) $f(\theta)\le 1\ \forall\ \theta\in R$

23. The maximum value of $z = 5x + 2y$, subject to the constraints $x + y \le 7$, $x + 2y \le 10$, $x, y \ge 0$ is

(a) 10 (b) 26 (c) 35 (d) 70

24. The volume of the greatest cylinder which can be inscribed in a cone of height 30 cm and semi-vertical angle 30° is

(a) $4000\pi/3\ cm^3$ (b) $400\pi/3\ cm^3$

(c) $4000\pi/\sqrt{3}\ cm^3$ (d) None of these

25. The equation of the plane through the line $x+y+z+3=0=2x-y+3z+1$ and parallel to the line $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$, is

(a) $x-5y+3z=7$ (b) $x-5y+3z=-7$

(c) $x+5y+3z=7$ (d) $x+5y+3z=-7$

26. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be non-coplanar unit vectors equally inclined to one another at an acute angle θ. Then $[\vec{a}\ \vec{b}\ \vec{c}]$ in terms of θ is equal to :

(a) $(1+\cos\theta)\sqrt{\cos 2\theta}$

(b) $(1+\cos\theta)\sqrt{1-2\cos 2\theta}$

(c) $(1-\cos\theta)\sqrt{1+2\cos\theta}$

(d) None of these

27. General solution of the equation

$\sin 2x-\sin 4x+\sin 6x=0$ is

(a) $\frac{n\pi}{4}$ or $n\pi\pm\frac{\pi}{6}$ (b) $n\pi$ or $n\pi\pm\frac{\pi}{3}$

(c) $n\pi\pm\frac{\pi}{4}$ (d) $n\pi$ or $2n\pi\pm\frac{\pi}{4}$

28. A focus of an ellipse is at the origin. The directrix is the line $x = 4$ and the eccentricity is $\frac{1}{2}$. Then the length of the semi-major axis is

(a) $\frac{8}{3}$ (b) $\frac{2}{3}$ (c) $\frac{4}{3}$ (d) $\frac{5}{3}$

29. The locus of a point that is equidistant from the lines $x+y-2\sqrt{2}=0$ and $x+y-\sqrt{2}=0$ is

(a) $x+y-5\sqrt{2}=0$ (b) $x+y-3\sqrt{2}=0$

(c) $2x+2y-3\sqrt{2}=0$ (d) $2x+2y-5\sqrt{2}=0$

30. A ray of light coming from the point (1, 2) is reflected at a point A on the x-axis and then passes through the point (5, 3). The co-ordinates of the point A is

(a) $\left(\frac{13}{5}, 0\right)$ (b) $\left(\frac{5}{13}, 0\right)$

(c) (–7, 0) (d) None of these

31. If $x \in \mathbf{R}-\{0\}$, then $\tan^{-1}\left(\frac{\sqrt{1+x^2}+\sqrt{1-x^2}}{\sqrt{1+x^2}-\sqrt{1-x^2}}\right)$

(a) $\frac{1}{2}\cos^{-1}(x^2)$ (b) $\frac{\pi}{2}+\frac{1}{2}\cos^{-1}(x^2)$

(c) $\frac{\pi}{4}+\frac{1}{2}\cos^{-1}(x^2)$ (d) None of these

32. If $y=x^{x^2}$, then $\frac{dy}{dx}$ is equal to

(a) $(2\ln x)$ (b) $(2\ln x+1)$

(c) $(\ln\ln x+1)x^{x^2}$ (d) None of these

33. In a triangle ABC, $\angle C = 90°$, then $\frac{a^2 - b^2}{a^2 + b^2}$ is equal to :
(a) $\sin(A + B)$ (b) $\sin(A - B)$
(c) $\cos(A + B)$ (d) $\sin\left(\frac{A-B}{2}\right)$

34. The internal angles of a convex polygon are in A.P. The smallest angle is 120° and the common difference is 5°. The number to sides of the polygon is
(a) 8 (b) 9 (c) 10 (d) 16

35. In a binomial distribution n = 5, P(X = 1) = 0.4096 and P (X = 2) = 0.2048, then the mean of the distribution is equal to
(a) 1 (b) 1.5 (c) 2 (d) 2.5

36. The equation of tangent to the curve
$y = \sin^{-1}\frac{2x}{1+x^2}$ at $x = \sqrt{3}$ is
(a) $y = -\frac{1}{2}\left(x - \sqrt{3}\right)$
(b) $y - \frac{\pi}{3} = -\frac{1}{2}\left(x - \sqrt{3}\right)$
(c) $y + \frac{\pi}{3} = -\frac{1}{2}\left(x - \sqrt{3}\right)$
(d) None of these

37. Let A, B be two events such that the probability of A is $\frac{3}{10}$ and conditional probability of A given B is $\frac{1}{2}$. The probability that exactly one of the events A or B happen equals
(a) $\frac{1}{2}$ (b) $\frac{1}{6}$ (c) $\frac{3}{10}$ (d) $\frac{7}{10}$

38. If the line passing through $P(1, 2)$ making an angle with the x-axis in the positive direction meets the pair of lines $x^2 + 4xy + y^2$ at A and B, then $PA . PB$ =
(a) 13/3 (b) 13/6 (c) 11/6 (d) 11/3

39. If the curves $ay + x^2 = 7$ and $x^3 = y$ cut orthogonally at (1, 1), then the value of a is.
(a) 5 (b) 6 (c) 7 (d) 8

40. The value of $\cos\left(2\cos^{-1}x + \sin^{-1}x\right)$ at $x = \frac{1}{5}$ is
(a) $-\frac{2\sqrt{6}}{5}$ (b) $-2\sqrt{6}$ (c) $-\frac{\sqrt{6}}{5}$ (d) None

41. Which of the following is logically equivalent to $\sim(\sim p \Rightarrow q)$
(a) $p \wedge q$ (b) $p \wedge \sim q$
(c) $\sim p \wedge q$ (d) $\sim p \wedge \sim q$

42. The area of the region bounded by the curves $y = |x - 2|, x = 1, x = 3$ and the x-axis is
(a) 4 (b) 2 (c) 3 (d) 1

43. If the slope of the tangent at (x, y) to a curve passing through $\left(1, \frac{\pi}{4}\right)$ is given by $\frac{y}{x} - \cos^2\left(\frac{y}{x}\right)$, then the equation of the curve is :
(a) $y = \tan^{-1}\log(e/x)$
(b) $y = e^{1+\cot(y/x)}$
(c) $y = x\tan^{-1}\log(e/x)$
(d) $y = e^{1+\tan(y/x)}$

44. A fair coin is tossed 99 times. If X is the number of times head occurs, P(X = r) is maximum when r is
(a) 49 or 50 (b) 50 or 51
(c) 51 (d) None of these

45. The fourth term of an A.P. is three times of the first term and the seventh term exceeds the twice of the third term by one, then the common difference of the progression is
(a) 2 (b) 3 (c) $\frac{3}{2}$ (d) –1

46. The eccentricity of the hyperbola
$x^2 - 3y^2 = 2x + 8$ is
(a) $\frac{2}{3}$ (b) $\frac{1}{3}$ (c) $\frac{2}{\sqrt{3}}$ (d) $\frac{3}{2}$

47. The differential equation representing the family of curves $y^2 = 2c\left(x + \sqrt{c}\right)$, where c is a positive parameter, is of
(a) order 3 (b) order 2
(c) degree 3 (d) degree 4

48. If $f(x) = \frac{1}{1-x}$, the number of points of discontinuity of f{f [f(x)]} is :
(a) 2 (b) 1 (c) 0 (d) infinite

49. If $x = a(\cos t + t\sin t)$ and $y = a(\sin t - t\cos t)$, then $\frac{d^2y}{dx^2}$ is
(a) $\sec^3 t$ (b) $at\sec^3 t$
(c) $\frac{\sec^3 t}{at}$ (d) $\sec^2 t$

50. The number of solutions of equation $x_2 - x_3 = 1, - x_1 + 2x_3 = 2, x_1 - 2x_2 = 3$ is
(a) zero (b) one (c) two (d) infinite

ANSWER KEYS & SOLUTIONS

(MHT-CET 2020)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(c)	**11**	(c)	**16**	(a)	**21**	(d)	**26**	(c)	**31**	(b)	**36**	(d)	**41**	(c)	**46**	(d)
2	(c)	**7**	(b)	**12**	(d)	**17**	(b)	**22**	(c)	**27**	(c)	**32**	(b)	**37**	(c)	**42**	(d)	**47**	(a)
3	(b)	**8**	(c)	**13**	(a)	**18**	(d)	**23**	(d)	**28**	(a)	**33**	(a)	**38**	(c)	**43**	(c)	**48**	(d)
4	(b)	**9**	(c)	**14**	(a)	**19**	(d)	**24**	(d)	**29**	(b)	**34**	(b)	**39**	(a)	**44**	(b)	**49**	(a)
5	(a)	**10**	(a)	**15**	(c)	**20**	(b)	**25**	(c)	**30**	(c)	**35**	(b)	**40**	(b)	**45**	(b)	**50**	(d)
CHEMISTRY																			
51	(a)	**56**	(d)	**61**	(c)	**66**	(a)	**71**	(c)	**76**	(b)	**81**	(d)	**86**	(c)	**91**	(a)	**96**	(c)
52	(a)	**57**	(b)	**62**	(b)	**67**	(b)	**72**	(d)	**77**	(c)	**82**	(b)	**87**	(a)	**92**	(c)	**97**	(b)
53	(b)	**58**	(d)	**63**	(c)	**68**	(b)	**73**	(a)	**78**	(b)	**83**	(b)	**88**	(c)	**93**	(b)	**98**	(a)
54	(a)	**59**	(b)	**64**	(a)	**69**	(c)	**74**	(d)	**79**	(c)	**84**	(d)	**89**	(d)	**94**	(a)	**99**	(a)
55	(d)	**60**	(a)	**65**	(b)	**70**	(a)	**75**	(a)	**80**	(b)	**85**	(d)	**90**	(d)	**95**	(b)	**100**	(a)
SECTION-B																			
MATHEMATICS																			
1	(c)	**6**	(c)	**11**	(c)	**16**	(a)	**21**	(d)	**26**	(c)	**31**	(c)	**36**	(b)	**41**	(d)	**46**	(c)
2	(b)	**7**	(c)	**12**	(a)	**17**	(a)	**22**	(a)	**27**	(a)	**32**	(d)	**37**	(c)	**42**	(d)	**47**	(c)
3	(c)	**8**	(c)	**13**	(b)	**18**	(b)	**23**	(c)	**28**	(a)	**33**	(b)	**38**	(a)	**43**	(c)	**48**	(a)
4	(d)	**9**	(b)	**14**	(b)	**19**	(b)	**24**	(a)	**29**	(c)	**34**	(b)	**39**	(b)	**44**	(a)	**49**	(c)
5	(a)	**10**	(d)	**15**	(d)	**20**	(b)	**25**	(a)	**30**	(a)	**35**	(a)	**40**	(a)	**45**	(a)	**50**	(a)

SECTION-A

PHYSICS

1. **(a)** $\delta = \dfrac{W\ell^3}{3YI}$, where W = load, ℓ = length of beam and I is geometrical moment of inertia for rectangular beam,

$I = \dfrac{bd^3}{12}$ where b = breadth and d = depth

For square beam $b = d$ $\quad \therefore \ I_1 = \dfrac{b^4}{12}$

For a beam of circular cross-section, $I_2 = \left(\dfrac{\pi r^4}{4}\right)$

$$\therefore \quad \delta_1 = \frac{W\ell^3 \times 12}{3Yb^4} = \frac{4W\ell^3}{Yb^4}$$

(for sq. cross-section)

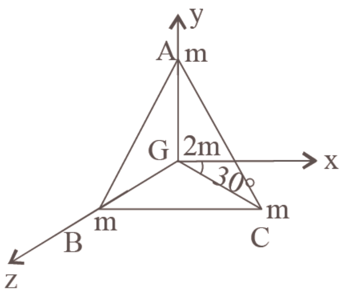
and $\delta_2 = \dfrac{W\ell^3}{3Y(\pi r^4/4)} = \dfrac{4W\ell^3}{3Y(\pi r^4)}$

(for circular cross-section)

Now $\dfrac{\delta_1}{\delta_2} = \dfrac{3\pi r^4}{b^4} = \dfrac{3\pi r^4}{(\pi r^2)^2} = \dfrac{3}{\pi}$

($\because b^2 = \pi r^2$ *i.e.*, they have same cross-sectional area)

2. **(c)**



$$F_{GA} = \frac{Gm(2\,m)}{1}\hat{j}$$

$$F_{GB} = \frac{Gm(2m)}{1}(-\hat{i}\cos 30° - \hat{j}\sin 30°)$$

$$F_{GC} = \frac{Gm(2m)}{1}(\hat{i}\cos 30° - \hat{j}\sin 30°)$$

$\therefore$ Resultant force on (2m) is F_R

$= F_{GA} + F_{GB} + F_{GC}$

$= 2Gm^2\hat{j} + 2Gm^2\hat{i}(-\cancel{\cos 30°} + \cancel{\cos 30°})$

$+ 2\,Gm^2\,\hat{j}(-\sin 30° - \sin 30°)$

$= 2Gm^2\hat{j}.2Gm^2\hat{j}\left(-\cancel{2} \times \frac{1}{\cancel{2}}\right)$

$= 2Gm^2\hat{j} - 2Gm^2\hat{j} = 0$.

3. **(b)** Reverse resistance

$$= \frac{\Delta V}{\Delta I} = \frac{1}{0.5 \times 10^{-6}} = 2 \times 10^6\,\Omega$$

4. **(b)** $v_1 = \frac{dy_1}{dt} = 0.1 \times 100\pi\cos\left(100\pi t + \frac{\pi}{3}\right)$

$$v_2 = \frac{dy_2}{dt} = -0.1\pi\sin\pi t = 0.1\pi\cos\left(\pi t + \frac{\pi}{2}\right)$$

$\therefore$ Phase diff. $= \phi_1 - \phi_2 = \frac{\pi}{3} - \frac{\pi}{2} = \frac{2\pi - 3\pi}{6} = -\frac{\pi}{6}$

5. **(a)** $L_0 = 60\,cm$ $\quad \nu_0 = 256\,Hz.$

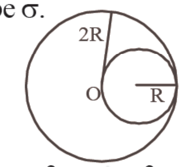
$\nu = \frac{1}{2L}\sqrt{\frac{T}{m}}$ $\quad \therefore \quad \nu \propto \frac{1}{L}$

$$\frac{\nu_1}{\nu_0} = \frac{L_0}{L_1} \Rightarrow \nu_1 = \nu_0\frac{L_0}{L_1} = 256 \times \frac{60}{15} = 1024\ Hz.$$

6. **(c)** $m \times 10 = 2 \times 3 \times 10^{-2} \times \frac{10}{100}$

or $m = 6 \times 10^{-4}\,kg = 6 \times 10^{-4} \times 10^3\,g = 0.6\,g$

7. **(b)** Let the mass per unit area be σ. Then the mass of the complete disc



$= \sigma[\pi(2R)^2] = 4\pi\sigma R^2$

The mass of the removed disc $= \sigma(\pi R^2) = \pi\sigma R^2$

Let us consider the above situation to be a complete disc of radius 2R on which a disc of radius R of negative mass is superimposed. Let O be the origin. Then the above figure can be redrawn keeping in mind the concept of centre of mass as :

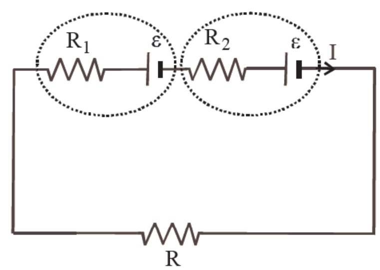
$$\underset{O}{4\pi\sigma R^2} \xleftrightarrow{\;R\;} \pi\sigma R^2$$

$$X_{c.m} = \frac{(4\pi\sigma R^2) \times 0 + (-\pi\sigma R^2)R}{4\pi\sigma R^2 - \pi\sigma R^2}$$

$$\therefore\ x_{c.m} = \frac{-\pi\sigma R^2 \times R}{3\pi\sigma R^2}$$

$$\therefore\ x_{c.m} = -\frac{R}{3} \Rightarrow \alpha = \frac{1}{3}$$

8. **(c)** $I = \frac{2\varepsilon}{R + R_1 + R_2}$



Pot. difference across second cell

$= V = \varepsilon - IR_2 = 0$

$$\varepsilon = \frac{2\varepsilon}{R + R_1 + R_2}.R_2 = 0$$

$R + R_1 + R_2 - 2R_2 = 0$

$R + R_1 - R_2 = 0 \qquad \therefore\ R = R_2 - R_1$

9. **(c)**

As the sphere floats in the liquid. Therefore its weight will be equal to the upthrust force on it

Weight of sphere = $\frac{4}{3}\pi R^3 \rho g$ ...(i)

Upthrust due to oil and mercury

$$= \frac{2}{3}\pi R^3 \times \sigma_{oil} g + \frac{2}{3}\pi R^3 \sigma_{Hg} g \quad \text{...(ii)}$$

Equating (i) and (ii)

$$\frac{4}{3}\pi R^3 \rho g = \frac{2}{3}\pi R^3 0.8g + \frac{2}{3}\pi R^3 + 13.6g$$

$$\Rightarrow 2\rho = 0.8 + 13.6 = 14.4 \Rightarrow \rho = 7.2$$

10. **(a)** $B = \frac{\mu_0 I}{2r} \times \frac{\theta}{2\pi} = \frac{\mu_0 I\theta}{4\pi r}$

11. **(c)** $P_c = \frac{P_t}{1 + \frac{m_a^2}{2}} = \frac{12}{1 + \frac{(0.5)^2}{2}} = \frac{12}{1.25} = 9.6 \text{ kW}$

12. **(d)** $\nu' = \nu\left(\frac{v + v_D}{v - v_S}\right)$

Here, $\nu = 600$ Hz, $v_D = 15$ m/s
$v_s = 20$ m/s, $v = 340$ m/s

$\therefore \quad \nu' = 600\left(\frac{355}{320}\right) \approx 666$ Hz

13. **(a)** Potential at the given point = Potential at the point due to the shell + Potential due to the particle

$$= -\frac{GM}{a} - \frac{2GM}{a} = -\frac{3GM}{a}$$

14. **(a)** In $x = A\cos\omega t$, the particle starts oscillating from extreme position. So at $t = 0$, its potential energy is maximum.

15. **(c)** The electron moves with constant velocity without deflection. Hence, force due to magnetic field is equal and opposite to force due to electric field.

$$qvB = qE \Rightarrow v = \frac{E}{B} = \frac{20}{0.5} = 40 \text{ m/s}$$

16. **(a)** $T = 2\pi\sqrt{\left(\frac{I}{MB_H}\right)}$

$$T' = 2\pi\sqrt{\left(\frac{I}{4MB_H}\right)} = \frac{1}{2}\left[2\pi\sqrt{\frac{I}{(MB_H)}}\right]$$

$$= \frac{1}{2} \times 2 = 1 \text{ second.}$$

17. **(b)** Current in the circuit,

$$I = \frac{\varepsilon}{R + r}$$

Potential difference across R,

$$V = IR = \left(\frac{\varepsilon}{R + r}\right)R = \frac{\varepsilon}{1 + \frac{r}{R}}$$

When $R = 0$, $V = 0$
$R = \infty$, $V = \varepsilon$

18. **(d)** $\lambda_{IR} > \lambda_{UV}$ also wavelength of emitted radiation $\lambda \propto \frac{1}{\Delta E}$.

19. **(d)** For stress to be equal, $\frac{T_1}{A_1} = \frac{T_2}{A_2}$

$\therefore \quad \frac{T_1}{T_2} = \frac{A_1}{A_2} = \frac{1}{2}$

20. **(b)** $|\vec{A} + \vec{B}| = \sqrt{A^2 + B^2 + 2AB\cos 120°}$ $(\theta = 120°)$

$$= \sqrt{A^2 + B^2 + \cancel{2}AB\left(\frac{-1}{\cancel{2}}\right)} \left(\cos 120° = -\frac{1}{2}\right)$$

$$= \sqrt{A^2 + B^2 - A(A)} = \sqrt{B^2} = B \quad (\because A = B)$$

21. **(d)** It is a one of Fraunhoffer diffraction from single slit. so for bright fringe where a is the width of slit.

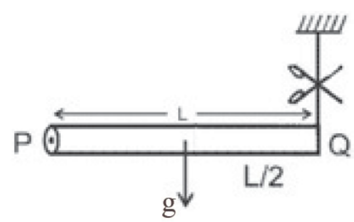
$$a\sin\theta = (2n + 1)\frac{\lambda}{2}$$

$$\lambda = \frac{2a\sin\theta}{2n + 1} = \frac{2 \times 1.2 \times 10^{-5} \times 0.0906}{2 \times 1 + 1} = 7248\text{Å}.$$

22. **(c)** $\mu = \frac{F}{R} = \frac{mg\sin\alpha}{mg\cos\alpha} = \tan\alpha$

23. **(d)** $\frac{H_1}{H_2} = \frac{u^2\sin^2\theta/2g}{u^2\sin^2(90° - \theta)/2g} = \tan^2\theta$

24. **(d)**



angular acceleration $\alpha = \frac{3g}{2L}$

25. **(c)** We know that $\frac{Q^2}{2C}$ is energy of capacitor, so it represent the dimension of energy $= [ML^2T^{-2}]$.

26. **(c)** Power gain = voltage gain × current gain

$= V_G \cdot I_G = \frac{V_0}{V_i} \cdot \frac{I_0}{I_i}$

$= \frac{V_0^2}{V_i^2} \cdot \frac{R_i}{R_0} = 50 \times 50 \times \frac{100}{200} = 1250$

27. **(c)** Due to volume expansion of both mercury and flask, the change in volume of mercury relative to flask is given by

$\Delta V = V_0\left[\gamma_L - \gamma_g\right]\Delta\theta = V\left[\gamma_L - 3\alpha_g\right]\Delta\theta$

$= 50\,[\,180 \times 10^{-6} - 3 \times 9 \times 10^{-6}]\,(38 - 18)$

$= 0.153$ cc

28. **(a)** With the increase in temperature, the surface tension of liquid decreases and angle of contact also decreases.

29. **(b)** $i = \frac{A + \delta_m}{2} = \frac{60 + 30}{2} = 45^\circ$

30. **(c)** $\frac{(v_e)_p}{(v_e)_e} = \frac{\sqrt{\frac{2GM_p}{R_p}}}{\sqrt{\frac{2GM_e}{R_e}}} = \sqrt{\frac{M_p}{M_e} \times \frac{R_e}{R_p}}$

$= \sqrt{\frac{10M_e}{M_e} \times \frac{R_e}{R_e/10}} = 10$

$\therefore$ $(v_e)_p = 10 \times (v_e)_e = 10 \times 11 = 110$ *km/s*

31. **(b)** Fringe width $\beta = \frac{\lambda D}{d}$

32. **(b)** According to Einsten's photoelectric effect, the K.E. of the radiated electrons

$K.E_{max} = E - W$

$\frac{1}{2}mv_1^2 = (1 - 0.5)$ eV $= 0.5$ eV

$\frac{1}{2}mv_2^2 = (2.5 - 0.5)$ eV $= 2$ eV

$\frac{v_1}{v_2} = \sqrt{\frac{0.5}{2}} = \frac{1}{\sqrt{4}} = \frac{1}{2}$

33. **(a)** $\frac{E_0}{B_0} = c \cdot$ also $k = \frac{2\pi}{\lambda}$ and $\omega = 2\pi v$

These relation gives $E_0 k = B_0 \omega$

34. **(b)** Here, $R_g = 100\,\Omega$; $I_g = 10^{-5}$ A; I = 1A; S = ?

$S = \frac{I_g R_g}{\mathbf{I} - \mathbf{I}_g} = \frac{10^{-5} \times 100}{1 - 10^{-5}} = 10^{-3}\,\Omega$ in parallel

35. **(b)** Terminal velocity, $v_0 = \frac{2\,r^2(\rho - \rho_0)g}{9\eta}$

$= \frac{2 \times (2 \times 10^{-3})^2 \times (8 - 1.3) \times 10^3 \times 9.8}{9 \times 0.83}$

$= 0.07\ \text{ms}^{-1}$

36. **(d)** $T_2 = 7°C = (7 + 273) = 280$ K

$\eta = 1 - \frac{T_2}{T_1} \Rightarrow \frac{T_2}{T_1} = 1 - \eta$

$= 1 - \frac{50}{100} = \frac{50}{100} = \frac{1}{2}$

$\therefore$ $T_1 = 2 \times T_2 = 2 \times 280 = 560$ K

New efficiency, $\eta' = 70\%$

$\therefore$ $\frac{T_2}{T_1} = 1 - \eta' = 1 - \frac{70}{100} = \frac{30}{100} = \frac{3}{10}$

$\therefore$ $T_1{}' = \frac{10}{3} \times 280 = \frac{2800}{3} = 933.3\,K$

$\therefore$ Increase in the temperature of high temp. reservoir = 933.3 – 560 = 373.3 K = 380 K

37. **(c)** As m would slip in vertically downward direction, then

$mg = \mu N$

$\Rightarrow$ $N = \frac{mg}{\mu} = \frac{100}{0.5} = 200$ Newton

Same normal force would accelerated M,

thus $a_M = \frac{200}{50} = 4\ \text{m/s}^2$

Taking $m + M$ as system

$F = (m + M)\,4 = 240$ N

38. **(c)** $\frac{\Delta P}{P} \times 100 = \frac{\Delta F}{F} \times 100 + 2\frac{\Delta \ell}{\ell} \times 100$

$= 6\% + 2 \times 3\%$

39. **(a)** Here, $u = 0$; $a = \frac{eE}{m}$; $v = ?$; $t = t$

$\therefore$ $v = u + at = 0 + \frac{eE}{m}t$

de-Broglie wavelength,

$\lambda = \frac{h}{mv} = \frac{h}{m(eEt/m)} = \frac{h}{eEt}$

Rate of change of de-Broglie wavelength

$\frac{d\lambda}{dt} = \frac{h}{eE}\left(-\frac{1}{t^2}\right) = \frac{-h}{eEt^2}$

40. **(b)** $R_1 = 60$ cm, $R_2 = \infty$, $\mu = 1.6$

$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = (1.6 - 1)\left(\frac{1}{60}\right) \Rightarrow f = 100$ cm.

41. **(c)** The tension T_1 at the topmost point is given by

$T_1 = \frac{mv_1^2}{20} - mg$

Centrifugal force acting outward while weight acting downward.
The tension T_2 at the lowest point

$$T_2 = \frac{m v_2^2}{20} + m g$$

Centrifugal force and weight (both) acting downward

$$T_2 - T_1 = \frac{m v_2^2 - m v_1^2}{20} + 2 m g$$

$$v_1^2 = v_2^2 - 2gh \text{ or } v_2^2 - v_1^2 = 2g(40) = 80g$$

$$\therefore \quad T_2 - T_1 = \frac{80 m g}{20} + 2 m g = 6 m g$$

42. **(d)** Mutual inductance between two coil in the same plane with their centers coinciding is given by

$$M = \frac{\mu_0}{4\pi}\left(\frac{2\pi^2 R_2^2 N_1 N_2}{R_1}\right) henry.$$

43. **(c)** $[x] = [bt^2]$. Hence $[b] = [x/t^2] = km/s^2$

44. **(b)** $3 \times \frac{v}{4l_c} = 4 \times \frac{v}{2l_0}$ or $\frac{l_c}{l_0} = \frac{3v}{4} \times \frac{2}{4v} = \frac{3}{8}$

45. **(b)** $\frac{n_1 + n_2}{\gamma - 1} = \frac{n_1}{\gamma_1 - 1} + \frac{n_2}{\gamma_2 - 1}$

or $\frac{2}{\gamma - 1} = \frac{1}{\frac{5}{3} - 1} + \frac{1}{\frac{7}{5} - 1}$

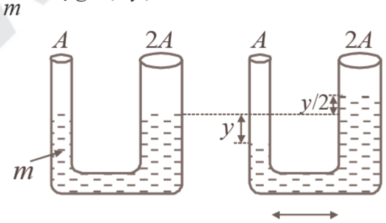
$\therefore \quad \gamma = \frac{3}{2}$.

46. **(d)** At resonance $\omega L = 1/\omega C$
and $i = E/R$, So power dissipated in circuit is $P = i^2 R$.

47. **(a)** Suppose the liquid in left side limb is displaced slightly by y, the liquid in right limb will increase by $y/2$.
The restoring force

$$F = -PA$$
$$= -\rho g\left(\frac{3y}{2}\right) \times 2A = 3\rho g A(-y).$$

$$a = \frac{F}{m} = 3\rho g A(-y)/m$$



On comparing with, $a = -\omega^2 y$, we get

$$\omega = \sqrt{\frac{3\rho g A}{m}} \text{ and } T = 2\pi\sqrt{\frac{m}{3\rho g A}}$$

48. **(d)** Let 'n' such capacitors are in series and such 'm' such branch are in parallel.

$\therefore \quad 250 \times n = 1000 \quad \therefore \quad n = 4 \quad \ldots(i)$

Also $\frac{8}{n} \times m = 16 \Rightarrow m = \frac{16 \times n}{8} = 8 \quad \ldots(ii)$

$\therefore$ No. of capacitor $= 8 \times 4 = 32$

49. **(a)** Distance of closest approach

$$r_0 = \frac{Ze(2e)}{4\pi\varepsilon_0\left(\frac{1}{2}mv^2\right)}$$

Energy, $E = 5 \times 10^6 \times 1.6 \times 10^{-19}$ J

$$\therefore r_0 = \frac{9 \times 10^9 \times (92 \times 1.6 \times 10^{-19})(2 \times 1.6 \times 10^{-19})}{5 \times 10^6 \times 1.6 \times 10^{-19}}$$

$\Rightarrow r = 5.2 \times 10^{-14}\, m = 5.3 \times 10^{-12}$ cm.

50. **(d)** $\tau = MB \sin\theta \Rightarrow \tau_{max} = NiAB, \; [\theta = 90°]$

CHEMISTRY

51. **(a)** $4KO_2 + 2CO_2 \rightarrow 2K_2CO_3 + 3O_2$.
KO_2 is used as an oxidising agent. It is used as air purifier in space capsules. Submarines and breathing masks as it **produces oxygen** and **remove carbon dioxide**.

52. **(a)** Bactericidal are the drugs that kills bacteria. Ofloxacin works by stopping the growth of bacteria. This antibiotic treats only bacterial infections.

53. **(b)** $\Delta U = q + w$
$= 10 \times 1000 - 2 \times (20) \times 101.3 = 5948$ J

54. **(a)** $m = \frac{E \times i \times t}{96500}$; $2 = \frac{31.75 \times .5 \times t}{96500}$,

$\therefore \quad t = 12157.48$ sec.

55. **(d)** Aldol condensation is given by only those aldehydes or ketones which have α-hydrogen atom on a saturated carbon; α-H present on unsaturated carbon atom cannot be easily removed by a base.

56. **(d)** For a *fcc* unit cell

$$r = \frac{\sqrt{2}a}{4}$$

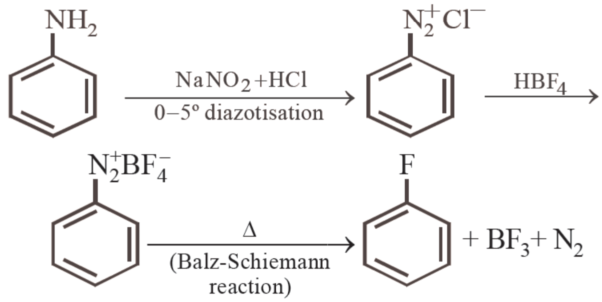
$$a = \frac{4r}{\sqrt{2}} = 2\sqrt{2} \times 0.14 = 0.39 \approx 0.4 \text{ nm.}$$

57. **(b)** $PV = RT, PV = \frac{w}{M}RT$,

$$20P = \frac{120}{40} \times .0821 \times 400$$

or $\quad P = 4.92$ atm

58. (d)



59. (b) Benzoic acid is used as preservative as sodium benzoate.

60. (a) Only 1° aromatic amines undergo coupling reactions to form a dye.

61. (c) $H_2^+ : \sigma 1s^1 \quad \therefore \text{ B.O.} = \frac{1}{2}(1-0) = \frac{1}{2}$

$H_2^- : \sigma 1s^2 \sigma^* 1s^1 \quad \therefore \text{ B.O.} = \frac{1}{2}(2-1) = \frac{1}{2}$

Even though the bond order of H_2^+ and H_2^- are equal but H_2^+ is more stable than H_2^- as in the latter, one electron is present in the antibonding ($\sigma * 1s$) orbital of higher energy.

62. (b) Moles of glucose $= \frac{18}{180} = 0.1$

Moles of water $= \frac{178.2}{18} = 9.9$

Total moles $= 0.1 + 9.9 = 10$

p_{H_2O} = Mole fraction × total pressure

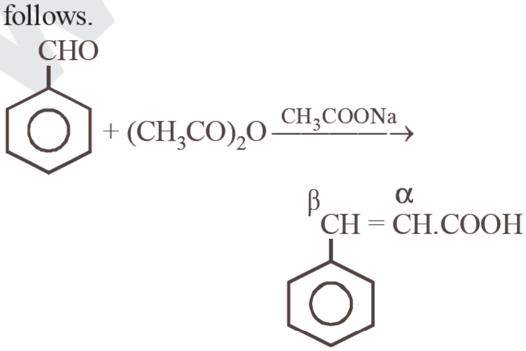
$= \frac{9.9}{10} \times 760$

$= 752.4$ Torr

63. (c) CO_2, SiO_2 are acidic, CaO is basic and SnO_2 is amphoteric.

64. (a) Since concentration of ions is the same hence $E_{cell} = E^\circ_{cell}$

65. (b) Benzaldehyde forms cinnamic acid as follows.



Cinnamic acid

66. (a) $[Fe(H_2O)_5NO]SO_4$

Let O.N. of Fe be x then,

$1 \times (x) + 5 \times (0) + 1 \times (+1) + 1 \times (-2) = 0$

$\therefore \quad x = +1$

67. (b)

$$C_4H_8 \xleftarrow[(-H_2O)]{\text{Conc.} H_2SO_4} C_4H_{10}O \xrightarrow{\text{Oxidation}} C_4H_8O \ (R-COCH_3)$$

Thus C_4H_8O should be $CH_3CH_2COCH_3$, hence $C_4H_{10}O$ should be $CH_3CH_2CHOHCH_3$

68. (b) The required equation is

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + \underset{\text{nascent oxygen}}{5[O]}$$

$$2Fe(C_2O_4) + 3H_2SO_4 + 3[O] \longrightarrow Fe_2(SO_4)_3 + 2CO_2 + 3H_2O$$

O required for 1 mol. of $Fe(C_2O_4)$ is 1.5, 5O are obtained from 2 moles of $KMnO_4$

$\therefore$ 1.5 [O] will be obtained from $= \frac{2}{5} \times 1.5 = 0.6$ moles of $KMnO_4$.

69. (c) This reaction occurs according to Markownikoff's rule which states that when an unsymmetrical alkene undergo hydrohalogenation, the negative part goes to that C-atom which contain lesser no. of H-atom.

$$CH_3-CH_2-C\equiv CH + HCl \longrightarrow CH_3-CH_2-\underset{\underset{Cl}{|}}{C}=CH_2$$

$$\xrightarrow{HI} CH_3-CH_2-\overset{\overset{I}{|}}{\underset{\underset{Cl}{|}}{C}}-CH_3$$

70. (a) $\frac{0.80-0.6}{0.80} = x_B; \ x_B = 0.25$

71. (c) MgO being high melting does not catch fire and hence protects the cooker against fire.

72. (d) $K_2Cr_2O_7 + \text{conc.} HCl \rightarrow Cl_2$

73. (a) Maximum lowering of vapour pressure will be given by the substance which give maximum number of particles in solution.

74. (d) Positive charge ↑; coagulating power ↑ so, $MgCl_2$ will be most effective.

75. (a) No compound of Ar has yet been reported with F_2.

76. (b) Oxygen being more electronegative, will be best oxidising agent among given options.

77. (c) $t_{1/2}$ is independent of initial concentration.

$\therefore \quad t_{1/2} \propto a^o$.

78. **(b)** $\Delta G = \Delta H - T\Delta S$
$= -382.64 + (298 \times 145.6 \times 10^{-3})$
$= -339.3 \text{ kJ mol}^{-1}$

79. **(c)** Polythene is a linear polymer.

80. **(b)** Since silica is acidic impurity the flux must be basic.
$CaO + SiO_2 \rightarrow CaSiO_3$

81. **(d)** $A \longrightarrow B, \Delta H = -10 \text{ kJ mol}^{-1}$
It is an exothermic reaction,
$E_{a(b)} = E_{a(f)} - (\Delta H)$
$= 50 - (-10) = 60 \text{ kJ}$

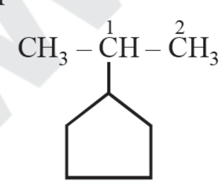
82. **(b)** Cl^- is oxidised to Cl_2 at anode.

83. **(b)** Density = 1.17 g/cc(Given)
As $d = \dfrac{\text{Mass}}{\text{Volume}}$
Volume = 1cc $\quad\therefore$ Mass = d = 1.17g
$\text{Molarity} = \dfrac{\text{No. of moles}}{\text{Volume in litre}} = \dfrac{1.17 \times 1000}{36.5 \times 1}$
$= \dfrac{1170}{36.5} = 32.05\text{M}$

84. **(d)** $LiHCO_3$ is unstable and exists only in solution.

85. **(d)** P_2O_5 have great affinity for water, so the final product will be orthophosphoric acid.
$P_4O_{10} \xrightarrow{2H_2O} 4HPO_3$ (Metaphosphoric acid)
$4HPO_3 \xrightarrow{2H_2O} 2H_4P_2O_7$ (Pyrophosphoric acid)
$2H_4P_2O_7 \xrightarrow{2H_2O} 4H_3PO_4$ (orthophosphoric acid)

86. **(c)** The cyclic portion contains more C-atoms than acyclic portion. Hence it is derivative of cyclopentane



1-(1-methyl)ethyl cyclopentane

87. **(a)** $2RCOOK \xrightarrow[\text{oxidation}]{\text{Electrolytic}} \underset{\text{Anode}}{2RCOO^-} + \underset{\text{Cathode}}{2K^+}$
At anode $\quad 2RCOO^- \rightarrow 2RCOO^\bullet + 2e^-$
$2RCOO^\bullet \rightarrow R{-}R + 2CO_2$
At cathode $\quad 2K^+ + 2e^- \rightarrow 2K$
$2K + H_2O \rightarrow 2KOH + H_2\uparrow$

88. **(c)** The lesser the electronegativity of halogen in NX_3 the more is the basic character. N can donate more electrons in that case.

89. **(d)** Both drugs are used as antacids.

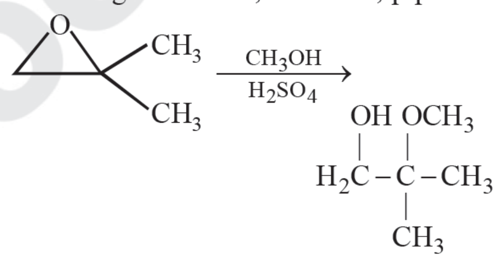
90. **(d)** Since sucrose is dextrorotatory while hydrolysis product of sucrose, having equimolar mixture of glucose and fructose, is laevorotatory. Hence the hydrolysed product of sucrose is known as invert sugar and the hydrolysis of sucrose is known as inversion.

91. **(a)** This method is very useful for removing all the oxygen and nitrogen present in the from of impurity in certain metals like Zr & Ti.
$Ti + 2I_2 \xrightarrow{523K} \underset{\text{Volatile stable compound}}{TiI_4} \xrightarrow{1700K} \underset{\text{Pure metal}}{Ti} + 2I_2$

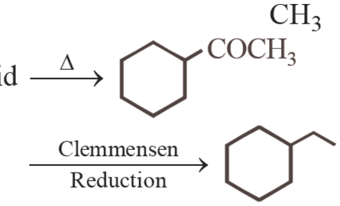
92. **(c)** $K_2Cr_2O_7 + 3SO_2 + 4H_2SO_4 \rightarrow$
$K_2SO_4 + Cr_2(SO_4)_3 + 3SO_3 + 4H_2O$
O.N.of chrominum changes from +6 to +3

93. **(b)** High density polythene is used for manufacturing of buckets, dustbins, pipes etc.

94. **(a)**



95. **(b)** β-keto acid



96. **(c)** $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$ are ionisation isomers

97. **(b)** In lanthanides, there is poorer shielding of $5d$ electrons by $4f$ electrons resulting in greater attraction of the nucleus over $5d$ electrons and contraction of the atomic radii.

98. **(a)** SARAN, a polymer of vinyl chloride ($CH_2{=}CHCl$) and vinylidene chloride, is used for making synthetic hair wigs.

99. **(a)** Wilkinson's catalyst in $[RhCl(PPh_3)_3]$, red-violet in colour and has square planar structure. It is used for selective hydrogenation of organic molecules at room temperature and pressure.
$TiCl_4 + (C_2H_5)_3Al$ is Zeigler Natta catalyst.
$(C_2H_5)_4Pb$ is an anti-knocking agent.
cis-platin is used as an anti-cancer agent.

100. **(a)** Work done during adiabatic expansion
$= C_v(T_2 - T_1)$
or $\quad -3000 = 20(T_2 - 300) \Rightarrow T_2 = 150K$

SECTION-B

MATHEMATICS

1. **(c)** We define the following events :
A_1 : He know the answer
A_2 : He does not know the answer
E : He gets the correct answer
Then, $P(A_1) = 9/10, P(A_2) = 1 - 9/10 = 1/10, P(E/A_1) = 1, P(E/A_2) = 1/4$.
Therefore, the required probability is

$$P(A_2 / E) = \frac{P(A_2)P(E/A_2)}{P(A_1)P(E/A_1) + P(A_2)P(E/A_2)}$$

$$= \frac{\frac{1}{10} \times \frac{1}{4}}{\frac{9}{10} \times 1 + \frac{1}{10} \times \frac{1}{4}} = \frac{1}{37}.$$

2. **(b)** $\frac{\pi}{2} < x < \pi$ then

$$\sqrt{\frac{1+\cos 2x}{2}} = |\cos x| = -\cos x$$

$$\therefore \quad \int x\sqrt{\frac{1+\cos 2x}{2}}dx = -\int x \cos x dx$$

$$= -[x \sin x + \cos x] + c$$

3. **(c)** $A = (x_2 - x_1)y$

$y = 3x_1$ and $y = 30 - 2x_2$

$$A(y) = \left(\frac{30-y}{2} - \frac{y}{3}\right)y$$

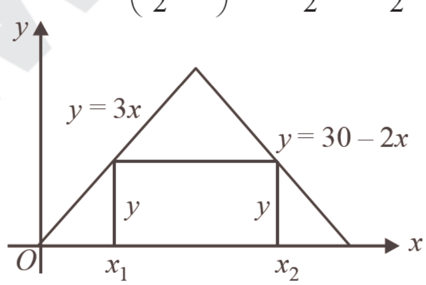
$$6A(y) = (90 - 3y - 2y)y = 90y - 5y^2$$

$$6A'(y) = 90 - 10y = 0$$

$$\Rightarrow y = 9;\ A''(y) = -10 < 0$$

$$x_1 = 3;\ x_2 = 21/2$$

$$\Rightarrow A_{max} = \left(\frac{21}{2} - 3\right)9 = \frac{15 \times 9}{2} = \frac{135}{2}$$



4. **(d)** We have $f(x) = 4x^3 - 7,\ x \in R$.
f is one-one. Let $x_1, x_2 \in R$ and $f(x_1) = f(x_2)$.

$$\Rightarrow 4x_1^3 - 7 = 4x_2^3 - 7 \quad \Rightarrow 4x_1^3 = 4x_2^3$$

$$\Rightarrow \ x_1^3 = x_2^3 \ \Rightarrow x_1^3 - x_2^3 = 0.$$

$$\Rightarrow (x_1 - x_2)(x_1^2 + x_1x_2 + x_2^2) = 0.$$

$$\Rightarrow (x_1 - x_2)\left[\left(x_1 + \frac{x_2}{2}\right)^2 + \frac{3x_2^2}{4}\right] = 0.$$

$\Rightarrow x_1 - x_2 = 0$, because the other factor is non-zero.
$\Rightarrow x_1 = x_2$ $\quad \therefore$ f is one-one.
f is onto. Let $k \in R$ any real number.

$$f(x) = k \Rightarrow 4x^3 - 7 = k \ \Rightarrow \ x = \left(\frac{k+7}{4}\right)^{1/3}$$

Now $\left(\frac{k+7}{4}\right)^{1/3} \in R$, because $k \in R$ and

$$f\left[\left(\frac{k+7}{4}\right)^{1/3}\right] = 4\left[\left(\frac{k+7}{4}\right)^{1/3}\right]^3 - 7$$

$$= 4\left(\frac{k+7}{4}\right) - 7 = k$$

$\therefore$ k is the image of $\left(\frac{k+7}{4}\right)^{1/3}$

$\therefore$ f is onto.
$\therefore$ f is a bijective function.

5. **(a)** $\sim((\sim p) \wedge q) \equiv \sim(\sim p) \vee \sim q \equiv p \vee (\sim q)$

6. **(c)** $I = \int_1^2 [x^2]dx - \int_1^2 [x]^2 dx$

$$= \int_1^{\sqrt{2}} dx + \int_{\sqrt{2}}^{\sqrt{3}} 2\ dx + \int_{\sqrt{3}}^{2} 3\,dx - \int_1^2 1\,dx$$

$$= 4 - \sqrt{2} - \sqrt{3}$$

7. **(c)** $x(1+y^2)^{1/2}dx + y(1+x^2)^{1/2}dy = 0$

$$\Rightarrow \quad \frac{xdx}{(1+x^2)^{1/2}} + \frac{ydy}{(1+y^2)^{1/2}} = 0$$

Integrating we get

$2\sqrt{1+x^2} + 2\sqrt{1+y^2} = 2c$ or

$$(1+x^2)^{1/2} + (1+y^2)^{1/2} = c$$

8. **(c)** $A^2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I_3$

9. **(b)** Let D (x, y, z) be the required point, Then, the mid-point of diagonal BD is

$$\left(\frac{x+1}{2}, \frac{y+2}{2}, \frac{z-4}{2}\right)$$

Also, the mid-point of diagonal AC is

$\left(\frac{3-1}{2}, \frac{-1+1}{2}, \frac{2+2}{2}\right)$ i.e., (1,0, 2).

But, the mid-points of the diagonals of a parallelogram always coincide.

$\therefore \frac{x+1}{2}=1, \frac{y+2}{2}=0$ and $\frac{z-4}{2}=2$

So, x = 1, y = –2, and z = 8.

Hence, the required point is D(1, –2, 8).

10. **(d)** $\int \frac{\sin x+\cos x}{\sqrt{1-\sin 2x}} dx$

$= \pm \int \frac{\sin x+\cos x}{\sin x-\cos x} dx = \pm \log(\sin x-\cos x)+c$

11. **(c)** Any plane containing $\frac{x+1}{-3} = \frac{y-3}{2} = \frac{z+2}{1}$ is

$a(x+1)+b(y-3)+c(z+2)=0$ ... (i)

where $-3a+2b+c=0$ ... (ii)

If the plane passes through (0, 7, – 7).

$\therefore \quad a+4b-5c=0$ ... (iii)

From Eqs. (ii) and (iii),

$$\frac{a}{-10-4} = \frac{b}{1-15} = \frac{c}{-12-2}$$

$\Rightarrow \quad \frac{a}{1} = \frac{b}{1} = \frac{c}{1}$

Therefore, the plane (i) becomes

$(x+1)+(y-3)+(z+2)=0$

$\Rightarrow \quad x+y+z=0$

12. **(a)** The equations of line BC are (using two point form)

$\frac{x-1}{5-1} = \frac{y-4}{4-4} = \frac{z-6}{4-6}$ i.e.,

$\frac{x-1}{2} = \frac{y-4}{0} = \frac{z-6}{-1}$

Any point on this line is (2t + 1, 4, –t + 6). If this is the foot of perpendicular from A on the line BC, then d.n. of this perpendicular are

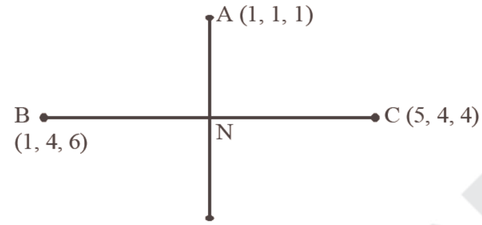
$< 2t+1-1, 4-1, -t+6-1 >$ i.e. $< 2t, 3, -t+5 >$

Using condition of perpendicularity, we have

$(2t)(2)+3\times 0+(-t+5)(-1)=0$

$\Rightarrow 5t-5=0 \Rightarrow t=1.$

$\therefore$ Required foot of perpendicular is $(2+1, 4, -1+6) = (3, 4, 5)$.



13. **(b)** $(p \wedge \sim q) \wedge (\sim p \wedge q) = (p \wedge \sim q) \wedge (\sim q \wedge q)$

$= f \wedge f = f$

(By using associative laws and commutative laws)

$\therefore (p \wedge \sim q) \wedge (\sim p \wedge q)$ is a contradiction.

14. **(b)** $2^m = 2^n + 56$

$\Rightarrow 2^m - 2^n = 64 - 8 = 2^6 - 2^3$

15. **(d)** For $x < 1$, $f(x) = \frac{x^2-1}{x^2+2x-3} = \frac{x+1}{x+3}$

$\therefore \lim_{x\to 1^-} f(x) = \frac{1}{2}$

For $x > 1$, $f(x) = \frac{x^2-1}{x^2-2x+1} = \frac{x+1}{x-1}$

$\therefore \lim_{x\to 1^+} f(x) = \infty$

$\therefore$ The function is not continuous at x = 1.

16. **(a)** Equation of the line through (1, – 2, 3) parallel to the line $\frac{x}{2} = \frac{y}{3} = \frac{z-1}{-6}$ is

$\frac{x-1}{2} = \frac{y+2}{3} = \frac{z-3}{-6} = r$ (say) ... (i)

Then, any point on Eq. (i) is

$(2r+1, 3r-2, -6r+3)$.

If this point lies on the plane $x - y + z = 5$, then

$(2r+1)-(3r-2)+(-6r+3)=5$

$\Rightarrow \quad -7r+6=5 \Rightarrow r = \frac{1}{7}$

Since, the point is $\left(\frac{9}{7}, -\frac{11}{7}, \frac{15}{7}\right)$.

Distance between (1, – 2, 3) and $\left(\frac{9}{7}, -\frac{11}{7}, \frac{15}{7}\right)$

$= \sqrt{\left(\frac{4}{49}+\frac{9}{49}+\frac{36}{49}\right)} = \sqrt{\left(\frac{49}{49}\right)} = 1$

17. **(a)** $\int \frac{x+\sin x}{1+\cos x} dx = \int \frac{x+2\sin\frac{x}{2}\cos\frac{x}{2}}{2\cos^2\frac{x}{2}} dx$

$= \int \left[\frac{x}{2}\sec^2\frac{x}{2} + \tan\frac{x}{2}\right] dx$

$$= \int x \frac{1}{2} \sec^2 \frac{x}{2} dx + \int \tan \frac{x}{2} dx$$

$$= x \tan \frac{x}{2} - \int \tan \frac{x}{2} dx + \int \tan \frac{x}{2} dx + C$$

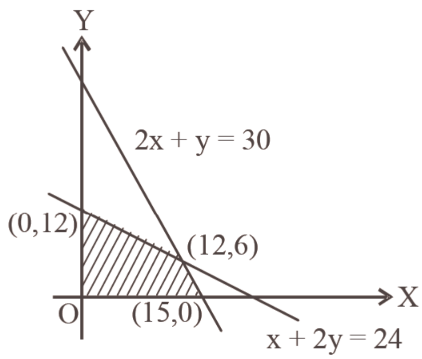
$$= x \tan \frac{x}{2} + C$$

18. **(b)** Here, $2x + y \le 30$, $x + 2y \le 24$, $x, y \ge 0$

The shaded region represents the feasible region, hence

$z = 6x + 8y$. Obviously it is maximum at (12, 6).

Hence $z = 12 \times 6 + 8 \times 6 = 120$



19. **(b)** In the interval $\frac{\pi}{3}$ to $\frac{\pi}{2}$, $[x] = 1$

$$\therefore I = \int_{\pi/3}^{\pi/2} x \sin(\pi - x)\, dx = \int_{\pi/3}^{\pi/2} x \sin x\, dx$$

$$= [-x \cos x + \sin x]_{\pi/3}^{\pi/2} = 1 - \frac{\sqrt{3}}{2} + \frac{\pi}{6}$$

20. **(b)** We write the given equation as

$$\tan\theta + \tan 4\theta = -\tan 7\theta(1 - \tan\theta \tan 4\theta)$$

$$\Rightarrow \tan(\theta + 4\theta) = -\tan 7\theta \Rightarrow \tan 5\theta = \tan(-7\theta)$$

$$\therefore 5\theta = n\pi + (-7\theta) \text{ or } 12\theta = n\pi$$

$$\therefore \theta = n\pi/12,\ n \in I$$

21. **(d)** We can write the given expression

$$= \{\hat{i}.(\vec{p} \times \vec{q})\}\hat{i} + \{\hat{j}.(\vec{p} \times \vec{q})\}\hat{j} + \{\hat{k}.(\vec{p} \times \vec{q})\}\hat{k}$$

$$= \vec{p} \times \vec{q}$$

Since for any vector $\vec{a}$,

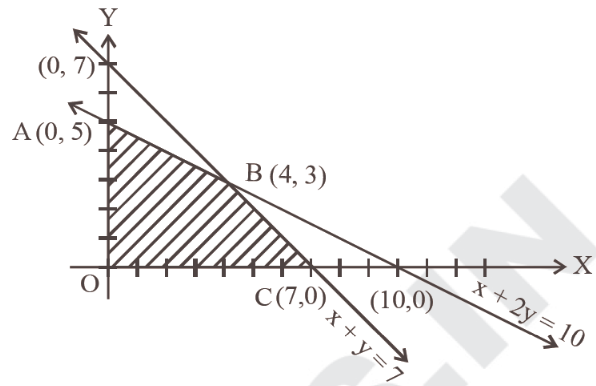
$$\vec{a} = (\vec{a}.\hat{i})\hat{i} + (\vec{a}.\hat{j})\hat{j} + (\vec{a}.\hat{k})\hat{k}$$

22. **(a)** $f(\theta) = \sin\theta(\sin\theta + \sin 3\theta)$

$= \sin\theta\,(2 \sin 2\theta \cos\theta)$

$= (2 \sin\theta \cos\theta) \sin 2\theta = (\sin 2\theta)^2 \ge 0 \ \forall\, \theta \in R$

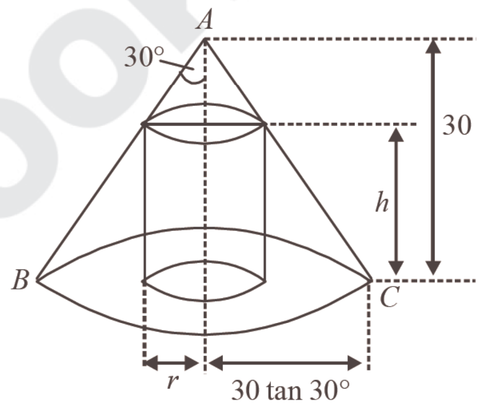
23. **(c)** Change the inequalities into equations and draw the graph of lines, thus we get the required feasible region as shown below.



The region bounded by the vertices A(0, 5), B(4, 3), C (7, 0).

The objective function is maximum at C(7, 0) and Max $z = 5 \times 7 + 2 \times 0 = 35$.

24. **(a)**



From geometry, we have $\frac{r}{30 \tan 30°} = \frac{30 - h}{30}$

or $h = 30 - \sqrt{3}r$

Now, the volume of cylinder,

$$V = \pi r^2 h = \pi r^2 (30 - \sqrt{3}r)$$

Now, let $\frac{dV}{dr} = 0$ or $\pi(60r - 3\sqrt{3}r^2) = 0$

or $r = \frac{20}{\sqrt{3}}$

Hence, $V_{max} = \pi\left(\frac{20}{\sqrt{3}}\right)^2 \left(30 - \sqrt{3}\frac{20}{\sqrt{3}}\right)$

$$= \pi \frac{400}{3} \times 10 = \frac{4000\pi}{3}$$

25. **(a)** Any plane through the given line

$2x - y + 3z + 1 + \lambda(x + y + z + 3) = 0$

(From $S + \lambda S' = 0$)

If this plane is parallel to the line $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$, then the normal to the plane is also perpendicular to the above line.

$\therefore \quad (2+\lambda)1+(\lambda-1)2+(3+\lambda)3=0$

$(\because l_1l_2+m_1m_2+n_1n_2=0)$

$\Rightarrow \quad \lambda=-\frac{3}{2}$

and the required plane is $x-5y+3z-7=0$.

26. **(c)** $|\vec{a}|=|\vec{b}|=|\vec{c}|=1$

$\vec{a}.\vec{b}=(1)(1)\cos\theta=\cos\theta$ and

$\vec{c}.\vec{a}=\cos\theta,\ \vec{b}.\vec{c}=\cos\theta$

$$[\vec{a}\,\vec{b}\,\vec{c}]^2=\begin{vmatrix}\vec{a}.\vec{a} & \vec{a}.\vec{b} & \vec{a}.\vec{c}\\ \vec{b}.\vec{a} & \vec{b}.\vec{b} & \vec{b}.\vec{c}\\ \vec{c}.\vec{a} & \vec{c}.\vec{b} & \vec{c}.\vec{c}\end{vmatrix}=\begin{vmatrix}1 & \cos\theta & \cos\theta\\ \cos\theta & 1 & \cos\theta\\ \cos\theta & \cos\theta & 1\end{vmatrix}$$

Operate $R_1\to R_1+R_2+R_3$

$$=(1+2\cos\theta)\begin{vmatrix}1 & 1 & 1\\ \cos\theta & 1 & \cos\theta\\ \cos\theta & \cos\theta & 1\end{vmatrix}$$

Operate $C_2\to C_2-C_1;\ C_3\to C_3-C_1$

$$=(1+2\cos\theta)\begin{vmatrix}1 & 0 & 0\\ \cos\theta & 1-\cos\theta & 0\\ \cos\theta & 0 & 1-\cos\theta\end{vmatrix}$$

$=(1+2\cos\theta)(1-\cos\theta)^2$

$\therefore [\vec{a}\ \vec{b}\ \vec{c}]=(1-\cos\theta)\sqrt{1+2\cos\theta}$

27. **(a)** $\sin 2x-\sin 4x+\sin 6x=0$

$\Rightarrow (\sin 2x+\sin 6x)-\sin 4x=0$

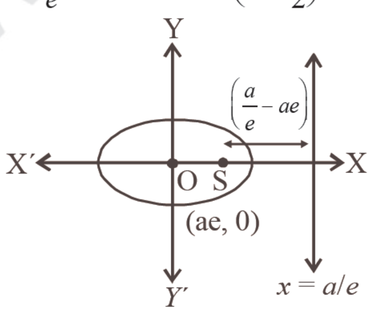
$\Rightarrow 2\sin 4x\cos 2x-\sin 4x=0$

$\sin 4x=0\Rightarrow 4x=n\pi\Rightarrow x=\frac{\pi}{4}$

$2\cos 2x-1=0\Rightarrow \cos 2x=\frac{1}{2}$

$\Rightarrow 2x=2n\pi\pm\frac{\pi}{3}$ *or* $x=n\pi\pm\frac{\pi}{6}$

28. **(a)** Perpendicular distance of directrix from focus $=\frac{a}{e}-ae=4 \Rightarrow a\left(2-\frac{1}{2}\right)=4 \Rightarrow a=\frac{8}{3}$



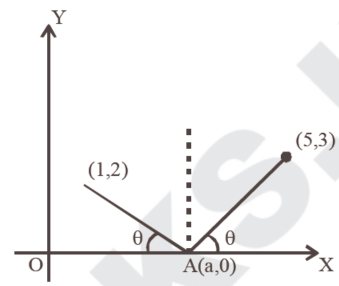
$\therefore$ Semi major axis $=8/3$

29. **(c)** For any point $P(x, y)$ that is equidistant from the given line, we have

$x+y-\sqrt{2}=-(x+y-2\sqrt{2})$

or $2x+2y-3\sqrt{2}=0$.

30. **(a)** Let the co-ordinates of A be (a, 0). Then the slope of the reflected ray is



$\frac{3-0}{5-a}=\tan\theta$ (say) ...(1)

Then the slope of the incident ray

$=\frac{2-0}{1-a}=\tan(\pi-\theta)$ ...(2)

from (1) and (2) $\quad \because \tan\theta+\tan(\pi-\theta)=0$

$\Rightarrow \frac{3}{5-a}+\frac{2}{1-a}=0\Rightarrow 3-3a+10-2a=0$

$\Rightarrow a=\frac{13}{5}$

Thus, the co-ordinates of A are $\left(\frac{13}{5},0\right)$.

31. **(c)** Let $x^2=\cos 2\theta\Rightarrow 0\le 2\theta<\frac{\pi}{2}$ $(\because x^2>0)$

The expression $=\tan^{-1}\left(\frac{\sqrt{2}\cos\theta+\sqrt{2}\sin\theta}{\sqrt{2}\cos\theta-\sqrt{2}\sin\theta}\right)$

$=\tan^{-1}\left(\frac{1+\tan\theta}{1-\tan\theta}\right)=\frac{\pi}{4}+\theta=\frac{\pi}{4}+\frac{1}{2}\cos^{-1}(x^2)$

32. **(d)** $y=x^{x^2}$, $\ln y=x^2\ln x$

$\frac{1}{y}\frac{dy}{dx}=2x\ln x+x^2.\frac{1}{x}=x(1+2\ln x)$

$\frac{dy}{dx}=x^{x^2}.x(1+2\ln x)=x^{x^2+1}(1+2\ln x)$

33. **(b)** $A+B=180°-C=90°$

$a=2R\sin A,\ b=2R\sin B,\ c=2R\sin C$

$\therefore \frac{a^2-b^2}{a^2+b^2}=\frac{\sin^2 A-\sin^2 B}{\sin^2 A+\sin^2 B}$

$=\frac{\sin(A+B)\sin(A-B)}{\sin^2 A+\sin^2(90°-A)}$ $[\because A+B=90°]$

$=\frac{\sin 90°\sin(A-B)}{\sin^2 A+\cos^2 A}=\sin(A-B)$

34. **(b)** From geometry, the sum of all internal angles $= (n-2)\times 180°$
where n is the number of sides of the polygon.

$\therefore \frac{n}{2}[2\times 120° + (n-1)\times 5°] = (n-2)\times 180°$

$\Rightarrow n^2 - 25n + 144 = 0 \Rightarrow (n-16)(n-9) = 0$

If n = 16 then the 16th internal angle $= 120° + (16-1)\times 5° = 195° > 180°$

$\therefore n \neq 16$. Hence n = 9

35. **(a)** $0.4096 = {}^5C_1 pq^4$

$0.2048 = {}^5C_2 p^2q^3$ where $p + q = 1$

$\Rightarrow \quad p = \frac{1}{5}, q = \frac{4}{5}$

Mean = np = 1

36. **(b)** $y = \sin^{-1}\frac{2x}{1+x^2} = \pi - 2\tan^{-1}x$, for $x > 1$

or $\frac{dy}{dx} = -\frac{2}{1+x^2}$

or $\left(\frac{dy}{dx}\right)_{x=\sqrt{3}} = -\frac{2}{1+3} = -\frac{1}{2}$

Also, when $x = \sqrt{3},\ y = \pi - 2\times\frac{\pi}{3} = \frac{\pi}{3}$

Hence, equation of tangent is

$y - \frac{\pi}{3} = -\frac{1}{2}(x - \sqrt{3})$.

37. **(c)** Desired probability $= P(A) + P(B) - 2P(A\cap B)$

and $P\left(\frac{A}{B}\right) = \frac{P(A\cap B)}{P(B)} = \frac{1}{2}$

38. **(a)** Put $\left(1+\frac{r}{\sqrt{2}}, 2+\frac{r}{\sqrt{2}}\right)$ in $x^2 + 4xy + y^2 = 0$,

we get $3r^2 + 9\sqrt{2}r + 13 = 0$ for which product of the roots is 13/3.

39. **(b)** $ay + x^2 = 7$, and $x^3 = y$ cuts orthogonally. Now

$\left(\frac{dy}{dx}\right) = -\frac{2x}{a}$ and $\left(\frac{dy}{dx}\right) = 3x^2$

or $\left[\left(-\frac{2x}{a}\right)(3x^2)\right]_{(1,\,1)} = -1$

or $-\frac{2}{a}\times 3 = -1$ or $a = 6$.

40. **(a)** $\cos\left[2\cos^{-1}x + \sin^{-1}x\right]$

$= \cos\left[\cos^{-1}x + \cos^{-1}x + \sin^{-1}x\right]$

$= \cos\left[\cos^{-1}x + \pi/2\right] = -\sin\cos^{-1}x$

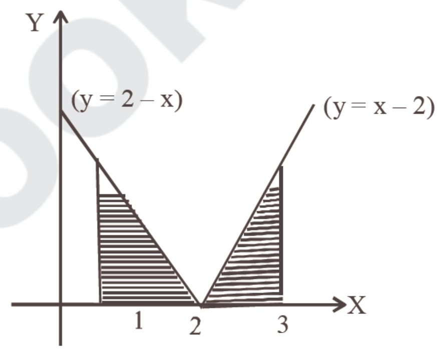
$= -\sin\sin^{-1}\sqrt{1-x^2} = -\sqrt{1-x^2}$

$= -\sqrt{1-\left(\frac{1}{5}\right)^2} = -\sqrt{\frac{24}{25}} = -\frac{2\sqrt{6}}{5}$

41. **(d)** Since $\sim(p \Rightarrow q) \equiv p \wedge \sim q$

$\sim(\sim p \Rightarrow q) = \sim p \wedge \sim q$

42. **(d)** The required area is shown by shaded region



Required Area

$A = \int_1^3 |x-2|dx = 2\int_2^3 (x-2)dx$

$= 2\left[\frac{x^2}{2} - 2x\right]_2^3 = 1$

43. **(c)** Given, $\frac{dy}{dx} = \frac{y}{x} - \cos^2\left(\frac{y}{x}\right)$

Putting y = vx so that $\frac{dy}{dx} = v + x\frac{dv}{dx}$

We get, $v + x\frac{dv}{dx} = v - \cos^2 v$

$\Rightarrow \frac{dv}{\cos^2 v} = -\frac{dx}{x} \Rightarrow \sec^2 v\, dv = -\frac{dx}{x}$

Integrating, we get, $\tan v = -\ln x + \ln c$

$\tan\left(\frac{y}{x}\right) = -\ln x + \ln c$

This passes through $\left(1, \frac{\pi}{4}\right) \Rightarrow \ln c = 1$

$\therefore y = x\tan^{-1}\left(\log\frac{e}{x}\right)$

44. **(a)** Putting n = 99 and p = $\frac{1}{2}$, we have (n + 1)p $= (100)\left(\frac{1}{2}\right) = 50$

so that the maximum value of P(X = r) occurs at r = (n + 1)p = 50 and at r = (n + 1)p–1 = 49

45. **(a)** Let the progression be a, a + d, a + 2d,

Then $x_4 = 3x_1 \Rightarrow a + 3d = 3a \Rightarrow 3d = 2a$ ...(i)

Again $x_7 = 2x_3 + 1$

$\Rightarrow a + 6d = 2(a + 2d) + 1 \Rightarrow 2d = a + 1$ ...(ii)

Solving (i) and (ii) we get

a = 3, d = 2

46. **(c)** The given equation reduces to

$\frac{(x-1)^2}{9} - \frac{y^2}{3} = 1$. Thus $a^2 = 9$, $b^2 = 3$

Using $b^2 = a^2(e^2 - 1)$, we get

$3 = 9(e^2 - 1) \Rightarrow e = \frac{2}{\sqrt{3}}$.

47. **(c)** $2yy_1 = 2c \Rightarrow c = yy_1$

Eliminating c, we get, $y^2 = 2yy_1(x + \sqrt{yy_1})$

or $(y^2 - 2x\ yy_1)^2 = 4y^3y_1^3$

It involves only 1st order derivative, its degree is 3 as y_1^3 is there.

48. **(a)** $f\{f[f(x)]\} = f\left[f\left(\frac{1}{1-x}\right)\right]$

$= f\left(\frac{1}{1-\frac{1}{1-x}}\right) = f\left(\frac{x-1}{x}\right)$

$\therefore$ f (x) is not defined for x = 1; $f\left(\frac{1}{1-x}\right)$ is not defined for x = 0.

$\therefore$ f {f [f(x)]} is discontinuous at x = 0 and 1

i.e., there are two points of discontinuity.

49. **(c)** It is given that $x = a(\cos t + t\sin t)$ and $y = (\sin t - t\cos t)$. Therefore,

$\frac{dx}{dt} = a[-\sin t + \sin t + t\cos t] = at\cos t$

$\frac{dy}{dt} = a[\cos t - \{\cos t - t\sin t\}] = at\sin t$

$\therefore \frac{dy}{dx} = \frac{\left(\frac{dy}{dt}\right)}{\left(\frac{dx}{dt}\right)} = \frac{at\sin t}{at\cos t} = \tan t$

Then, $\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$

$= \frac{d}{dx}(\tan t)$

$= \frac{d}{dt}(\tan t)\frac{dt}{dx}$

$= \sec^2 t \cdot \frac{dt}{dx} = \sec^2 t \cdot \frac{1}{at\cos t}$

$= \frac{\sec^3 t}{at}$

50. **(a)** The system is $0x_1 + x_2 - x_3 = 1$

$-x_1 + 0x_2 + 2x_3 = 2$

$x_1 - 2x_2 + 0x_3 = 3$

$\Rightarrow \begin{bmatrix} 0 & 1 & -1 \\ -1 & 0 & 2 \\ 1 & -2 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ or AX = B

Clearly $|A| = 0$

Now Adj A = $\begin{bmatrix} 4 & 2 & 2 \\ 2 & 1 & 1 \\ 2 & 1 & 1 \end{bmatrix}$

$\therefore$ (Adj A) B ≠ 0 ⇒ system is inconsistent

MHT-CET 2019

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  ***Section-A:** Physics & Chemistry - 50 Questions each and*
  ***Section-B:** Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. A sotne of mass 1 kg is tied to a string of length 2 m long and is rotated at constant speed of 40 ms^{-1} in a vertical circle. The ratio of the tension at the top and the bottom is [Take $g = 10\ ms^{-2}$]

(a) $\frac{81}{79}$ (b) $\frac{79}{81}$

(c) $\frac{19}{12}$ (d) $\frac{12}{19}$

2. Two coils have a mutual inductance of 0.01 H. The current in the first coil changes according to equation $I = 5 \sin 200\ \pi t$. The maximum value of e.m.f. induced in the second coil is

(a) 10π volt (b) 0.1π volt

(c) π volt (d) $0.01\ \pi$ volt

3. The radius of the earth and the radius of orbit around the sun are 6371 km and 149×10^6 km respectively. The order of magnitude of the diameter of the orbit is greater than that of earth by

(a) 10^3 (b) 10^2

(c) 10^4 (d) 10^5

4. Two open pipes of different lengths and of same diameter in which the air column vibrates with fundamental frequencies 'n_1' and 'n_2' respectively. When both pipes are joined to form a single pipe, its fundamental frequency will be

(a) $\frac{n_1 + n_2}{n_1 n_2}$ (b) $\frac{n_1 n_2}{2n_2 + n_1}$

(c) $\frac{2n_1 + n_2}{n_1 n_2}$ (d) $\frac{n_1 n_2}{n_1 + n_2}$

5. If 'C_p' and C_v are molar specific heats of an ideal gas at constant pressure and volume respectively, 'γ' is ratio of two specific heats and 'R' is univeral gas constant then 'C_p' is equal to

(a) $\frac{R\gamma}{\gamma - 1}$ (b) γR

(c) $\frac{1+\gamma}{1-\gamma}$ (d) $\frac{R}{\gamma - 1}$

6. In a series LCR circuit $R = 300\ \Omega$, $L = 0.9$ H, $C = 2\ \mu F$, $\omega = 1000$ rad/s. The impedance of the circuit is

(a) $500\ \Omega$ (b) $1300\ \Omega$

(c) $400\ \Omega$ (d) $900\ \Omega$

7. The quantity which *does not* vary periodically for a particle performing S.H.M. is

(a) acceleration (b) total energy
(c) displacement (d) velocity

8. Which of the following combinations of 7 identical capacitors each of 2 μF gives a resultant capacitance of $\frac{10}{11}$ μF?

(a) 3 in parallel and 4 in series
(b) 2 in parallel and 5 in series
(c) 4 in parallel and 3 in series
(d) 5 in parallel and 2 in series

9. Bohr model is applied to a particle of mass 'm' and charge 'q' moving in a plane under the influence of a transverse magnetic field 'B'. The energy of the charged particle in the nth level will be (h = Planck's constant)

(a) $\frac{2nhqB}{\pi m}$ (b) $\frac{nhqB}{2\pi m}$

(c) $\frac{nhqB}{4\pi m}$ (d) $\frac{nhqB}{\pi m}$

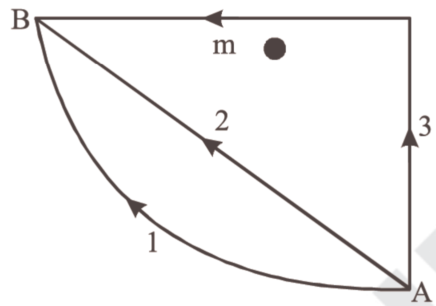
10. In moving coil galvanometer, strong horse shoe magnet of concave shaped pole pieces is used to

(a) increase space for rotation of coil
(b) reduce weight of galvanometer
(c) produce magnetic field which is parallel to plane of coil at any position
(d) make magnetic induction weak at the centre

11. Two identical wires of substances 'P' and 'Q' are subjected to equal stretching force along the length. If the elongation of 'Q' is more than that of 'P', then

(a) both P and Q are equally elastic
(b) P is more elastic than Q
(c) P is plastic and Q is elastic
(d) Q is more elastic than P

12. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 (as shown in fig.) in the gravitational field of the point mass 'm'. Find the correct relation between 'W_1', 'W_2' and 'W_3'



(a) $W_1 < W_3 < W_2$ (b) $W_1 < W_2 < W_3$
(c) $W_1 = W_2 = W_3$ (d) $W_1 > W_3 > W_2$

13. Assuming that the junction diode is ideal, the current in the arrangement shown in figure is

(a) 30 mA (b) 40 mA
(c) 20 mA (d) 10 mA

14. The equation of simple harmonic progressive wave is given by $Y = a \sin 2\pi (bt - cx)$

The maximum particle velocity will be twice the wave velocity if

(a) $c = \pi a$ (b) $c = \frac{1}{2\pi a}$

(c) $c = \frac{1}{\pi a}$ (d) $c = 2\pi a$

15. In fundamental mode, the time required for the sound wave to reach upto the closed end of a pipe filled with air is 't' second. The frequency of vibration of air column is

(a) $(2t)^{-1}$ (b) $4(t)^{-1}$
(c) $2(t)^{-1}$ (d) $(4t)^{-1}$

16. Two small drops of mercury each of radius 'R' coalesce to form a large single drop. The ratio of the total surface energies before and after the change is

(a) $2^{2/3} : 1$ (b) $\sqrt{2} : 1$

(c) $2^{1/3} : 1$ (d) $2 : 1$

17. If radius of the solid sphere is doubled by keeping its mass constant, the ratio of their moment of inertia about any of its diameter is

(a) 1 : 8 (b) 2 : 5
(c) 2 : 3 (d) 1 : 4

18. For a metallic wire, the ratio of voltage to corresponding current is
(a) independent of temperature
(b) increases with rise in temperature
(c) increases or decreases with rise in temperature depending upon the metal
(d) decreases with rise in temperature

19. A soap bubble in vacuum has a radius of 3 cm and another soap bubble in vacuum has a radius of 4 cm. If the two bubbles coalesce under isothermal condition, then the radius of the new bubble is
(a) 2.3 cm (b) 4.5 cm
(c) 5 cm (d) 7 cm

20. Two parallel conductors carrying unequal currents in the same direction
(a) neither attract nor repel each other
(b) repel each other
(c) attract each other
(d) will have rotational motion

21. A layer of atmosphere that reflects medium frequency radio waves which is ineffective during night, is
(a) F layer (b) E layer
(c) stratosphere (d) thermosphere

22. A transverse wave is propagating on the string. The linear density of a vibrating string is 10^{-3} kg/m. The equation of the wave is $y = 0.05 \sin(x + 15t)$ where x and y are in metre and time in second. The tension in the string is
(a) 0.2 N (b) 0.250 N
(c) 0.225 N (d) 0.325 N

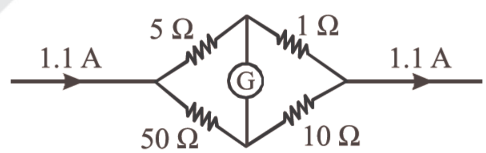
23. The kinetic energy of a revolving satellite (mass m) at a height equal to thrice the radius of the earth (R) is
(a) $\frac{mgR}{8}$ (b) $\frac{mgR}{16}$
(c) $\frac{mgR}{2}$ (d) $\frac{mgR}{4}$

24. A particle executes the simple hormonic motion with an amplitude 'A'. The distance travelled by it in one periodic time is
(a) $\frac{A}{2}$ (b) A
(c) 2 A (d) 4 A

25. A galvanometer has resistance of 100 Ω and a current of 10 mA produces full scale deflection in it. The resistance to be connected to it in series, to get a voltmeter of range 50 volt is
(a) 3900 Ω (b) 4000 Ω
(c) 4600 Ω (d) 4900 Ω

26. The angle made by orbital angular momentum of electron with the direction of the orbital magnetic moment is
(a) 120° (b) 60°
(c) 180° (d) 90°

27. The current in 1 Ω resistor in the following circuit is



(a) 1 A (b) 0.5 A
(c) 1.1 A (d) 0.8 A

28. The wavelength of the first line in Balmer series in the hydrogen spectrum is 'λ'. What is the wavelength of the second line in the same series?
(a) $\frac{20}{27}\lambda$ (b) $\frac{3}{16}\lambda$
(c) $\frac{5}{36}\lambda$ (d) $\frac{3}{4}\lambda$

29. Work done in stretching a wire through 1 mm is 2J. What amount of work will be done for elongating another wire of same material, with half the length and double the radius of cross section, by 1 mm?
(a) 1.2 J (b) 4 J
(c) 8 J (d) 16 J

30. The resultant $\vec{R}$ of $\vec{P}$ and $\vec{Q}$ is perpendicular to $\vec{P}$. Also $|\vec{P}| = |\vec{R}|$. The angle between $\overline{P}$ and $\overline{Q}$ is [tan45° = 1]

(a) $\frac{6\pi}{4}$ (b) $\frac{7\pi}{4}$

(c) $\frac{\pi}{4}$ (d) $\frac{3\pi}{4}$

31. A telescope has large diameter of the objective. Then its resolving power is

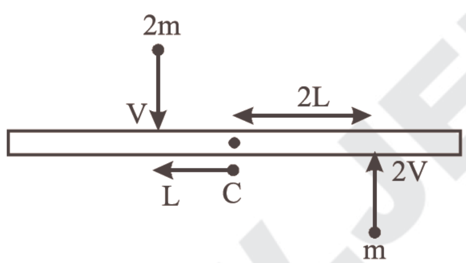
(a) independent of the diameter of the objective

(b) low

(c) zero

(d) high

32. A uniform rod of length '6L' and mass '8m' is pivoted at its centre 'C'. Two masses 'm' and '2m' with speed 2v, v as shown strikes the rod and stick to the rod. Initially the rod is at rest. Due to impact, if it rotates with angular velocity 'w_1' then 'w' will be



(a) $\frac{v}{4\,L}$ (b) Zero

(c) $\frac{8\,v}{6\,L}$ (d) $\frac{11\,v}{3\,L}$

33. If $\sqrt{A^2+B^2}$ represents the magnitude of resultant of two vectors $(\vec{A}+\vec{B})$ and $(\vec{A}-\vec{B})$, then the angle between two vectors is

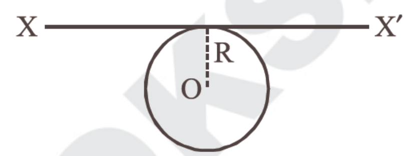
(a) $\cos^{-1}\left[\frac{2(A^2-B^2)}{(A^2+B^2)}\right]$

(b) $\cos^{-1}\left[-\frac{A^2-B^2}{A^2B^2}\right]$

(c) $\cos^{-1}\left[-\frac{(A^2+B^2)}{2(A^2-B^2)}\right]$

(d) $\cos^{-1}\left[-\frac{(A^2-B^2)}{A^2+B^2}\right]$

34. A thin metal wire of length 'L' and uniform linear mass density 'Q' is bent into a circular coil with 'o' as centre. The moment of inertia of a coil about the axis XX′ is



(a) $\frac{3QL^3}{8\pi^2}$ (b) $\frac{QL^3}{4\pi^2}$

(c) $\frac{3QL^2}{4\pi^2}$ (d) $\frac{QL^3}{8\pi^2}$

35. The dimensions of torque are same as that of

(a) moment of force (b) pressure

(c) acceleration (d) impulse

36. For transistor, the current ratio 'β_{dc}' is defined as the ratio of

(a) collector current to emitter current

(b) collector current to base current

(c) base current to collector current

(d) emitter current to collector current

37. A clock pendulum having coefficient of linear expansion $\alpha = 9 \times 10^{-7}$ /°C has a period of 0.5 s at 20°C. If the clock is used in a climate where the temperature is 30°C, how much time does the clock lose in each oscillation? (g = constant)

(a) 2.5×10^{-7} s (b) 5×10^{-7} s

(c) 1.125×10^{-6} s (d) 2.25×10^{-6} s

38. Two capillary tubes of different diameters are dipped in water. The rise of water is

(a) zero in both the tube

(b) same in both the tube

(c) more in the tube of larger diameter

(d) more in the tube of smaller diameter

39. A thin hollow prism of refracting angle 3°, filled with water gives a deviation of 1°. The refractive index of water is

(a) 1.59 (b) 1.33
(c) 1.46 (d) 1.51

40. A body is projected vertically from the surface of the earth of radius 'R' with velocity equal to half of the escape velocity. The maximum height reached by the body is

(a) $\frac{R}{5}$ (b) $\frac{R}{3}$
(c) $\frac{R}{2}$ (d) $\frac{R}{4}$

41. In biprism experiment, the distance between source and eyepiece is 1.2 m, the distance between two virtual sources is 0.84 mm. Then the wavelength of light used if eyepiece is to be moved transversely through a distance of 2.799 cm to shift 30 fringes is

(a) 6533 Å (b) 6537 Å
(c) 6535 Å (d) 6351 Å

42. When photons of energy hv fall on metal plate of work function 'W_0', photoelectrons of maximum kinetic energy 'K' are ejected. If the frequency of the radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be

(a) $K + W_0$ (b) $K + hv$
(c) K (d) 2K

43. If a star emitting yellow light is accelerated towards earth, then to an observer on earth it will appear

(a) becoming orange
(b) shining yellow
(c) gradually changing to blue
(d) gradually changing to red

44. The magnitude of magnetic induction at a point on the axis at a large distance (r) from the centre of circular coil of 'n' turns, and area 'A' carrying current (I) is given by

(a) $B_{axis} = \frac{\mu_0}{4\pi}.\frac{nA}{Ir^3}$ (b) $B_{axis} = \frac{\mu_0}{4\pi}.\frac{2nIA}{r^3}$
(c) $B_{axis} = \frac{\mu_0}{4\pi}.\frac{2nI}{Ar^3}$ (d) $B_{axis} = \frac{\mu_0}{4\pi}.\frac{nIA}{r^3}$

45. A metal sphere of radius 'R' and density 'e_1' is dropped in a liquid of density 'σ' moves with terminal velocity 'V'. Another metal sphere of same radius and density 'e_2' is dropped in the same liquid, its terminal velocity will be

(a) $V\left[\frac{(e_2+\sigma)}{(e_1+\sigma)}\right]$ (b) $V\left[\frac{(e_1+\sigma)}{(e_2+\sigma)}\right]$
(c) $V\left[\frac{(e_2-\sigma)}{(e_1-\sigma)}\right]$ (d) $V\left[\frac{(e_1-\sigma)}{(e_2-\sigma)}\right]$

46. If ∞ is the coefficient of performance of a refrigerator and 'Q_1' is heat released to the hot reservoir, then the heat extracted from the cold reservoir 'Q_2' is

(a) $\frac{\alpha Q_1}{\alpha-1}$ (b) $\frac{\alpha-1}{\alpha}Q_1$
(c) $\frac{\alpha Q_1}{1+\alpha}$ (d) $\frac{1+\alpha}{\alpha}Q_1$

47. The real force 'F' acting on a particle of mass 'm' performing circular motion acts along the radius of circle 'r' and is directed towards the centre of circle. The square root of magnitude of such force is (T = periodic time)

(a) $\frac{2\pi}{T}\sqrt{mr}$ (b) $\frac{Tmr}{4\pi}$
(c) $\frac{2\pi T}{\sqrt{mr}}$ (d) $\frac{T^2 mr}{4\pi}$

48. Dimensions of Gyromagnetic ratio are

(a) $[L^1M^0T^1I^1]$ (b) $[L^0M^{-1}T^1I^1]$
(c) $[L^1M^0T^0I^{-1}]$ (d) $[L^{-1}M^0T^1I^1]$

49. The maximum velocity of the photoelectron emitted by the metal surface is 'V'. Charge and mass of the photoelectron is denoted by 'e' and 'm' respectively. The stopping potential in volt is

(a) $\frac{V^2}{2\left(\frac{m}{e}\right)}$ (b) $\frac{V^2}{2\left(\frac{e}{m}\right)}$
(c) $\frac{V^2}{\left(\frac{e}{m}\right)}$ (d) $\frac{V^2}{\left(\frac{m}{e}\right)}$

50. The equiconvex lens has a focal length 'f'. If the lens is cut along the line perpendicular to principal axis and passing through the pole, what will be the focal length of any half part?

(a) $\frac{f}{2}$ (b) $2f$

(c) $\frac{3f}{2}$ (d) f

CHEMISTRY

51. Which of following methods is used to separate wolframite and stannic oxide present in cassiterite?

(a) Hydraulic washing using Wilfley table
(b) Froth flotation
(c) Hydraulic classifier
(d) Magnetic separation

52. In the reaction, $MnO_4^{-1}(aq.) + Br^{-1}(aq.) \rightarrow MnO_2(s) + BrO_3^{-1}(aq.)$, the correct change in oxidation number of the species involved is

(a) Br^{+5} to Br^{-1} (b) Mn^{+7} to Mn^{+2}
(c) Mn^{+7} to Mn^{+3} (d) Br^{-1} to Br^{+5}

53. How many isoprene units are present in abscisic acid?

(a) Three (b) Two
(c) Four (d) Five

54. Action of hydrogen iodide on anisole gives,

(a) phenol and iodomethane
(b) iodobenzene and methanol
(c) phenol and methanol
(d) iodobenzene and iodomethane

55. Which among the following compounds is used to decaffeinate coffee?

(a) Iodoform
(b) Carbon tetrachloride
(c) Methylene dichloride
(d) Chloroform

56. Which complex among the following gives a white precipitate on treatment with an aqueous solution of barium chloride?

(a) $[Pt(NH_3)_4Br_2]Cl_2$
(b) $[Co(NH_3)_5SO_4]NO_2$
(c) $[Co(NH_3)_5NO_2]SO_4$
(d) $[Pt(NH_3)_4Cl_2]Br_2$

57. When CuSO4 solution in water is treated with concentrated HCl it turns

(a) Violet (b) Yellow
(c) Purple (d) Green

58. Which of the following polymer is used in paints?

(a) Gutta percha (b) Melamine
(c) Buna-S (d) Novolac

59. Three moles of an ideal gas are expanded isothermally from a volume of 300 cm^3 to 2.5 L at 300 K against a pressure of 1.9 atm. The work done in joules is

(a) –423.56 J (b) +423.56 J
(c) –4.18 J (d) +4.8 J

60. Which among the following is used in the treatment of cancer?

(a) cis-$[Pt(en)_2Cl_2]$
(b) cis-$[PtCl_2(NH_3)_2]$
(c) trans-$[Pt(en)_2Cl_2]$
(d) trans-$[Pt(NH_3)_2Cl_2]$

61. Which among the following pairs of compounds in **NOT** isomorphous?

(a) $NaNO_3$ and $CaCO_3$
(b) K_2SO_4 and K_2SeO_4
(c) NaCl and KCl
(d) NaF and MgO

62. Which among the following compounds is used as selective weed killer?

(a) Picric acid
(b) 2, 4-dichlorophenoxy acetic acid
(c) 2, 4, 6-trichlorophenoxy acetic acid
(d) Salol

63. Calculate the difference between heat of combustion of carbon monoxide gas at constant pressure and at constant volume at 27°C? ($R = 2Cal\ K^{-1}\ mol^{-1}$)

(a) 54 cal (b) –600 cal
(c) –300 cal (d) 27 cal

64. The conductivity of an electrolytic solution decreases on dilution due to

(a) decrease in number of ions per unit volume
(b) increase in ionic mobility of ions
(c) increase in percentage ionisation
(d) increase in number of ions per unit volume

65. Identify B in the following reaction,

$$\text{Acetaldoxime} \xrightarrow[\text{Alcohol}]{\text{Na}} \text{A} \xrightarrow[\text{HCl}]{\text{NaNO}_2} \text{B} + H_2O + N_2\uparrow$$

(a) $CH_3CH_2CH_2OH$ (b) C_2H_5OH
(c) C_2H_5Cl (d) $C_2H_5NH_2$

66. Which among the following solids shows Frenkel defect?

(a) NaCl (b) CsCl
(c) KCl (d) AgCl

67. A cold drink bottle contains 200 mL liquid in which CO_2 is 0.1 molar. Considering CO_2 as an ideal gas the volume of the dissolved CO_2 at S.T.P. is

(a) 22.4 L (b) 0.224 L
(c) 2.24 L (d) 0.448 L

68. In the reaction,

$$2n\,\text{R-X} \xrightarrow[\text{Dry ether}]{+2n\,\text{Na}} \text{product}$$

The product obtained is

(a) $2n$ Alkene (b) n Soldium halide
(c) n Alchol (d) n Alkane

69. The bacteriostatic antibiotic from the following is

(a) Tetracycline (b) Aminoglycosides
(c) Penicillin (d) Ofloxacin

70. Nitroalkanes are obtained in laboratory from primary or secondary alkyl halides by the action of

(a) $AgNO_2$ (b) $NaNO_3$
(c) $AgNO_3$ (d) HNO_3

71. Which of following bonds has maximum bond length?

(a) C – O (b) C – H
(c) C – C (d) C – N

72. Which of the following sets of components form homogeneous mixture?

(a) Phenol + Water
(b) Sugar + Benzene
(c) Silver chloride + Water
(d) Ethyl alcohol + Water

73. Which among the following compounds in crystalline form is used for making Nicol's prism?

(a) $CaSO_4$ (b) Na_2AIF_6
(c) $CaCO_3$ (d) Al_2O_3

74. Two electroytic cells are connected in series containing $CuSO_4$ solution and molten $AlCl_3$. If in electrolysis 0.4 moles of 'Cu' are deposited on cathode of first cell. The number of moles of 'Al' deposited on cathode of the second cell is

(a) 0.6 moles (b) 0.27 moles
(c) 0.18 moles (d) 0.4 moles

75. Mandelonitrile is obtained by the reaction between hydrogen cyanide and

(a) Propionaldehyde (b) Benzaldehyde
(c) Acetaldehyde (d) Acetone

76. The ionic charges on chromate ion and dichromate ion respectively is

(a) –2, –2 (b) –3, –2
(c) –2, –4 (d) –4, –2

77. In the reaction,

$$C_6H_5COCH_3 \xrightarrow[\text{Zn-Hg/conc. HCl}]{[H]} X$$

X is

(a) toluene (b) methylbenzene
(c) benzylalcohol (d) ethylbenzene

78. What is the percentage of carbon in urea? (At mass C = 12, H = 1, N = 14, O = 16)

(a) 20% (b) 26.6%
(c) 6.67% (d) 46.0%

79. α -butylene when subjected to hydroboration oxidation reaction, yields

(a) iso-butyl alcohol (b) sec-butyl alcohol
(c) n-butyl alcohol (d) tert-butyl alcohol

80. Calculate Vant Hoff factor for 0.2 m aqueous solution of KCl which freezes at –0.680°C. (K_f = 1.86 K kg mol^{-1})

(a) 3.72 (b) 1.83
(c) 6.8 (d) 1.86

81. Which among the following sets of compounds is used as raw material for the preparation of sodium carbonate by solvay process?

(a) NaOH, HCl, CO_2
(b) NH_4Cl, H_2O, NaCl
(c) NaCl, NH_3, $Ca(OH)_2$
(d) NaCl, $CaCO_3$, H_2SO_4

82. What is the H-S-H bond angle is H_2S?

(a) 104.5° (b) 92.1°
(c) 91° (d) 90°

83. 'K' is Henry's constant and has the unit
(a) atm mol^{-1} dm^3
(b) mol^{-1} dm^3 atm^{-1}
(c) atm mol dm^{-3}
(d) mol dm^{-3} atm^{-1}

84. For the conversion of oxygen to ozone in the atmosphere, nitric oxide in gaseous phase acts as
(a) enzyme catalyst
(b) Inhibitor
(c) homogeneous catalyst
(d) heterogeneous catalyst

85. Which among the following group 15 elements does not exhibit allotropy?
(a) N (b) As
(c) Sb (d) Bi

86. Which among the following oxides of nitrogen is called nitrogen sesquioxide?
(a) NO_2 (b) N_2O_3
(c) N_2O_4 (d) N_2O_5

87. For the elementary reaction $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$, identify the correct among the following relations

(a) $\dfrac{-d[SO_{2(g)}]}{dt} = \dfrac{-d[O_{2(g)}]}{dt}$

(b) $+\dfrac{1}{2}\dfrac{d[SO_{3(g)}]}{dt} = \dfrac{d[SO_{2(g)}]}{dt}$

(c) $\dfrac{+d[SO_{3(g)}]}{dt} = \dfrac{-2d[O_{2(g)}]}{dt}$

(d) $\dfrac{+d[SO_{2(g)}]}{dt} = \dfrac{-d[O_{2(g)}]}{dt}$

88. For a process, entropy change of a system is expressed as
(a) H-TS (b) $\dfrac{q_{rev}}{T}$
(c) $\dfrac{T}{q_{rev}}$ (d) $q_{rev} \times T$

89. Which among the following is NOT a semi-synthetic polymer.
(a) Terylene
(b) Viscose-Rayon
(c) Cupra-ammonium silk
(d) Acetate Rayon

90. Basesemerization is used in the extraction of
(a) Iron (b) Copper
(c) Aluminium (d) Zinc

91. Which among the following reaction is an example of a zero order reaction?
(a) $C_{12}H_{22}O_{11(aq.)} + H_2O_{(l)} \rightarrow C_6H_{12}O_{6(aq.)} + C_6H_{12}O_{6(aq.)}$
(b) $2NH_{3(g)} \xrightarrow{Pt} N_{2(g)} + 3H_2$
(c) $2H_2O_{2(l)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$
(d) $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$

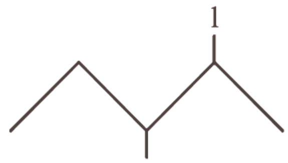
92. The resistance of $\dfrac{1}{10}$ M solution is 2.5×10^3 ohm. What is the molar conductivity of solution? (cell constant = 1.25 cm^{-1})
(a) 3.5 ohm^{-1} cm^2 mol^{-1}
(b) 5.0 ohm^{-1} cm^2 mol^{-1}
(c) 2.5 ohm^{-1} cm^2 mol^{-1}
(d) 2.0 ohm^{-1} cm^2 mol^{-1}

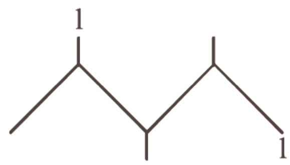
93. If the Vant Hoff factor for 0.1 M $Ba(NO_3)_2$ solution is 2.74, the degree of dissociaion is
(a) 0.87 (b) 0.74
(c) 0.91 (d) 87

94. What happens when ionic hydrides of S-block elements in molten state are electrolysed?
(a) Hydride ion migrates at cathode
(b) Dihydrogen is liberated at cathode
(c) Hydride ion reforms metal hydride
(d) Dihydrogen is liberated at anode

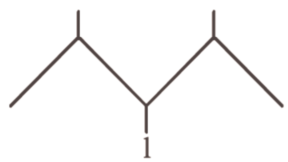
95. Which of following is NOT a property of red phosphorus?
(a) Insoluble in carbon disulphide
(b) It does not show chemiluminescence by action of air
(c) If forms phosphine when treated with hot sodium hydroxide solution
(d) It is non-poisonous

96. The bond line formula of 1-iodo –2, 3-dimethyl pentane is

(a) 

(b) 

(c) 

(d) 

97. When propene reacts with HCl in presence of peroxide, the product is

(a) 1-chloro propane
(b) 1, 1-dichloro propane
(c) 2-chloro propane
(d) 1, 2-dichloro propane

98. Which hydride among the following is strongest reducing agent?

(a) AsH_3
(b) BiH_3
(c) PH_3
(d) SbH_3

99. Which of the following is <u>NOT</u> an antiseptic compound?

(a) Boric acid
(b) Iodoform
(c) Hydrogen peroxide
(d) Potassium sulphite

100. β-pleated sheets of polypeptide chains are present in

(a) Secondary structure
(b) Primary structure
(c) Tertiary structure
(d) Quaternary structure

SECTION-B

MATHEMATICS

1. If P(x_1, y_1) is a point on the hyperbola $x^2 - y^2 = a^2$, then SP.S'P = ...

(a) $\dfrac{x_1^2 - y_1^2}{a^2}$ (b) $\dfrac{x_1^2 + y_1^2}{a^2}$

(c) $x_1^2 - y_1^2$ (d) $x_1^2 + y_1^2$

2. If $f(x) = \cos^{-1}\left[\dfrac{1-(\log x)^2}{1+(\log x)^2}\right]$, then $f'(e)$ = ...

(a) $\dfrac{1}{e}$ (b) $\dfrac{2}{e^2}$

(c) $\dfrac{2}{e}$ (d) 1

3. The order of the differential equation of all circles whose radius is 4, is ....

(a) 1 (b) 2
(c) 3 (d) 4

4. If $A = \begin{bmatrix} x & 1 \\ 1 & 0 \end{bmatrix}$ and $A = A^{-1}$, then x = ...

(a) 0 (b) 4
(c) 2 (d) 1

5. Which of the following function is not continuous at $x = 0$?

(a) $f(x)\begin{cases} f(x) = (1+2x)^{1/x}, & x \neq 0 \\ = e^2, & x = 0 \end{cases}$

(b) $f(x)\begin{cases} = \sin x - \cos x, & x \neq 0 \\ = -1, & x = 0 \end{cases}$

(c) $f(x)\begin{cases} = \dfrac{e^{1/x} - 1}{e^{1/x} + 1}, & x \neq 0 \\ = -1, & x = 0 \end{cases}$

(d) $f(x)\begin{cases} = \dfrac{e^{5x} - e^{2x}}{\sin 3x}, & x \neq 0 \\ = 1, & x = 0 \end{cases}$

6. It is observed that 25% of the cases related to child labour reported to the police station are solved. If 6 new cases are reported, then the probability that atleast 5 of them will be solved is ....

(a) $\left(\frac{1}{4}\right)^6$ (b) $\frac{19}{1024}$

(c) $\frac{19}{2048}$ (d) $\frac{19}{4096}$

7. For a G.P., if $S_n = \frac{4^n - 3^n}{3^n}$, then $t_2 =$ ....

(a) $\frac{1}{9}$ (b) $\frac{2}{9}$

(c) $\frac{7}{9}$ (d) $\frac{4}{9}$

8. The area of the region bounded by the curve $y = 2x - x^2$ and the line $y = x$ is .... square units

(a) $\frac{1}{6}$ (b) $\frac{1}{2}$

(c) $\frac{1}{3}$ (d) $\frac{7}{6}$

9. The general solution of $x\frac{dy}{dx} = y - x\tan\left(\frac{y}{x}\right)$ is ....

(a) $x^2 \sin\left(\frac{x}{y}\right) = c$ (b) $x \sin\left(\frac{x}{y}\right) = c$

(c) $x \sin\left(\frac{y}{x}\right) = c$ (d) $x^2 \sin\left(\frac{y}{x}\right) = c$

10. The statement pattern

$(p \wedge q) \wedge [\sim r \vee (p \wedge q)] \vee (\sim p \wedge q)$

is equivalent to ....

(a) r (b) q

(c) $p \wedge q$ (d) p

11. A bag contains 6 white and 4 black balls. Two balls are drawn at random. The probability that they are of the same colour is ....

(a) $\frac{5}{7}$ (b) $\frac{1}{7}$

(c) $\frac{7}{15}$ (d) $\frac{1}{15}$

12. $\int \frac{\cos x + x\sin x}{x^2 + x\cos x}dx =$ ....

(a) $\log\left|\frac{x\sin x}{x + \cos x}\right| + c$

(b) $\log\left|\frac{x}{x + \cos x}\right| + c$

(c) $\log|\cos x + x\sin x| + c$

(d) $\log|x^2 + x\cos x| + c$

13. A stone is dropped into a pond. Waves in the form of circles are generated and radius of outermost ripple increases at the rate of 5 cm/sec. The area increased after 2 seconds is ....

(a) $100\,\pi$ cm^2/sec (b) 40 cm^2/sec

(c) 50 cm^2/sec (d) 25 cm^2/sec

14. If $f(x) = 3x - 2$ and $g(x) = x^2$, then $fog(x) =$ ....

(a) $3x^2 - 2$ (b) $3x^2 + 2$

(c) $3x - 2$ (d) $2 - 3x^2$

15. Which of the following is NOT equivalent to $p \to q$.

(a) p only if q

(b) q is necessary for p

(c) q only if p

(d) p is sufficient for q

16. The value of $\int_{-3}^{3}(ax^5 + bx^3 + cx + k)dx$, where a, b, c, k are constants, depends only on ....

(a) a, b and c (b) k

(c) a and b (d) a and k

17. The general solution of the differential equation of all circles having centre at A(–1, 2) is ....

(a) $x^2 + y^2 + x - 2y + c = 0$

(b) $x^2 + y^2 - 2x + 4y + c = 0$

(c) $x^2 + y^2 - x + 2y + c = 0$

(d) $x^2 + y^2 + 2x - 4y + c = 0$

18. If A is non-singular matrix such that $(A - 2I)(A - 4I) = 0$ then $A + 8A^{-1} =$ ....

(a) I (b) 0

(c) 3 I (d) 6 I

19. If G(3, –5, r) is centroid of triangle ABC where A(7, –8, 1), B(p, q, 5) and C(q + 1, 5p, 0) are vertices of a triangle then values of p, q, r are respectively ....

(a) 6, 5, 4 (b) –4, 5, 4
(c) –3, 4, 3 (d) –2, 3, 2

20. $\int \frac{1}{(x^2+1)^2}dx =$ ....

(a) $\tan^{-1}x - \frac{1}{2x(x^2+1)} + c$

(b) $\frac{1}{2}\tan^{-1}x + \frac{x}{2(x^2+1)} + c$

(c) $\tan^{-1}x + \frac{x}{x^2+1} + c$

(d) $\tan^{-1}x + \frac{1}{2(x^2+1)} + c$

21. If $\theta = \frac{17\pi}{3}$ then $\tan\theta - \cot\theta =$ ....

(a) $\frac{1}{2\sqrt{3}}$ (b) $\frac{-1}{2\sqrt{3}}$

(c) $\frac{2}{\sqrt{3}}$ (d) $-\frac{2}{\sqrt{3}}$

22. Derivative of $\log_e^2(\log x)$ with respect to x is ....

(a) $\frac{2}{x\log x}$ (b) $\frac{1}{x\log x}$

(c) $\frac{1}{x\log x^2}$ (d) $\frac{2}{\log x}$

23. In Δ ABC; with usual notations, if $\cos A = \frac{\sin B}{\sin C}$, then the triangle is ....

(a) Acute angled triangle
(b) Equilateral triangle
(c) Obtuse angled triangle
(d) Right angled triangle

24. For a G.P, if $(m+n)^{th}$ term is p and $(m-n)^{th}$ term is q, then m^{th} term is ....

(a) pq (b) $\sqrt{pq}$

(c) $\frac{p}{q}$ (d) $\frac{q}{p}$

25. A random variable X has following probability distribution

$X = x$	1	2	3	4	5	6
$P(X = x)$	K	3K	5K	7K	8K	K

Then $P(2 \le x < 5) =$ ....

(a) $\frac{3}{5}$ (b) $\frac{7}{25}$

(c) $\frac{23}{25}$ (d) $\frac{24}{25}$

26. The equation of normal to the curve $y = \log_e x$ at the point P(1, 0) is ....

(a) $2x + y = 2$ (b) $x - 2y = 1$
(c) $x - y = 1$ (d) $x + y = 1$

27. The values of x in $\left(0, \frac{\pi}{2}\right)$ satisfying the equation $\sin x \cos x = \frac{1}{4}$ are ....

(a) $\frac{\pi}{6}, \frac{\pi}{12}$ (b) $\frac{\pi}{12}, \frac{5\pi}{12}$

(c) $\frac{\pi}{8}, \frac{3\pi}{8}$ (d) $\frac{\pi}{8}, \frac{\pi}{4}$

28. If $\vec{a}+\vec{b}, \vec{b}+\vec{c}$ and $\vec{c}+\vec{a}$ are coterminous edges of a parallelopiped then its volume is ....

(a) $3[\vec{a}\ \vec{c}\ \vec{b}]$ (b) 0

(c) $2[\vec{a}\ \vec{b}\ \vec{c}]$ (d) $4[\vec{b}\ \vec{a}\ \vec{c}]$

29. If the c.d.f. (cumulative distribution function) is given by $F(x) = \frac{x-25}{10}$, then $P(27 \le x \le 33) =$ ......

(a) $\frac{3}{5}$ (b) $\frac{3}{10}$

(c) $\frac{1}{5}$ (d) $\frac{1}{10}$

30. The joint equation of pair of straight lines passing through origin and having slopes $(1+\sqrt{2})$ and $\left(\frac{1}{1+\sqrt{2}}\right)$ is ....

(a) $x^2 - 2\sqrt{2}xy + y^2 = 0$

(b) $x^2 - 2\sqrt{2}xy - y^2 = 0$

(c) $x^2 + 2xy - y^2 = 0$

(d) $x^2 + 2xy + y^2 = 0$

31. The angle between lines $\frac{x-2}{2} = \frac{y-3}{-2} = \frac{z-5}{1}$ and $\frac{x-2}{1} = \frac{y-3}{2} = \frac{z-5}{2}$ is ....

(a) 30° (b) 60°
(c) 45° (d) 90°

32. If the line passes through the points P(6, –1, 2), Q(8, –7, 2λ) and R(5, 2, 4) then value of λ is ....

(a) –3 (b) 0
(c) –1 (d) 2

33. The equivalent form of the statement $\sim(p \rightarrow \sim q)$ is ....

(a) $p \wedge q$ (b) $p \wedge \sim q$
(c) $p \vee \sim q$ (d) $\sim p \vee q$

34. If $A = \{x \in R : x^2 - 5|x| + 6 = 0\}$, then $n(A) =$ ....

(a) 2 (b) 0
(c) 1 (d) 4

35. If the function $f(x) = \frac{\log(1+ax) - \log(1-bx)}{x}$, $x \neq 0$ is continuous at $x = 0$ then, $f(0) =$ ......

(a) $\log a - \log b$ (b) $a + b$
(c) $\log a + \log b$ (d) $a - b$

36. The coordinates of the foot of perpendicular drawn from origin to the plane $2x - y + 5z - 3 = 0$ are ....

(a) $\left(\frac{2}{\sqrt{30}}, \frac{-1}{\sqrt{30}}, \frac{5}{\sqrt{30}}\right)$ (b) $(2, -1, 5)$

(c) $\left(\frac{2}{3}, \frac{-1}{3}, \frac{5}{3}\right)$ (d) $\left(\frac{1}{5}, \frac{-1}{10}, \frac{1}{2}\right)$

37. $\int \frac{\sqrt{x^2 - a^2}}{x} dx =$ ....

(a) $\sqrt{x^2 - a^2} - a\cos^{-1}\left(\frac{a}{x}\right) + c$

(b) $x\sqrt{x^2 - a^2} - \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right) + c$

(c) $\sqrt{x^2 - a^2} + a\sec^{-1}\left(\frac{x}{a}\right) + c$

(d) $\sqrt{x^2 - a^2} + \frac{1}{x}\sec^{-1}(x) + c$

38. The maximum value of $z = 9x + 11y$ subject to $3x + 2y \leq 12, 2x + 3y \leq 12, x \geq 0, y \geq 0$ is ....

(a) 44 (b) 54
(c) 36 (d) 48

39. $\int_0^4 \frac{1}{1+\sqrt{x}} dx =$ ....

(a) $\log\left(\frac{e^4}{6}\right)$ (b) $\log\left(\frac{e^4}{3}\right)$

(c) $\log\left(\frac{e^4}{9}\right)$ (d) $\log\left(\frac{e^3}{4}\right)$

40. The number of solutions of $\sin^2\theta = \frac{1}{2}$ in $[0, \pi]$ is ....

(a) three (b) four
(c) two (d) one

41. If $\vec{p}, \vec{q}$ and $\vec{r}$ are nonzero, noncoplanar vectors then $[\vec{p}+\vec{q}-\vec{r} \quad \vec{p}-\vec{q} \quad \vec{q}-\vec{r}] =$ ....

(a) $3[\vec{p}\ \vec{q}\ \vec{r}]$ (b) 0

(c) $[\vec{p}\ \vec{q}\ \vec{r}]$ (d) $2[\vec{p}\ \vec{q}\ \vec{r}]$

42. Which of the following equation has no solution?

(a) $\sec\theta = 23$ (b) $\cos\theta = \sqrt{2}$

(c) $\tan\theta = 2019$ (d) $\sin\theta = -\frac{1}{5}$

43. The minimum value of $z = 10x + 25y$ subject to $0 \leq x \leq 3, 0 \leq y \leq 3, x + y \geq 5$ is ....

(a) 80 (b) 95
(c) 105 (d) 30

44. If $f(x) = 3x^3 - 9x^2 - 27x + 15$, then the maximum value of $f(x)$ is ....

(a) –66 (b) 30
(c) –30 (d) 66

45. The equationof the plane passing through the point (–1, 2, 1) and perpendicular to the line joining the points (–3, 1, 2) and (2, 3, 4) is ....

(a) $\overline{r}.(5\hat{i}+2\hat{j}+2\hat{k})=1$

(b) $\overline{r}.(5\hat{i}+2\hat{j}+2\hat{k})=-1$

(c) $\overline{r}.(5\hat{i}-2\hat{j}+2\hat{k})=-5$

(d) $\overline{r}.(5\hat{i}-2\hat{j}-2\hat{k})=1$

46. If the lengths of the transverse axis and the latus rectum of a hyperbola are 6 and $\frac{8}{3}$ respectively, then the equation of the hyperbola is ....

(a) $4x^2 - 9y^2 = 72$ (b) $4x^2 - 9y^2 = 36$
(c) $9x^2 - 4y^2 = 72$ (d) $9x^2 - 4y^2 = 36$

47. The value of

$\tan^{-1}\frac{1}{3}+\tan^{-1}\frac{1}{5}+\tan^{-1}\frac{1}{7}+\tan^{-1}\frac{1}{8}$ is ....

(a) $\frac{11\pi}{5}$ (b) $\frac{\pi}{4}$

(c) π (d) $\frac{3\pi}{4}$

48. The joint equation of the lines passing through the origin and trisecting the first quadrant is ....

(a) $\sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$

(b) $x^2 + \sqrt{3}xy - y^2 = 0$

(c) $3x^2 - y^2 = 0$

(d) $x^2 - \sqrt{3}xy - y^2 = 0$

49. If P(2, 2), Q(–2, 4) and R(3, 4) are the vertices of ΔPQR then the eqution of the median through vertex R is ....

(a) $x+3y+9=0$ (b) $x-3y+9=0$
(c) $x-3y-9=0$ (d) $x+3y-9=0$

50. If $x=\sqrt{a^{\sin^{-1}t}}$, $y=\sqrt{a^{\cos^{-1}t}}$, then $\frac{dy}{dx}=$ ......

(a) $\frac{-y}{x}$ (b) $\frac{x}{y}$

(c) $\frac{y}{x}$ (d) $\frac{-x}{y}$

ANSWER KEYS & SOLUTIONS

(MHT-CET 2019)

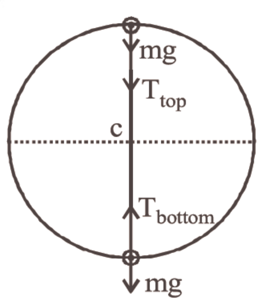
Answer KEYS

SECTION-A																			
PHYSICS																			
1	(b)	**6**	(a)	**11**	(b)	**16**	(c)	**21**	(b)	**26**	(c)	**31**	(d)	**36**	(b)	**41**	(None)	**46**	(c)
2	(a)	**7**	(b)	**12**	(c)	**17**	(d)	**22**	(c)	**27**	(a)	**32**	(None)	**37**	(d)	**42**	(b)	**47**	(a)
3	(c)	**8**	(d)	**13**	(c)	**18**	(b)	**23**	(a)	**28**	(a)	**33**	(c)	**38**	(d)	**43**	(c)	**48**	(b)
4	(d)	**9**	(c)	**14**	(c)	**19**	(c)	**24**	(d)	**29**	(d)	**34**	(a)	**39**	(b)	**44**	(b)	**49**	(b)
5	(a)	**10**	(c)	**15**	(d)	**20**	(c)	**25**	(d)	**30**	(d)	**35**	(a)	**40**	(b)	**45**	(c)	**50**	(b)
CHEMISTRY																			
51	(d)	**56**	(c)	**61**	(c)	**66**	(d)	**71**	(b)	**76**	(a)	**81**	(c)	**86**	(b)	**91**	(b)	**96**	(c)
52	(d)	**57**	(b)	**62**	(b)	**67**	(d)	**72**	(d)	**77**	(d)	**82**	(b)	**87**	(c)	**92**	(b)	**97**	(c)
53	(a)	**58**	(d)	**63**	(c)	**68**	(d)	**73**	(c)	**78**	(a)	**83**	(d)	**88**	(a)	**93**	(a)	**98**	(b)
54	(a)	**59**	(a)	**64**	(a)	**69**	(a)	**74**	(b)	**79**	(c)	**84**	(c)	**89**	(a)	**94**	(d)	**99**	(d)
55	(c)	**60**	(b)	**65**	(b)	**70**	(a)	**75**	(b)	**80**	(b)	**85**	(d)	**90**	(b)	**95**	(c)	**100**	(a)
SECTION-B																			
MATHEMATICS																			
1	(d)	**6**	(d)	**11**	(c)	**16**	(b)	**21**	(d)	**26**	(d)	**31**	(d)	**36**	(d)	**41**	(c)	**46**	(b)
2	(*)	**7**	(d)	**12**	(b)	**17**	(d)	**22**	(c)	**27**	(b)	**32**	(c)	**37**	(a)	**42**	(b)	**47**	(b)
3	(b)	**8**	(a)	**13**	(a)	**18**	(d)	**23**	(d)	**28**	(c)	**33**	(a)	**38**	(d)	**43**	(a)	**48**	(a)
4	(a)	**9**	(c)	**14**	(a)	**19**	(d)	**24**	(b)	**29**	(a)	**34**	(d)	**39**	(c)	**44**	(b)	**49**	(b)
5	(c)	**10**	(b)	**15**	(c)	**20**	(b)	**25**	(a)	**30**	(a)	**35**	(b)	**40**	(c)	**45**	(a)	**50**	(a)

SECTION-A

PHYSICS

1. **(b)** $T_{top} = \frac{mv^2}{r} - mg$ ...(i)



$$T_{bottom} = \frac{mv^2}{r} + mg \quad \text{...(ii)}$$

Solving (i) and (ii) we get :

$$\frac{T_{top}}{T_{bottom}} = \frac{v^2 - rg}{v^2 + rg} = \frac{79}{81}$$

2. **(a)** $\varepsilon = -M\frac{di}{dt} = -M\frac{d}{dt}(5\sin 200\pi t)$

$= -M \times 5 \times 200\pi \cos(200\pi t)$

$|\varepsilon|_{max} = 10\pi$ volt

3. **(c)**

4. **(d)** $v = n\lambda$ [for open pipe in fundamental mode $\lambda = 2l$, where l is the length of the pipe]

So, $v = n_1(2l_1) = n_2(2l_2) = n_3\,2(l_1 + l_2)$

$$\Rightarrow \frac{1}{n_3} = \frac{1}{n_1} + \frac{1}{n_2} \quad \Rightarrow n_3 = \frac{n_1 n_2}{n_1 + n_2}$$

5. **(a)** $C_p - C_v = R$ ...(i)

$$\frac{C_p}{C_v} = \gamma \quad \text{...(ii)}$$

Solving (i) and (ii)

We get : $C_p = \dfrac{R\gamma}{\gamma - 1}$

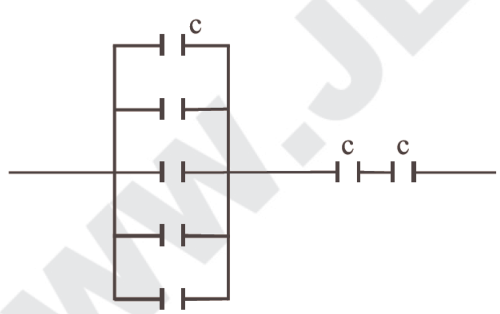
6. **(a)** $z = \sqrt{R^2 + \left(\omega L - \dfrac{1}{\omega c}\right)^2}$

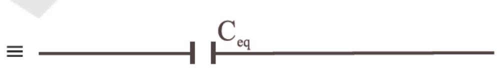
Putting $R = 300\,\Omega$, $L = 0.9H$, $C = 2 \times 10^{-6}F$ and $\omega = 1000$ rad/s

We get : $z = 500\,\Omega$

7. **(b)**

8. **(d)**





$$= C_{eq} = \frac{1}{\left(\frac{1}{5c} + \frac{1}{c} + \frac{1}{c}\right)} = \frac{5c}{1+5+5}$$

$$= \frac{5c}{11} = \frac{5 \times 2\,\mu F}{11} = \frac{10}{11}\mu F$$

9. **(c)** $q\,v\,B = \dfrac{mv^2}{r}$ ...(i)

$m\,v\,r = \dfrac{nh}{2\pi}$ ...(ii)

K.E. $= \dfrac{1}{2}mv^2$ ...(iii)

Solving (i), (ii) and (iii) we get:

K.E. $= \dfrac{1}{2}rqvB$

$$= \frac{1}{2} \times qB \times \frac{nh}{2\pi m} = \frac{nhqB}{4\pi m}$$

10. **(c)**

11. **(b)** $Y \alpha \dfrac{1}{\Delta l}$

12. **(c)**

13. **(c)** $i = \dfrac{3v - 1v}{100\Omega} = \dfrac{2}{100}\,A = 20mA$

14. **(c)** Particle velocity

$$v_1 = \frac{dY}{dt} = a\,2\pi b \cos 2\pi(bt - cx)$$

So, $V_1 max = a \times 2\pi \times b = 2\pi ab$

wave velocity $v_2 = \dfrac{\omega}{K} = \dfrac{2\pi b}{2\pi c} = \dfrac{b}{c}$

Now, $\dfrac{v_1 max}{v_2} = \dfrac{2\pi ab}{b/c} \Rightarrow 2 = 2\pi ac$

$$\Rightarrow c = \frac{1}{\pi a}$$

15. **(d)** For fundamental mode
let time period be T, then

So, $t = \frac{T}{4}$

$\Rightarrow T = 4t$

$\Rightarrow \frac{1}{T} = (4t)^{-1}$

$\Rightarrow \upsilon = (4t)^{-1}$

16. **(c)** R_{big} single drop = $2^{\frac{1}{3}}$ $r_{small\ drop}$

$U = T \times A$

So, $\frac{U_{initially}}{U_{finally}} = \frac{2 \times T \times 4\pi r^2}{T \times 4\pi R^2}$

$= \frac{2r^2}{\left(2^{1/3} r\right)^2} = 2^{\left(1 - \frac{2}{3}\right)} = 2^{1/3} : 1$

17. **(d)** $I = \frac{2}{5} mr^2$

$\Rightarrow I \propto r^2 \quad \Rightarrow \quad I_1 : I_2$

$= r_1^2 : (2r_1)^2 = 1 : 4 \qquad [\text{as } r_2 = 2r_1]$

18. **(b)** $R = \frac{V}{I}$ and for conductor R increases with increase in temperature.

19. **(c)** $r^2 = r_1^2 + r_2^2$

$r = \sqrt{3^2 + 4^2}$

$= 5$ cm

20. **(c)** Parallel currents in the same direction attract each other.

21. **(b)**

22. **(c)** as $y = 0.05 \sin(x + 15t)$

so, $v = \frac{\omega}{K} = \frac{15}{1}$

Now $v = \sqrt{\frac{F}{\mu}}$

$\Rightarrow F = v^2 \mu = (15)^2 \times (10^{-3}) = 0.225$ N

[Here F = tension force and $\mu = 10^{-3}$ kg/m]

23. **(a)** $\frac{mv^2}{r} = \frac{GmM}{r^2}$

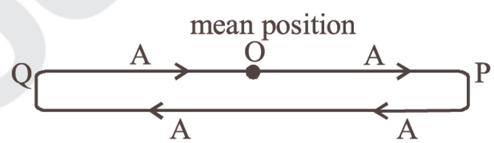
$\Rightarrow v^2 = \frac{GM}{r} \quad \Rightarrow v = \sqrt{\frac{GM}{r}}$

Now, Kinetic energy $= \frac{1}{2} mv^2$

$\frac{1}{2} m \frac{GM}{r} = \frac{1}{2} \frac{mGM}{(3R + R)} = \frac{1}{8} mgR$

$\left[\text{As} \quad g = \frac{GM}{R^2}\right]$

24. **(d)**



in one time period total distance travelled $= A + A + A + A = 4A$

[as in each quarter starting from mean position it travelles A distance as shown]

25. **(d)** $i\,(Rg + R) = 50$

$iRg + iR = 50$

$\Rightarrow \quad R = \frac{50}{10 \times 10^{-3}} - 100 = 4900\,\Omega$

26. **(c)**

27. **(a)** Given circuit forms wheat stone bridge :

so, $i_1 (5 + 1)\,\Omega = i_2 (50 + 10)\,\Omega$

$\Rightarrow \quad i_1 = 10 i_2$ ...(i)

also $i_1 + i_2 = 1.1$ A ...(ii)

Solving (i) and (ii) we get i_1 = IA which passes through 1Ω resistor

28. **(a)** $\frac{1}{\lambda} = K\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\Rightarrow \frac{1}{\lambda_1} = K\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$

[for first line of Balmer series $n_1 = 2$ and $n_2 = 3$]

also $\frac{1}{\lambda_2} = K\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$

[for second line in Balmer series $n_1 = 2$ and $n_2 = 4$]

so, $\frac{\lambda_2}{\lambda_1} = \frac{20}{27} \Rightarrow \lambda_2 = \frac{20}{27}\lambda_1 = \frac{20}{27}\lambda$

29. **(d)** Work done in streatching a wire

$= \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume}$

$= \frac{1}{2} \times Y \times (\Delta l)^2 \times \frac{\pi r^2}{l}$

so, $\frac{w_2}{w_1} = \left(\frac{r_2}{r_1}\right)^2 \times \left(\frac{l_1}{l_2}\right)$

$\Rightarrow w_2 = 8w_1 = 16J$

30. **(d)**

31. **(d)** Resolving power $\propto$, d

Resolving power of a telescope is proportional to the diameter.

32. **(None)**

33. **(c)**

34. **(a)** $I = \frac{3MR^2}{2} = \frac{3}{8\pi^2}.Q.L^3$

35. **(a)** Torque = Force × distance

Moment of force = Force × distance

So, Moment of force and torque have same dimension.

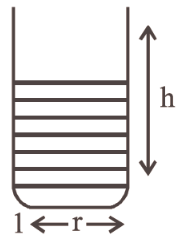
36. **(b)** $\beta_{dc} = \frac{I_C}{I_B}$

$= \frac{\text{Collector current}}{\text{Base current}}$

37. **(d)** $\Delta T = \frac{1}{2}T\alpha\theta$

$= \frac{1}{2} \times 9 \times 10^{-7} \times 10 \times 0.5$

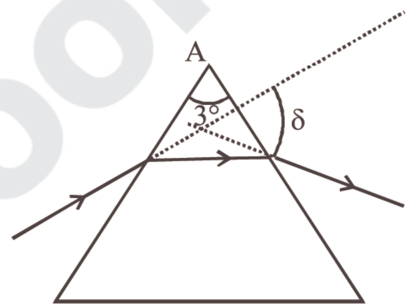
38. **(d)**



Height in the capillary

$h = \frac{2s\cos\theta}{\rho g r} \quad \therefore \quad h \propto \frac{1}{r}$

39. **(b)**



Angular deviation $\delta = (\mu - 1)A$

$\therefore 1 = (\mu - 1)3$

$\therefore \mu = 1 + \frac{1}{3}$

$= 1.33$

40. **(b)** Using conservation of energy

Total mechanical energy at surface = total mechanical energy at height h

Using this, we have

$\frac{1}{R} - \frac{1}{r} = \frac{1}{4R}$

$\therefore \frac{1}{r} = \frac{1}{R} - \frac{1}{4R}$

$= \frac{1}{R}.\frac{3}{4}$

$\therefore r = 4/3R$

$\therefore h = R/3$

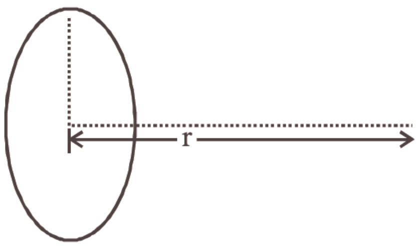
41. **(None)**

42. **(b)** $K_{max} = h\upsilon - \varphi$

$\therefore K_2 = 2h\upsilon - Wn = k + h\upsilon$

43. **(c)** From Doppler's effect. We know that frequency increases.

44. **(b)**



$$B_{axis} = \frac{\mu_0}{4\pi}\frac{2}{r^3}NIA$$

45. **(c)** Terminal velocity $\nu \propto \rho_s - \rho_l$

$$\therefore \frac{v_2}{v_1} = \frac{e_2 - \sigma}{e_1 - \sigma}$$

$$\therefore v_2 = \left[\frac{e_2 - \sigma}{e_1 - \sigma}\right]v$$

46. **(c)** $\alpha = \frac{Q_2}{Q_1 - Q_2}$

$$\therefore \frac{1}{\alpha} = \frac{Q_1 - Q_2}{Q_2}$$

$$= \frac{Q_1}{Q_2} - 1$$

$$\therefore \frac{Q_1}{Q_2} = 1 + \frac{1}{\alpha}$$

$$= \frac{\alpha + 1}{\alpha}$$

$$\therefore Q_2 = \frac{\alpha}{\alpha + 1}.Q_1$$

47. **(a)** $F = m\omega^2 r$

$$= mr\frac{4\pi^2}{T^2}$$

$$\therefore \sqrt{F} = \sqrt{mr}.\frac{2\pi}{T}$$

48. **(b)**

49. **(b)** $K_{max} = \frac{hc}{\lambda} - \varphi$

$$\therefore Vs = \frac{1}{2}\frac{mv^2}{e} = \frac{v^2}{2\frac{e}{m}}$$

50. **(b)** Focal length of new lens = 2 × focal length of convex lens.

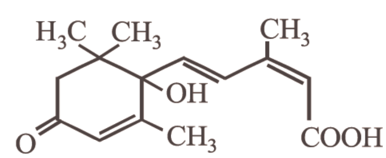
CHEMISTRY

51. **(d)** Wolframite is magnetic in nature whereas stannic oxide is non-magnetic in nature. Hence they can be separated by magnetic seperation method.

52. **(d)** $\overset{+7}{Mn}O_4^- + Br^- \longrightarrow \overset{+4}{Mn}O_2 + \overset{+5}{Br}O_3^-$

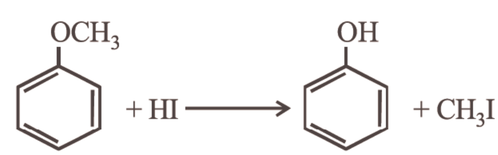
Hence (d) is correct option.

53. **(a)** Abscisic acid (molecular formula ($C_{15}H_{20}O_4$) composed of three isoprene residues and having a cyclohexene ring with keto and one hydroxyl group and a side chain with terminal carboxylic group in its structure.



Abscisic acid

54. **(a)**



55. (c) The decaffeination process includes soaking green coffee in hot water and then some of solvent or activated carbon is used to extract the caffeine. The solvent typically used are methylene dichloride or ethyl acetate.

56. (c) $[Co(NH_3)_5NO_2]SO_4 + BaCl_2 \rightarrow [Co(NH_3)_5NO_2]\,Cl_2 + \underset{\text{(White ppt)}}{BaSO_4}$

The precipitate of barium sulphate is white in colour.

57. (b) When concentrated HCl is added to a very diluted solution of $CuSO_4$, the pale blue solution slowly turns greenish yellow on the formation of copper chloride complex.

$\underset{\text{(Pale blue)}}{[Cu(H_2O)_6]^{2+}} + 4Cl^- \longrightarrow \underset{\text{(Yellow)}}{[CuCl_4]^{2-}} + 6H_2O$

58. (d) Novolac polymer is used in paints.

59. (a) Given, n = 3 moles, $v_1 = 0.3L$, $v_2 = 2.5L$, $P_{ext} = 1.9$ atm

Workdone in isothermal process, $w = -P_{ex}dv$

$\therefore\ w = -1.9 \times (2.5 - 0.3)$

$w = -4.18L\ atm$

$w = -4.18L\ atm \times 101.325\ JL^{-1}\ atm^{-1}$

$= -423.54J$

60. (b) *cis*-platin is used in the treatment of cancer.

61. (c) NaCl and KCl have same atomic ratio, similar molecular formula and similar chemical properties but different crystal structure. Thus NaCl and KCl are not isomorphous.

62. (b) 2, 4-dichlorophenoxy acetic acid is the active ingredient in many products as an herbicide to kill weeds on land and in the water.

63. (c) $CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g)$

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta H - \Delta U = \Delta n_g RT$

$\Delta n_g = 1 - 1 + \frac{1}{2} = -\frac{1}{2}$

$\therefore\ \Delta H - \Delta U = -\frac{1}{2} \times 2 \times 300$

$= -300cal$

64. (a) Conductivity decreases with decrease in concentration as the number of ions per unit volume that carries the current in a solution decreases on dilution.

65. (b)

$\underset{\text{Acetaldoxime}}{CH_3 - CH = N - OH} \xrightarrow[\text{alcohol}]{\text{Na}} \underset{(A)}{CH_3\,CH_2\,NH_2}$

$\xrightarrow[\text{HCl}]{\text{NaNO}_2} \underset{(B)}{CH_3\,CH_2OH} + H_2O + N_2$

66. (d) Frenkel defect is found in AgCl because there is a large difference between the size of Ag^+ and Cl^-. Hence the cation Ag^+ occupy the interstitial site by leaving a corresponding number of normal lattice site vacant.

67. (d) 0.1 molar $\approx$ 0.1 mol is present in 1L

Given volume = 200 mL $\approx$ 0.2L

No. of mole in 0.2 L liquid

$= \frac{2}{1} \times 0.1$

$=$ 0.02 mol of CO_2

$V = 0.02 \times 22.4 = 0.448L$

68. (d) The given reaction is an example of Wurtz reaction which is used in preparation of alkanes.

69. (a) Bacteriostatic antibiotics limit the growth of bacteria by interfering with bacterial protein production, DNA replication or other aspects of bacterial cellular metabolism. This group includes tetracyclines.

70. (a) Alkyl halides react with silver nitrite in ethanolic solution to give nitro compounds.

$R - X + Ag\,NO_2 \longrightarrow RNO_2 + Ag\,I$

71. (b) Bond length order for the given options is,

$C - H > C - C > C - N \approx C - O$

72. **(d)** Ethyl alcohol and water, after mixing, can very easily become a homogeneous mixture, because the two liquids are miscible, soluble in all proportions. The dipoles on the ethanol and water molecules cause the formation of hydrogen bonds between the molecules.

73. **(c)** Nicol's prism is a type of polarizer, an optical device made from calcite crystal. Calcite is a carbonate mineral and the most stable polymorph of calcium carbonate.

74. **(b)** Applying Faraday's second law of electrolysis

$$\frac{\text{wt. of Cu}}{\text{wt. of Al}} = \frac{E_W \text{ of Cu}}{E_W \text{ of Al}}$$

$$E_W \text{ of Cu} = \frac{\text{Atomic wt}}{\text{n factor}} = \frac{63.5}{2}$$

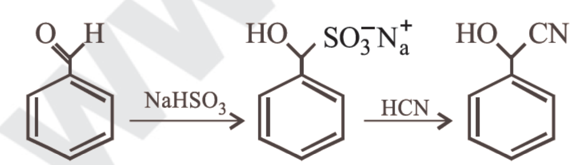
$$E_W \text{ of Al} = \frac{27}{3}$$

$$\therefore \frac{0.4 \times 63.5}{\text{wt of Al}} = \frac{31.75}{9}$$

wt of Al = 7.2 g

$$\text{wt of Al in moles} = \frac{7.2}{27} = 0.27 \text{ mol}$$

75. **(b)**



Benzaldehyde Mandelonitrile

76. **(a)** $K_2CrO_4 \longrightarrow 2K^+ + CrO_4^{2-}$

$K_2Cr_2O_7 \longrightarrow 2K^+ + Cr_2O_7^{2-}$

Both ions contain – 2 charge.

77. **(d)**

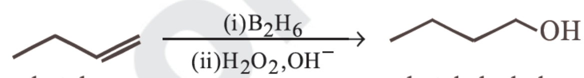
$$C_6H_5COCH_3 \xrightarrow[\text{Zn-Hg/conc. HCl}]{[H]} C_6H_5CH_2CH_3$$

Acetophenone Clemmensen reduction Ethylbenzene

78. **(a)** Molar mass of urea ($NH_2CO\,NH_2$)
$= 28 + 4 + 12 + 16 = 60$ g/mol.
60g urea contains 12g C.

$$\therefore \text{ 100g urea contains } \frac{12}{60} \times 100 = 20\% \text{ C}$$

79. **(c)**



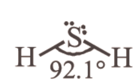
α-butylene n-butyl alcohol

80. **(b)**

$$\begin{aligned}
\Delta T_f &= i.K_f m \\
\text{Given, } \Delta T_f &= T_f^\circ - T_f \\
&= 0 - (-0.680) \\
&= +0.680°C \\
m &= 0.2 \\
K_f &= 1.86 \\
\text{Thus, } 0.680 &= i \times 0.2 \times 1.86 \\
i &= \frac{0.680}{0.2 \times 1.86} = 1.83
\end{aligned}$$

81. **(c)** NaCl, NH_3, $Ca(OH)_2$
$Ca(OH)_2$ is used for the regeneration of ammonia
$2NH_4Cl(aq) + Ca(OH)_2\,(aq/s) \rightarrow CaCl_2(aq) + 2NH_3(g) + 2H_2O(l)$

82. **(b)**



83. **(d)** mol dm^{-3} atm^{-1}

84. **(c)** Nitric oxide (pollutant) act as an homogeneous catalyst in the conversion of oxygen to ozone, since at very high concentration in air it converts into NO_2 which generate free oxygen atom.

85. **(d)** Bi does not exhibit allotropy.

86. **(b)** Nitrogen sesquioxide is N_2O_3.

87. **(c)** $\frac{-1}{2}\frac{d[SO_2]}{dt}=\frac{-d[O_2]}{dt}=\frac{1}{2}\frac{d[SO_3]}{dt}$

$$\therefore \quad \frac{d[SO_3]}{dt}=\frac{-2d[O_2]}{dt}$$

88. **(a)** $\Delta s=\frac{q_{rev}}{T}$

89. **(a)** Terylene is a synthetic polymer which is formed by the interaction of ethylene glycol and terephthalic acid.

90. **(b)** Copper

91. **(b)** The decomposition of ammonia on platinum surface is a zero order reaction.

92. **(b)** Resistance $(R)=2.5\times10^3$ ohm

$$\text{Conductivity }(\kappa)=\frac{\text{Cell constant}}{\text{Resistance}}$$

$$\text{Conductivity }(\kappa)=\frac{1.25\text{cm}^{-1}}{2.5\times10^3\text{ohm}}$$

$$=5\times10^{-4}\text{ohm}^{-1}\text{cm}^{-1}$$

$$\text{Molar conductivity }(\Lambda_m)=\frac{\kappa}{C}\times1000$$

$$\Lambda_m=\frac{5\times10^{-4}\text{ohm}^{-1}\text{cm}^{-1}}{0.1\text{ mol cm}^{-3}}\times1000$$

$$\Lambda_m=5\text{ ohm}^{-1}\text{ cm}^2\text{ mol}^{-1}$$

93. **(a)** $Ba(NO_3)_2 \longrightarrow Ba^{2+}+2NO_3^-$

n mol	0	0
n-nα	nα	2nα

Total moles of particles

$$=n-n\alpha+n\alpha+2n\alpha=n(1+2\alpha)$$

$$\text{Vant Haff factor }(i)=\frac{n(1+2\alpha)}{n}$$

$$2.74=\frac{n(1+2\alpha)}{n}=1+2\alpha$$

$$\alpha=\frac{2.74-1}{2}=0.87$$

94. **(d)** Ionic hydrides of S-block elements, in molten state, liberate dihydrogen gas at anode on electrolysis.

$$2H^-(\text{melt})\xrightarrow{\text{anode}}H_2(g)+2e^-$$

95. **(c)** Phosphine is formed by heating white phosphorous with conc. NaOH solution.

96. **(c)** $CH_3-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-\overset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2I$

1-Iodo-2, 3-dimethylpentane

97. **(c)**

$$\underset{\text{Propene}}{CH_3-CH=CH_2}+HCl\xrightarrow{\text{Peroxide}}\underset{\text{2-Chloropropane}}{CH_3-\overset{\displaystyle Cl}{\overset{|}{CH}}-CH_3}$$

98. **(b)** As we move down the group, M-H bond dissociation enthalpy of hydrides decreases. Therefore, reducing property of metal hydrides increases in the order as follows,

$PH_3 < AsH_3 < SbH_3 < BiH_3$

99. **(d)** Potassium sulphite is not an antiseptic.

100. **(a)** Secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structures viz. α-helix and β-pleated sheet structure.

SECTION-B

MATHEMATICS

1. **(d)** $\because$ P(x_1, y_1) lie on $x^2 - y^2 = a^2$.

then; $x_1^2 - y_1^2 = a^2$

$\Rightarrow x_1^2 - a^2 = y_1^2$ ...(i)

$\because x^2 - y^2 = a^2$ is an equation of rectangular hyperbola.

$\therefore e = \sqrt{2}$

$SP = ex_1 - a = \sqrt{2}x_1 - a$

$S'P = ex_1 + a = \sqrt{2}x_1 - a$

$\therefore SP.\ S'P = e^2x_1^2 - a^2 = 2x_1^2 - a^2$

$= x_1^2 + x_1^2 - a^2 = x_1^2 + y_1^2$ (from (i))

2. **(*)** $f(x) = \cos^{-1}\left[\dfrac{1-(\log x)^2}{1+(\log x)^2}\right]$

Let $1 + (\log x)^2 = u$

$\Rightarrow 1 - (\log x)^2 = 2 - u$

$$\Rightarrow f(u) = \cos^{-1}\left(\frac{2-u}{u}\right) = \cos^{-1}\left(\frac{2}{u} - 1\right)$$

$$\Rightarrow f'(u) = \left(\frac{\left(\frac{2}{u^2}\right)}{\sqrt{1-\left(\frac{2}{u}-1\right)^2}}\right) = \frac{1}{u\sqrt{u-1}}$$

$$\Rightarrow f'(x) = \frac{1}{(1+((\log x)^2)\sqrt{(\log x)^2}}$$

$$= \frac{1}{\log x\left(1+(\log x)^2\right)}$$

$$\Rightarrow f'(e) = \frac{1}{\log e(1+(\log e)^2)} = \frac{1}{2}$$

3. **(b)** Equation of family of circles whose radius is 4 is :

$(x-a)^2 + (y-b)^2 = 16$ ...(i)

(where a & b are arbitrary constant)

Differentiating we get:

$2(x-a) + 2(y-b)y_1$ ...(ii)

$\left(y_1 = \dfrac{dy}{dx}\right)$

Again differentiating we get :

$1 + y_1 \cdot y_1 + (y-b)y_2 = 0$ $\left(y_2 = \dfrac{d^2y}{dx^2}\right)$

$\Rightarrow 1 + y_1^2 + (y-b)y_2 = 0$

$\Rightarrow (y-b)y_2 = -\left(1+y_1^2\right)$

$$\Rightarrow y - b = -\frac{\left(1+y_1^2\right)}{y_2} \quad \text{...(iii)}$$

from (ii) we get:

$x - a = -(y-b)y_1$

$\therefore$ from (i), we get:

$(y-b)^2y_1^2 + (y-b)^2 = 16$

$\Rightarrow (y-b)^2 - (1+y_1^2) = 16$

$$\Rightarrow \left(\frac{(1+y_1^2)^2}{y_2^2}\right)\left(1+y_1^2\right) = 16 \quad \text{(from (iii))}$$

$\Rightarrow (1+y_1^2)^3 = 16y_2^2$

$$\Rightarrow \left[1+\left(\frac{dy}{dx}\right)^2\right]^3 = 16\left[\frac{d^2y}{dx^2}\right]^2$$

$\therefore$ Order = 2 & degree = 2

4. **(a)** $A=\begin{bmatrix} x & 1 \\ 1 & 0 \end{bmatrix}$

$|A| = 0 - 1 = -1$

$\therefore A^{-1} = -1\begin{bmatrix} 0 & -1 \\ -1 & x \end{bmatrix}$

$\because = A = A^{-1} \Rightarrow x = 0$

5. **(c)**

(a) $\lim\limits_{n\to 0} f(x) = \lim\limits_{n\to 0}(1+2x)^{1/x} = e^2$

$\& f(0) = e^2$

$\therefore$ Continuous at $x = 0$

(b) $\lim\limits_{n\to 0} f(x) = \lim\limits_{n\to 0}(\sin x - \cos x) = 0 - 1 = -1$

$\& f(0) = -1$

$\therefore$ Continuous at $x = 0$

(c) $\lim\limits_{n\to 0} f(x) = \lim\limits_{n\to 0} \dfrac{e^{1/x}-1}{e^{1/x}+1}$

$$= \lim_{n\to 0} \frac{e^{1/x}\left[1-\frac{1}{e^{1/x}}\right]}{e^{1/x}\left[1+\frac{1}{e^{1/x}}\right]}$$

$= \dfrac{(1-0)}{(1+0)} = 1 \& f(0) = -1$

$\therefore$ not continuous at $x = 0$

(d) $\lim\limits_{n\to 0} f(x) = \lim\limits_{n\to 0} \dfrac{e^{5x}-e^{2x}}{\sin 3x}$ $\quad \left(\dfrac{0}{0}\right)$

is using L' Hospital's rule :

$= \lim\limits_{n\to 0} \dfrac{5e^{5x}-2e^{2x}}{3\cos x} = \dfrac{5(1)-2(1)}{3} = \dfrac{3}{3} = 1$

$\therefore \& f(0) = 1$

$\therefore$ Continuous at $x = 0$

6. **(d)**

7. **(d)** $S_n = \dfrac{4^n - 3^n}{3^n}$ $\qquad S_1 = \dfrac{4-3}{3} = \dfrac{1}{3}$

$S_2 = \dfrac{4^2-3^2}{3^2} = \dfrac{16-9}{9} = \dfrac{7}{9}$

$\therefore t_2 = S_2 - S_1 = \dfrac{7}{9} - \dfrac{1}{3} = \dfrac{7-3}{9} = \dfrac{4}{9}$

8. **(a)** Given curves are $y = 2x - x^2$

$\& y = x$

From the above equations we get,

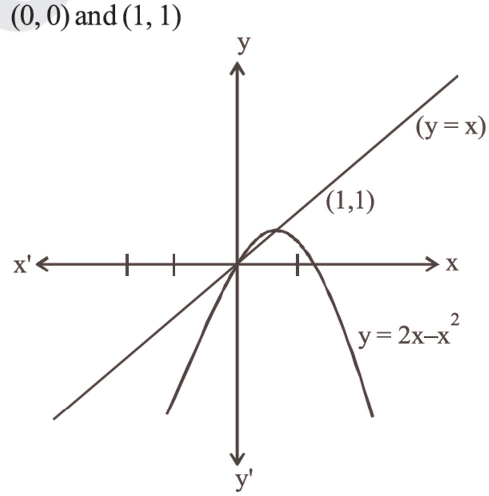
$x = 2x - x^2$

$\Rightarrow x^2 - x = 0$

$\Rightarrow x(x-1) = 0 \Rightarrow x = 0, 1$

$\Rightarrow y = 0, 1$ (respectively)

$\therefore$ intersecting points of the two curves are $(0, 0)$ and $(1, 1)$



$\therefore$ required area $= \int\limits_0^1 (2x - x^2)dx - \int\limits_0^1 x \cdot dx$

$= \left[\dfrac{2x^2}{2} - \dfrac{x^3}{3}\right]_0^1 - \left[\dfrac{x^2}{2}\right]_0^1$

$= \left[1 - \dfrac{1}{3}\right] - \left[\dfrac{1}{2}\right]$

$= \dfrac{2}{3} - \dfrac{1}{2} = \dfrac{1}{6}$ sq. units.

9. **(c)** Given : $x\frac{dy}{dx} = y - x\tan\left(\frac{y}{x}\right)$

$\Rightarrow \frac{dy}{dx} = \frac{y}{x} - \tan\left(\frac{y}{x}\right)$ ... (i)

Put $\frac{y}{x} = v \Rightarrow y = xv = \frac{dy}{dx} = v + x\frac{dv}{dx}$.

$\Rightarrow x\frac{dv}{dx} + v = v - \tan v$ [from (i)]

$\Rightarrow x\frac{dv}{dx} = -\tan v$

$\Rightarrow \frac{dv}{\tan v} = -\frac{dx}{x}$

$\Rightarrow \cot v\, dv = -\frac{dx}{x}$

Integrating we get :

ln (sin$v$) = –ln (xc)

$\Rightarrow$ ln (sin$v$) = $\ln\left(\frac{c_1}{x}\right)$.

$\Rightarrow \sin v = \frac{c_1}{x} \Rightarrow x\sin v = \frac{y}{x} = c_1$.

10. **(b)**

p	q	r	~r	~p	$p \wedge q$	$\sim p \wedge q$	$\sim r \vee (p \wedge q)$	$(p \wedge q) \wedge [\sim r \vee (p \wedge q)]$	$(p \wedge q) \wedge [\sim r \vee (p \wedge q)] \vee (\sim p \wedge q)$
T	T	T	F	F	T	F	T	T	T
T	T	F	T	F	T	F	T	T	T
T	F	T	F	F	F	F	F	F	F
T	F	F	T	F	F	F	T	F	F
F	T	T	F	T	F	T	F	F	T
F	T	F	T	T	F	T	T	F	T
F	F	T	F	T	F	F	F	F	F
F	F	F	T	T	F	F	T	F	F

$\therefore (p \wedge q) \wedge [\sim r \vee (p \wedge q)] \vee (\sim p \wedge q) \equiv q$

11. **(c)** Total number of balls = 10.

No. of ways of drawing 2 balls out of 10 = ${}^{10}C_2 = 45$

No. of ways of drawing 2 white balls out of 6 $= {}^{6}C_2 = 15$.

No. of ways of drawing 2 balck balls out of 4 $= {}^{4}C_2 = 6$.

$\therefore$ required probability $= \frac{15+6}{45} = \frac{21}{45} = \frac{7}{15}$.

12. **(b)** Let $I = \int \frac{\cos x + x\sin x}{x^2 + x\cos x}dx$

$= \int \frac{(x+\cos x) - x(1-\sin x)}{x(x+\cos)}dx.$

$= \int \left[\frac{1}{x} - \frac{(1-\sin x)}{(x+\cos x)}\right]dx.$

Put $f(x) = x + \cos x \Rightarrow f'(x) = 1 - \sin x$.

$\Rightarrow I = \int \left[\frac{1}{x} - \frac{f'(x)}{f(x)}\right]dx.$

$= \log|x| - \log|f(x)| + c$

$= \log\left|\dfrac{x}{x+\cos x}\right| + c.$

13. (a) Radius increases at the rate of 5 cm/sec.

$\therefore$ radius after 2 seconds = 10 cm.

Now, Area $(A) = \pi r^2$ $(r = \text{radius})$

$\Rightarrow \dfrac{dA}{dt} = 2\pi r.\dfrac{dr}{dt}.$

$\therefore$ after 2 seconds.

$\dfrac{dA}{dt} = 2\pi(10)(5) = 100\pi\, \text{cm}^2/\text{sec}.$

14. (a) $f(x) = 3x - 2$ and $g(x) = x^2$.

$\Rightarrow f[g(x)] = 3(x^2) - 2 = 3x^2 - 2.$

15. (c) "q only if p" is not equivalent "$p \to q$".

16. (b) $\displaystyle\int_{-3}^{3} (ax^5 + bx^3 + cx + k)dx$

$$= \left[\frac{ax^6}{6} + \frac{bx^4}{4} + \frac{cx^2}{2} + kx\right]_{-3}^{3}$$

$$= \left[\frac{a(3)^6}{6} + \frac{b(3)^4}{4} + \frac{c(3)^2}{2} + k(3)\right]$$

$$- \left[\frac{a(-3)^6}{6} + \frac{b(-3)^4}{4} + \frac{c(-3)^2}{2} + k(-3)\right]$$

$$= \frac{3^6 a}{6} + \frac{3^4 b}{4} + \frac{a}{2}c + 3k$$

$$- \frac{3^6 a}{6} - \frac{3^4 b}{4} - \frac{a}{2}c + 3k$$

$= 6k.$

$\therefore$ given integral depends only on k.

17. (d) Equation of all circles having centre at $(-1, 2)$ is :

$(x - (-1))^2 + (y - 2)^2 = r^2$ $(r = \text{radius}).$

$\Rightarrow (x+1)^2 + (y-2)^2 = r^2$

$\Rightarrow x^2 + 1 + 2x + y^2 + 4 - 4y = r^2.$

$\Rightarrow x^2 + y^2 + 2x - 4y + 5 - r^2 = 0.$

$\Rightarrow x^2 + y^2 + 2x - 4y + c = 0,$

where $(c = 5 - r^2)$.

Above equation is the required solution.

18. (d) $\because (A - 2I)(A - 4I) = 0$

$\Rightarrow A^2 - 4A - 2A + 8I = 0$

$\Rightarrow A^2 - 6A + 8I = 0$

Multiply A^{-1} both sides we get :

$A^{-1}.A.A - 6A^{-1}.A + 8A^{-1}.\text{I} = A^{-1}.0$

$\Rightarrow IA - 6I + 8A^{-1} = 0$

$\Rightarrow A - 6I + 8A^{-1} = 0$

$\Rightarrow A + 8A^{-1} = 6I.$

19. (d) Here; $\dfrac{7+p+q+1}{3} = 3 \Rightarrow p + q = 1$ ...(i)

$\dfrac{-8+q+5p}{3} = -5 \Rightarrow 5p + q = -7$ ....(ii)

and $\dfrac{1+5+0}{3} = r \Rightarrow r = 2$

Subtract (ii) form (i), we get:

$p + q - 5p - q = 1 + 7$

$\Rightarrow -4p = 8 \Rightarrow p = -2.$

from (1) we get,

$-2 + q = 1 \Rightarrow \text{q} = 3.$

$\therefore p = -2, q = 3 \;\&\; r = 2.$

20. (b) let $I = \displaystyle\int \frac{1}{(x^2+1)^2}dx$

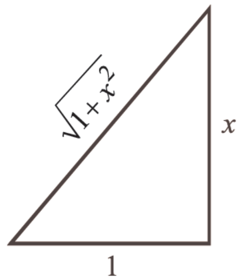
Put $x = \tan\theta \Rightarrow dx = \sec^2\theta\, d\theta.$

$\Rightarrow I = \displaystyle\int \frac{\sec^2\theta\, d\theta}{(\tan^2\theta + 1)^2} = \int \frac{\sec^2\theta}{\sec^4\theta} d\theta$

$\Rightarrow I = \displaystyle\int \cos^2\theta\, d\theta = \frac{1}{2}\int (\cos 2\theta + 1) d\theta$

$\Rightarrow I = \dfrac{1}{4}\sin 2\theta + \dfrac{\theta}{2} + c.$ ...(1)

$\because \tan\theta = x$



$\Rightarrow \sin\theta = \frac{x}{\sqrt{1+x^2}}$ & $\cos\theta = \frac{1}{\sqrt{1+x^2}}$.

$\Rightarrow \sin 2\theta = 2\sin\theta\cos\theta = \frac{2x}{(1+x^2)}$.

$\therefore\ I = \frac{1}{2}.\frac{x}{(1+x^2)} + \frac{1}{2}\tan^{-1}x + c.$

21. (d) $\because\ \theta = \frac{17\pi}{3} = 6\pi - \frac{\pi}{3}$.

$\therefore \tan\theta - \cot\theta = \tan\left(6\pi - \frac{\pi}{3}\right) - \cot\left(6\pi - \frac{\pi}{3}\right)$

$= -\tan\frac{\pi}{3} + \cot\frac{\pi}{3}$.

$= -\sqrt{3} + \frac{1}{\sqrt{3}} = \frac{-3+1}{\sqrt{3}} = \frac{-2}{\sqrt{3}}$

22. (c) Let $y = \log_{e^2}(\log x)$

$= \frac{\log(\log x)}{\log e^2} = \frac{\log(\log x)}{2}$.

$\Rightarrow \frac{dy}{dx} = \frac{1}{2}.\frac{1}{\log x}\frac{d}{dx}(\log x)$

$= \frac{1}{2\log x}.\frac{1}{x} = \frac{1}{2x\log x} = \frac{1}{x\log x^2}$

23. (d) $\because\ \cos A = \frac{\sin B}{\sin C}$

$\Rightarrow$ cos A sin C = sin B.

$\Rightarrow$ cos A sin C = sin (π – (A + C))

($\because$ A + B + C = π).

$\Rightarrow$ cos A sin C = sin (A + C)

$\Rightarrow$ cos A sin C = sin A cos C + cos A sin C

$\Rightarrow$ sin A cos C = 0

$\Rightarrow$ Either sin A = 0 or cos C = 0.

For sin A = 0, A = 0° (not possible)

For cos C = 0, C = 90°

$\therefore\ \Delta$ABC is right angled triangle.

24. (b) Let a is the first term & r is the common ratio.

$\therefore\ p = ar^{m+n-1}$ & $q = ar^{m-n-1}$

$\Rightarrow pq = a^2 r^{m+n-1} r^{m-n-1}$

$\Rightarrow pq = a^2 r^{2m-2} = (ar^{m-1})^2$

$\Rightarrow \sqrt{pq} = ar^{m-1} = m^{\text{th}}$ term.

25. (a)

$X = x$	1	2	3	4	5	6
$P(X = x)$	k	$3k$	$5k$	$7k$	$8k$	k

$\because \sum_{x=1}^{6} P(X) = 1$

$\Rightarrow k + 3k + 5k + 7k + 8k + k = 1 \Rightarrow k = \frac{1}{25}$

$\therefore\ P(2 \le x < 5) = P(2) + P(3) + P(4)$

$= 3k + 5k + 7k = 15 \times \frac{1}{25} = \frac{3}{5}$.

26. (d) $\because\ y = \log_e x \Rightarrow \frac{dy}{dx} = \frac{1}{x}$.

$\Rightarrow \left.\frac{dy}{dx}\right)_{(1,0)} = 1$.

$\therefore$ equation of normal is :

$(y - 0) = -1\ (x - 1)$

$\Rightarrow y = -x + 1 \Rightarrow x + y = 1$.

27. (b) $\because \sin x \cos x = \frac{1}{4} \Rightarrow 2\sin x \cos x = \frac{1}{2}$

$\Rightarrow \sin 2x = \frac{1}{2}$ Þ $2x = n\pi + (-1)^n \frac{\pi}{6}, n \in I.$

For $n = 0,\ x = \frac{\pi}{12}.$

For $n = 1,\ x = \frac{5\pi}{12}.$

$\therefore x$ has only 2 values is $\left(0, \frac{\pi}{2}\right).$

28. (c) $\because\ \vec{a}+\vec{b}, \vec{b}+\vec{c}$ and $\vec{c}+\vec{a}$ are coterminous edges of a parallelopiped.

Then, its volume $(v) = \left[\vec{a}+\vec{b}\quad \vec{b}+\vec{c}\quad \vec{c}+\vec{a}\right]$

We know, scalar triple product

$[\vec{a}\ \vec{b}\ \vec{c}] = \vec{a}.(\vec{b}\times\vec{c}) \equiv (\vec{a}\times\vec{b}).\vec{c}$

Consider $[\vec{a}+\vec{b}\quad \vec{b}+\vec{c}\quad \vec{c}+\vec{a}]$

$= (\vec{a}+\vec{b}) . \{(\vec{b}+\vec{c}) \times (\vec{c}+\vec{a})\}$

$= (\vec{a}+\vec{b}).\{(\vec{b}\times\vec{c}) + (\vec{b}\times\vec{a}) + (\vec{c}\times\vec{c}) + (\vec{c}\times\vec{a})\}$

$= (\vec{a}+\vec{b}) . \{(\vec{b}\times\vec{c}) + (\vec{b}\times\vec{a}) + (\vec{c}\times\vec{a})\}$

$(\because \vec{c}\times\vec{c} = 0)$

$= \vec{a} . (\vec{b}\times\vec{c}) + \vec{a} .(\vec{b}\times\vec{a}) + \vec{a} .(\vec{c}\times\vec{a}) + \vec{b} .(\vec{b}\times\vec{c}) + \vec{b} .(\vec{b}\times\vec{a}) + \vec{b} .(\vec{c}\times\vec{a})$

$= [\vec{a}\ \vec{b}\ \vec{c}] + [\vec{a}\ \vec{b}\ \vec{a}] + [\vec{a}\ \vec{c}\ \vec{a}] + [\vec{b}\ \vec{b}\ \vec{c}] + [\vec{b}\ \vec{b}\ \vec{a}] + [\vec{b}\ \vec{c}\ \vec{a}]$

$= [\vec{a}\ \vec{b}\ \vec{c}] + [\vec{b}\ \vec{c}\ \vec{a}] = 2\ [\vec{a}\ \vec{b}\ \vec{c}]$

29. (a)

30. (a) Equations of lines are :

$(x-0) = (1+\sqrt{2})(y-0)$ & $(x-0)$

$= \left(\frac{1}{1+\sqrt{2}}\right)(y-0)$

or $x = y(1+\sqrt{2})$ & $x = \frac{y}{1+\sqrt{2}} \times \frac{1-\sqrt{2}}{1-\sqrt{2}}$

or $x - y(1+\sqrt{2}) = 0$ & $x + y\ (1-\sqrt{2}) = 0$

$\therefore$ joint equation is :

$\left[x - y(1+\sqrt{2})\right]\left[x + y(1-\sqrt{2})\right] = 0$

$\Rightarrow x^2 + xy(1-\sqrt{2}) - xy(1+\sqrt{2}) - y^2(1-(\sqrt{2})^2) = 0$

$\Rightarrow\ x^2 + xy - xy\sqrt{2} - xy - xy\sqrt{2} - y^2(-1) = 0$

$\Rightarrow\ x^2 - 2\sqrt{2}xy + y^2 = 0.$

31. (d) Angle beween the lines :

$\frac{x-x_1}{a_1} = \frac{y-y_1}{b_1} = \frac{z-z_1}{c_1}$

and $\frac{x-x_2}{a_2} = \frac{y-y_2}{b_2} = \frac{z-z_2}{c_2}.$

is :

$$\cos\theta = \left|\frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{a_1^2+b_1^2+c_1^2}\sqrt{a_2^2+b_2^2+c_2^2}}\right|$$

$\therefore$ angle between two given lines is :

$$\cos q = \left|\frac{(2)(1)+(-2)(2)+(1)(2)}{\sqrt{4+4+1}\sqrt{1+4+4}}\right|$$

$$= \left|\frac{2-4+2}{9}\right|$$

$\Rightarrow \cos\theta = 0 \Rightarrow \theta = 90°.$

32. (c) Here the given three points P (6, –1, 2), Q(8, –7, 2λ) and R (5, 2, 4) are collinear.
we know that if three points (x_1, y_1, z_1), (x_2, y_2, z_2) and (x_3, y_3, z_3) are collinear, then

$$\frac{x_1-x_2}{x_2-x_3}=\frac{y_1-y_2}{y_2-y_3}=\frac{z_1-z_2}{z_2-z_3}.$$

$$\therefore \frac{6-8}{8-5}=\frac{-1+7}{-7-2}=\frac{2-2\lambda}{2\lambda-4}$$

$$\Rightarrow \frac{-2}{3}=\frac{2-2\lambda}{2\lambda-4}\Rightarrow -4\lambda+8=6-6\lambda$$

$$\Rightarrow 2\lambda=-2 \Rightarrow \lambda=-1.$$

33. (a) $\sim(p\to\sim q)=p\wedge\sim(\sim q)=p\wedge q$

34. (d) $x^2-5|x|+6=0.$
If $x<0$, then $|x|=-x$
$\therefore x^2+5x+6=0$
$\Rightarrow x^2+3x+2x+6=0$
$\Rightarrow x(x+3)+2(x+3)=0$
$\Rightarrow (x+3)(x+2)=0$
$\Rightarrow x=-3,-2.$
If $x>0$, then $|x|=x$
$\therefore x^2-5x+6=0$
$\Rightarrow x^2-3x-2x+6=0$
$\Rightarrow x(x-3)-2(x-3)=0$
$\Rightarrow (x-2)(x-3)=0$
$\Rightarrow x=2, 3.$
$\therefore n(A)=4.$

35. (b)

$$\lim_{x\to0} f(x)=\lim_{x\to0}\frac{\log(1+ax)-\log(1-bx)}{x}\left(\frac{0}{0}\right)$$

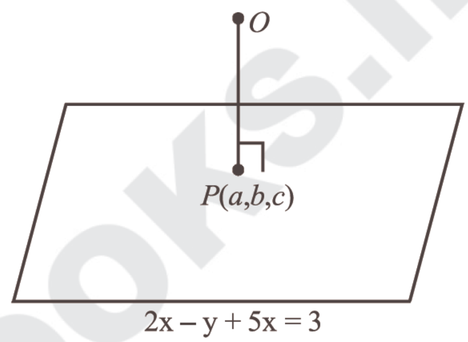
$$=\lim_{x\to0}\frac{\frac{a}{1+ax}+\frac{b}{1-bx}}{1} \text{ (Using L' Hospital's Rule)}$$

$$=\frac{a}{1+0}+\frac{b}{1-0}=a+b.$$

$\because$ $f(x)$ is continuous at $x=0$.

$$\therefore f(0)=\lim_{x\to0} f(x)=a+b.$$

36. (d) let the co-ordinates of foot of perpendicular from the orgin (0) to the plane $2x-y+5x=3$ is $P(a, b, c)$.
$\therefore$ direction ratios of OP are $<a, b, c>$ which is also the direction ratios of normal to the given plane.



$$\therefore \frac{a}{2}=\frac{b}{-1}=\frac{c}{5}=k.$$

$\Rightarrow a=2k, b=-k, c=5k.$
$\because P(a, b, c)$ passes the given plane
$\therefore 2(2k)-(-k)+5(5k)=3$
$\Rightarrow 4k+k+25k=3$

$$\Rightarrow k=\frac{3}{30}=\frac{1}{10}.$$

$$\therefore a=\frac{2}{10}=\frac{1}{5};\ b=-\frac{1}{10} \text{ and } c=\frac{5}{10}=\frac{1}{2}.$$

37. (a) Let $I=\int\frac{\sqrt{x^2-a^2}}{x}dx$

Put $x=a\sec\theta \Rightarrow dx=a\sec\theta\tan\theta\, d\theta$

$$\Rightarrow I=\int\frac{\sqrt{a^2(\sec^2\theta-1)}}{a\sec\theta}.\,a\sec\theta\tan\theta\, d\theta$$

$$=\int a\tan^2\theta.d\theta=a\int(\sec^2\theta-1)d\theta$$

$$=a(\tan\theta-\theta)+c\ \ (\because \int\sec^2 x\, dx=\tan x).$$

$$=a\sqrt{\sec^2\theta-a}-a\,\theta+c$$

$$= a\sqrt{\left(\frac{x^2}{a^2}\right) - a} - a\sec^{-1}\left(\frac{x}{a}\right) + c.$$

$$\left(\because \ \sec\theta = \frac{x}{a}\right)$$

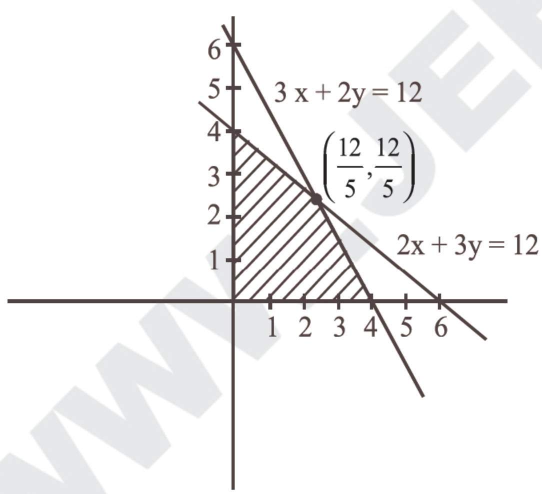
$$= \sqrt{x^2 - a^2} - a \ \ \sec{-1}\left(\frac{x}{a}\right) + c.$$

$$= \sqrt{x^2 - a^2} - a\cos{-1}\left(\frac{a}{x}\right) + c.$$

38. **(d)** $\because \ 3x + 2y$ £ 12 or $\frac{x}{4} + \frac{y}{6}$ £ 1

$2x + 3y$ £ 12 or $\frac{x}{6} + \frac{y}{4}$ £ $1.$

and x ³ 0 , y ³ 0



$\therefore$ Corner points are : (0, 0), (0, 4),(4, 0) and $\left(\frac{12}{5}, \frac{12}{5}\right)$.

$\because z = 9x + 11y.$
At $(0, 0)$, $z = 0.$
At $(0, 4)$, $z = 44.$
At $(4, 0)$, $z = 36.$

At $\left(\frac{12}{5}, \frac{12}{5}\right), z = \frac{108 + 132}{5} = \frac{240}{5} = 48.$

$\therefore$ maximum value of z is 48.

39. **(c)** Let $I = \int_0^4 \frac{1}{1+\sqrt{x}}\,dx$

put $u = \sqrt{x} \Rightarrow u^2 = x \Rightarrow 2u\,du = dx.$
when $x = 0, u = 0$ & when $x = 4, u = 2.$

$$\Rightarrow I = \int_0^2 \frac{1}{1+u} 2u\,du.$$

$$= 2\int_0^2 \frac{u}{1+u}\,du$$

put $1 + u = w \Rightarrow du = dw.$
when $u = 0, w = 1$ & when $u = 2, w = 3$

$$\Rightarrow I = 2\int_0^3 \frac{w-1}{w}\,dw = 2\int_1^3 \left(1 - \frac{1}{w}\right)dw$$

$$= 2\left[w - \log w\right]_1^3$$
$$= 2[3 - \log 3] - 2\,[1 - \log 1]$$
$$= 6 - 2\log 3 - 2 = 4 - 2\log 3$$

$$= 4\log e - \log 3^2 = \log e^4 - \log 9 = \log\left(\frac{e^4}{9}\right)$$

40. **(c)** $\because \sin^2 q = \frac{1}{2}$

$$\Rightarrow \sin^2\theta = \left(\frac{1}{\sqrt{2}}\right)^2$$

$$\Rightarrow \sin^2\theta = \sin^2\left(\frac{\pi}{4}\right).$$

$$\Rightarrow \theta = n\pi \pm \frac{\pi}{4},\ n \in I.$$

$\therefore$ in $[0, \pi]$, there are only two solutions i.e; $\frac{\pi}{4}$ and $\frac{3\pi}{4}$.

41. **(c)** $[\vec{p}+\vec{q}-\vec{r} \quad \vec{p}-\vec{q} \quad \vec{q}-\vec{r}]$

$=(\vec{p}+\vec{q}-\vec{r}).[(\vec{p}-\vec{q})\times(\vec{q}-\vec{r})].$

$=(\vec{p}+\vec{q}-\vec{r}).[\vec{p}\times\vec{q}-\vec{p}\times\vec{r}-\vec{q}\times\vec{q}+\vec{q}\times\vec{r}]$

$=[\vec{p}+\vec{q}-\vec{r}].[\vec{p}\times\vec{q}-\vec{p}\times\vec{r}+\vec{q}\times\vec{r}] \quad (\because \vec{a}\times\vec{a}=0)$

$=[\vec{p}\ \vec{p}\ \vec{q}]-[\vec{p}\ \vec{p}\ \vec{r}]+[\vec{p}\ \vec{q}\ \vec{r}]+[\vec{q}\ \vec{p}\ \vec{q}]-[\vec{q}\ \vec{p}\ \vec{r}]$

$+[\vec{q}\ \vec{q}\ \vec{r}]-[\vec{r}\ \vec{p}\ \vec{q}]+[\vec{r}\ \vec{p}\ \vec{r}]-[\vec{r}\ \vec{q}\ \vec{r}]$

$=0-0+[\vec{p}\,\vec{q}\,\vec{r}]-0-[\vec{q}\,\vec{p}\,\vec{r}]+0-[\vec{r}\,\vec{p}\,\vec{q}]+0-0$

$[\because [\vec{a}\ \vec{a}\ \vec{b}]=0]$

$=[\vec{p}\ \vec{q}\ \vec{r}]+[\vec{p}\ \vec{q}\ \vec{r}]-[\vec{p}\ \vec{q}\ \vec{r}]$

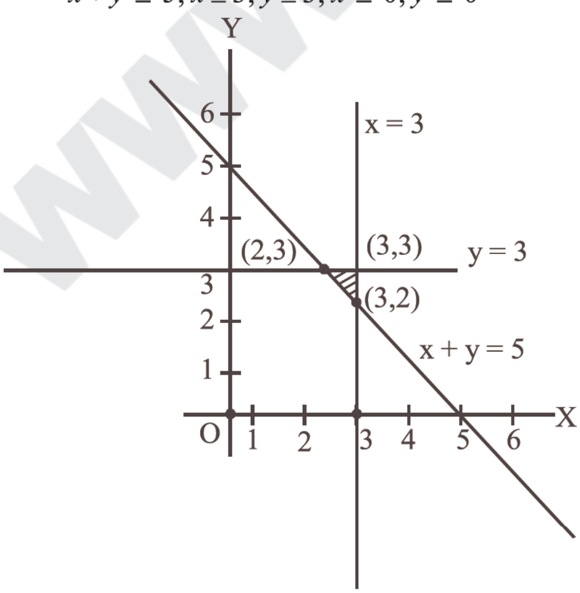
$\because [\vec{a}\ \vec{b}\ \vec{c}]=[\vec{b}\ \vec{c}\ \vec{a}]=-[\vec{b}\ \vec{a}\ \vec{c}]$

$=[\vec{p}\ \vec{q}\ \vec{r}].$

42. **(b)** $\cos\theta=\sqrt{2}$ has no solution, since value of $\cos\theta$ lies in $[-1, 1]$

43. **(a)** $z=10x+25y$ subject to :

$x+y \geq 5; x\leq 3; y\leq 3; x \geq 0; y \geq 0$



$\therefore$ Corner points of the bounded region are : (3, 2), (2, 3) & (3, 3)

$z=10x+25y.$

At (3, 2), $z=30+50=80$ (Minimum).

At (2, 3), $z=20+75=95$

At (3, 3), $z=30+75=105.$

44. **(b)** $f(x)=3x^3-9x^2-27x+15.$

$f'(x)=9x^2-18x-27.$

For maxima or minima :

$f'(x)=0 \Rightarrow 9x^2-18x-27=0.$

$\Rightarrow x^2-2x-3=0$

$\Rightarrow x^2-3x+x-3=0$

$\Rightarrow x(x-3)+1(x-3)=0$

$\Rightarrow x=-1, 3.$

$f''(x)=18x-18.$

$f''(-1)=-18-18=-36<0$

$f''(3)=18(3)-18=36>0.$

$\therefore f(x)$ has maximum value at $x=-1.$

& max. value $=3(-1)^3-9(-1)^2-27(-1)+15$

$=-3-9+27+15=30.$

45. **(a)** We know that equation of plane passing through a point with position vector $\vec{a}$ and normal to the vector $\vec{r}$ is :

$(\vec{r}-\vec{a})\cdot n=0$

$\because$ the plane passes through (–1, 2, 1)

$\therefore \vec{a}=-\hat{i}+2\hat{j}+\hat{k}$

Also plane is perpendicular to the line containing (–3, 1, 2) and (2, 3, 4)

$\therefore \vec{n}=5\hat{i}+2\hat{j}+2\hat{k}$

$\therefore$ required equation is :

$[\vec{r}-(-\hat{i}+2\hat{j}+\hat{k})].(5\hat{i}+2\hat{j}+2\hat{k})=0$

$\Rightarrow \vec{r}.(5\hat{i}+2\hat{j}+2\hat{k})$

$-[(-\hat{i}+2\hat{j}+\hat{k}).(5\hat{i}+2\hat{j}+2\hat{k})]=0$

$\Rightarrow \vec{r}.(5\hat{i}+2\hat{j}+2\hat{k})-[-5+4+2]=0$

$\Rightarrow \vec{r}.(5\hat{i}+2\hat{j}+2\hat{k})=1$

46. (b) For $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$

Length of transverse axis $= 2a = 6 \Rightarrow a = 3$

and length of latus rectum $= \frac{2b^2}{a}=\frac{8}{3}$

$\Rightarrow \frac{2b^2}{3}=\frac{8}{3} \Rightarrow b^2 = 4$

$\therefore$ equation of hyperbola is :

$\frac{x^2}{9}-\frac{y^2}{4}=1$

$\Rightarrow 4x^2-9y^2=36$

47. (b) $\because \tan^{-1}+\tan^{-1}y=\tan^{-1}\left(\frac{x+y}{1-xy}\right)$, if $xy<1$.

$\therefore \tan^{-1}\frac{1}{3}+\tan^{-1}\frac{1}{5}+\tan^{-1}\frac{1}{7}+\tan^{-1}\frac{1}{8}$

$=\tan^{-1}\left[\frac{\frac{1}{3}+\frac{1}{5}}{1-\frac{1}{15}}\right]+\tan^{-1}\left[\frac{\frac{1}{7}+\frac{1}{8}}{1-\frac{1}{56}}\right]$

$=\tan^{-1}\left[\frac{\frac{5+3}{15}}{\frac{14}{15}}\right]+\tan^{-1}\left[\frac{\frac{7+8}{56}}{\frac{55}{56}}\right]$

$=\tan^{-1}\frac{8}{14}+\tan^{-1}\frac{15}{55}$

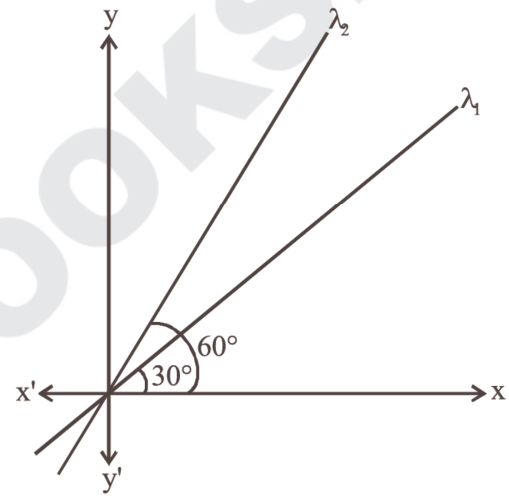
$=\tan^{-1}\frac{4}{7}+\tan^{-1}\frac{3}{11}$

$=\tan^{-1}\left[\frac{\frac{4}{7}+\frac{3}{11}}{1-\frac{12}{77}}\right]=\tan^{-1}\left[\frac{\frac{44+21}{77}}{\frac{65}{77}}\right]$

$=\tan^{-1}\left(\frac{65}{65}\right)$

$=\tan^{-1}(1)=\frac{\pi}{4}$

48. (a) Let ℓ_1 and ℓ_2 are the two lines, which trisects the first quadrant (as shown in the figure)



slope of $\ell_1 = \tan 30° = \frac{1}{\sqrt{3}}$

and slope of $\ell_2 = \tan 60° = \sqrt{3}$

$\therefore$ equation of ℓ_i is :

$x=\frac{y}{\sqrt{3}}$ ($\because \ell_i$ passes through centre)

& equation of ℓ_2 is :

$x=\sqrt{3}y$ ($\because \ell_2$ passes through centre)

$\therefore$ joint equation is :

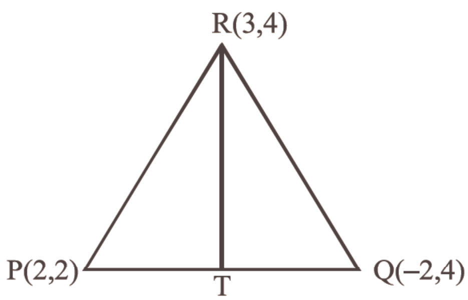
$\left(x-\frac{y}{\sqrt{3}}\right)(x-\sqrt{3}y)=0$

$x^2-\sqrt{3}xy-\frac{xy}{\sqrt{3}}+y^2=0$

$$\Rightarrow \frac{\sqrt{3}x^2 - 3xy - xy + \sqrt{3}y^2}{\sqrt{3}} = 0$$

$$\Rightarrow \sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$$

49. **(b)** From figure it is clear that T is the mid point of PQ



$\therefore$ co-ordinates of $T \equiv \left(\frac{2-2}{2}, \frac{2+4}{2}\right)$

$\equiv (0,3).$

Equation of RT is $(y-4) = \left(\frac{3-4}{0-3}\right)(x-3)$

or $(y-4) = \frac{1}{3}(x-3)$ or $3y - 12 = x - 3$

or $x - 3y + 9 = 0.$

50. **(a)** $x = \sqrt{a^{\sin^{-1}t}}$

$$\Rightarrow \frac{dx}{dt} = \frac{1}{2\sqrt{a^{\sin^{-1}t}}}.\frac{a^{\sin^{-1}t}\log a}{\sqrt{1-t^2}} = \frac{\log a}{2}\frac{\sqrt{a^{\sin^{-1}t}}}{\sqrt{1-t^2}}.$$

and $y = \sqrt{a^{\cos^{-1}t}}$

$$\Rightarrow \frac{dy}{dt} = \frac{1}{2\sqrt{a^{\cos^{-1}t}}}.\frac{a^{\cos^{-1}t}\log a}{\left(-\sqrt{1-t^2}\right)} = \frac{-\log a}{2}\frac{\sqrt{a^{\cos^{-1}t}}}{\sqrt{1-t^2}}.$$

$$\therefore \frac{dy}{dt} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{-\log a}{2}\frac{y}{\sqrt{1-t^2}} \times \frac{2}{\log a}\frac{\sqrt{1-t^2}}{x} = \frac{-y}{x}.$$

MHT-CET 2018

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  ***Section-A:** Physics & Chemistry - 50 Questions each and*
  ***Section-B:** Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. The path length of oscillation of simple pendulum of length 1 meter is 16 cm. Its maximum velocity is ($g = \pi^2$ m/s^2)

(a) 2π cm/s (b) 4π cm/s
(c) 8π cm/s (d) 16π cm/s

2. A vessel completely filled with water has holes 'A' and 'B' at depths 'h' and '3h' from the top respectively. Hole 'A' is a square of side 'L' and 'B' is circle of radius 'r'. The water flowing out per second from both the holes is same. Then 'L' is equal to

(a) $r^{\frac{1}{2}}(\pi)^{\frac{1}{2}}(3)^{\frac{1}{2}}$ (b) $r\cdot(\pi)^{\frac{1}{2}}(3)^{\frac{1}{4}}$

(c) $r\cdot(\pi)^{\frac{1}{2}}(3)^{\frac{1}{4}}$ (d) $r^{\frac{1}{2}}(\pi)^{\frac{1}{3}}(3)^{\frac{1}{2}}$

3. A transistor is used as a common emitter amplifier with a load resistance 2 KΩ. The input resistance is 150 Ω. Base current is changed by 20 μA which results in a change in collector current by 1.5 mA. The voltage gain of the amplifier is

(a) 900 (b) 1000 (c) 1100 (d) 1200

4. A dics has mass 'M' and radius 'R'. How much tangential force should be applied to the rim of the disc so as to rotate with angular velocity 'ω' in times 't' ?

(a) $\frac{MR\omega}{4t}$ (b) $\frac{MR\omega}{2t}$

(c) $\frac{MR\omega}{t}$ (d) $MR\,\omega\,t$

5. A circular coil carrying current 'I' has radius 'R' and magnetic field at the centre is 'B'. At what distance from the centre along the axis of the magnetic field will be $\frac{B}{8}$?

(a) $R\sqrt{2}$ (b) $R\sqrt{3}$ (c) 2R (d) 3R

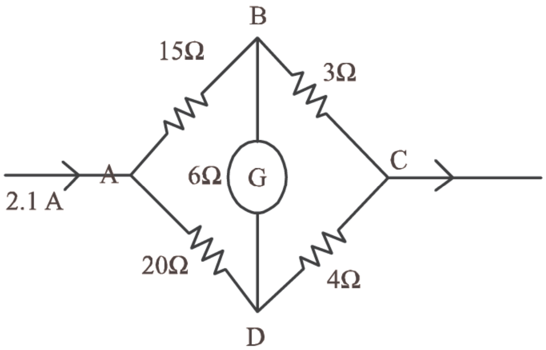
6. Two light waves of intensities 'I_1' and 'I_2' having same frequency pass through same medium at a time in same direction and interface. The sum of the minimum and maximum intensities is

(a) $(I_1 + I_2)$ (b) $2(I_1 + I_2)$
(c) $(\sqrt{I_1} + \sqrt{I_2})$ (d) $(\sqrt{I_1} - \sqrt{I_2})$

7. An alternative voltage e = $200\sqrt{2}$ sin (100 t) volt is connected to 1 μF capacitor through a.c. ammeter. The reading of ammeter is

(a) 5 mA (b) 10 mA (c) 15 mA (d) 20 mA

8. In the following network, the current flowing through 15Ω resistance is



(a) 0.8 A (b) 1.0 A (c) 1.2 A (d) 1.4 A

9. The angle made by incident ray of light with normal of the reflecting surface is called
(a) glancing angle (b) angle of incidence
(c) angle of deviation (d) angle of refraction

10. In non uniform circular motion, the ratio of tangential to radius acceleration is (r = radius of circle, v = speed of the particle, α = angular acceleration)

(a) $\frac{\alpha^2 r^2}{v}$ (b) $\frac{\alpha^2 r}{v^2}$ (c) $\frac{\alpha r^2}{v^2}$ (d) $\frac{v^2}{r^2\alpha}$

11. If numerical aperture of a microscope is increased then its
(a) resolving power remains constant
(b) resolving power becomes zero
(c) limit of resolution is decreased
(d) limit of resolution is increased

12. In amplitude modulation
(a) amplitude remains constant but frequency changes
(b) both amplitude and frequency do not change
(c) both amplitude and frequency change
(d) amplitude of the carrier wave changes according to information signal

13. If M_Z = magnetization of a paramagnetic sample, B = external magnetic field, T = absolute temperature, C = curie constant then according to Curie's law in Magnetism, the correct relation is

(a) $M_z = \frac{T}{CB}$ (b) $M_z = \frac{CB}{T}$

(c) $C = \frac{M_z B}{T}$ (d) $C = \frac{T^2}{M_z B}$

14. An electron of stationary hydrogen atom jumps from 4th energy level to ground level. The velocity that the photon acquired as a result of electron transition will be (h = Planck's constant, R = Rydberg's constant, m = mass of photon)

(a) $\frac{9Rh}{16m}$ (b) $\frac{11hR}{16m}$

(c) $\frac{13hR}{16m}$ (d) $\frac{15hR}{16m}$

15. A metal wire of density 'ρ' floats on water surface horizontally. If it is **NOT** to sink in water then maximum radius of wire is proportional to (T = surface of water, g = gravitational acceleration)

(a) $\sqrt{\frac{T}{\pi\rho g}}$ (b) $\sqrt{\frac{\pi\rho g}{T}}$

(c) $\frac{T}{\pi\rho g}$ (d) $\frac{\pi\rho g}{T}$

16. A sphere of mass 'm' moving with velocity 'v' collides head-on another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)

(a) $\frac{e-1}{2}$ (b) $\frac{e}{2}$ (c) $\frac{e+1}{2}$ (d) e

17. For a particle performing linear S.H.M., its average speed over one oscillation is (a = amplitude of S.H.M., n = frequency of oscillation)
(a) 2 an (b) 4 an (c) 6 an (d) 8 an

18. An ideal transformer converts 220 V a.c. to 3.3 kV a.c. to transmit a power of 4.4 kW. If primary coil has 600 turns, then alternating current in secondary coil is

(a) $\frac{1}{3}$ A (b) $\frac{4}{3}$ A (c) $\frac{5}{3}$ A (d) $\frac{7}{3}$ A

19. A conducing wire has length 'L_1' and diameter 'd_1'. After stretching the same wire length becomes 'L_2' and diameter 'd_2' The ratio of resistances before and after stretching is

(a) $d_2^4 : d_1^4$ (b) $d_1^4 : d_2^4$

(c) $d_2^2 : d_1^2$ (d) $d_1^2 : d_2^2$

20. The molar specific heat of an ideal gas at constant pressure and constant volume is 'C_p' and 'C_V' respectively. If 'R' is the universal gas constant and the ratio of 'C_p' to 'C_v' is 'γ' then C_V=

(a) $\frac{1-\gamma}{1+\gamma}$ (b) $\frac{1+\gamma}{1-\gamma}$ (c) $\frac{\gamma-1}{R}$ (d) $\frac{R}{\gamma-1}$

21. In a capillary tube having area cross-section 'A' water rises to a height 'h'. If cross-sectional area is reduced to $\frac{A}{9}$, the rise of water in the capillary tube is

(a) 4h (b) 3h (c) 2h (d) h

22. With forward biased mode, the p-n junction diode

(a) is one in which width of depletion layer increases
(b) is one in which potential barrier increases
(c) acts as closed switch
(d) acts as open switch

23. An alternating electric field of frequency 'v' is applied across the dees (radius R) of a cyclotron to accelerate protons (mass m). The operating magnetic field 'B' used and K.E. of the proton beam produced by it are respectively (e = charge on proton)

(a) $\frac{2\pi mv}{e}, 2\pi^2 mv^2R^2$

(b) $\frac{2\pi^2 mv}{e^2}, 4\pi^2 mv^2R^2$

(c) $\frac{\pi mv}{e}, \pi^2 mv^2R^2$

(d) $\frac{2\pi^2 m^2 v^2}{e}, 2\pi^2 mv^2R^2$

24. A ray of light is incident normally on a glass slab of thickness 5 cm and refractive index 1.6. The time taken to travel by a from source of slab is same as to travel through glass slab. The distance of source from the surface is

(a) 4 cm (b) 8 cm (c) 12 cm (d) 16 cm

25. A string is vibrating in its fifth overtone between two rigid supports 2.4 m apart. The distance between successive node and antinode is

(a) 0.1 m (b) 0.2 m (c) 0.6 m (d) 0.8 m

26. If $\vec{A}=3\hat{i}-2\hat{j}+\hat{k}, \vec{B}=\hat{i}-3\hat{j}+5\hat{k}$ and $\vec{C}=2\hat{i}+\hat{j}-4\hat{k}$ form a right angled triangle then out of the following which one is satisfied ?

(a) $\vec{A}=\vec{B}+\vec{C}$ and $A^2=B^2+C^2$

(b) $\vec{A}=\vec{B}+\vec{C}$ and $B^2=A^2+C^2$

(c) $\vec{B}=\vec{A}+\vec{C}$ and $B^2=A^2+C^2$

(d) $\vec{B}=\vec{A}+\vec{C}$ and $A^2=B^2+C^2$

27. A square frame ABCD is formed by four identical rods each of mass 'm' and length 'ℓ'. This frame is in X-Y plane such that side AB coincides with X-axis and side AD along Y-axis. The moment of inertia of the frame about X-axis is

(a) $\frac{5ml^2}{3}$ (b) $\frac{2ml^2}{3}$ (c) $\frac{4ml^2}{3}$ (d) $\frac{ml^2}{12}$

28. A unit vector is represented as $(0.8\hat{i}+b\hat{j}+0.4\hat{k})$. Hence the value of 'b' must be

(a) 0.4 (b) $\sqrt{0.6}$ (c) 0.2 (d) $\sqrt{0.2}$

29. Magnetic susceptibility for a paramagnetic and diamagnetic materials is respectively

(a) small, positive and small, positive
(b) large, positive and small, negative
(c) small, positive and small, negative
(d) large, negative and large, positive

30. A mass is suspended from a vertical spring which is executing S.H.M. of frequency 5 Hz. The spring is unstretched at the highest point of oscillation. Maximum speed of the mass is [acceleration due to gravity g = 10 m/s^2]

(a) 2π m/s (b) π m/s

(c) $\frac{1}{2\pi}$ m/s (d) $\frac{1}{\pi}$ m/s

31. The moment of inertia of a ring about an axis passing through the centre and perpendicular to its plane is 'I'. It is rotating with angular velocity 'ω'. Another identical ring is gently placed on it so that their centres coincide. If both the rings are rotating about the same axis then loss in kinetic energy is

(a) $\frac{I\omega^2}{2}$ (b) $\frac{I\omega^2}{4}$ (c) $\frac{I\omega^2}{6}$ (d) $\frac{I\omega^2}{8}$

32. A bomb at rest explodes into 3 parts of same mass. The momentum of two parts is $-3P\hat{i}$ and $2P\hat{j}$ respectively. The magnitude of momentum of the third part is

(a) P (b) 5P (c) 11 P (d) $\sqrt{13}$ P

33. In a photocell, frequency of incident radiation is increased by keeping other factors constant ($\nu > \nu_0$), the stopping potential
(a) decreases
(b) increases
(c) becomes zero
(d) first decreases and then increase

34. A mass attached to one end of a string crosses top-most point on a vertical circle with critical speed. Its centripetal acceleration when string becomes horizontal will be (g = gravitational acceleration)
(a) g (b) 3g (c) 4g (d) 6g

35. The expression for electric field intensity at a point outside uniformly charged thin plane sheet is (d is the distance of point from plane sheet)
(a) independent of d
(b) directly proportional to $\sqrt{d}$
(c) directly proportional to d
(d) directly proportional to $\frac{1}{\sqrt{d}}$

36. When source of sound moves towards a stationary observer, the wavelength of sound received by him
(a) decrease while frequency increase
(b) remains the same whereas frequency increases
(c) increases and frequency also increases
(d) decreases while frequency remains the same

37. The deflection in galvanometer falls to $\left(\frac{1}{4}\right)^{th}$ when it is shunted by 3Ω. If additional shunt of 2Ω is connected to earlier shunt, the deflection in galvanometer falls to

(a) $\frac{1}{2}$ (b) $\left(\frac{1}{3}\right)^{th}$

(c) $\left(\frac{1}{4}\right)^{th}$ (d) $\left(\frac{1}{8.5}\right)^{th}$

38. A body is thrown from the surface of the earth with velocity 'u' m/s. The maximum height in m above the surface of the earth upto which it will reach is (R = radius of earth, g = acceleration due to gravity)

(a) $\frac{u^2R}{2gR-u^2}$ (b) $\frac{2u^2R}{gR-u^2}$

(c) $\frac{u^2R^2}{2gR^2-u^2}$ (d) $\frac{u^2R}{gR-u^2}$

39. A series combination of N_1 capacitors (each of capacity C_1) is charged to potential difference '3V'. Another parallel combination of N_2 capacitors (each of capacity C_2) is charged to potential difference 'V'. The total energy stored in both the combinations is same. The value of C_1 in terms of C_2 is

(a) $\frac{C_2N_1N_2}{9}$ (b) $\frac{C_2N_1^2N_2^2}{9}$

(c) $\frac{C_2N_1}{9N_2}$ (d) $\frac{C_2N_2}{9N_1}$

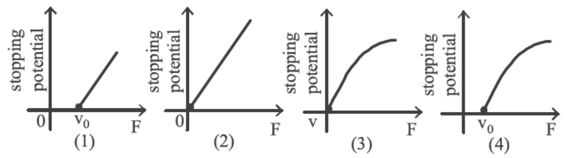
40. Heat energy is incident on the surface at the rate of 1000 J/min. If coefficient of absorption is 0.8 and coefficient of reflection is 0.1 then heat energy transmitted by the surface in 5 minutes is
(a) 100 J (b) 500 J (c) 700 J (d) 900 J

41. Two metal wires 'P' and 'Q' of same length and material are stretched by same load. Their masses are in the ratio $m_1 : m_2$. The ratio of elongation of wire 'P' to that of 'Q' is

(a) $m_1^2 : m_2^2$ (b) $m_2^2 : m_1^2$
(c) $m_2 : m_1$ (d) $m_1 : m_2$

42. Let $x = \left[\frac{a^2b^2}{c}\right]$ be the physical quantity. If the percentage error in the measurement of physical quantities a, b and c is 2, 3 and 4 percent respectively then percentage error in the measurement of x is
(a) 7% (b) 14% (c) 21% (d) 28%

43. Following graphs show the variation of stopping potential corresponding to the frequency of incident radiation (F) for a given metal. The correct variation is shown in graph
(v_0 = Threshold frequency)



(a) (1) (b) (2) (c) (3) (d) (4)

44. In compound microscope, the focal length and aperture of the objective used is respectively
(a) large and large (b) large and small
(c) short and large (d) short and small

45. The energy of an electron having de-Broglie wavelength 'λ' is (h = Plank's constant, m = mass of electron)

(a) $\frac{h}{2m\lambda}$ (b) $\frac{h^2}{2m\lambda^2}$

(c) $\frac{h^2}{2m^2\lambda^2}$ (d) $\frac{h^2}{2m^2\lambda}$

46. 'n' number of waves are produced on a string in 0.5 second. Now the tension in the string is doubled (Assume length and radius constant), the number of waves produced in 0.5 second for the same harmonic will be

(a) n (b) $\sqrt{2}$ n (c) $\frac{n}{\sqrt{2}}$ (d) $\frac{n}{\sqrt{5}}$

47. The increase in energy of a metal bar of length 'L' and cross-sectional area 'A' when compressed with a load 'M' along its length is (Y = Young's modulus of the material of metal bar)

(a) $\frac{FL}{2AY}$ (b) $\frac{F^2L}{2AY}$

(c) $\frac{FL}{AY}$ (d) $\frac{F^2L^2}{2AY}$

48. The ratio of magnetic fields due to a bar magnet at the two axial points P_1 and P_2 which are separated from each other by 10 cm is 25 : 2. Points P_1 is situated at 10 cm from the centre of the magnet. Magnetic length of the bar magnet is (Points P_1 and P_2 are on the same side of magnet and distance of P_2 from the centre is greater than distance of P_1 from the centre of magnet)
(a) 5 cm (b) 10 cm (c) 15 cm (d) 20 cm

49. A satellite is revolving in a circular orbit at a height 'h' above the surface of the earth of radius 'R'. The speed of the satellite in its orbit is one-fourth the escape velocity from the surface of the earth. The relation between 'h' and 'R' is
(a) h = 2R (b) h = 3R (c) h = 5R (d) h = 7R

50. A pipe closed at one end has length 83 cm. The number of possible natural oscillations of air column whose frequencies lie below 1000 Hz are (velocity of sound in air = 332 m/s)
(a) 3 (b) 4 (c) 5 (d) 6

CHEMISTRY

51. A certain reaction occurs in two steps as
(i) $2SO_2(g) + 2NO_2(g) \rightarrow 2SO_3(g) + 2NO(g)$
(ii) $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$
In the reaction
(a) $NO_2(g)$ is intermediate
(b) NO(g) is intermediate
(c) NO(g) is catalyst
(d) $O_2(g)$ is intermediate

52. Which among the following equations represents the first law of thermodynamics under isobaric conditions ?
(a) $\Delta U = q_p - P_{ex}.\Delta V$ (b) $q_v = \Delta U$
(c) $\Delta U = W$ (d) $W = -q$

53. During galvanization of iron, which metal is used for coating iron surface ?
(a) Copper (b) Zinc
(c) Nickel (d) Tin

54. Formation of PCl_3 is explained on the basis of what hybridisation of phosphorus atom ?
(a) sp^2 (b) sp^3
(c) sp^3d (d) sp^3d^2

55. Identify the element that forms amphoteric oxide.
(a) Copper (b) Zinc
(c) Calcium (d) Sulphur

56. Identify the product 'C' in the following reaction.
Aniline

$$\text{Aniline} \xrightarrow[\text{Pyridine}]{(CH_3CH)_2O} A \xrightarrow[CH_3COOH]{Br_2} B \xrightarrow{H^+ \text{ or } OH^-} C$$

(a) Acetanilide
(b) $p-$Bromoacetanilide
(c) $p-$Bromoaniline
(d) $o-$Bromoaniline

57. Identify the functional group that has electron donating inductive effect.
(a) $-COOH$ (b) $-CN$
(c) $-CH_3$ (d) $-NO_2$

58. Which among the following metals crystallise as a simple cube ?
(a) Polonium (b) Iron
(c) Copper (d) Gold

59. Which among the following oxoacids of phosphorus shows a tendency of disproportionation ?
(a) Phosphinic acid (H_3PO_2)
(b) Orthophosphoric acid (H_3PO_4)
(c) Phosphonic acid (H_3PO_3)
(d) Pyrophosphoric acid ($H_4P_2O_7$)

60. What is the oxidation number of gold in the complex $[AuCl_4]^{1-}$?
(a) +4 (b) +3 (c) +2 (d) +1

61. Which symbol replaces the unit of atomic mass, amu ?
(a) u (b) A (c) M (d) n

62. Which of the following compounds reacts immediately with Lucas reagent ?
(a) CH_3CH_2OH
(b) $CH_3CH_2CH_2OH$
(c) $CH_3-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_3$
(d) $CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle OH}{|}}{C}}-CH_3$

63. What is the catalyst used for oxidation of SO_2 to SO_3 in lead chamber process for manufacturer of sulphuric acid ?
(a) Nitric oxide (b) Nitrous oxide
(c) Potassium iodide (d) Dilute HCl

64. The number of moles of electrons passed when current of 2 A is passed through a solution of electrolyte for 20 minutes is
(a) 4.1×10^{-4} mol e^- (b) 1.24×10^{-2} mol e^-
(c) 2.487×10^{-2} mol e^- (d) 2.487×10^{-1} mol e^-

65. The molarity of urea (molar mass 60 g mol^{-1}) solution by dissolving 15 g of urea in 500 cm^3 of water is
(a) 2 mol dm^{-3} (b) 0.5 mol dm^{-3}
(c) 0.125 mol dm^{-3} (d) 0.0005 mol dm^{-3}

66. Which carbon atom of deoxy Ribose sugar in DNA does **NOT** contain $-\overset{|}{\underset{|}{C}}-OH$ bond ?
(a) C_5 (b) C_3 (c) C_2 (d) C_1

67. Which of the following carboxylic acids is most reactive towards esterification ?
(a) $(CH_3)_3CCOOH$
(b) $(CH_3)_2CHCOOH$
(c) CH_3CH_2COOH
(d) $(C_2H_5)_2)CHCOOH$

68. Molarity is
(a) the number of moles of solute present in 1 dm^3 volume of solution
(b) the number of moles of solute dissolved in 1 kg of solvent
(c) the number of moles of solute dissolved in 1 kg of solution
(d) the number of moles of solute dissolved in 100 dm^3 volume of solution

69. Which of the followings is a tricarboxylic acid ?
(a) Citric acid (b) Malonic acid
(c) Succinic acid (d) Malic acid

70. What is the number of donor atoms in dimethylglyoximato ligand ?
(a) 1 (b) 2 (c) 3 (d) 4

71. In which substance does nitrogen exhibit the lowest oxidation state ?
(a) nitrogen gas (b) ammonia
(c) nitrous oxide (d) nitric oxide

72. Which of the following is most reactive towards addition reaction of hydrogen cyanide to form corresponding cyanohydrin ?
(a) Acetone (b) Formaldehyde
(c) Acetaldehyde (d) Diethylketone

73. The most basic hydroxide from following is
(a) $Pr(OH)_3$ (Z = 59) (b) $Sm(OH)_3$ (Z = 62)
(c) $Ho(OH)_3$ (Z = 67) (d) $La(OH)_3$ (Z = 57)

74. What is the SI unit of density ?
(a) g cm^{-3} (b) g m^{-3}
(c) kg m^{-3} (d) kg cm^{-3}

75. Which of the following compounds does **NOT** undergo haloform reaction ?
(a) $CH_3-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_3$ (b) $CH_3-\underset{\underset{\displaystyle O}{\|}}{C}-CH_3$
(c) $C_2H_5-\underset{\underset{\displaystyle OH}{|}}{CH}-C_2H_5$ (d) $CH_3-\underset{\underset{\displaystyle O}{\|}}{C}-C_2H_5$

76. Two moles of an idea gas are allowed to expand from a volume of 10 dm^3 to 2m^3 at 300 K against a pressure of 101.325 KPa. Calculate the work done.
(a) −201.6 kJ (b) 13.22 kJ
(c) −810.6 J (d) −18.96 kJ

77. In which among the following solids, Schottky defect is **NOT** observed ?
(a) ZnS (b) NaCl (c) KCl (d) CsCl

78. What are the products of auto-photolysis of water ?
(a) H_2 and O_2 (b) Steam
(c) H_3O^+ and OH^- (d) Hydrogen peroxide

79. Bauxite, the ore of aluminium, is purified by which process ?
(a) Hoope's process (b) Hall's process
(c) Mond's process (d) Liquation process

80. Phenol in presence of sodium hydroxide reacts with chloroform to form salicylaldehyde. The reaction is known as
(a) Kolbe's reaction
(b) Reimer-Tiemann reaction
(c) Stephen reaction
(d) Etard reaction

81. Which among the following elements of group-2 exhibits anomalous properties ?
(a) Be (b) Mg (c) Ca (d) Ba

82. Excess of ammonia with sodium hypochloride solution in the presence of glue or gelatine gives
(a) $NaNH_2$ (b) NH_2NH_2
(c) N_2 (d) NH_4Cl

83. What is the density of solution of sulphuric acid used as an electrolyte in lead accumulator ?
(a) $1.5\ g\ mL^{-1}$ (b) $1.2\ g\ mL^{-1}$
(c) $1.8\ g\ mL^{-1}$ (d) $2.0\ g\ mL^{-1}$

84. Which of the following polymers is used to manufacture clothes for firefighters ?
(a) Thiokol (b) Kevlar
(c) Nomex (d) Dynel

85. Which elements is obtained in the pure form by van Arkel method ?
(a) Aluminium (b) Titanium
(c) Silicon (d) Nickel

86. Which of the following is **NOT** a tranquilizer ?
(a) Meprobamate (b) Equanil
(c) Chlordiazepoxide (d) Bromopheniramine

87. Conversion of hexane into benzene involves the reaction of
(a) hydration (b) hydrolysis
(c) hydrogenation (d) dehydrogenation

88. The element that does **NOT** exhibit allotropy is
(a) phosphorus (b) arsenic
(c) antimony (d) bismuth

89. Which of the following reactions is used to prepare aryl fluorides from diazonium salts and fluoroboric acid ?
(a) Sandmeyer reaction
(b) Balz-Schiemann reaction
(c) Gattermann reaction
(d) Swarts reaction

90. The correct relation between elevation of boiling point and mass of solute is
(a) $M_2 = \dfrac{K_b \cdot W_2}{\Delta T_b \cdot W_1}$ (b) $M_2 = \dfrac{K_b \cdot W_1}{\Delta T_b \cdot W_2}$
(c) $M_2 = \dfrac{\Delta T_b \cdot K_b}{W_1 \cdot W_2}$ (d) $M_2 = \dfrac{\Delta T_b \cdot W_1}{K_b \cdot W_2}$

91. Which among the group – 15 elements does **NOT** exists as tetra atomic molecule ?
(a) Nitrogen (b) Phosphorus
(c) Arsenic (d) Antimony

92. Identify the monosaccharide containing only one asymmetric carbon atom in its molecule.
(a) Ribulose (b) Ribose
(c) Erythrose (d) Glyceraldehyde

93. Identify the oxidation states of titanium (Z = 22) and copper (Z = 29) in their colourless compounds.
(a) Ti^{3+}, Cu^{2+} (b) Ti^{2+}, Cu^{2+}
(c) Ti^{4+}, Cu^{1+} (d) Ti^{4+}, Cu^{2+}

94. Arenes on treatments with chlorine in presence of ferric chloride as a catalyst undergo what type of reaction ?
(a) Electrophilic substitution
(b) Nucleophilic substitution
(c) Electrophilic addition
(d) Nucleophilic addition

95. In case of R, S configuration the group having highest priority is
(a) $-NO_2$ (b) $-NH_2$ (c) $-CN$ (d) $-OH$

96. Lactic acid and glycollic acid are the monomers used for preparation of polymer
(a) Nylon-2 nylon-6 (b) Dextron
(c) PHBV (d) Buna-N

97. What is the geometry of water molecule ?
(a) distorted tetrahedral
(b) tetrahedral
(c) trigonal planer
(d) diagonal

98. With which halogen the reactions, of alkanes are explosive ?
(a) Fluorine (b) Chlorine
(c) Bromine (d) Iodine

99. Calculate the work done during combustion of 0.138 kg of ethanol, $C_2H_5OH(1)$ at 300 K. Given : $R = 8.314\ Jk^{-1}\ mol^{-1}$ molar mass of ethanol = 46 $g\ mol^{-1}$.
(a) –7482 J (b) 7482 J
(c) –2494 J (d) 2494 J

100. Slope of the straight line obtained by plotting $\log_{10}k$ against represents what term ?
(a) $-E_a$ (b) $-2.303\ E_a/R$
(c) $-E_a/2.303\ R$ (d) $-E_a/R$

SECTION-B

MATHEMATICS

1. If $\int_0^K \frac{dx}{2+18x^2} = \frac{\pi}{24}$, then the value of K is

(a) 3 (b) 4 (c) $\frac{1}{3}$ (d) $\frac{1}{4}$

2. The cartesian co-ordinates of the point on the parabola $y^2 = -16x$, whose parameter is $\frac{1}{2}$, are

(a) $(-2, 4)$ (b) $(4, -1)$
(c) $(-1, -4)$ (d) $(-1, 4)$

3. $\int \frac{1}{\sin x . \cos^2 x} dx =$

(a) $\sec x + \log|\sec x + \tan x| + c$
(b) $\sec x . \tan x + c$
(d) $\sec x + \log|\sec x - \tan x| + c$
(c) $\sec x + \log|\operatorname{cosec} x - \cot x| + c$

4. If $\log_{10}\left(\frac{x^3 - y^3}{x^3 + y^3}\right) = 2$ then $\frac{dy}{dx} =$

(a) $\frac{x}{y}$ (b) $-\frac{y}{x}$

(c) $-\frac{x}{y}$ (d) $\frac{y}{x}$

5. If $f : R - \{2\} \to R$ is a function defined by $f(x) = \frac{x^2 - 4}{x - 2}$, then its range is

(a) R (b) $R-\{2\}$
(c) $R-\{4\}$ (d) $R-\{-2,2\}$

6. If $f(x) = x^2 + \alpha$ for $x > 0 = 2\sqrt{x^2+1} + \beta$ for $x < 0$) is continuous at $x = 0$ and $f\left(\frac{1}{2}\right) = 2$ then $\alpha^2 + \beta^2$ is

(a) 3 (b) $\frac{8}{25}$ (c) $\frac{25}{8}$ (d) $\frac{1}{3}$

7. If $y = (\tan^{-1} x)^2$ then $(x^2+1)^2 \frac{d^2y}{dx^2} + 2x(x^2+1)\frac{dy}{dx} =$

(a) 4 (b) 2 (c) 1 (d) 0

8. The line $5x + y - 1 = 0$ coincides with one of the lines given by $5x^2 + xy - kx - 2y + 2 = 0$ then the value of k is

(a) -11 (b) 31 (c) 11 (d) -31

9. If $A = \begin{bmatrix} 1 & 2 & 3 \\ -1 & 1 & 2 \\ 1 & 2 & 4 \end{bmatrix}$ then $(A^2 - 5A)A^{-1} =$

(a) $\begin{bmatrix} 4 & 2 & 3 \\ -1 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} -4 & 2 & 3 \\ -1 & -4 & 2 \\ 1 & 2 & -1 \end{bmatrix}$

(c) $\begin{bmatrix} -4 & -1 & 1 \\ 2 & -4 & 2 \\ 3 & 2 & -1 \end{bmatrix}$ (d) $\begin{bmatrix} -1 & -2 & 1 \\ 4 & -2 & -3 \\ 1 & 4 & -2 \end{bmatrix}$

10. The equation of line passing through $(3, -1, 2)$ and perpendicular to the lines

$\vec{r} = (\hat{i} + \hat{j} - \hat{k}) + \lambda(2\hat{i} - 2\hat{j} + \hat{k})$ and

$\vec{r} = (2\hat{i} + \hat{j} - 3\hat{k}) + \mu(\hat{i} - 2\hat{j} + 2\hat{k})$ is

(a) $\frac{x+3}{2} = \frac{y+1}{3} = \frac{z-2}{2}$

(b) $\frac{x-3}{3} = \frac{y+1}{2} = \frac{z-2}{2}$

(c) $\frac{x-3}{2} = \frac{y+1}{3} = \frac{z-2}{2}$

(d) $\frac{x-3}{2} = \frac{y+1}{2} = \frac{z-2}{3}$

11. Lettrs in the word HULULULU are rearrnged. The Probability of all three L being together is

(a) $\frac{3}{20}$ (b) $\frac{2}{5}$ (c) $\frac{3}{28}$ (d) $\frac{5}{23}$

12. The sum of the first 10 terms of the series $9 + 99 + 999 + \ldots$, is

(a) $\frac{9}{8}(9^{10} - 1)$ (b) $\frac{100}{9}(10^9 - 1)$

(c) $10^9 - 1$ (d) $\frac{100}{9}(10^{10} - 1)$

13. If A, B, C are the angles of Δ ABC then $\cot A . \cot B + \cot B . \cot C + \cot C + \cot A =$

(a) 0 (b) 1 (c) 2 (d) -1

14. If $\int \frac{dx}{\sqrt{16 - 9x^2}} = A \sin^{-1}(Bx) + C$ then $A + B =$

(a) $\frac{9}{4}$ (b) $\frac{19}{4}$ (c) $\frac{3}{4}$ (d) $\frac{13}{12}$

15. $\int e^x \left[\frac{2+\sin 2x}{1+\cos 2x}\right] dx =$

(a) $e^x \tan x + c$ (b) $e^x \tan x + c$
(c) $2e^x \tan x + c$ (d) $e^x \tan 2x + c$

16. A coin is tossed three times. If X denotes the absolute difference beween the number of heads and the number of tails then $P(X = 1) =$

(a) $\frac{1}{2}$ (b) $\frac{2}{3}$ (c) $\frac{1}{6}$ (d) $\frac{3}{4}$

17. If $2 \sin\left(\theta + \frac{\pi}{3}\right) = \cos\left(\theta - \frac{\pi}{6}\right)$, then $\tan \theta$, =

(a) $\sqrt{3}$ (b) $-\frac{1}{\sqrt{3}}$ (c) $\frac{1}{\sqrt{3}}$ (d) $-\sqrt{3}$

18. The area of the region bounded by $x^2 = 4y$, $y = 1$, $y = 4$ and the y-axis lying in the first quadrant is square units.

(a) $\frac{22}{3}$ (b) $\frac{28}{3}$ (c) 30 (d) $\frac{21}{4}$

19. If $f(x) = \frac{e^{x^2} - \cos x}{x^2}$, for $x \neq 0$ is continuous at $x = 0$, then value of (0) is

(a) $\frac{2}{3}$ (b) $\frac{5}{2}$ (c) 1 (d) $\frac{3}{2}$

20. The maximum value of $2x + y$ subject to $3x + 5y \leq 26$ and $5x + 3y \leq 30$, $x \geq 0$, $y \geq 0$ is

(a) 12 (b) 11.5 (c) 10 (d) 17.33

21. If $\vec{a}, \vec{b}, \vec{c}$ are mutually perpendicular vectors having magnitudes 1, 2, 3 respectively, then $\left[\vec{a}+\vec{b}+\vec{c} \;\; \vec{b}-\vec{a} \;\; \vec{c}\right] =$

(a) 0 (b) 6 (c) 12 (d) 18

22. If points P(4,5, x), Q(3, y, 4) and R(5, 8, 0) are collinear, then the value of $x + y$ is

(a) -4 (b) 3 (c) 5 (d) 4

23. If the slope of one the lines given by $ax^2 + 2hxy + by^2 = 0$ is two times the other then

(a) $8h^2 = 9ab$ (b) $8h^2 = 9ab^2$
(c) $8h = 9ab$ (d) $8h = 9ab^2$

24. The equation of the line passing through the point (–3,1) and bisecting the angle between co-ordinate axes is

(a) $x + y + 2 = 0$ (b) $-x + y + 2 = 0$
(c) $x - y + 4 = 0$ (d) $2x + y + 5 = 0$

25. The negation of the statement : "Getting above 95% marks is necessary condition for Hema to get the admission in good college".

(a) Hema gets above 95% marks but she does not get the admission in good college
(b) Hema does not get above 95% marks and she gets admission in good college
(c) If Hema does not get above 95% marks then she will not get the admission in good college
(d) Hema does not get above 95% marks or she gets the admission in good college

26. $\cos 1^\circ . \cos 2^\circ . \cos 3^\circ \ldots \cos 179^\circ =$

(a) 0 (b) 1 (c) $-\frac{1}{2}$ (d) -1

27. If planes $x - cy - bz = 0$, $cx - y + az = 0$ and $bx + ay - z = 0$ pass through a straight line then $a^2 + b^2 + c^2 =$

(a) $1 - abc$ (b) $abc - 1$
(c) $1 - 2abc$ (d) $2abc - 1$

28. The point of intersection of line represented by $x^2 - y^2 + 3y - 2 = 0$ is

(a) $(1, 0)$ (b) $(0, 2)$
(c) $\left(-\frac{1}{2}, \frac{3}{2}\right)$ (d) $\left(\frac{1}{2}, \frac{1}{2}\right)$

29. A die is rolled. If X denotes the number of positive divisors of the outcome then the range of the random variable X is

(a) $\{1, 2, 3\}$ (b) $\{1, 2, 3, 4\}$
(c) $\{1, 2, 3, 4, 5, 6\}$ (d) $\{1, 3, 5\}$

30. A die is thrown four times. The probability of getting perfect square in at least one throw is

(a) $\frac{16}{81}$ (b) $\frac{65}{81}$ (c) $\frac{23}{81}$ (d) $\frac{58}{81}$

31. $\int_0^{\pi/4} x . \sec^2 x \, dx =$

(a) $\frac{\pi}{4} + \log\sqrt{2}$ (b) $\frac{\pi}{4} - \log\sqrt{2}$
(c) $1 + \log\sqrt{2}$ (d) $1 - \frac{1}{2}\log 2$

32. In Δ ABC, with usual notations, if a, b, c are in A.P. Then $a \cos^2\left(\frac{C}{2}\right) + c\cos^2\left(\frac{A}{2}\right) =$

(a) $3\frac{a}{2}$ (b) $3\frac{c}{2}$ (c) $3\frac{b}{2}$ (d) $\frac{3abc}{2}$

33. If $x = e^{\theta}, (\sin\theta - \cos\theta)$, $y = e^{\theta}(\sin\theta + \cos\theta)$ then $\frac{dy}{dx}$ at $\theta = \frac{\pi}{4}$ is

(a) 1 (b) 0 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$

34. The number of solutions of $\sin x + \sin 3x + \sin 5x = 0$ in the interval $\left[\frac{\pi}{2}, 3\frac{\pi}{2}\right]$ is

(a) 2 (b) 3 (c) 4 (d) 5

35. If $\tan^{-1} 2x + \tan^{-1} 3x = \frac{\pi}{4}$, then $x =$

(a) -1 (b) $\frac{1}{3}$ (c) $\frac{1}{6}$ (d) $\frac{1}{2}$

36. Matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 1 & 5 \\ 2 & 4 & 7 \end{bmatrix}$ then the value of $a_{31} A_{31} + a_{32} A_{32} + a_{33} A_{33}$ is

(a) 1 (b) 13 (c) -1 (d) -13

37. The contrapositive of the statement : "If the weather is fine then my friends will come and we go for a picnic."

(a) The weather is fine but my friends will not come or we do not go for a picnic
(b) If my friends do not come or we do not go for picnic then weather will not be fine
(c) If the weather is not fine then my friends will not come or we do not go a picnic
(d) The weather is not fine but friends will come and we go for a picnic

38. If $f(x) = \frac{x}{x^2+1}$ is increasing function then the value of x lies in

(a) R (b) $(-\infty, -1)$
(c) $(1, \infty)$ (d) $(-1, 1)$

39. If $X = \{4^n - 3n - 1 : n \in N\}$ and $Y = \{9n - 1\} : n \in N\}$, then $X \bigcap Y =$

(a) X (b) Y (c) ϕ (d) $\{0\}$

40. The statement pattern $P \wedge (\sim p \wedge q)$ is

(a) a tautology
(b) a contradiction
(c) equivalent to $p \wedge q$
(d) equivalent to $p \vee q$

41. If the line $y = 4x - 5$ touches to the curve $y^2 = ax^3 + b$ at the point (2, 3) then $7a + 2b =$

(a) 0 (b) 1 (c) -1 (d) 2

42. The sides of a rectangle are given by $x = \pm a$ and $y = \pm b$. The equation of the circle passing through the vertices of the rectangle is

(a) $x^2 + y^2 = a^2$
(b) $x^2 + y^2 = a^2 + b^2$
(c) $x^2 + y^2 = a^2 - b^2$
(d) $(x - (a)^2 + (Y - (b)^2 = a^2 + b^2$

43· The minimum value of the function $f(x) = x\log x$ is

(a) $-\frac{1}{e}$ (b) $-e$ (c) $\frac{1}{e}$ (d) e

44. If $X \sim B(n, p)$ with $n = 10, p = 0.4$ then $E(X^2) =$

(a) 4 (b) 2.4 (c) 3.6 (d) 18.4

45. The general solution of differential equation $\frac{dx}{dy} = \cos(x + y)$ is

(a) $\tan\left(\frac{x+y}{2}\right) = y + c$

(b) $\tan\left(\frac{x+y}{2}\right) = x + c$

(c) $\cot\left(\frac{x+y}{2}\right) = y + c$

(d) $\cot\left(\frac{x+y}{2}\right) = x + c$

46. If planes $\vec{r}.\left(p\hat{i} - \hat{j} + 2\hat{k}\right) + 3 = 0$ and $\vec{r}.\left(2\hat{i} - p\hat{j} - \hat{k}\right) - 5 = 0$ include angle $\frac{\pi}{3}$ then the value of p is

(a) 1, -3 (b) $-1, -3$
(c) -3 (d) 3

47. The order of the differential equation of all parabolas, whose latus rectum is 4a and axis parallel to the x-axis, is

(a) one (b) four (c) three (d) two

48. If lines $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-1}{4}$ and $x - 3 = \frac{y-k}{2} = z$ intersect then the value of k is

(a) $\frac{9}{2}$ (b) $\frac{1}{2}$ (c) $\frac{5}{2}$ (d) $\frac{7}{2}$

49. If a line makes angles 120^o and 60^o with the positive directions of X and Z axes respectively then the angle made by the line with positive Y-axis is

(a) 150^o (b) 60^o (c) 135^o (d) 120^o

50. L and M are two points with position vectors $2\vec{a} - \vec{b}$ and $\vec{a} + 2\vec{b}$ respectively. The position vector of the point N which divides the line segment LM in the ratio 2 : 1 extenally is

(a) $3\vec{b}$ (b) $4\vec{b}$

(c) $5\vec{b}$ (d) $3\vec{a} + 4\vec{b}$

ANSWER KEYS & SOLUTIONS

(MHT-CET 2018)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(c)	**6**	(b)	**11**	(c)	**16**	(c)	**21**	(b)	**26**	(c)	**31**	(b)	**36**	(a)	**41**	(c)	**46**	(b)
2	(c)	**7**	(d)	**12**	(d)	**17**	(b)	**22**	(c)	**27**	(a)	**32**	(d)	**37**	(d)	**42**	(b)	**47**	(b)
3	(b)	**8**	(c)	**13**	(b)	**18**	(b)	**23**	(a)	**28**	(d)	**33**	(b)	**38**	(a)	**43**	(a)	**48**	(a)
4	(b)	**9**	(b)	**14**	(d)	**19**	(c)	**24**	(b)	**29**	(c)	**34**	(b)	**39**	(a)	**44**	(b)	**49**	(d)
5	(b)	**10**	(c)	**15**	(a)	**20**	(d)	**25**	(b)	**30**	(d)	**35**	(a)	**40**	(b)	**45**	(b)	**50**	(c)
CHEMISTRY																			
51	(b)	**56**	(c)	**61**	(a)	**66**	(c)	**71**	(c)	**76**	(a)	**81**	(a)	**86**	(d)	**91**	(a)	**96**	(b)
52	(a)	**57**	(c)	**62**	(d)	**67**	(c)	**72**	(b)	**77**	(a)	**82**	(b)	**87**	(d)	**92**	(d)	**97**	(a)
53	(b)	**58**	(a)	**63**	(a)	**68**	(d)	**73**	(d)	**78**	(c)	**83**	(b)	**88**	(d)	**93**	(c)	**98**	(a)
54	(b)	**59**	(c)	**64**	(c)	**69**	(a)	**74**	(c)	**79**	(b)	**84**	(c)	**89**	(b)	**94**	(c)	**99**	(b)
55	(b)	**60**	(b)	**65**	(b)	**70**	(b)	**75**	(c)	**80**	(b)	**85**	(b)	**90**	(a)	**95**	(d)	**100**	(c)
SECTION-B																			
MATHEMATICS																			
1	(c)	**6**	(c)	**11**	(c)	**16**	(d)	**21**	(c)	**26**	(a)	**31**	(b)	**36**	(c)	**41**	(a)	**46**	(d)
2	(d)	**7**	(b)	**12**	(b)	**17**	(d)	**22**	(d)	**27**	(c)	**32**	(c)	**37**	(b)	**42**	(b)	**47**	(d)
3	(d)	**8**	(c)	**13**	(b)	**18**	(b)	**23**	(a)	**28**	(c)	**33**	(a)	**38**	(d)	**43**	(a)	**48**	(a)
4	(d)	**9**	(b)	**14**	(d)	**19**	(d)	**24**	(a)	**29**	(b)	**34**	(b)	**39**	(a)	**44**	(d)	**49**	(c)
5	(a)	**10**	(c)	**15**	(a)	**20**	(a)	**25**	(b)	**30**	(b)	**35**	(c)	**40**	(b)	**45**	(a)	**50**	(c)

SECTION-A

PHYSICS

1. **(c)** Given : Path length = 16 cm

$\therefore$ Amplitude $a = \frac{16}{2} = 8\ cm$

Time period $T = 2\pi\sqrt{\frac{l}{g}}$

$= 2\pi\sqrt{\frac{1}{\pi^2}} = 2\pi \times \frac{1}{\pi} = 2s$

Maximum velocity $V_{max} = a\omega$

$= a \times \frac{2\pi}{T} = 8 \times \frac{2\pi}{2} = 8\pi\ cm/s$

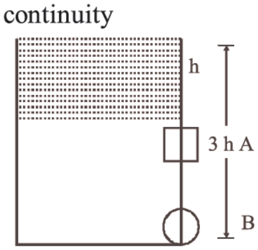
2. **(c)** Using equation of continuity

$A_1V_1 = A_2V_2$

$L^2\sqrt{2gh} = \pi r^2\sqrt{6gh}$

$L^4 gh = \pi^2 r^4 6gh$

$\therefore \quad L = (\pi)^{\frac{1}{2}}(r)(3)^{\frac{1}{4}}$



3. **(b)** Voltage gain $= \dfrac{V_o}{V_i} = \dfrac{R_o \times I_c}{R_i \times I_B}$

$$= \frac{2000 \times 1.5 \times 10^{-3}}{150 \times 20 \times 10^{-6}} = \frac{3}{3000 \times 10^{-6}} = 1000$$

4. **(b)** Torque, $\tau = I\alpha$

$$F \times R = \frac{M R^2}{2} \times \frac{\omega}{t}$$

$\therefore$ Tangential force, $F = \dfrac{MR\omega}{2t}$

5. **(b)** $B_{\text{centre}} = \dfrac{\mu_0 \eta I}{R}$

Let at a distance x from the centre, magnetic field becomes $\dfrac{B}{8}$

$$\frac{B}{8} = \frac{\mu_0 \eta I R^2}{\left(R^2 + x^2\right)^{3/2}}$$

$$\Rightarrow \frac{\mu_0 \eta I}{8R} = \frac{\mu_0 \eta I R^2}{\left(R^2 + x^2\right)^{3/2}}$$

or, $8R^3 = (R^2 + x^2)^{3/2}$

$\Rightarrow 2R = (R^2 + x^2)^{1/2}$ ... (i)

or $4R^2 = R^2 + x^2$ [from squarring both sides of equation (i)]

$\Rightarrow 3R^2 = x^2$

$\therefore x = \sqrt{3R^2} = \sqrt{3}\,R$

6. **(b)** $I_{max} = (a_1 + a_2)^2$ and $I_{min} = (a_1 - a_2)^2$

$I_{max} + I_{min} = a_1^2 + a_2^2 + a_1^2 + a_2^2$

$= 2\left(a_1^2 + a_2^2\right) = 2(I_1 + I_2)$

7. **(d)** Alternating voltage, $e = e_0 \sin \omega t$

From question,

$e_0 = 200\sqrt{2}V, \ \omega = 100$

$$I_{rms} = \frac{v_{rms}}{X_c} = \frac{V_0 \omega C}{\sqrt{2}}$$

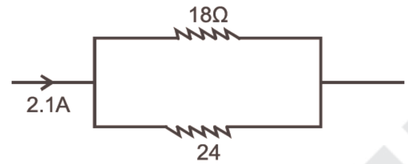
$$= \frac{200\sqrt{2} \times 100 \times 10^{-6}}{\sqrt{2}}$$

$= 2 \times 10^{-2} = 20mA$

8. **(c)** $I = I_1 + I_2 = 2.1\,A$

$18 I_1 = 24 I_2$

$\Rightarrow 3I_1 = 4I_2 = 4(2.1 - I_1)$



or, $7I_1 = 8.4$

$\therefore I_1 = \dfrac{8.4}{7} = 1.2\,A$

9. **(b)**

10. **(c)** Tangential acceleration $= \alpha r$

Radial acceleration $= \dfrac{v^2}{r}$

$\therefore$ Ratio $= \dfrac{\alpha r}{v^2/r} = \dfrac{\alpha r^2}{v^2}$

11. **(c)** $d = \dfrac{\lambda}{2\mu \sin\alpha} = \dfrac{\lambda}{2N.A}$

N.A. limit of resolution is decrease (c).

12. **(d)** In amplitude modulaion amplitude of the carrier wave changes according to information signal.

13. **(b)** Magnetisation of a paramagnetic $M_z = \dfrac{M_{ext}}{V}$

$M_z = \dfrac{CB}{T}$ ... (Paranmagnetic)

14. **(d)** $\dfrac{1}{\lambda} = R\left(\dfrac{1}{\eta_1} - \dfrac{1}{\eta_2}\right)$

$\dfrac{1}{\lambda} = R\left[\dfrac{1}{1} - \dfrac{1}{16}\right] = \dfrac{15 - R}{16} \quad \therefore \lambda = \dfrac{16}{15R}$

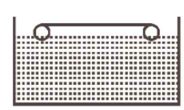
$P = \dfrac{h}{\lambda}$ or, $mv = \dfrac{h}{\lambda} \quad \therefore v\ \dfrac{h}{m\lambda} = \dfrac{15hR}{m16}$

15. **(a)** Suspension tension, $T = \dfrac{f}{\ell}$

$mg = T.l$

$\pi r^2 \rho g = Tl$

$r^2 = \dfrac{T}{\pi \rho g}$



$r = \sqrt{\dfrac{T}{\pi \rho g}}$

16. (c) Before collision After collision

$mV + 0 = mV_1 + mV_2$

$V_1 + V_2 = V$

$e = \dfrac{V_2 - V_1}{u_1 - u_2}$ $e = \dfrac{V_2 - V_1}{V - 0}$

Coefficient of restitution, e

$eV = V_2 - V_1$

$eV + V = 2V_2 \Rightarrow V_2 = \dfrac{V(e+1)}{2}$

$\therefore$ Ratio, $\dfrac{V_2}{V} = \dfrac{e+1}{2}$

17. (b) Distance travelled in one oscillation = 4a

Average velocity $= \dfrac{total\ distance}{Time}$

$= \dfrac{4a}{T} = 4an$ [$\therefore$ n $= \dfrac{1}{T}$]

18. (b) Given : $V_{in} = 220$ V ; $V_{out} = 3.3 \times 10^3 V$
Power, P = 4.4 kW and no. of turns in secondary coil, $N_P = 600$

$P = V_{in} \times I_{in} \Rightarrow I_{in} = \dfrac{4.4 \times 1000}{220}$

$= \dfrac{44 \times 10}{22} = 20\,A$; $\dfrac{e_s}{e_p} = \dfrac{I_P}{I_s}$

$I_S = I_P = \dfrac{e_P}{e_s} = \dfrac{20 \times 220}{3.3 \times 1000} = \dfrac{44}{33} = \dfrac{4}{3} A$

19. (c) Using, $R = f\dfrac{\ell}{A}$

$$\frac{R_1}{R_2} = \frac{L_1}{L_2} \times \frac{A_2}{l_2} = \frac{L_1}{L_2} \times \frac{\frac{\pi d_2^2}{4}}{\frac{\pi d_1^2}{4}}$$

$\therefore$ Ratio $\dfrac{R_1}{R_2} = \dfrac{d_2^2}{d_1^2}$

20. (d) $C_P - C_V = R$, $\dfrac{C_P}{C_V} = \gamma \Rightarrow C_P = \gamma C_V$

$\gamma C_V - C_V = R = \Rightarrow C_V(r-1) = R$

$\therefore C_V = \dfrac{R}{(\gamma - 1)}$

21. (b) From Jurin's law, $h \propto \dfrac{1}{r}$ or, rh = constant

$r_1h_1 = r_2h_2$ $A_1 = \pi r_1^2$

$\dfrac{r_1}{r_2} = \dfrac{h_2}{h_1}$ $A_2 = \pi r_2^2$

$3 = \dfrac{h_2}{h_1} = \dfrac{h_2}{h_1}$ $\dfrac{\pi r_1^2}{9} = \pi r_2^2$

$h_2 = 3h_1 = 3h$ $\dfrac{r_1^2}{r_2^2} = 9 \Rightarrow \dfrac{r_1}{r_2} = 3h$

22. (c) P-N junction diode with forward biosed mode.

23. (a) Time period, $T = 1/V = \dfrac{2\pi m}{eB}$

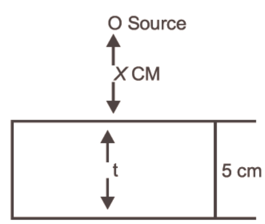
$\Rightarrow B = \dfrac{2\pi m}{e} v$

$R = \dfrac{mv}{eB} = \dfrac{P}{eB}$ [$\because$ F $= \dfrac{mv^2}{R} = eB$]

$P = eBR = e \times \dfrac{2\pi mv^2}{2m} = 2\pi mvR$

$K.E = \dfrac{P^2}{2m} = \dfrac{(2\pi mvR)^2}{2m} = 2\pi^2 mv^2R^2$

24. (b) According to question,



Let 'x' be the distance of source from the surface of glass slab
time taken to travel light, from source to surface of the glass slab, (t_1) = time taken to travel in glass slab (t_2)

$t_1 = \dfrac{x}{3\times10^8}$ and, $t_2 = \dfrac{5}{\dfrac{3\times10^8}{1.6}}$

[$\because$ Velocity of light in glass medium, $= \dfrac{C}{M}$]

$\therefore\ \dfrac{x}{3\times10^8} = \dfrac{5}{\dfrac{3\times10^8}{1.6}}$

or, $x = 5 \times 1.6 = 8.0$ cm

25. **(b)** Fifth overtone, $2.4 = 6n$

$A = 0.4\,m = \dfrac{\lambda}{2} \Rightarrow \lambda = 0.8$

$\therefore$ Distance between successive node and antinode,

$\dfrac{\lambda}{4} = \dfrac{0.8}{4} = 0.2\,m$

26. **(c)** Here, $|A| = \sqrt{9+4+1} = \sqrt{14}$

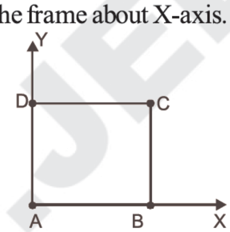
$|B| = \sqrt{1+9+25} = \sqrt{35}$

$|C| = \sqrt{4+1+16} = \sqrt{21}$

Clearly, $\vec{B} = \vec{A} + \vec{C}$ and $B^2 = A^2 + C^2$

27. **(a)** Moment of inertia of the frame about X-axis.

$\dfrac{ml^2}{3} + \dfrac{ml^2}{3} + ml^2$



$I = \dfrac{5}{3}ml^2$

28. **(d)** Magnitude of unit vector = 1

$\sqrt{(0.8)^2 + (b)^2 + (0.4)^2} = 1$

$\Rightarrow \sqrt{64 + b^2 + 0.16} = 1 \Rightarrow \sqrt{0.80 + b^2} = 1$

$\Rightarrow 0.8 + b^2 = 1 \Rightarrow b^2 = 0.2 \therefore b = \sqrt{0.2}$

29. **(c)** (Relation between magnetic permeability and susceptibility)

$B = (1 + X)H$

X = for paramagnetic positive and small

X' = for diamagnetic negative and small

30. **(d)** Time period, $T = 2\pi\sqrt{\dfrac{m}{k}}$

and, frequency, $n = \dfrac{1}{T} = \dfrac{1}{2\pi}\sqrt{\dfrac{k}{m}}$

$25 = \dfrac{1}{4\pi^2}\dfrac{k}{m} \Rightarrow k = 100\,\pi^2 m$

$kA = mg \Rightarrow A = \dfrac{mg}{k}$

$V_{max} = \omega A = \dfrac{2\pi}{T}A = 2\pi nA$

$= \dfrac{2\pi 5 \times mg}{k} = \dfrac{10\pi \times m \times 10}{100\pi^2 m} = \dfrac{1}{\pi}$

31. **(b)** Conservation of angular momentum,

$I_1\omega_1 = I_2\omega_2$

or, $I\omega = 2I\omega_1 \Rightarrow \omega_1 = \dfrac{\omega}{2}$

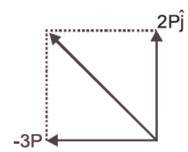
Original $KE = 2\dfrac{1}{2}I\omega^2$

New $KE = 2\dfrac{1}{2}I\omega_1^2 = \dfrac{1}{2}2I\left(\dfrac{\omega}{2}\right)^2 = \dfrac{I\omega^2}{4}$

Change in $KE = \dfrac{1}{2}I\omega^2 - \dfrac{I\omega^2}{4} = \dfrac{I\omega^2}{4}$

32. **(d)** Magnitude of momentum of the 3rd part.

$\sqrt{9P^2 + 4P^2} = \sqrt{13}\,P$



33. **(b)** In the photocell, stopping potential directly proportional to frequency of incident radiation.

34. **(b)** Speed at top most point, $v = \sqrt{3rg}$

Centripetal acceleration, $a_c = \dfrac{v^2}{T} = \dfrac{3rg}{r} = 3g$

35. **(a)** Electric field intensity at a point outside a uniformly charged thin plane sheet $= \dfrac{\sigma}{2\varepsilon_0}$

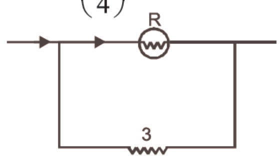
So it is independent of d

36. **(a)** Apparent frequency,

$n_a = n\left[\dfrac{v}{v - v_s}\right]$ *i.e.*, frequency increase

As frequency increases, so wevelength decreases.

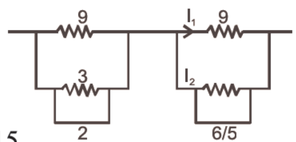
37. (d) According to question, the deflection in galvanometer falls to $\left(\frac{1}{4}\right)^{th}$ when it is shunted by 3Ω.



$\therefore I-\frac{I}{4}=\frac{3I}{4}$

$\frac{R}{4}=\frac{3I}{4}\times 3$

$\Rightarrow R=9\,\Omega$



$I-I_1=I_2$

$9I_1=\frac{6}{5}I_2 \Rightarrow \frac{15}{2}I_1=I_2$

$I=I_1+\frac{15}{2}I_1=\frac{17}{2}I_1$ or, $I_2=\frac{2I}{17}=\frac{I}{8.5}$

38. (a) Let $'h'$ be the height of the body above the surface of the earth.

$$\frac{GMm}{R}+\frac{1}{2}mu^2=0+-\frac{GMm}{R+h}$$

$$\frac{GM}{R+h}=\frac{Gm}{R}-\frac{u^2}{2}$$

$$\frac{GM}{(R+h)}=\frac{2Gm-Ru^2}{2R}$$

$$\frac{R+h}{GM}=\frac{2R}{2GM-Ru^2}$$

$$h=\frac{2GMR}{2GM-Ru^2}-R$$

$$=\frac{2GMR-2GMR+R^2u^2}{2GM-Ru^2}$$

$$=\frac{R^2u^2}{2GM-Ru^2}=\frac{Ru^2}{2gR-u^2}$$

39. (a) N_1 number of cap acitors each of capacity, C_1 charged to potential difference, 3V are in series.

$\therefore C_{eq}=\frac{C_1}{N_1}; V=3V$

$E=\frac{1}{2}CV^2=\frac{1}{2}\frac{C_1}{N_1}9V^2$

N_2 number of capacitors each of capacity, C_2 charged to potential difference, V are in parallel,

$\therefore C_{eq}=N_2C_2; V=V$

$E=\frac{1}{2}CV^2=\frac{1}{2}C_2N_2V^2$

From question, total energy stored in both the combination is same.

$\therefore \frac{9}{2}\frac{C_1}{N_1}V^2=\frac{C_2N_2V^2}{2} \Rightarrow C_1=C_2\frac{N_2N_1}{9}$

40. (b) Heat energy incident on the surface, $Q_i=1000\,J/m$

Coefficient of absorption, $a=0.8$ coefficient of reflection, $r=0.1$ Heat energy transmitted in 5 minutes, $Q_t=?$

$\because 1=r+a+t \Rightarrow t=1-0.1-0.8=0.1$

$Q_t=Q_i\times t\times T$ (t = cofficient of transmitance)

$Q_t=0.1\times 1000\times 5=500\,J$

41. (c) $Y=\frac{Fl}{A\Delta l}, \Delta l=\frac{Fl}{YA}$

$m=\rho V=\rho\times A\times l$

$A\propto m\ \frac{\Delta lP}{\Delta lQ}=\frac{A_2}{A_1}=\frac{m_2}{m_1}$

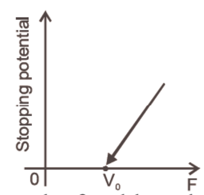
42. (b) Percentage error in the measurement of x

$\frac{\Delta x}{x}=2\frac{\Delta a}{a}+2\frac{\Delta b}{b}+\frac{\Delta c}{c}$

$=2\times 2+2\times 3+4$

$=4+6+4=14\%$

43. (a) The variation of stopping potential corresponding to the frequency of incident radiation (F) as shown below.



44. (b) In compound microscope, the focal length and aperture of the objective used is respectively large and small.

45. (b) de-Broglie wavelength

$\lambda=\frac{h}{p}\ \frac{h}{\sqrt{2mK.E}}$

or, $\lambda^2=\frac{h^2}{2m(K.E)}$

$\therefore K.E.=\frac{h^2}{2m\lambda^2}$

46. **(b)** Frequency of waves produced in string when tension in string T,

$$n=\frac{1}{2L}\sqrt{\frac{T}{m}}$$

When tension in string is doubled i.e., $2T$.

$$n'=\frac{1}{2L}\sqrt{\frac{2T}{m}}=\sqrt{2}\frac{1}{2L}\sqrt{\frac{T}{m}}$$

Clearly, $n'=\sqrt{2}n$

47. **(b)** $\because Y=\frac{FL}{Al}\quad \therefore l\frac{FL}{AY}$

Work done / increase in energy

$$=\frac{YAl^2}{2L}=\frac{F^2L}{2AY}$$

48. **(a)** According to question,

$$\frac{B_1}{B_2}=\frac{25}{2}\Rightarrow\frac{\frac{\mu_0}{4\pi}\frac{M\,d_1}{\left(d_1^2-l^2\right)^2}}{\frac{\mu_0}{4\pi}\frac{M\,d_2}{\left(d_2^2-l^2\right)}}=\frac{25}{2}$$

$$\frac{d_1}{d_2}\times\frac{\left(d_2^2-l^2\right)^2}{\left(d_1^2-l^2\right)^2}=\frac{25}{2}$$

$d_1=10$ cm, $d_2=20$ cm

$$\frac{10}{20}\times\left(\frac{20^2-l^2}{10^2-l^2}\right)=\frac{25}{2}$$

$400-l^2=5(100-l^2)$

$4l^2=100\Rightarrow t^2=25$ or, $l=5$ cm

49. **(d)** According to question, speed of satellite in its orbit.

$$v_c=\frac{1}{4}v_e.$$

(v_e = escape speed)

$$\sqrt{\frac{GM}{R+h}}=\frac{1}{4}\sqrt{\frac{2GM}{(R)}}\ ;\ \sqrt{\frac{GM}{(R+h)}}=\frac{1}{16}\times\frac{2Gm}{(R)}$$

$R+h=8(R)$

$R+h=8R$

$7R=h$

50. **(c)** In case of closed organ pipe, fundamental frequency

$$n\frac{V}{4L}=\frac{332}{4\times83\times10^{-2}}$$

or, $n=100$ Hz

Hence frequency of overtones $n_1 : n_2 : n_3$: -------- = 1 : 3 : 3 i.e., 100, 300, 500, 700 and 900 Hz

So number of possible natural oscillations of air column whose frequencies lie below 1000 are 5.

CHEMISTRY

51. **(b)**

52. **(a)** $\Delta U=q+W$

According to first law of thermodynamics

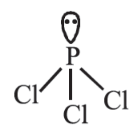
$=q+(-P_{ex}.\Delta V)$ ($\because$ $W=-P_{ex}.\Delta V$)

$\Delta U=q_p-P_{ex}.\Delta V$

53. **(b)** Zinc is used for coating iron surface. Because zinc get oxidized first when comes in contact with moisture and hence iron suface is protected from corosion.

54. **(b)** PCl_3 - has 3 sigma bond and 1 tone pair.

3 + 1 = 4



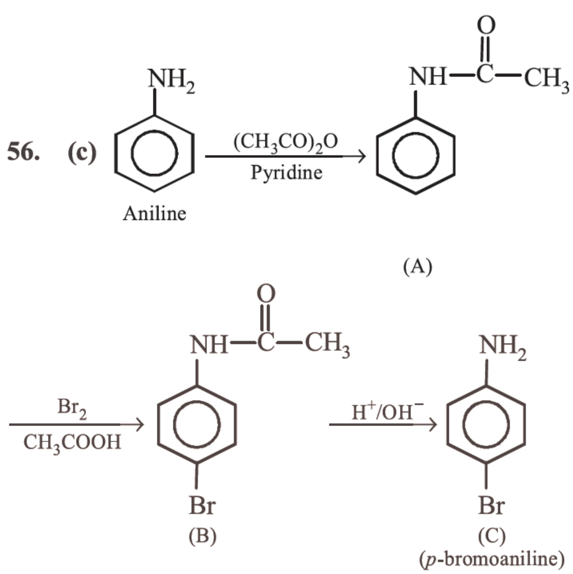
Hence, hybridization = sp^3

55. **(b)** Zn forms amphoteric oxide ZnO

$ZnO+2HCl\longrightarrow 2nCl_2+H_2O$ (acid)

$ZnO+2NaOH\longrightarrow Na_2ZnO_2+H_2O$ (Base)

56. **(c)**



57. **(c)** $-CH_3$ is electron donating group which shows + I effect.

58. **(a)**

59. **(c)** $\underset{\text{(phosphonic acid)}}{4H_3PO_3} \longrightarrow 3H_3PO_4 + PH_3$

$H_3PO_3 \longrightarrow H_3PO_4 \text{ (oxidation)}$

$H_3PO_3 \longrightarrow PH_3 \text{ (reduction)}$

60. **(b)** In $[AuCl_4]^{1-}$ Let the oxidation number of Au = x

$x + 4(-1) = -1$

$x - 4 = -1$

$x = -1 + 4$

$x = +3$

61. **(a)**

62. **(d)** $CH_3-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large OH}{|}}{C}}-CH_3$

3° alcohol reacts with lucas reagent (HCl + anhydrous $ZnCl_2$) immediately & gives two separate layers.

63. **(a)** Nitric oxide

64. **(c)** Moles of electron

$= \frac{\text{Charge}}{F} = \frac{\text{Current} \times \text{Time}}{96500}$

$\frac{2 \times 20 \times 60}{96500} = 0.02487$

or 2.487×10^{-2} mol e^-

65. **(b)** $\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in (L)}}$

Urea (molar mass) = 60 g/mol

$\text{molarity} = \frac{15 \times 1000}{60 \times 500} = \frac{15}{6 \times 5} = \frac{1}{2}$

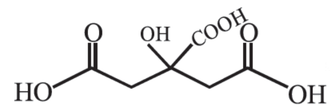
$= 0.5 \text{ mol dm}^{-3}$

66. **(c)** C_2

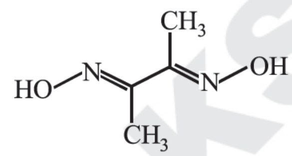
67. **(c)** CH_3CH_2COOH is most reactive towards esterification as bulkier group near the site of reaction, slows down esterification.

68. **(d)** $\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Vol. of Solution in dm}^3}$

69. **(a)** Citric acid is a tricarboxylic acid.



70. **(b)** No. of donor atom = 2



71. **(c)** Nitrous oxide (N_2O) has the lowest oxidation state (zero) as it is a neutral molecule.

72. **(b)** Formaldehyde is most reactive towards addition reaction.

73. **(d)** $La(OH)_3 (Z = 57)$ is the most basic hydroxide due to lanthanide contration.

74. **(c)** $kg\, m^{-3}$

75. **(c)** $C_2H_5-\underset{\underset{\large OH}{|}}{CH}-C_2H_5$

Because haloform is given by compound containing

$CH_3-\overset{\overset{\large O}{\|}}{C}-$ group or $R-\underset{\underset{\large OH}{|}}{CH}-CH_3$ only

76. **(a)** Work done is as :-

$W = -PdV$

$W = -P(V_2 - V_1)$

$V_1 = 10 \text{ dm}^3 = 10^{-2} \text{ m}^3$

$V_2 = 2 \text{m}^3$

$P = 101.325 \times 10^3$ pa

$W = -101.325 \times 10^3 (1.99)$

$= -201.6$ kJ

77. **(a)** ZnS because it shows Frenkel defect.

78. **(c)** Autophotolysis of water is as :-

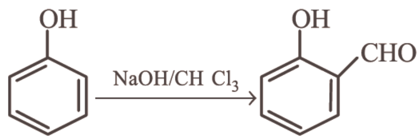
$H_2O \rightleftharpoons H^+ + OH^-$

$H_2O + H^+ \rightarrow H_3O^+$

$2H_2O \rightarrow H_3O^+ + OH^-$

79. **(b)** Hall's process is used to purify the ore of aluminium.

80. **(b)**



This reaction is known as Reimer-Tiemann reaction

81. **(a)** Be-belongs to second period which exhibits anomalous properties.

82. **(b)** $\underset{\text{(Excess)}}{NH_3} + NaOCl \longrightarrow \underset{\text{(Hydrazine)}}{NH_2 - NH_2} + NaCl + H_2O$

83. **(b)** 1.2 g mL^{-1}

84. **(c)** Nomex is used to manufacture clothes for firefighters.

85. **(b)** Titanium is obtained in pure form by Van Arkel method.

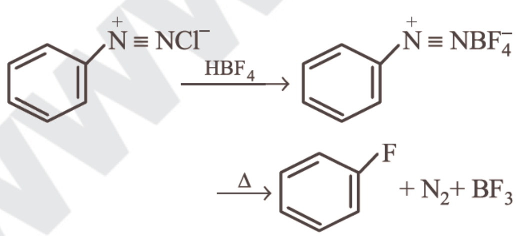
86. **(d)** Bromopheniramine is an Antihistamine.

87. **(d)** $\underset{\text{Hexane}}{CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3}$

Benzene

88. **(d)** Bismuth does not exhibit allotrophy.

89. **(b)** In Balz-Schiemann reaction aryl fluoride is prepared from diazonium salts and fluoroboric acid.



90. **(a)** $\Delta T_b = \dfrac{K_b \times W_2 \times 1000}{W_1 \times M_2}$

$$M_2 = \frac{K_b \times W_2}{\Delta T_b \times W_1}$$

91. **(a)** Nitrogen exists as N_2 (diatomic molecule), not as tetra atomic molecule.

92. **(d)**

$$\begin{array}{c} CHO \\ | \\ H - \overset{*}{C} - OH \\ | \\ CH_2OH \end{array}$$ glyceraldehyde

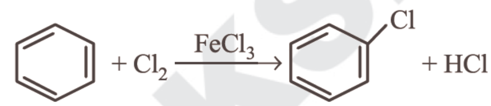
asymmetric carbon atom

93. **(c)** Ti^{4+}, Cu^{1+} are colourless compound

Ti : [Ar] $4s^2 3d^2$ Cu : [Ar] $4s^1 3d^{10}$

Ti^{4+} : [Ar] $4s^0\, 3d^0$ Cu^{1+} : [Ar] $4s^0\, 3d^{10}$

94. **(c)** It is an Electrophillic addition reaction.



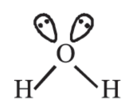
95. **(d)** – OH Atomic mass of oxygen is more than that of C & N.

96. **(b)** Dextron

$$n\,\underset{\text{Lactic acid}}{CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}} - COOH} + n\,\underset{\text{Glycolic acid}}{HO - CH_2 - COOH}$$

$$\longrightarrow \underset{\text{Dextron}}{\left[O - \underset{\underset{CH_3}{|}}{CH} - \overset{\overset{O}{\|}}{C} - O - CH_2 - \overset{\overset{O}{\|}}{C} \right]_n}$$

97. **(a)**



Distorted tetrahedral

98. **(a)** Fluorine

$$\underset{\text{(alkane)}}{R - H} + F_2 \xrightarrow{\text{dark}} R - F + HF$$

(highly exothermic)

99. **(b)** Combustion of ethanol is as :-

$$\underset{1}{C_2H_5OH} + \underset{3}{3O_2} \longrightarrow \underset{2}{2CO_2} + \underset{3}{3H_2O}$$

0.138 kg = 138/46 = 3 mole

138 g

$3C_2H_5OH(l) + 9O_2(g) \rightarrow 6CO_2(g) + 9H_2O(l)$

$\Delta n = 6 - 9 = -3$

Work = – ΔnRT

= – (– 3) × 8.314 × 300 = 7482 J

100. **(c)** Acc to Arrhenius equation.

$$K = Ae^{-E_a/RT}$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

$$\log k = \log A - \frac{E_a}{2.303\,R} \times \frac{1}{T}$$

$y = mx + C$

$y = \log k;\ x = \frac{1}{T}$; Slope $= \frac{-E_a}{2.303\,R}$

$$m = \frac{-E_a}{2.303\,R}$$

SECTION-B

MATHEMATICS

1. **(c)** Here, $\int_0^k \frac{dx}{2+18x^2} = \frac{\pi}{24}$

$$\Rightarrow \frac{\pi}{24} = \frac{1}{18}\int_0^k \frac{dx}{\left(\frac{1}{9}\right)+x^2} = \frac{1}{18}\int_0^k \frac{dx}{\left(\frac{1}{3}\right)^2 + x^2}$$

$$\Rightarrow \frac{\pi}{24} = \frac{1}{18} \times \frac{1}{\left(\frac{1}{3}\right)} \tan^{-1}\left[\frac{x}{\left(\frac{1}{3}\right)}\right]_0^k$$

$$\Rightarrow \frac{\pi}{24} = \frac{3}{18}\tan^{-1}[3x]_0^k = \frac{1}{6}\left[\tan^{-1}3k - \tan^{-1}0\right]$$

$$\Rightarrow \frac{\pi}{24} = \frac{1}{6}\left[\tan^{-1}3k - 0\right]$$

$$\therefore \frac{6\pi}{24} = \tan^{-1}3k \Rightarrow \tan\frac{\pi}{4} = 3k$$

$$\Rightarrow 1 = 3K \Rightarrow K = \frac{1}{3}$$

2. **(d)** $\because y^2 = -16x$

Comparing it with $y^2 = -4ax$

$\therefore$ a = 4

Parametric equations are

$x = -at^2,\ y = 2at$

or $x = -4\left(\frac{1}{2}\right)^2, y = 2(4)\left(\frac{1}{2}\right)$

or $x = -1, y = 4$

3. **(d)** $\int \frac{dx}{\sin x\cos^2 x} = \int \frac{\sin^2 x + \cos^2 x}{\sin x \cos^2 x}dx$

$$= \int \frac{\sin x}{\cos^2 x}dx + \int \frac{dx}{\sin x} = \int \tan x \sec x + \int \operatorname{cosec} x\, dx$$

$$= \sec x + \log|\operatorname{cosec} x - \cot x| + c$$

4. **(d)** Since, $\log_{10}\left(\frac{x^3-y^3}{x^3+y^3}\right) = 2$

$\therefore$ $\log(x^3 - y^3) - \log(x^3 + y^3) = 2$

$\Rightarrow$ $\log(x^3 - y^3) = 2 + \log(x^3 + y^3)$

Differentiating b/s w.r.t. x

$$\Rightarrow \frac{1}{x^3-y^3}\left[3x^2 - 3y^2\frac{dy}{dx}\right] = \frac{1}{x^3+y^3}\left[3x^2 + 3y^2\frac{dy}{dx}\right]$$

$$\Rightarrow \frac{3x^2}{x^3-y^3} - \frac{3y^2}{x^3-y^3}\frac{dy}{dx} = \frac{3x^2}{x^3+y^3} + \frac{3y^2}{x^3+y^3}\frac{dy}{dx}$$

$$\Rightarrow \frac{3x^2}{x^3-y^3} - \frac{3x^2}{x^3+y^3} = \left[\frac{3y^2}{x^3+y^3} + \frac{3y^2}{x^3-y^3}\right]\frac{dy}{dx}$$

$$\Rightarrow 3x^2\left[\frac{1}{x^3-y^3} - \frac{1}{x^3+y^3}\right] = 3y^2\left[\frac{1}{x^3+y^3} + \frac{1}{x^3-y^3}\right]\frac{dy}{dx}$$

$$\Rightarrow 3x^2\left[\frac{2y^3}{(x^3-y^3)(x^3+y^3)}\right] = 3y^2\left[\frac{2x^3}{(x^3+y^3)(x^3-y^3)}\right]\frac{dy}{dx}$$

$$\Rightarrow \frac{y}{x} = \frac{dy}{dx}$$

5. **(a)** Here $f(x) = \frac{x^2-4}{x-2} = \frac{(x-2)(x+2)}{(x-2)} = x+2$

$\therefore$ Range is R

6. **(c)** $f(x) = \begin{cases} x^2+\alpha & \text{if } x \ge 0 \\ 2\sqrt{x^2+1}+\beta & \text{if } x < 0 \end{cases}$

is continuous at $x = 0$

$\therefore f(0) = \lim\limits_{x\to 0^-} f(x)$

$\Rightarrow \quad 0+\alpha = \lim\limits_{x\to 0^-} 2\sqrt{x^2+1}+\beta$

$\Rightarrow \quad \alpha = 2+\beta \Rightarrow \alpha-\beta = 2$

$f\left(\frac{1}{2}\right) = \left(\frac{1}{2}\right)^2 + \alpha = 2 \Rightarrow \alpha = 2-\frac{1}{4} = \frac{7}{4}$

$\therefore \ \beta = \frac{7}{4}-2 = \frac{-1}{4}$

$\therefore \ \alpha^2+\beta^2 = \left(\frac{7}{4}\right)^2 + \left(\frac{-1}{4}\right)^2 = \frac{49+1}{16} = \frac{50}{16} = \frac{25}{8}$

7. **(b)** Since, $y = (\tan^{-1}x)^2$

$\Rightarrow \frac{dy}{dx} = \frac{2\tan^{-1}x}{1+x^2}$

$\Rightarrow \left(1+x^2\right)\frac{dy}{dx} = 2\tan^{-1}x = 2\sqrt{y}$

$\Rightarrow \left(1+x^2\right)^2\left(\frac{dy}{dx}\right)^2 = 4y$

Again differentiating b/s with respect to x, we get:

$$2\left(1+x^2\right)(2x)\left(\frac{dy}{dx}\right)^2 + 2\left(\frac{dy}{dx}\right)\frac{d^2y}{dx^2}\left(1+x^2\right)^2 = 4\frac{dy}{dx}$$

$$\Rightarrow 4x\left(1+x^2\right)\left(\frac{dy}{dx}\right)^2 + 2\left(1+x^2\right)^2\left(\frac{dy}{dx}\right)\frac{d^2y}{dx^2} = 4\frac{dy}{dx}$$

$$\Rightarrow 4x\left(1+x^2\right)\frac{dy}{dx} + 2\left(1+x^2\right)^2\frac{d^2y}{dx^2} = 4$$

$$\Rightarrow \left(x^2+1\right)^2\frac{d^2y}{dx^2} + 2x\left(1+x^2\right)\frac{dy}{dx} = 2$$

8. **(c)** $5x+y-1=0$ coincides
$5x^2+xy-kx-2y+2=0$

$\therefore a = 5, b = 0, \ h = \frac{1}{2}, \ g = -\frac{k}{2}, \ f = -1, c = 2$

If the above equation represents a pair of straight lines, then

$$\begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = 0 \ \Rightarrow \begin{vmatrix} 5 & \frac{1}{2} & -\frac{k}{2} \\ \frac{1}{2} & 0 & -1 \\ -\frac{k}{2} & -1 & 2 \end{vmatrix} = 0$$

$\therefore \ 5(0-1) - \frac{1}{2}\left(1-\frac{k}{2}\right) - \frac{k}{2}\left(\frac{-1}{2}-0\right) = 0$

$\therefore -5-\frac{1}{2}+\frac{k}{4}+\frac{k}{4} = 0 \Rightarrow \frac{k}{2} = \frac{11}{2} \Rightarrow k = 11$

9. **(b)** $(A^2-5A)A^{-1} = A^2A^{-1} - 5AA^{-1} = A.AA^{-1} - 5I$
$= A - 5I$

$$= \begin{bmatrix} 1 & 2 & 3 \\ -1 & 1 & 2 \\ 1 & 2 & 4 \end{bmatrix} - \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix}$$

$$= \begin{bmatrix} -4 & 2 & 3 \\ -1 & -4 & 2 \\ 1 & 2 & -1 \end{bmatrix}$$

10. **(c)** Let a, b, c be d. rs of desired line which is also perpendicular to the given lines.
$\therefore 2a-2b+c = 0$
$a-2b+2c = 0$

$$\Rightarrow \frac{a}{\begin{vmatrix} -2 & 1 \\ -2 & 2 \end{vmatrix}} = \frac{-b}{\begin{vmatrix} 2 & 1 \\ 1 & 2 \end{vmatrix}} = \frac{c}{\begin{vmatrix} 2 & -2 \\ 1 & -2 \end{vmatrix}}$$

$$\Rightarrow \frac{a}{-4+2} = \frac{-b}{4-1} = \frac{c}{-4+2}$$

$$\Rightarrow \frac{a}{-2} = \frac{b}{-3} = \frac{c}{-2}$$

$\therefore$ direction ratios are $<-2, -3, -2>$
Hence equation of desired line is

$$\frac{x-3}{-2} = \frac{y+1}{-3} = \frac{z-2}{-2} \text{ or } \frac{x-3}{2} = \frac{y+1}{3} = \frac{z-2}{2}$$

11. **(c)** The word HULULULU contains 4U, 3L & 1H. Consider 3L together i.e. we have to arrange 6 units which contains 4U.
Hence number of possible arrangements

$$=\frac{6!}{4!}=6\times5=30$$

Number of ways of arranging all letters of given word $=\frac{8!}{3!4!}=\frac{8\times7\times6\times5}{3\times2}=8\times7\times5$

Hence required probability $=\frac{30}{8\times7\times5}=\frac{6}{8\times7}=\frac{3}{28}$

12. **(b)** $9+99+999+........$ upto 10 terms
$=(10-1)+(100-1)+(1000-1)+........$ upto 10 terms
$=(10+100+1000+..........$ upto 10 terms$)-(1+1+...$ upto 10 times$)$

$$=\frac{10\left[(10)^{10}-1\right]}{10-1}-10$$

$$=\frac{10\left(10^{10}-1\right)}{9}-10=\frac{10^{11}-10-90}{9}$$

$$=\frac{10^{11}-100}{9}=\frac{100\left(10^{9}-1\right)}{9}$$

13. **(b)** We know that if $A+B+C=\pi$, then
$\tan A+\tan B+\tan C=\tan A\tan B\tan C$

$$\Rightarrow\frac{1}{\tan B\tan C}+\frac{1}{\tan A\tan C}+\frac{1}{\tan A\tan B}=1$$

$\Rightarrow\cot B\cot C+\cot A\cot C+\cot A\cot B=1$

14. **(d)** $\displaystyle\int\frac{dx}{\sqrt{16-9x^2}}=\frac{1}{3}\int\frac{dx}{\sqrt{\left(\frac{16}{9}\right)-x^2}}=\frac{1}{3}\int\frac{dx}{\sqrt{\left(\frac{4}{3}\right)^2-x^2}}$

$$=\frac{1}{3}\sin^{-1}\left[\frac{x}{\left(\frac{4}{3}\right)}\right]+C\quad\therefore\ A=\frac{1}{3}\text{ and }B=\frac{3}{4}$$

$$\therefore\ A+B=\frac{1}{3}+\frac{3}{4}=\frac{13}{12}$$

15. **(a)** $\displaystyle\int e^x\left[\frac{2+\sin2x}{1+\cos2x}\right]dx=\int e^x\left[\frac{2(1+\sin x\cos x)}{2\cos^2x}\right]$

$$=\int e^x\left[\sec^2x+\tan x\right]dx=e^x\tan x+c$$

16. **(d)** A coin is tossed 3 times.
$\therefore$ possibilities are
$HHH\rightarrow X=3-0=3$
$TTT\rightarrow X=3-0=3$
$HHT\rightarrow X=2-1=1$
$HTH\rightarrow X=2-1=1$
$THH\rightarrow X=2-1=1$
$HTT\rightarrow X=2-1=1$
$TTH\rightarrow X=2-1=1$
$THT\rightarrow X=2-1=1$

$$\therefore P(X=1)=\frac{6}{8}=\frac{3}{4}$$

17. **(d)** $2\sin\left(\theta+\frac{\pi}{3}\right)=\cos\left(\theta-\frac{\pi}{6}\right)$

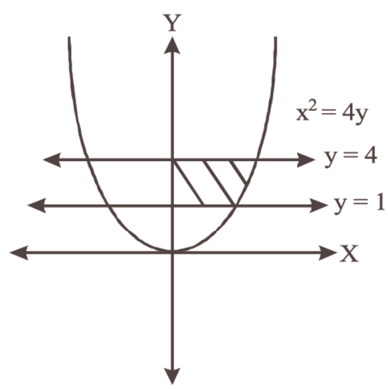
$$\Rightarrow2\left[\sin\theta\cos\frac{\pi}{3}+\cos\theta\sin\frac{\pi}{3}\right]=\cos\theta\cos\frac{\pi}{6}+\sin\theta\sin\frac{\pi}{6}$$

$$\Rightarrow2\left[\frac{\sin\theta}{2}+\cos\theta\left(\frac{\sqrt3}{2}\right)\right]=\cos\theta\left(\frac{\sqrt3}{2}\right)+\sin\theta\left(\frac{1}{2}\right)$$

$$\Rightarrow\sin\theta+\sqrt3\cos\theta=\frac{\sqrt3}{2}\cos\theta+\frac{1}{2}\sin\theta$$

$$\Rightarrow\frac{1}{2}\sin\theta=\frac{-\sqrt3}{2}\cos\theta\Rightarrow\ \tan\theta=-\sqrt3$$

18. **(b)**



We have $x^2=4y\Rightarrow x=2\sqrt{y}$

$\therefore$ area between $x=2\sqrt{y}$, $y=1$ & $y=4$

$$=\int_1^4 2\sqrt{y}\,dy=2\left[\frac{y^{3/2}}{3/2}\right]_1^4$$

$$=2\left(\frac{2}{3}\right)\left[y\sqrt{y}\right]_1^4=\frac{4}{3}(8-1)=\frac{28}{3}$$

19. **(d)** $f(x)=\dfrac{e^{x^2}-\cos x}{x^2}$

Since f(x) is continuous at x = 0

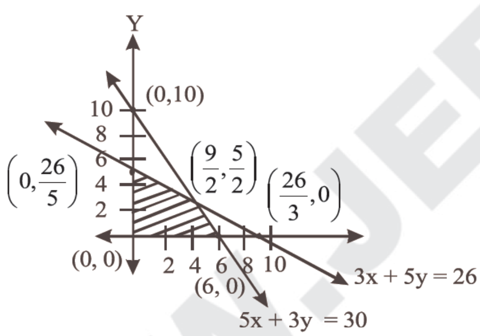
$\Rightarrow f(0)=\lim\limits_{x\to 0} f(x)$

$\Rightarrow f(0)=\lim\limits_{x\to 0}\dfrac{\left(e^{x^2}-1\right)-(\cos x-1)}{x^2}$

$\Rightarrow f(0)=\lim\limits_{x\to 0}\dfrac{e^{x^2}-1}{x^2}-\lim\limits_{x\to 0}\dfrac{-2\sin^2\frac{x}{2}}{x^2}$

$\Rightarrow f(0)=1+2\lim\limits_{x\to 0}\left[\dfrac{\sin\frac{x}{2}}{\frac{x}{2}}\right]^2\times\dfrac{1}{4}=1+\dfrac{2}{4}=\dfrac{3}{2}$

20. **(a)**



Corner Points	**Value of z = 2x + y**
(0, 0)	$z=0$
(6, 0)	$z=2(6)+0=12$
$\left(\dfrac{9}{2},\dfrac{5}{2}\right)$	$z=2\left(\dfrac{9}{2}\right)+\dfrac{5}{2}=11.5$
$\left(0,\dfrac{26}{5}\right)$	$z=2(0)+\dfrac{26}{5}=5.2$

21. **(c)** $|\vec{a}|=1,\ |\vec{b}|=2, |\vec{c}|=3$

$\vec{a}.\vec{b}=\vec{b}.\vec{c}=\vec{a}.\vec{c}=0$

Now, $\left[\vec{a}+\vec{b}+\vec{c}\ \ \vec{b}-\vec{a}\ \ \vec{c}\right]$

$=(\vec{a}+\vec{b}+\vec{c}).\left[(\vec{b}-\vec{a})\times\vec{c}\right]=(\vec{a}+\vec{b}+\vec{c}).\left(\vec{b}\times\vec{c}-\vec{a}\times\vec{c}\right)$

$=\left[\vec{a}\ \vec{b}\ \vec{c}\right]-\left[\vec{b}\ \vec{a}\ \vec{c}\right]=2\left[\vec{a}\ \vec{b}\ \vec{c}\right]=2\vec{a}.(\vec{b}\times\vec{c})$

$=2|\vec{a}|.|\vec{b}\times\vec{c}|\cos 0^\circ$ $\left(\because \vec{a}\ \&\ (\vec{b}\times\vec{c})\text{ are parallel}\right)$

$=2|\vec{a}|\cdot|\vec{b}\times\vec{c}|=2|\vec{a}||\vec{b}||\vec{c}|\sin 90^\circ$

$=2(1)(2)(3)=12$

22. **(d)** $\overrightarrow{PQ}=(-1,\ y-5,\ 4-x)$

$\overrightarrow{QR}=(2,\ 8-y,\ -4)$

$\because$ P, Q, R are collinear

$\therefore \dfrac{-1}{2}=\dfrac{y-5}{8-y}=\dfrac{4-x}{-4}$

$\Rightarrow -8+y=2y-10\ \&\ 4=8-2x$

$\Rightarrow y=2\ \&\ x=2$

$\therefore \boxed{x+y=4}$

23. **(a)** $\because\ ax^2+2hxy+2by^2=0$

Let the slope of one line is m.

In slope of other line = 2m.

We know that

$m+2m=\dfrac{-2h}{b}\ \&\ m\times 2m=\dfrac{a}{b}.$

$\Rightarrow 3m=\dfrac{-2h}{b}\ \&\ 2m^2=\dfrac{a}{b}.$

$\Rightarrow m=\dfrac{-2h}{b}\ \Rightarrow m^2=\dfrac{4h^2}{9b^2}.$

$\therefore 2\left(\dfrac{4h^2}{9b^2}\right)=\dfrac{a}{b}.\ \Rightarrow 8h^2=9ab$

24. **(a)** $y-1=(-1)(x+3)\Rightarrow x+y+z=0$

25. **(b)** p : Hema gets the admission in good college

q : Hema gets 95% marks

$\therefore$ given statement can be written as :

$p\to q$

$\therefore$ its negation is $p\wedge\sim q$

26. **(a)** $\cos 1^\circ\cos 2^\circ\cos 3^\circ.......\cos 179^\circ=0$

Since $\cos 90^\circ=0$

$\therefore$ required product = 0

27. **(c)** Planes $x - cy - bz = 0$

$$cx - y + az = 0$$
$$bx + ay - z = 0$$

Since the given planes pass through a straight line.

$\therefore$ planes are concurrent

$$\begin{vmatrix} 1 & -c & -b \\ c & -1 & a \\ b & a & -1 \end{vmatrix} = 0$$

$1(1 - a^2) + c(-c - ab) - b(ac + b) = 0$

$1 - a^2 - c^2 - abc - abc - b^2 = 0$

$a^2 + b^2 + c^2 + 2abc = 1$

$a^2 + b^2 + c^2 = 1 - 2abc$

28. **(c)** $x^2 - y^2 + x + 3y - 2 = 0$

Comparing the above equation with

$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$

we get

$$a = 1, h = 0, b = -1,\ g = \frac{1}{2},\ f = \frac{3}{2}, c = -2$$

$\therefore$ req. point of intersection is:

$$\left(\frac{hf - bg}{ab - h^2}, \frac{gh - af}{ab - h^2}\right)$$

$$\equiv \left(\frac{0 + \frac{1}{2}}{-1}, \frac{0 - \frac{3}{2}}{-1}\right) \equiv \left(-\frac{1}{2}, \frac{3}{2}\right)$$

29. **(b)** When we get 1, number of positive divisors are 1

When we get 2, number of positive divisors are 2

When we get 3, number of positive divisors are 2

When we get 4, number of positive divisors are 3

When we get 5, number of positive divisors are 2

When we get 6, number of positive divisors are 4

Hence range of random variable X is $\{1, 2, 3, 4\}$

30. **(b)** P (getting perfect square in atleast one throw) = 1 – P (not getting perfect square in any throw)

$$= 1 - \left(\frac{4}{6} \times \frac{4}{6} \times \frac{4}{6} \times \frac{4}{6}\right)$$

$$= 1 - \left(\frac{2}{3}\right)^4 = 1 - \frac{16}{81} = \frac{65}{81}$$

31. **(b)** $\displaystyle\int_0^{\pi/4} x \sec^2 x\, dx$

$$= \left[x \int \sec^2 x\, dx\right]_0^{\pi/4} - \int_0^{\pi/4} \left[\frac{d}{dx} x \int \sec^2 x\, dx\right] dx$$

$$= [x.\tan x]_0^{\pi/4} - \int_0^{\pi/4} [\tan x]\, dx$$

$$= [x.\tan x]_0^{\pi/4} - [\log|\sec x|]_0^{\pi/4}$$

$$= \left[\frac{\pi}{4} - 0\right] - \left[\log\left|\sec\frac{\pi}{4}\right| - \log|\sec 0|\right]$$

$$= \frac{\pi}{4} - \left[\log\sqrt{2} - \log 1\right]$$

$$= \frac{\pi}{4} - \log\sqrt{2}$$

32. **(c)** $\because$ a, b, c are in A.P.

$\therefore 2b = a + c$ ....(i)

Now, $a\cos^2\left(\frac{C}{2}\right) + c\cos^2\left(\frac{A}{2}\right)$

$$= a\frac{[1 + \cos C]}{2} + c\frac{[1 + \cos A]}{2}$$

$$= \frac{a + c + a\cos C + C\cos A}{2}$$

$$= \frac{a + c + b}{2} \qquad [\because b = a\cos C + c\cos A]$$

$$= \frac{2b + b}{2} = \frac{3b}{2} \qquad \text{[Using equation (i)]}$$

33. **(a)** $x = e^\theta(\sin\theta - \cos\theta)$ & $y = e^\theta(\sin\theta + \cos\theta)$

$$\therefore \frac{dx}{d\theta} = e^\theta(\cos\theta + \sin\theta) + (\sin\theta - \cos\theta)e^\theta$$

$$= e^\theta[2\sin\theta]$$

$$\& \frac{dy}{d\theta} = e^\theta(\cos\theta - \sin\theta) + (\sin\theta + \cos\theta)e^\theta = e^\theta[2\cos\theta]$$

$$\therefore \frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{e^\theta[2\cos\theta]}{e^\theta[2\sin\theta]}$$

$\Rightarrow \frac{dy}{dx} = \cot\theta$

$\Rightarrow \frac{dy}{dx}\Big|_{\theta=\frac{\pi}{4}} = \cot\frac{\pi}{4} = 1$

34. **(b)** $\sin x + \sin 3x + \sin 5x = 0$
$\sin 5x + \sin x + \sin 3x = 0$
$2\sin 3x.\cos 2x + \sin 3x = 0$
$\therefore \sin 3x\,[2\cos 2x + 1] = 0$
$\therefore \sin 3x = 0$ or $2\cos 2x + 1 = 0$
$\Rightarrow \sin 3x = \sin n\pi$
$\Rightarrow 3x = n\pi$

$\Rightarrow x = \frac{n\pi}{3}$

also $2\cos 2x = -1$

$\Rightarrow \cos 2x = -1/2$

$\Rightarrow \cos 2x = -\cos\pi/3$

$\cos 2x = \cos(\pi - \pi/3)$

$\Rightarrow \cos 2x = \cos\frac{2\pi}{3}$

$\Rightarrow 2x = 2n\pi \pm \frac{2\pi}{3}$

$x = \frac{n\pi}{3},\ x = n\pi \pm \frac{\pi}{3}$

$x \in \left[\frac{\pi}{2}, \frac{3\pi}{2}\right]$ gives

$x = \pi, \frac{2\pi}{3}$ & $\frac{4\pi}{3}$

35. **(c)** $\tan^{-1}2x + \tan^{-1}3x = \frac{\pi}{4}$

$\Rightarrow \tan^{-1}\left(\frac{2x+3x}{1-6x^2}\right) = \frac{\pi}{4}$

$\Rightarrow \frac{5x}{1-6x^2} = \tan\frac{\pi}{4}$

$\Rightarrow \frac{5x}{1-6x^2} = 1$

$\Rightarrow 5x = 1 - 6x^2$
$\Rightarrow 6x^2 + 5x - 1 = 0$
$\Rightarrow 6x^2 + 6x - x - 1 = 0$
$\Rightarrow 6x(x+1) - 1(x+1) = 0$
$\Rightarrow (x+1)(6x-1) = 0$

$\therefore x = -1,\ x = \frac{1}{6}$

When $x = \frac{1}{6}$, given equation is satisfied.

When $x = -1$, we get sum of two negative angles, hence discarded.

$\therefore x = \frac{1}{6}$

36. **(c)** Here $A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 1 & 5 \\ 2 & 4 & 7 \end{bmatrix}$

we know that,
$a_{31}A_{31} + a_{32}A_{32} + a_{33}A_{33} = |A|$
$= +1(7-20) - 2(7-10) + 3(4-2)$
$= -13 + 6 + 6 = -1$

37. **(b)** p = The weather is fine
q = My friends will come and we go for a picnic.
$\therefore$ given statement can be written as : $p \to q$
$\therefore$ its contrapositive is : $\sim q \to \sim p$
i.e. If my friends do not come or we do not go for picnic, then weather will not be fine.

38. **(d)** $f(x) = \frac{x}{x^2+1}$

$\Rightarrow f'(x) = \frac{(x^2+1)(1) - (x)(2x)}{(x^2+1)^2}$

$\Rightarrow f'(x) = \frac{1-x^2}{(x^2+1)^2}$

$\because f(x)$ is increasing function.

$\therefore f'(x) > 0$

$\Rightarrow \frac{1-x^2}{\left(x^2+1\right)^2} > 0$

Here $x^2 + 1 \neq 0$, $x^2 \neq -1$
$1 - x^2 > 0$, $x^2 < 1$
$x \in (-1, 1)$

39. **(a)** $X = 4^n - 3n - 1 \quad n \in N$

$\& \; Y = 9(n-1) \quad n \in N$

$\Rightarrow \; X = \{0, 9, 54, 243, ...\}$

$\& \; Y = \{0, 9, 18, 27, 36, 45, 54, ...\}$

$\therefore X \cap Y = X$

40. **(b)** $p \wedge (\sim p \wedge q)$

$= (p \wedge \sim p) \wedge q$ ....(Associative law)

$= F \wedge q$ ....(Compliment law)

$= F$ ....(Identity law)

41. **(a)** Line $y = 4x - 5 \rightarrow$ slope of line $m = 4$ ...(i)

curve $y^2 = ax^3 + b$

$\therefore$ differentiating w.r.t. 'x'

$$2y\frac{dy}{dx} = 3ax^2$$

$$\frac{dy}{dx} = \frac{3ax^2}{2y} = \text{slope of tangent}$$

$$\therefore \left.\frac{dy}{dx}\right|_{(2,3)} = \frac{3a \times 4}{2 \times 3} = 2a \quad ...(ii)$$

$\therefore$ from (i) and (ii), we get

$4 = 2a \Rightarrow a = 2$

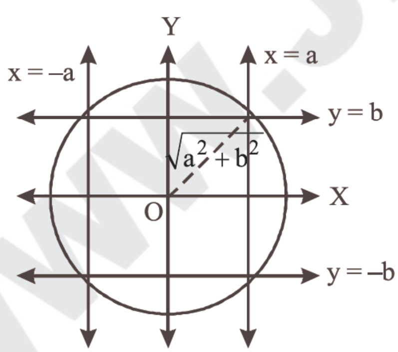
Since, (2, 3) is a point on the curve : $y^2 = ax^3 + b$.

$\therefore (3)^2 = 2(2)^3 + b$

$\Rightarrow b = -7$

$\therefore 7a + 2b = 7 \times 2 + 2(-7) = 0$

42. **(b)**



Centre = (0, 0) & radius = $r = \sqrt{a^2 + b^2}$

$\therefore$ equation of circle

$x^2 + y^2 = a^2 + b^2$

43. **(a)** $f(x) = x \log x$

$\therefore f'(x) = 1 + \log x$

For minimum value

$f'(x) = 0 \Rightarrow 1 + \log x = 0$

$$\Rightarrow \log x = -1 \Rightarrow x = \frac{1}{e}$$

$$\text{min value } = f\left(\frac{1}{e}\right) = \frac{1}{e}.\log\left(\frac{1}{e}\right)$$

$$= \frac{1}{e}(\log 1 - \log e) = \frac{1}{e}(0-1) = -\frac{1}{e}$$

44. **(d)** $n = 10, p = 0.4, q = 0.6$

$\because E(x) = np = 4$

$\& \; V(x) = npq = 10(0.4)(0.6) = 2.4$

Now, $V(x) = E(x^2) - [E(x)]^2$

$\Rightarrow 2.4 = E(x^2) - (4)^2$

$\Rightarrow E(x^2) = 18.4$

45. **(a)** $\frac{dx}{dy} = \cos(x+y)$

$$\Rightarrow \frac{dy}{dx} = \frac{1}{\cos(x+y)}$$

Put $x + y = V$

Differentiating w.r.t. 'x'

$$1 + \frac{dy}{dx} = \frac{dV}{dx}$$

$$\Rightarrow \frac{dy}{dx} = \frac{dV}{dx} - 1$$

$$\Rightarrow \frac{dV}{dx} - 1 = \frac{1}{\cos V}$$

$$\Rightarrow \frac{dV}{dx} = \frac{1}{\cos V} + 1$$

$$\Rightarrow \frac{dV}{dx} = \frac{1+\cos V}{\cos V}$$

$$\Rightarrow \frac{\cos V}{(1+\cos V)}dV = dx$$

Integrate both sides, we get :

$$\int \frac{(1+\cos V) - 1}{1+\cos V}dV = \int dx$$

$$\Rightarrow \int \left[1 - \frac{1}{2\cos^2\frac{V}{2}}\right]dV = \int dx$$

$$\Rightarrow V - \frac{1}{2}\frac{\tan\frac{V}{2}}{\frac{1}{2}} = x + C_1$$

$$\Rightarrow x + y - \tan\left(\frac{x+y}{2}\right) = x + C_1$$

$$\Rightarrow \tan\left(\frac{x+y}{2}\right) = y + C \qquad [\because C = -C_1]$$

46. **(d)** We have $\vec{r}.\left(p\hat{i} - \hat{j} + 2\hat{k}\right) + 3 = 0$ and

$\vec{r}.\left(2\hat{i} - p\hat{j} - \hat{k}\right) - 5 = 0$

Since angle between them is $\frac{\pi}{3}$.

$$\therefore \cos\theta = \left|\frac{\vec{n}_1.\vec{n}_2}{|\vec{n}_1|.|\vec{n}_2|}\right|$$

$$\Rightarrow \cos\frac{\pi}{3} = \frac{\left(p\hat{i} - \hat{j} + 2\hat{k}\right).\left(2\hat{i} - p\hat{j} - \hat{k}\right)}{\sqrt{(p)^2 + (-1)^2 + (2)^2}\sqrt{(2)^2 + (-p)^2 + (-1)^2}}$$

$$\Rightarrow \frac{1}{2} = \frac{2p + p - 2}{\left(\sqrt{p^2+5}\right)\left(\sqrt{p^2+5}\right)} \Rightarrow \frac{1}{2} = \frac{3p-2}{\left(p^2+5\right)}$$

$\Rightarrow p^2 + 5 = 6p - 4 \Rightarrow p^2 - 6p + 9 = 0$
$\Rightarrow (p-3)^2 = 0 \Rightarrow p = 3$

47. **(d)** Equation of parabola whose axis is parallel to X axis and latus rectum is 4a
$(y-k)^2 = 4a(x-h)$
(where h & k are arbitrary constants)
differentiating b/s, we get
$2(y-k)y' = 4ax$ ....(i)
again differentiating b/s, we get.

$$(y-k)y'' + y'^2 = 2a$$

$$\Rightarrow \frac{2ax}{y'}.y'' + y'^2 = 2a \qquad \text{from (i)}$$

$$\Rightarrow 2axy'' + y'^3 = 2ay'$$

$\Rightarrow$ order 2.

48. **(a)** Points on the given lines are respectively (1, –1, 1) and (3, k, 0) and their direction ratios are respectively 2, 3, 4 and 1, 2, 1
Since lines intersect, then lines are coplanar

$$\therefore \begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$$

$$\therefore \begin{vmatrix} 2 & k+1 & -1 \\ 2 & 3 & 4 \\ 1 & 2 & 1 \end{vmatrix} = 0$$

$\therefore 2(-5) - (k+1)(-2) - 1(1) = 0$
$-11 + 2k + 2 = 0$

$$k = \frac{9}{2}$$

49. **(c)** Let cos α, cos β & cos γ are the direction cosines of the line. We know that
$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$
$\Rightarrow (\cos 120°)^2 + \cos^2\beta + (\cos 60°)^2 = 1$

$$\Rightarrow \left(-\frac{1}{2}\right)^2 + \cos^2\beta + \left(\frac{1}{2}\right)^2 = 1$$

$$\Rightarrow \cos^2\beta = 1 - \frac{1}{2} = \frac{1}{2} \Rightarrow \cos\beta = \pm\frac{1}{\sqrt{2}}$$

$\Rightarrow \beta = 135°$

50. **(c)** We have $L \equiv (2, -1)$ and $M \equiv (1, 2)$ and is divided by N in ratio 2 : 1 externally.

$$\therefore N \equiv \frac{(2)(1) - (2)(1)}{2-1}, \frac{(2)(2) - (1)(-1)}{2-1}$$

i.e. $N \equiv \left(0, \frac{5}{1}\right)$ i.e. $N \equiv (0, 5)$

$\therefore$ position vector of point N is $5\vec{b}$

MHT-CET 2017

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. The frequencies for series limit of Balmer and Paschen series respectively are 'v_1' and 'v_3'. If frequency of first line of Balmer series is 'v_2' then the relation between 'v_1', 'v_2' and 'v_3' is

(a) $v_1 - v_2 = v_3$ (b) $v_1 + v_3 = v_2$
(c) $v_1 + v_2 = v_3$ (d) $v_1 - v_3 = 2v_1$

2. When three capacitors of equal capacities are connected in parallel and one of the same capacity is connected in series with its combination. The resultant capacity is 3.75μF. The capacity of each capacitor is

(a) 5 μF (b) 6 μF (c) 7 μF (d) 8 μF

3. Sensitivity of moving coil galvanometer is 'S'. If shunt of $\frac{1}{8}$ th of the resistance of galvanometer is connected to moving coil galvanometer, its sensitivity becomes

(a) $\frac{S}{3}$ (b) $\frac{S}{6}$ (c) $\frac{S}{9}$ (d) $\frac{S}{12}$

4. Two unknown resistances are connected in two gaps of a meter-bridge. The null point is obtained at 40 cm from left end. A 30 Ω resistance is connected in series with the smaller of the two resistances, the null point shifts by 20 cm to the right end. The value of smaller resistance in Ω is

(a) 12 (b) 24 (c) 36 (d) 48

5. In Fraunhofer diffraction pattern, slit width is 0.2 mm and screen is at 2 m away from the lens. If wavelength of light used is 5000Å, then the distance between the first minimum on either side of the central maximum is (θ is small and measured in radian)

(a) 10^{-1}m (b) 10^{-2}m
(c) 2×10^{-2}m (d) 2×10^{-1}m

6. In series *LCR* circuit R= 18 Ω and impedance is 33 Ω An rms voltage 220V is applied across the circuit. The ture power consumed in AC circuit is

(a) 220w (b) 400w (c) 600w (d) 800w

7. Two parallel plate air capacitors of same capacity C are connected in series to a battery of emf *E*. Then one of the capacitors is completely filled with dielectric material of constant *K*. The change in the effective capacity of the series combination is

(a) $\frac{C}{2}\left[\frac{K-1}{K+1}\right]$ (b) $\frac{2}{C}\left[\frac{K-1}{K+1}\right]$

(c) $\frac{C}{2}\left[\frac{K+1}{K-1}\right]$ (d) $\frac{C}{2}\left[\frac{K-1}{K+1}\right]^2$

8. The polarising angle for transparent medium is 'θ' and 'v' is the speed of light in that medium. Then relation between 'θ' and 'v' is
(c = velocity if light in air)

(a) $\theta = \tan^{-1}\left(\frac{v}{c}\right)$ (b) $\theta = \cot^{-1}\left(\frac{v}{c}\right)$

(c) $\theta = \sin^{-1}\left(\frac{v}{c}\right)$ (d) $\theta = \cos^{-1}\left(\frac{v}{c}\right)$

9. Two identical light waves having phase difference 'ϕ' propagate in same direction. When they superpose, the intensity of resultant wave is proportional to

(a) $\cos^2 \phi$ (b) $\cos^2\left(\frac{\phi}{2}\right)$

(c) $\cos^2\left(\frac{\phi}{3}\right)$ (d) $\cos^2\left(\frac{\phi}{4}\right)$

10. For a transistor, α_{dc} and β_{dc} are the current ratios, then the value of $\frac{\beta_{dc}-\delta_{dc}}{\alpha_{dc}.\beta_{dc}}$

(a) 1 (b) 1.5 (c) 2 (d) 2.5

11. A radioactive element has rate of disintegration 10,000 disintegrations per minute at a particular instant. After four minutes it become 2500 disintegrations per minute. The decay constant per minute is

(a) $0.2 \log_e 2$ (b) $0.5 \log_e 2$

(c) $0.6 \log_e 2$ (d) $0.8 \log_e 2$

12. When the same monochromatic ray of light travels through glass slab and through water, the number of waves in glass slab of thickness 6cm is same as in water column of height 7cm. If refractive index of glass is 1.5, then refractive index of water is

(a) 1.258 (b) 1.269 (c) 1.286 (d) 1.310

13. If the electron in hydrogen atom jumps from second Bohr orbit to ground state and difference between energies of the two states is radiated in the form of photons. If the work function of the material is 4.2 eV, then stopping potential is

[Energy of electron in nth orbit $= -\frac{13.6}{n^2}$ eV]

(a) 2V (b) 4V (c) 6V (d) 8V

14. The magnetic moment of electron due to orbital motion is proportional to

(n = principal quantum numbers)

(a) $\frac{1}{n^2}$ (b) $\frac{1}{n}$ (c) n^2 (d) n

15. Photodiode is a device

(a) which is always operated in reverse bias

(b) which is always operated in forward bias

(c) in which photo curent is independent of intensity of incident radiation

(d) which may be operated in forwad or revese bias.

16. A wheel of moment of inertia 2 kg m^2 is rotating about an axis passing through centre and perpendicular to its plane at a speed 60 rad/s. Due to friction, it comes to rest in 5 minutes. The angular momentum of the wheel three minutes before it stops rotating is

(a) 24 kg m^2/s (b) 48 kg m^2/s

(c) 72 kg m^2/s (d) 96 kg m^2/s

17. The equation of the progressive wave is y = $3\sin\left[\pi\left(\frac{t}{3}-\frac{x}{5}\right)+\frac{\pi}{4}\right]$, where x and y are in metre and time in second. Which of the following is correct?

(a) Velocity v = 1.5 m/s

(b) Amplitude A = 3cm

(c) Frequency f = 0.2Hz

(d) Wavelength λ = 10m

18. Two spherical black bodies have radii 'r_1' and 'r_2'. Their surface temperature are 'T_1' and 'T_2'. If they radiate same power, then $\frac{r_2}{r_1}$ is

(a) $\frac{T_1}{T_2}$ (b) $\frac{T_2}{T_1}$

(c) $\left(\frac{T_1}{T_2}\right)^2$ (d) $\left(\frac{T_2}{T_1}\right)^2$

19. The closed and open organ pipes have same length. When they are vibrating simultaneously in first overtone, produce three beats. The lenght of open pipe is made $\frac{1}{3}$rd and closed pipe is made three times the original, the number of beats produced will be

(a) 8 (b) 14 (c) 17 (d) 20

20. A lift of mass 'm' is connected to a rope which is moving upward with maximum acceleration 'a'. For maximum safe stress, the elastic limit of the rope is 'T'. The minimum diameter of the rope is (g = gravitational acceleration)

(a) $\left[\frac{2m(g+a)}{\pi T}\right]^{\frac{1}{2}}$ (b) $\left[\frac{4m(g+a)}{\pi T}\right]^{\frac{1}{2}}$

(c) $\left[\frac{m(g+a)}{\pi T}\right]^{\frac{1}{2}}$ (d) $\left[\frac{m(g+a)}{2\pi T}\right]^{\frac{1}{2}}$

21. A solid sphere of mass 2 kg is rolling on a frictionless horizontal surface with velocity 6m/s. It collides on the free end of an ideal spring whose other end is fixed. The maximum compression produced in the spring will be (Force constant of the spring = 36 N/m)

(a) $\sqrt{14\,m}$ (b) $\sqrt{2.8\,m}$

(c) $\sqrt{14\,m}$ (d) $\sqrt{0.7\,m}$

22. A flywheel at rest is to reach an angular velocity of 24rad/s in 8 second with constant angular acceleration. The total angle turned through during this interval is

(a) 24 rad (b) 48 rad (c) 72 rad (d) 96 rad

23. Two uniform wires of the same material are vibrating under the same tension. If the first overtone of the first wire is equal to the second overtone of the second wire and radius of the first wire is the twice the radius of the second wire, then the ratio of the lengths of the first wire to second wire is

(a) $\frac{1}{3}$ (b) $\frac{1}{4}$ (c) $\frac{1}{5}$ (d) $\frac{1}{6}$

24. When one end of the capillary is dipped in water, the height of water column is 'h'. The upward force of 105 dyne due to surface tension is balanced by the force due to the weight of water column. The inner circumference of capillary is (Surface tension of water = 7×10^{-2} N/m)

(a) 1.5 cm (b) 2 cm (c) 2.5 cm (d) 3 cm

25. For a rigid diatomic molecule, universal gas constant $R = nC_p$, where 'C_p' is the molar specific heat at constant pressure and 'n' is a number. Hence 'n' is equal to

(a) 0.2257 (b) 0.4 (c) 0.2857 (d) 0.3557

26. An ideal gas has pressure 'p' volume 'V' and absolute temperature 'T'. If 'm' is the mass of each molecules and 'K' is the Boltzmann constant, then density of the gas is

(a) $\frac{pm}{KT}$ (b) $\frac{KT}{pm}$ (c) $\frac{Km}{pT}$ (d) $\frac{pK}{Tm}$

27. A big water drop is formed by the combination of 'n' small water drops of equal radii. The ratio of the surface energy of 'n'drops to the surface energy of big drop is

(a) $n^2 : 1$ (b) $n : 1$ (c) $\sqrt{n} : 1$ (d) $\sqrt[3]{n} : 1$

28. The ratio of binding energy of a satellite at rest on earth's surface to the binding energy of a satellite of same mass revolving around the earth at a height h above the earth's surface is (R = radius of the earth).

(a) $\frac{2(R+h)}{R}$ (b) $\frac{R+h}{2}$

(c) $\frac{R+h}{R}$ (d) $\frac{R}{R+h}$

29. A particle performing SHM starts equilibrium position and its time period is 16 seconds. After 2 seconds its velocity is π m/s. Amplitude of oscillation is $\left(\cos 45° = \frac{1}{\sqrt{2}}\right)$

(a) $2\sqrt{2}\text{m}$ (b) $4\sqrt{2}\text{m}$

(c) $6\sqrt{2}\text{m}$ (d) $8\sqrt{2}\text{m}$

30. In sonometer experiment, the string of length 'L' under tension vibrates in second overtone between two bridges. The amplitude of vibration is maximum at

(a) $\frac{L}{3}, \frac{2L}{3}, \frac{5L}{6}$ (b) $\frac{L}{8}, \frac{L}{4}, \frac{L}{2}$

(c) $\frac{L}{2}, \frac{L}{4}, \frac{L}{6}$ (d) $\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$

31. The depth 'd' at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the earth's surface is (R = radius of earth)

(a) $d = R\left(\frac{n}{n-1}\right)$ (b) $d = R\left(\frac{n-1}{2n}\right)$

(c) $d = R\left(\frac{n-1}{n}\right)$ (d) $d = R^2\left(\frac{n-1}{n}\right)$

32. A particle is performing SHM starting extreme position, graphical representation shows that between displacement and acceleration there is a phase difference of

(a) 0 rad (b) $\frac{\pi}{4}$ rad

(c) $\frac{\pi}{2}$ rad (d) π rad

33. The fundamental frequency of an air column is a pipe closed at one end is 100 Hz. If the same pipe is open at both the ends, the frequencies produced in Hz are

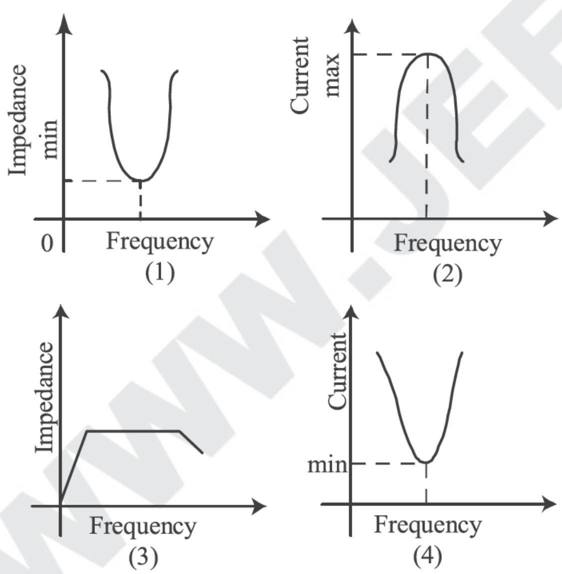
(a) 100, 200, 300, 400...
(b) 100, 300, 500, 700...
(c) 200, 300, 400, 500...
(d) 200, 400, 600, 800

34. For a particle moving in vertical circle, the total energy at different positions along the path
(a) is conserved
(b) increases
(c) decreases
(d) may increase or decrease

35. A simple pendulum of length 'L' has mass 'M' and it oscillates freely with amplitude 'A'. At extreme position, its potential energy is (g=acceleration due to gravity)
(a) $\frac{MgA^2}{2L}$ (b) $\frac{MgA}{2L}$
(c) $\frac{MgA^2}{L}$ (d) $\frac{2MgA^2}{L}$

36. On a photosensitive material when frequency of incident radiation is increased by 30%, kinetic energy of emitted photoelectrons increases from 0.4 eV. The work function of the surface is
(a) 1 eV. (b) 1.267 eV
(c) 1.4 eV (d) 1.8 eV

37. Out of the following graphs, which graphs shows the correct relation (graphical representation) for LC parallel resonant circuit



(a) 1 (b) 2 (c) 3 (d) 4

38. According to de-Broglie hypothesis, the wavelength associated with moving electron of mass 'm' is 'λ_e'. Using mass energy relation and Planck's quantum theory, the wavelength associated with photon is 'λ_p'. If the energy (E) of electron and photon is same, then relation between 'λ_e' and 'λ_p' is
(a) $\lambda_p \propto \lambda_e$ (b) $\lambda_p \propto \lambda_e^2$
(c) $\lambda_p \propto \sqrt{\lambda_e}$ (d) $\lambda_p \propto \frac{1}{\lambda_e}$

39. A parallel plate air capacity 'C' farad, potential 'V' volt and energy 'E' joule. When the gap between the plastes is completely filled with dielectric
(a) both V and E increase
(b) both V and E decrease
(c) V decrease, E increases
(d) V increases, E decrease

40. The resistivity of potentiometer wire is 40×10^{-8} ohm-metre and its area of cross- section is 8×10^{-6}m^2. If 0.2 ampere current is flowing through the wire, then the potential gradient of the wire is
(a) 10^{-1} V/m (b) 10^{-2} V/m
(c) 10^{-3} V/m (d) 10^{-4} V/m

41. A ceiling fan rotates about its own axis with some angular velocity. When the fan is switched off the angular velocity becomes $\left(\frac{1}{4}\right)$th of the original in time 't' and 'n' revolutions are made in that time. The number of revolutions made by the fan during the time interval between switch off and rest are (Angular retardation is uniform)
(a) $\frac{4n}{15}$ (b) $\frac{8n}{15}$ (c) $\frac{16n}{15}$ (d) $\frac{32n}{15}$

42. A disc of moment of inertia 'I_1' is rotating in horizontal plane about an axis passing through a centre and perpendicular to its plane with constant angular speed 'ω_1'. Another disc of moment of inertia 'I_2' having zero angular speed is placed co-axially on a rotating disc. Now, both the discs are rotating with constant angular speed 'ω_2'. The energy lost by the initial rotating disc is
(a) $\frac{1}{2}\left[\frac{I_1+I_2}{I_1I_2}\right]\omega_1^2$ (b) $\frac{1}{2}\left[\frac{I_1I_2}{I_1-I_2}\right]\omega_1^2$
(c) $\frac{1}{2}\left[\frac{I_1-I_2}{I_1I_2}\right]\omega_1^2$ (d) $\frac{1}{2}\left[\frac{I_1I_2}{I_1+I_2}\right]\omega_1^2$

43. A particle performs linear SHM at a particular instant, velocity of the particle is 'u' and acceleration is α while at another instant velocity is 'v' and acceleration is 'β' ($0 < \alpha < \beta$). The distance between the two position is
(a) $\frac{u^2-v^2}{\alpha+\beta}$ (b) $\frac{u^2+v^2}{\alpha+\beta}$
(c) $\frac{u^2-v^2}{\alpha-\beta}$ (d) $\frac{u^2+v^2}{\alpha-\beta}$

44. The observer is moving with velocity 'v_0' towards the stationary source of sound and then after crossing moves away from the source with velocity 'v_0'. Assume that the medium through which the sound waves travel is at rest. If v is the velocity of sound and n is the frequency emitted by the source, then the difference between apparent frequencies heard by the observer is

(a) $\frac{2nv_0}{v}$ (b) $\frac{nv_0}{v}$ (c) $\frac{v}{2nv_0}$ (d) $\frac{v}{nv_0}$

45. A metal rod of length 'L' and cross-sectional area 'A' is heated through 'T°C'. What is the force required to prevent the expansion of the rod lengthwise

(a) $\frac{YA\alpha T}{(1-\alpha T)}$ (b) $\frac{YA\alpha T}{(1+\alpha T)}$

(c) $\frac{(1-\alpha T)}{YA\alpha T}$ (d) $\frac{(1+\alpha T)}{YA\alpha T}$

46. Two coils P and Q are kept near each other. When no current flows through coil P and current increase in coil Q at the rate 10A/s, the emf in coil P is 15mV. When coil Q carries no current and current of 1.8A flows through coil P, the magnetic flux linked with the coil Q is

(a) 1.4 m Wb (b) 2.2 mWb
(c) 2.7 m Wb (d) 2.9 m Wb

47. In Young's double experiment, in air interference pattern second minimum is observed exactly in front of one slit. The distance between the two coherent source is 'd' and the distance between source and screen is 'D'. The wavelength of light source used is

(a) $\frac{d^2}{D}$ (b) $\frac{d^2}{2D}$ (c) $\frac{d^2}{3D}$ (d) $\frac{d^2}{4D}$

48. In communication system, the process of superimposing a low frequency signal on a high frequency wave is know n as

(a) repeater (b) attenuation
(c) modulation (d) demodulation

49. A bar magnet has length 3 cm, cross-sectional area 2 cm^3 and magnetic moment 3 Am^2. The intensity of magnetisation of bar magnet is

(a) 2×10^5 A/m (b) 3×10^5 A/m
(c) 4×10^5 A/m (d) 5×10^5 A/m

50. The magnetic flux near the axis and inside the air core solenoid of length 60cm carrying current 'I' is 157×10^{-6} Wb. Its magnetic moment will be (cross-sectional area of a solenoid is very small as compared to its length, $\mu_0 = 4\pi \times 10^{-7}$ SI unit)

(a) 0.25 A (b) 0.50 A (c) 0.75 A (d) 1 A

CHEMISTRY

51. The work done during combustion of 9×10^{-2} kg of ethane, C_2H_6 (g) at 300 K is
(Given R = 8.314 J deg^{-1}, atomic mass C = 12, H = 1

(a) 6.236 kJ (b) – 6.236 kJ
(c) 18.71 kJ (d) –18.71 kJ

52. What type of sugar molecule is present is DNA?

(a) D-3-deoxyribose (b) D-ribose
(c) D-2-deoxyribose (d) D-glucopyranose

53. The molality of solution containing 15.20 g of urea, (molar mass = 60) dissolved in 150 g or water is

(a) 1.689 mol kg^{-1} (b) 0.1689 mol kg^{-1}
(c) 0.5922 mol kg^{-1} (d) 0.2533 mol kg^{-1}

54. The acid, which contains both –OH and –COOH groups is

(a) phthalic acid (b) adipic acid
(c) glutaric acid (d) salicylic acid

55. Identify the compound, in which phosphorus exists in the oxidation state of +1.

(a) Phosphonic acid (H_3PO_3)
(b) Phosphinic acid (H_3PO_2)
(c) Pyrophosphorus acid ($H_4P_2O_5$)
(d) Orthophosphoric acid (H_3PO_4)

56. Identify the weakest oxidising agent among the following.

(a) Li^+ (b) Na^+ (c) Cd^{2+} (d) I_2

57. The monomers used in preparation of dextron are

(a) lactic acid and glycolic acid
(b) 3-hydroxy butanoic acid and 3-hydroxy pentanoic acid
(c) styrene and 1, 3-butadiene
(d) hexamethylenediamine and adipic acid

58. Which among the following compounds does not act as reducing agent?

(a) H_2O (b) H_2S (c) H_2Se (d) H_2Te

59. Which of the following processes is not used to preserve the food?

(a) Irradiation (b) Addition of salts
(c) Addition of heat (d) Hydration

60. In case of substituted aniline the group which decreases the basic strength is

(a) $-OCH_3$ (b) $-CH_3$
(c) $-NH_2$ (d) $-C_6H_5$

61. (+2) 2-methylbutan-1-ol (-) 2-methylbutan-1-ol have different values for which property?

(a) Boiling point (b) Relative density
(c) Refraction index (d) Specific rotation

62. Which among the following is not is mineral of iron?

(a) Haematite (b) Magnesite
(c) Magnetite (d) Siderite

63. Nitration of which among the following compounds yields cyclonite?
(a) Formaldehyde
(b) Benzaldehyde
(c) Urotropine
(d) Acetaldehyde ammonia

64. Calculate the work done during compression of 2 mol of an ideal gas from a volume of $1m^3$ to $10\ dm^3$ 300K against a pressure of 100 KPa.
(a) –99 kJ (b) + 99 kJ
(c) +22.98 kJ (d) –22.98 kJ

65. Which element among the following does form $p\pi - p\pi$ multiple bonds?
(a) Arsenic (b) Nitrogen
(c) Phosphorus (d) Antimony

66. Which of the following statement(s) is/are incorrect in case of Hofmann bromamide degradation?
(a) Reaction is useful for decreasing length of carbon chain by one carbon atom
(b) It gives tertiary amine
(c) It gives primary amine
(d) Aqueous or alco. KOH is used with bromine

67. Which of the following statement (s) is/are incorrect for pair of elements Zr-Hf ?
(a) Both possess same number of valence electrons.
(b) Both have identical sizes.
(c) Both have almost identical radii.
(d) Both of these belong to same period of periodic table.

68. Aldehyde or ketones when treated with $C_6H_5 - NH–NH_2$, the product formed is
(a) semicarbazone (b) phenlhydrazone
(c) hydrazone (d) oxime

69. Solubility of which among the following solids in water changes slightly with temperature?
(a) KNO_3 (b) $NaNO_3$
(c) KBr (d) NaBr

70. What is the quantity of hydrogen gas liberated when 46 g sodium reacts with excess ethanol?
(a) 2.4×10^{-3} kg (b) 2.0×10^{-3} kg
(c) 4.0×10^{-3} kg (d) 2.4×10^{-2} kg

71. *Tert*-butyl methyl ether on treatment with hydrogen iodide in cold gives
(a) *tert*-butyl iodide and methyl iodide
(b) *tert*-butyl alcohol and methyl alcohol
(c) *tert*-butyl alcohol and methyl iodide
(d) *tert*-butyl iodide and methyl alcohol

72. Name the process that is employed to refine aluminium.
(a) Hall's process (b) Mond process
(c) Hoope's process (d) Serperck's process

73. The colour and magnetic nature of manganate ion (MnO_4^{2-}) is
(a) green, paramagnetic
(b) purple, diamagnetic
(c) green, diamagnetic
(d) purple, paramagnetic

74. The osmotic pressure of solution containing 34.2 g of cane sugar (molar mass = 342 g mol^{-1}) in 1L of solution at 20°C is (Given R = 0.082 L atm K^{-1} mol^{-1})
(a) 2.40 atm (b) 3.6 atm
(c) 24 atm (d) 0.0024 atm

75. In assigning R-S configuration, which among the following groups has highest priority?
(a) $–SO_3H$ (b) – COOH
(c) –CHO (d) $–C_6H_5$

76. Which of the following is used as antiseptic?
(a) Chloramphenicol (b) Bithional
(c) Cimetidine (d) Chlordiazepoxide

77. In preparation of sulphuric acid from sulphur dioxide in lead chamber process. What substance is used as a catalyst?
(a) Manganese dioxide
(b) Vanadium pentoxide
(c) Nitric oxide
(d) Raney nickel

78. The correct charge on and co-ordination number of 'Fe' in $K_3[Fe(CN)_6]$ is
(a) +2, 4 (b) +3, 6 (c) +2, 6 (d) +3, 3

79. Which among the following reactions is an example of pseudo first order reaction?
(a) Inversion of cane sugar
(b) Decomposition of H_2O_2
(c) Conversion of cyclopropane to propene
(d) Decomposition of N_2O_5

80. The amine, which reacts with *p*-toluenesulphonyl chloride to give a clear solution, which on acidification gives insoluble compound is
(a) $C_2H_5NH_2$ (b) $(C_2H_5)_2NH$
(c) $(C_2H_5)_3N$ (d) $CH_3NHC_2H_5$

81. Which among the following equation represents Arrhenius equation?

(a) $k = A_e^{\frac{E_a}{RT}}$ (b) $k = A.e^{\frac{RT}{E_a}}$

(c) $k = \frac{A}{e^{E_a/RT}}$ (d) $k = \frac{A}{e^{RT/E_a}}$

82. Which of the following compound will give positive iodoform test?
(a) Isopropyl alcohol
(b) Propionaldehyde
(c) Ethylphenyl ketone
(d) Benzyl alcohol

83. The first law of thermodynamics for isothermal process is
(a) $q = -W$ (b) $\Delta U = W$
(c) $\Delta U = q_v$ (d) $\Delta U = q_v$

84. The conversion of ethyl bromide using sodium iodide and dry acetone, this reaction is know as
(a) Swarts reaction
(b) Finkelstein reaction
(c) Sandmeyer reaction
(d) Stephen reaction

85. What is the hybridisation of carbon atoms in fullerene?
(a) sp^3 (b) sp (c) sp^2 (d) dsp^3

86. What is the SI unit of conductivity?
(a) Sm (b) Sm^{-1} (c) Sm^2 (d) Sm^{-2}

87. Which of the following in Baeyer's reagent?
(a) Alkaline $KMnO_4$ (b) Acidic $K_2Cr_2O_7$
(c) Alkaline $Na_2Cr_2O_7$ (d) MnO_2

88. What is the chief constituent of pyrex glass?
(a) B_2O_3 (b) SiO_2 (c) AI_2O_3 (d) Na_2O

89. Which of the following compounds has lowest boiling point?
(a) *n*-butyl alcohol (b) Iso-butyl alcohol
(c) *Tert*-butyl alcohol (d) *Sec*-butyl alcohol

90. Identify the invalid equation
(a) $\Delta H = \Sigma H_{\text{products}} - \Sigma H_{\text{reactants}}$
(b) $\Delta H = \Delta U + p\Delta V$
(c) $\Delta H^\circ_{\text{(reaction)}} = \Sigma H^\circ_{\text{(product bonds)}} - \Sigma H^\circ_{\text{(reactant bonds)}}$
(d) $\Delta H = \Delta U + \Delta nRT$

91. The rate constant for a first order reaction is $7.0 \times 10^{-4}\ s^{-1}$. If initial concentration of reactant is 0.080 M, what is the half life of reaction?
(a) 990 s (b) 79.2 s
(c) 12375 s (d) 10.10×10^{-4} s

92. The polymer used in making handles of cookers and frying pans is
(a) bakelite (b) nylon-2-nylon-6
(c) orlon (d) Polyvinyl chloride

93. Which halogen has the highest value of negative electron gain enthalpy?
(a) Fluorine (b) Chlorine
(c) Bromine (d) Iodine

94. What is the actual volume occupied by water molecules present in 20 cm^3 of water?
(a) 20 cm^3 (b) 10 cm^3
(c) 40 cm^3 (d) 24.89 cm^3

95. Which of the following co-ordinate complexes if an exception to EAN rule? (Given atomic number Pt = 78, Fe = 26, Zn = 30, Cu = 29)
(a) $[Pt(NH_3)_6]^{4+}$ (b) $[Fe(CN)_6]^{4-}$
(c) $[Zn(NH_3)_4]^{2+}$ (d) $[Cu(NH_3)_4]^{2+}$

96. Which among the following equations represents the reduction reaction taking place in lead accumulator at positive electrode, while it is being used as a source of electrical energy?
(a) $Pb \rightarrow Pb^{2+}$ (b) $Pb^{4+} \rightarrow Pb$
(c) $Pb^{2+} \rightarrow Pb$ (d) $Pb^{4+} \rightarrow Pb^{2+}$

97. For which among the following equimolar aqueous solutions Van't Hoff factor has the lowest value?
(a) Aluminium chloride
(b) Potassium sulphate
(c) Ammonium chloride
(d) Urea

98. The amino acid, which is basic in nature is
(a) histidine (b) tyrosine
(c) proline (d) valine

99. Which element among the following does not form diatomic molecules?
(a) Argon (b) Oxygen
(c) Nitrogen (d) Bromine

100. A molecule of stachyose contains how many carbon atoms?
(a) 6 (b) 12 (c) 18 (d) 24

SECTION-B

MATHEMATICS

1. The number of principal solutions of $\tan 2\theta = 1$ is
(a) one (b) two (c) three (d) four

2. The object function $z = 4x_1 + 5x_2$, subject to $2x_1 + x_2 \geq 7$, $2x_1 + 3x_2 \leq 15$, $x_2 \leq 3$, $x_1, x_2 \geq 0$ has minimum value at the point
(a) on *X*-axis
(b) on *Y*-axis
(c) at the origin
(d) on the line parallel to *X*-axis

3. If z_1 and z_2 are *z*-coordinates of the points of trisection of the segment joining the points $A(2, 1, 4,)$, $B(-1, 3, 6)$, then $z_1 + z_2 =$
(a) 1 (b) 4 (c) 5 (d) 10

4. The maximum value of
$$f(x) = \frac{\log x}{x} (x \neq 0, x \neq 1) \text{ is}$$
(a) e (b) $\frac{1}{e}$ (c) e^2 (d) $\frac{1}{e^2}$

5. $\int_0^1 x \tan^{-1} x\, dx =$

(a) $\frac{\pi}{4}+\frac{1}{2}$ (b) $\frac{\pi}{4}-\frac{1}{2}$

(c) $\frac{1}{2}-\frac{\pi}{4}$ (d) $-\frac{\pi}{4}-\frac{1}{2}$

6. The statement pattern $(\sim p \wedge q)$ is logically equivalent to

(a) $(p \vee q) \vee \sim p$ (b) $(p \vee q) \wedge \sim p$

(c) $(p \wedge q) \rightarrow p$ (d) $(p \vee q) \rightarrow p$

7. If $g(x)$ is the inverse function of $f(x)$ and $f'(x)=\frac{1}{1+x^4}$, then $g'(x)$ is

(a) $1+[g(x)]^4$ (b) $1-[g(x)]^4$

(c) $1+[f(x)]^4$ (d) $\frac{1}{1+[g(x)]^4}$

8. The inverse of the matrix $\begin{bmatrix} 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \end{bmatrix}$ is

(a) $-\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ 3 & 1 & 0 \\ 9 & 2 & -3 \end{bmatrix}$ (b) $-\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$

(c) $-\frac{1}{3}\begin{bmatrix} 3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$ (d) $-\frac{1}{3}\begin{bmatrix} -3 & 0 & 0 \\ -3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$

9. If $\int \frac{1}{\sqrt{9-16x^2}}dx = \alpha \sin^{-1}(\beta x)+c$, then $\alpha+\frac{1}{\beta}=$

(a) 1 (b) $\frac{7}{12}$ (c) $\frac{19}{12}$ (d) $\frac{9}{12}$

10. O(0,0), A(1, 2), B(3, 4) are the vertices of ΔOAB The joint equation of the altitude and median drawn from O is

(a) $x^2+7xy-y^2=0$ (b) $x^2+7xy+y^2=0$

(c) $3x^2-xy-2y^2=0$ (d) $3x^2+xy-2y^2=0$

11. If the function $f(x)=\left[\tan\left(\frac{\pi}{4}+x\right)\right]^{\frac{1}{x}}$ for $x \neq 0$ is $=K$ for $x=0$ continuous at $x=0$, then K = ?

(a) e (b) e^{-1} (c) e^2 (d) e^{-2}

12. For a invertible matrix A if $A(\text{adj}A)=\begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$, then $|A|=$

(a) 100 (b) -100 (c) 10 (d) -10

13. The solution of the differential equation $\frac{dy}{dx} = \tan\left(\frac{y}{x}\right)+\left(\frac{y}{x}\right)$ is

(a) $\cos\left(\frac{y}{x}\right)=cx$ (b) $\sin\left(\frac{y}{x}\right)=cx$

(c) $\cos\left(\frac{y}{x}\right)=cy$ (d) $\sin\left(\frac{y}{x}\right)=cy$

14. In ΔABC, if $\sin^2 A+\sin^2 B=\sin^2 C$ and $l(AB)=10$, then the maximum value of the area of ΔABC is

(a) 50 (b) $10\sqrt{2}$

(c) 25 (d) $25\sqrt{2}$

15. If $x=f(t)$ and $y=g(t)$ are differentiable functions of t, then $\frac{d^2y}{dx^2}$ is

(a) $\frac{f'(t).g''(t)-g'(t).f''(t)}{[f'(t)]^3}$

(b) $\frac{f'(t).g''(t)-g'(t).f''(t)}{[f'(t)]^2}$

(c) $\frac{g'(t).f''(t)-f'(t).g''(t)}{[f'(t)]^3}$

(d) $\frac{g'(t).f''(t)+f'(t).g''(t)}{[f'(t)]^3}$

16. The equation of line equality inclined to coordinate axes and passing through $(-3, 2, -5)$ is

(a) $\frac{x+3}{1}=\frac{y-2}{1}=\frac{z+5}{1}$

(b) $\frac{x+3}{-1}=\frac{y-2}{1}=\frac{5+z}{-1}$

(c) $\frac{x+3}{-1}=\frac{y-2}{1}=\frac{z+5}{1}$

(d) $\frac{x+3}{-1}=\frac{2-y}{1}=\frac{z+5}{-1}$

17. If $\int_0^{\frac{\pi}{2}} \log \cos x\, dx = \frac{\pi}{2}\log\left(\frac{1}{2}\right)$, then

$\int_0^{\frac{\pi}{2}} \log \sec dx =$

(a) $\frac{\pi}{2}\log\left(\frac{1}{2}\right)$ (b) $1-\frac{\pi}{2}\log\left(\frac{1}{2}\right)$

(c) $1+\frac{\pi}{2}\log\left(\frac{1}{2}\right)$ (d) $\frac{\pi}{2}\log 2$

18. A boy tosses fair coin 3 times. If he gets $2X$ for X heads, then his expected gain equals to ....

(a) 1 (b) $\frac{3}{2}$ (c) 3 (d) 4

19. Which of the following statement pattern is a tautology?

(a) $p \vee (q \to p)$ (b) $\sim q \to \sim p$

(c) $(q \to p) \vee (\sim p \leftrightarrow q)$ (d) $p \wedge \sim p$

20. If the angle between the planes

$r.(m\hat{i} - \hat{j} + 2\hat{k}) + 3 = 0$ and

$r.(2\hat{i} - m\hat{j} - \hat{k}) - 5 = 0$ is $\frac{\pi}{3}$, then $m =$

(a) 2 (b) ± 3 (c) 3 (d) –2

21. If the origin and the points $P(2, 3, 4)$, $Q(1, 2, 3)$ and $R(x, y, z)$ are coplanar, then

(a) $x - 2y - z = 0$ (b) $x + 2y + z = 0$

(c) $x - 2y + z = 0$ (d) $2x - 2y + z = 0$

22. If lines represented by equation $px^2 - qy^2 = 0$ are distinct, then

(a) $pq > 0$ (b) $pq < 0$

(c) $pq = 0$ (d) $p + q = 0$

23. Let $\square$ *PQRS* be a quadrilateral. If M and N are the mid-points of the sides PQ and RS respectively, then PS + QR =

(a) 3 MN (b) 4MN (c) 3 MN (d) 2NM

24. If slopes of lines represented by $kx^2 + 5xy + y^2 = 0$ differ by 1, then k =

(a) 2 (b) 3 (c) 6 (d) 8

25. If vector r with dc's l, m, n is equally inclined to the coordinate axes, then the total number of such vectorse is

(a) 4 (b) 6 (c) 8 (d) 2

26. If $\int \frac{1}{(x^2+4)(x^2+9)}\, dx = A\tan^{-1}\frac{x}{2}$

$+ B\tan^{-1}\left(\frac{x}{3}\right) + C$, then A – B =

(a) $\frac{1}{6}$ (b) $\frac{1}{30}$ (c) $-\frac{1}{30}$ (d) $-\frac{1}{6}$

27. If α and β are roots of the equation $x^2 + 5|x| - 6 = 0$, then the value of $|\tan^{-1}\alpha - \tan^{-1}\beta|$ is

(a) $\frac{\pi}{2}$ (b) 0 (c) π (d) $\frac{\pi}{4}$

28. If $x = a\left(t - \frac{1}{t}\right)$, $y = a\left(t + \frac{1}{t}\right)$, where t is the parameter, then $\frac{dy}{dx} =$?

(a) $\frac{y}{x}$ (b) $\frac{-x}{y}$ (c) $\frac{x}{y}$ (d) $\frac{-y}{x}$

29. The point on the curve $y = \sqrt{x-1}$, where the tangent is perpendicular to the line $2x + y - 5 = 0$ is

(a) (2, –1) (b) (10, 3)

(c) (2, 1) (d) (5, –2)

30. If $\int \sqrt{\frac{x-5}{x-7}}\, dx = A\sqrt{x^2 - 12x + 35} + \log|x| - 6$

$+ \sqrt{x^2 - 12x + 35} + C|$, then A =

(a) –1 (b) $\frac{1}{2}$

(c) $-\frac{1}{2}$ (d) 1

31. At random variable $X \sim B(n, p)$, if values of mean and variance of X are 18 and 12 respectively, then total number of possible values of X are

(a) 54 (b) 55 (c) 12 (d) 18

32. The area of the region bounded by the lines $y = 2x + 1$, $y = 3x + 1$ and $x = 4$ is

(a) 16 sq unit (b) $\frac{121}{3}$ sq unit

(c) $\frac{121}{6}$ sq unit (d) 8 sq unit

33. A box contains 6 pens, 2 of which are defective. Two pens are taken randomly from the box. If r.v. X : number of defective pens obtained, then standard deviation of X =

(a) $\pm\frac{4}{3\sqrt{5}}$ (b) $\frac{8}{3}$

(c) $\frac{16}{45}$ (d) $\frac{4}{3\sqrt{5}}$

34. If the volume of spherical ball is increasing at the rate of 4π cm^3/s, then the rate of change of its surface area when the volume is 288π cm^3, is

(a) $\frac{4}{3}\pi$ cm^2/s (b) $\frac{2}{3}\pi$ cm^2/s
(c) 4π cm^2/s (d) 2π cm^2/s

35. If $f(x) = \log(\sec^2 x)^{\cot^2 x}$ for $x \neq 0 = K$ for $x = 0$ is continuous at $x = 0$, then K is
(a) e^{-1} (b) 1 (c) e (d) 0

36. If c denotes the contradiction, then dual of the compound statement $\sim p \wedge (q \vee c)$ is
(a) $\sim p \vee (q \wedge t)$ (b) $\sim p \wedge (q \vee t)$
(c) $p \vee (\sim q \vee t)$ (d) $\sim p \vee (q \wedge c)$

37. The differential equation of all parabolas whose axis is Y-axis, is

(a) $x\frac{d^2y}{dx^2} - \frac{dy}{dx} = 0$ (b) $x\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$

(c) $\frac{d^2y}{dx^2} - y = 0$ (d) $\frac{d^2y}{dx^2} - \frac{dy}{dx} = 0$

38. $\int_0^3 [x]\,dx =$ ...., where $[x]$ is greatest integer function.
(a) 3 (b) 0 (c) 2 (d) 1

39. The objective function of LPP defined over the convex set attains it optimum value at
(a) atleast two of the corner points
(b) all the corner points
(c) atleast one of the corner points
(d) None of the corner points

40. If the inverse of the matrix $\begin{bmatrix} \alpha & 14 & -1 \\ 2 & 3 & 1 \\ 6 & 2 & 3 \end{bmatrix}$

does not exist, then the value of α is
(a) 1 (b) -1 (c) 0 (d) -2

41. If $f(x) = x$ for $x \le 0 = 0$ for $x > 0$, then $f(x)$ at $x = 0$ is
(a) continuous but not differentiable
(b) not continuous but differentiable
(c) continuous and differentiable
(d) not continuous and not differentiable

42. The equation of plane through $(-1, 1, 2)$, whose normal makes equal acute angles with coordinate axes is

(a) $r \cdot (\hat{i} + \hat{j} + \hat{k}) = 2$ (b) $r \cdot (\hat{i} + \hat{j} + \hat{k}) = 6$

(c) $r \cdot (3\hat{i} - 3\hat{j} + 3\hat{k}) = 2$ (d) $r \cdot (\hat{i} - \hat{j} + \hat{k}) = 3$

43. Probability that a person will develop immunity after vaccinations is 0.8. if 8 people are given the vaccine, then probability that all develop immunity is =
(a) $(0.2)^8$ (b) $(0.8)^8$
(c) 1 (d) ${}^8C_6\,(0.2)^6\,(0.8)^2$

44. If the distance of points $2\hat{i} + 3\hat{j} + \lambda\hat{k}$ from the plane $r \cdot (3\hat{i} + 2\hat{j} + 6\hat{k}) = 13$ is 5 units, then $\lambda =$

(a) $6, -\frac{17}{3}$ (b) $6, \frac{17}{3}$

(c) $-6, -\frac{17}{3}$ (d) $-6, \frac{17}{3}$

45. The value of $\cos^{-1}\left(\cot\left(\frac{\pi}{2}\right)\right) + \cos^{-1}\left(\sin\left(\frac{2\pi}{2}\right)\right)$ is

(a) $\frac{2\pi}{3}$ (b) $\frac{\pi}{3}$

(c) $\frac{\pi}{2}$ (d) π

46. The particular solution of the differential equation $x\,dy + 2y\,dx = 0$, when $x = 2$, $y = 1$ is
(a) $xy = 4$ (b) $x^2y = 4$
(c) $xy^2 = 4$ (d) $x^2y^2 = 4$

47. ΔABC has vertices at $A = (2, 3, 5)$, $B = (-1, 3, 2)$ and $C = (\lambda, 5, \mu)$. If the median through A is equally inclined to the axes, then the values of λ and μ respectively are
(a) 10, 7 (b) 9, 10
(c) 7, 9 (d) 7, 10

48. For the following distribution function F (x) of a rv.x.

x	1	2	3	4	5	6
$F(x)$	0.2	0.37	0.48	0.62	0.85	1

$P(3 < x < 5) =$
(a) 0.48 (b) 0.37 (c) 0.27 (d) 1.47

49. The lines $\frac{x-1}{2} = \frac{y+1}{2} = \frac{z-1}{4}$ and

$\frac{x-3}{1} = \frac{y-k}{2} = \frac{z}{1}$ intersect each other at point
(a) $(-2, -4, 5)$ (b) $(-2, -4, -5)$
(c) $(2, 4, -5)$ (d) $(2, -5)$

50. $\int \frac{\sec^8 x}{\operatorname{cosec} x} dx =$

(a) $\frac{\sec^8 x}{8} + c$ (b) $\frac{\sec^7 x}{7} + c$

(c) $\frac{\sec^6 x}{6} + c$ (d) $\frac{\sec^9 x}{9} + c$

ANSWER KEYS & SOLUTIONS

(MHT-CET 2017)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(d)	**11**	(b)	**16**	(c)	**21**	(b)	**26**	(a)	**31**	(c)	**36**	(b)	**41**	(c)	**46**	(c)
2	(a)	**7**	(a)	**12**	(c)	**17**	(d)	**22**	(d)	**27**	(d)	**32**	(d)	**37**	(d)	**42**	(d)	**47**	(c)
3	(c)	**8**	(b)	**13**	(c)	**18**	(c)	**23**	(a)	**28**	(a)	**33**	(d)	**38**	(a)	**43**	(a)	**48**	(c)
4	(b)	**9**	(b)	**14**	(d)	**19**	(c)	**24**	(a)	**29**	(d)	**34**	(a)	**39**	(b)	**44**	(a)	**49**	(d)
5	(b)	**10**	(a)	**15**	(a)	**20**	(b)	**25**	(c)	**30**	(d)	**35**	(a)	**40**	(b)	**45**	(b)	**50**	(c)
CHEMISTRY																			
51	(c)	**56**	(a)	**61**	(d)	**66**	(b)	**71**	(d)	**76**	(b)	**81**	(c)	**86**	(b)	**91**	(a)	**96**	(d)
52	(c)	**57**	(a)	**62**	(b)	**67**	(d)	**72**	(c)	**77**	(c)	**82**	(a)	**87**	(a)	**92**	(a)	**97**	(d)
53	(a)	**58**	(a)	**63**	(c)	**68**	(b)	**73**	(a)	**78**	(b)	**83**	(a)	**88**	(b)	**93**	(b)	**98**	(a)
54	(d)	**59**	(d)	**64**	(b)	**69**	(d)	**74**	(a)	**79**	(a)	**84**	(b)	**89**	(c)	**94**	(b)	**99**	(a)
55	(b)	**60**	(d)	**65**	(b)	**70**	(b)	**75**	(a)	**80**	(a)	**85**	(c)	**90**	(c)	**95**	(d)	**100**	(d)
SECTION-B																			
MATHEMATICS																			
1	(b)	**6**	(b)	**11**	(c)	**16**	(b)	**21**	(c)	**26**	(a)	**31**	(b)	**36**	(a)	**41**	(a)	**46**	(b)
2	(a)	**7**	(a)	**12**	(c)	**17**	(d)	**22**	(a)	**27**	(a)	**32**	(d)	**37**	(a)	**42**	(a)	**47**	(d)
3	(d)	**8**	(b)	**13**	(b)	**18**	(c)	**23**	(c)	**28**	(c)	**33**	(d)	**38**	(a)	**43**	(b)	**48**	(b)
4	(b)	**9**	(a)	**14**	(c)	**19**	(c)	**24**	(c)	**29**	(c)	**34**	(a)	**39**	(c)	**44**	(a)	**49**	(b)
5	(b)	**10**	(d)	**15**	(a)	**20**	(c)	**25**	(c)	**30**	(d)	**35**	(b)	**40**	(d)	**45**	(a)	**50**	(b)

SECTION-A

PHYSICS

1. (a) Using $v = n\lambda$, $\dfrac{1}{\lambda} = \dfrac{n}{v}$

$$\Rightarrow \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\Rightarrow v = Rc\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\therefore v_2 = Rc\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = Rc\left(\frac{1}{4} - \frac{1}{9}\right) \quad ..(i)$$

$$v_1 = Rc\left(\frac{1}{2^2}\right) = \frac{Rc}{4}$$

$$v_3 = Rc\left(\frac{1}{3^2}\right) = \frac{Rc}{9}$$

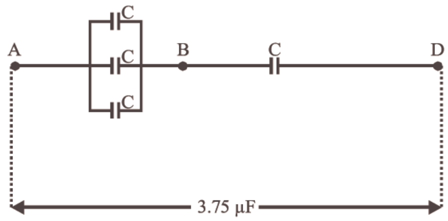
$$\Rightarrow v_1 - v_3 = Rc\left(\frac{1}{4} - \frac{1}{9}\right) \quad ...(ii)$$

From eqs. (i) and (ii),

$$v_1 - v_3 = v_2 \Rightarrow v_1 - v_2 = v_3$$

2. (a) Net capacitance between A and B

$C' = C + C + C = 3C$



Net capacitance between A and D

$$Ceq = \frac{3C \times C}{3C + C} = \frac{3C}{4}$$

$$\therefore C = \frac{4C_{eq}}{3} = \frac{4 \times 3.75}{3} = 5.00\,\mu F$$

3. **(c)** $S = \dfrac{G}{8}$ (Given) ...(i)

And, $S = \dfrac{G}{n-1}$ ...(ii)

From eqs. (i) and (ii),

$$\frac{G}{8} = \frac{G}{n-1} \Rightarrow 8 = n - 1$$

$\therefore n = 8 + 1 = 9$

Since, the range of galvanometer is increased by 9 times, therefore its sensitivity reduces to $\dfrac{S}{9}$

4. **(b)** From question, $1_X = 40$ cm, $I_R = 60$ cm.
using principle of metre-bridge,

$$\frac{X}{R} = \frac{I_X}{I_R} = \frac{40}{60} = \frac{2}{3} \quad \text{...(i)}$$

When 30Ω resistance is connected in series with the smaller of the two resistances

$$\frac{X+30}{R} = \frac{60}{40} = \frac{3}{2}$$

$$\Rightarrow R = \frac{2(X+30)}{3} \quad \text{...(ii)}$$

From eqs. (i) and (ii),

$$\frac{X}{2\left(\dfrac{X+30}{3}\right)} = \frac{2}{3} \Rightarrow \frac{3X}{2(X+30)} = \frac{2}{3}$$

or, $9X = 4X + 120 \Rightarrow 5X = 120$

$\therefore X = 24\,\Omega$

5. **(b)** Given $d = 0.2 \times 10^{-3}$m, $D = 2$m and $\lambda = 5 \times 10^{-7}$m

From $B = \dfrac{\lambda D}{d} = \dfrac{5 \times 10^{-7} \times 2}{0.2 \times 10^{-3}} = \dfrac{5 \times 10^{-7}}{10^{-4}}$

$\therefore B = 510^{-3}$m

Distance between 1st minima on either side

$= 5 \times 10^{-3} + 5 \times 10^{-3} = 10 \times 10^{-3} = 10^{-2}$ m

6. **(d)** Given, $R = 18\Omega$, $Z = 33\Omega$, $V_{rms} = 220$V

$\lambda = 5 \times 10^{-7}$ m

Power consumed in an AC circuit

$$P = e_{rms} \cdot i_{rms} \cdot \cos\phi = e_{rms} \cdot \frac{e_{rms}}{Z} \cdot \frac{R}{Z}$$

$$\left[\because \cos\phi = \frac{R}{Z}\right]$$

$$= \frac{220 \times 220 \times 18}{33 \times 33} = 20 \times 20 \times 2 = 800\text{W}$$

7. **(a)** Effective capacity of the series combination of capacitors

$$\frac{1}{C_1} = \frac{1}{C} + \frac{1}{C} = \frac{2}{5} \text{ or, } C_1 = \frac{C}{2}$$

Effective capacity of the series combination of capacitors with dielectric material

$$\frac{1}{C_1} = \frac{1}{C} + \frac{1}{KC}; \frac{1}{C_2} = \frac{1}{C}\left[1 + \frac{1}{K}\right]$$

$$\text{or, } C_2 = \frac{C}{\left(1 + \dfrac{1}{K}\right)} = \frac{CK}{(K+1)}$$

$\therefore$ Change in effective capacitance

$$\Delta C = C_2 - C_1$$

$$= \frac{CK}{(K+1)} - \frac{C}{2} = C\left[\frac{K}{K+1} - \frac{1}{2}\right]$$

$$= C\left[\frac{2K - K - 1}{2(K+1)}\right] = \frac{C}{2}\left[\frac{K-1}{K+1}\right]$$

8. **(b)** Polarising angle, $\tan\theta = \mu$

Also, $M = \dfrac{C}{V}$

or, $\cot\theta = \dfrac{v}{c}$ $\therefore \theta = \cot^{-1}\dfrac{v}{c}$

9. **(b)** Resultant intensity for two coherent sources,

$$I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

For two identical light waves, $I_1 = I_2 = I$

$$\therefore I_R = 4I\cos^2\frac{\phi}{2} \text{ or, } 1_R \propto \cos^2\frac{\phi}{2}$$

10. **(a)** As we know, $\beta_{dc} = \dfrac{\alpha_{dc}}{1-\alpha_{dc}}$

$\therefore \left(1-\alpha_{dc}\right) = \dfrac{\alpha_{dc}}{\beta_{dc}}$ ...... (i)

Also, $\dfrac{\beta_{dc}-\alpha_{dc}}{\alpha_{dc}.\beta_{dc}} = \dfrac{\beta_{dc}\left(1-\dfrac{\alpha_{dc}}{\beta_{dc}}\right)}{\alpha_{dc}.\beta_{dc}}$

From equation (i)

$\dfrac{1-\dfrac{\alpha_{dc}}{\beta_{dc}}}{\alpha_{dc}} = \dfrac{1-\left(1-\alpha_{dc}\right)}{\alpha_{dc}}$

$= \dfrac{1-1+\alpha_{dc}}{\alpha_{dc}} = 1$

11. **(b)** According to question,
N_0=10,000 disintegeration/min
N_t = 2500 disintegeration/min
t = 4 min
From the radioactive decay law,

$\dfrac{Nt}{N_0} = e^{-\lambda t}$

or, $\dfrac{2500}{10000} = e^{-\lambda\times 4}$

$\Rightarrow \dfrac{1}{4}e^{-4\lambda} \Rightarrow e^{4\lambda} = 4$

$\Rightarrow 4\lambda = \log_e 4 \Rightarrow 4\lambda = \log_e 2^2$

$\Rightarrow\ 4\lambda = 2\log_e 2$

$\therefore\ \lambda = 0.5\log_e 2$

12. **(c)** $\because$ Number of waves in glass slab
= number of waves in water column

$\therefore\ \mu_g.h_g = \mu_w.h_w$

h_g = thickness of slab and h_w = height of water column.

or, $\mu_w = \dfrac{\mu_g.h_g}{hw} = \dfrac{1.5\times 6}{7} = 1.286$

13. **(c)** Energy difference between two states

$\Delta E = E_2 - E_1 = \dfrac{-13.6}{2^2} - \left(\dfrac{-13.6}{1^2}\right)$

$\Delta = \dfrac{13.6}{1^2} - \dfrac{13.6}{2^2}$

$\Delta = 13.6\left[\dfrac{4-1}{4}\right] = 13.6\times\dfrac{3}{4}$

$\therefore\ \Delta E = 10.2\,\text{eV}$

Since, the energy is radiaed in form of photons,
$\therefore$ Energy of photons = hv = 10.2 eV
From Einstein's photoelectric equation,

$hv = \phi_0 + eV_s$

$10.2\,\text{eV} = 4.2\text{eV} + eV_s$

$\Rightarrow\ 6\,\text{eV} = eV_s$

$\therefore\ V_s = 6V$

14. **(d)** Magnetic moment $\left(M_0\right) = \dfrac{e}{2me}\times L$

Where, L = orbital angular momentum.

And $L = \dfrac{nh}{2\pi}$ ..... (i)

$\Rightarrow L \propto n$ ..... (ii)

n = principal quantum number
h = planck's constant.

$\therefore M_0 \propto n.$

15. **(a)** Photodiode is a reversed biased p-n junction.

16. **(c)** According to question, I = 2kg m^2

$\omega_0 = 60\,\text{rad/s},\ \omega = 0$

$t = 5\,\text{min} = 5\times 60 = 300\,\text{s}$

using, $\omega = \omega_0 + \alpha t \Rightarrow \alpha = \dfrac{\omega-\omega_0}{t}$

$= \dfrac{0-60}{300} = \dfrac{-60}{300} = \dfrac{-1}{5}\,\text{rad/s}^2$

For t = 2 min

$\omega = \omega_0 + \alpha t$

$= 60 - \dfrac{1}{5}\times 120 = 60 - 24 \Rightarrow \omega = 36\text{ rad/s}$

Angular momentum,

$L = 1\omega = 2\times 36 = 72\,\text{kg m}^2/\text{s}$

17. **(d)** Standard equation of wave motion,

$Y = A\sin\left[2\pi\left(\dfrac{t}{T}-\dfrac{x}{\lambda}\right)+\dfrac{\pi}{4}\right]$

When compare the given equation with standard equation we get,
Amplitude, A = 3m
Wavelength, $\lambda = 10\,\text{m}$

18. **(c)** Rate of energy radiation.

$$\frac{Q}{t}=\sigma AT^4 \text{ i.e., power, } P=\sigma AT^4$$

$$\therefore\ A\propto\frac{1}{T^4}$$

If body radiates same power, then

$$\frac{A_2}{A_1}=\frac{T_1^4}{T_2^4}\Rightarrow\frac{4\pi r_2^2}{4\pi r_1^2}=\frac{T_1^4}{T_2^4}$$

$$\therefore\frac{r_2}{r_1}=\left(\frac{T_1}{T_2}\right)^2$$

19. **(c)** For open pipe first overtone, $v_1=\frac{v}{L}$

For closed pipe first overtone, $v_1=\frac{3v}{4L}$

$$\therefore\ v_1-v_1=\frac{V}{L}-\frac{3V}{4L}=3$$

or, $\frac{V}{4L}=3\ \ \therefore\frac{V}{L}=12$

When length of open pipe is made $\frac{L}{3}$,

Fundamental frequency $v=\frac{V}{2\left(\frac{L}{3}\right)}=\frac{3V}{2L}$

When length of closed pipe is made 3 times,

Fundamental frequency $v'=\frac{V}{4(3L)}=\frac{V}{12L}$

Beats produced = v – v'

$$=\frac{3V}{2L}-\frac{V}{12L}=\frac{17}{12},\frac{V}{L}\qquad\left[\because\ \frac{V}{L}=12\right]$$

$$=\frac{17}{12}\times12=17$$

20. **(b)** Maximum tension in the rope $=m\,(g+a)$

Stress in the rope, $T=\frac{m(g+a)}{\pi r^2}$

$$\therefore T=\frac{m(g+a)}{\pi r^2}=\frac{m(g+a)}{\pi\left(\frac{d}{2}\right)^2}$$

or, $T=\frac{4m(g+a)}{\pi d^2}\Rightarrow d^2=\frac{4m(g+a)}{\pi T}$

$$\therefore\ d=\left[\frac{4m(g+a)}{\pi T}\right]^{1/2}$$

21. **(b)** Given, mass, $m=2$ kg, $v=6$ m/s and force constant $K=36$ N/m Kinetic energy of rolling solid sphere

$$=\frac{1}{2}mv^2+\frac{1}{2}I\omega^2$$

$$=\frac{1}{2}mv^2+\frac{1}{2}\times\frac{2}{5}mr^2\omega^2$$

$$=\frac{1}{2}mv^2+\frac{1}{5}mv^2=\frac{7}{10}mv^2$$

The potential energy of the spring on maximum compression $x=\frac{1}{2}kx^2$

$$\therefore\frac{1}{2}kx^2=\frac{7}{10}mv^2$$

$$\Rightarrow x^2=\frac{14}{10}\frac{mv^2}{k}=\frac{14}{10}\times\frac{2\times(6)^2}{36}=2.8$$

or, $x=\sqrt{2.8}$ m

22. **(d)** According to question,

$\omega_0=0,\ \omega=24\,\text{rad/s}$ and $t=8\,\text{s}$

using $\omega=\omega_0+\alpha t$

$$\alpha=\frac{\omega-\omega_0}{t}=\frac{24}{8}=3\,\text{rad/s}^2$$

Substituting the given values, we get

Now using,

$$\theta=\omega_0 t+\frac{1}{2}\alpha t^2=0+\frac{1}{2}\times3\times(8)^2$$

$$=\frac{3\times64}{2}=96\,\text{rad}$$

23. **(a)** Fundamental frequency of the wire

$$f=\frac{1}{2L_1}\sqrt{\frac{T}{m}}=\frac{1}{2L_1}\sqrt{\frac{T}{\pi r_1^2\rho}}=\frac{1}{2L_1r_1}\sqrt{\frac{T}{\pi\rho}}$$

First overtone of the first wire,

$$f_1=2f=\frac{2}{2L_1r_1}\sqrt{\frac{T}{\pi\rho}}=\frac{1}{L_1r_1}\sqrt{\frac{T}{\pi\rho}}\quad\text{...(i)}$$

Second overtone of the second wire

$$f_2 = \frac{3}{2L_2 r_2}\sqrt{\frac{T}{\pi\rho}} \qquad ...(ii)$$

$\because f_1 = f_2$

$$\therefore \frac{1}{L_1 r_1}\sqrt{\frac{T}{\pi\rho}} = \frac{3}{2L_2 r_2}\sqrt{\frac{T}{\pi\rho}}$$

$\because f_1 = f_2$

$\therefore 3L_1 r_1 = 2L_2 r_2$

$$\Rightarrow \frac{L_1}{L_2} = \frac{2}{3}.\frac{r_2}{r_1} = \frac{2}{3}.\frac{r_2}{2r_2} = \frac{1}{3} \quad [\because r_1 = 2r_2]$$

24. (a) According to question,

force $F = 150$ dyne 105×10^{-5} N and

Surface tension $T = 7 \times 10^{-2}$ N/m

$\because$ Circumference of the capillary × surface tension = upward force

$\therefore 2\pi r T = F$

$$\text{or, } 2\pi r = \frac{F}{T} = \frac{105 \times 10^{-5}}{7 \times 10^{-2}} = 15 \times 10^{-3}\,\text{m}$$

$$= 1.5 \times 10^{-2} = 1.5\,\text{cm}$$

25. (c) For rigid diatomic molecule, $\frac{C_p}{C_v} = \frac{7}{5}$

$$\therefore C_v = \frac{5}{7}C_p \qquad ...(i)$$

Also, $C_p - C_v = R$

or, $C_p - \frac{5}{7}C_p = R \Rightarrow \frac{2}{7}C_p = R$

$$n = \frac{2}{7} = 0.2857$$

26. (a) Ideal gas equation, $pV = nRT$

$pV = \frac{m'}{M}RT$ here, m' is the mass of the gas

and M molecular weight $p = \frac{m'}{V}\frac{RT}{M}$

$$\therefore p = \frac{\rho RT}{M}$$

$\therefore \rho = \frac{m'}{V}$ density of the gas

$\rho = \frac{pM}{RT} = \frac{pM}{NkT}$, N is Avogadro, number

$\rho = \frac{pm}{KT}$, where $m = \frac{M}{N}$ mass of each molecule.

27. (d) Let radius of big drop = R

and of small drop = r

Volume of big drop = n (Volume of small drop)

$$\frac{4}{3}\pi R^3 = n.\frac{4}{3}\pi r^3$$

$R^3 = nr^3 \Rightarrow R = n^{1/3}.r$

Surface energy of n drops,

$$E_2 = n \times 4\pi r^2 \times T$$

Surface energy of big drop,

$$E_1 = 4\pi R^2 T$$

$$\therefore \frac{E_2}{E_1} = \frac{nr^2}{R^2} = \frac{nr^2}{\left(n^{1/3}.r\right)^2}$$

$$= \frac{nr^2}{n^{2/3}.r^2} = n^{1/3} \quad [\because R = n^{1/3}.r]$$

or, ratio of energy, $E_2 : E_1 = \sqrt[3]{n} : 1$

28. (a) Binding energy on the surface of the earth

$$E_1 = \frac{GMm}{R} \qquad .....(i)$$

Binding energy of revolving satellite at a height h from the earth surface,

$$E_2 = \frac{GMm}{2(R+h)} \qquad ....(ii)$$

From eqs. (i) and (ii),

$$\frac{E_1}{E_2} = \frac{2(R+h)}{R}$$

29. (d) Given, particle velocity, $v = \pi$ m/s and time period $T = 16$ s

Displacement of the particle, $x = A \sin \omega t$

Velocity of the particle,

$$v = \frac{dx}{dt} = A\omega \cos\omega t \qquad ...(i)$$

Angular velocity,

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{16} = \frac{\pi}{8} = \text{rad/s}$$

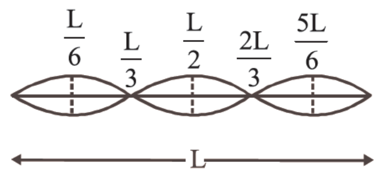
Now from eq. (i),

$$\pi = A \times \frac{\pi}{8} \times \cos\frac{\pi}{8} \times 2$$

$$1 = \frac{A}{8}\cos\frac{\pi}{4} = \frac{A}{8}.\frac{1}{\sqrt{2}}$$

$\therefore\ A = 8\sqrt{2}\,\text{m}$

30. **(d)** The figure represents string vibrating in second overtone between two bridges



Clearly, amplitude of vibration is maximum at

$\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$

31. **(c)** Acceleration due to gravity varies with depth d as,

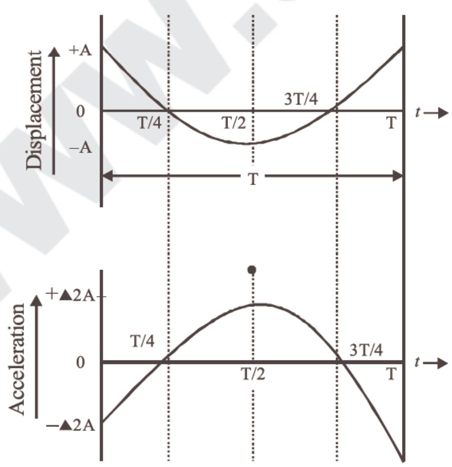
$$g' = g\left(1 - \frac{d}{R}\right)$$

And according to question, $g' = \frac{g}{n}$

$$g' = \frac{g}{n} = g\left(1 - \frac{d}{R}\right) \Rightarrow \frac{1}{n} = 1 - \frac{d}{R}$$

or, $\frac{d}{R} = 1 - \frac{1}{n} = \frac{n-1}{n}\ \therefore d = R\left(\frac{n-1}{n}\right)$

32. **(d)** The relation of displacement and acceleration with time in SHM are shown below,



Clearly, the phase difference between displacement and acceleration is π.

33. **(d)** Fundamental frequency, for a closed pipe

$$v_1 = \frac{V}{4L} = 100\,\text{Hz}$$

Fundamental frequency, for an open pipe

$$v_1 = \frac{V}{2L} = 200\,\text{Hz}$$

In a pipe open at both the ends, all multiples of the fundamental frequency are produced.

$\therefore\ 1\times 200, 2\times 200, 3\times 200...$

i.e., 200, 400, 600...

34. **(a)** The total mechanical energy remains conserved, kinetic energy changes into potential energy and vice-versa. At the highest point potential energy is maximum and at the lowest point its velocity and hence kinetic energy is maximum.

35. **(a)** Potential energy of a simple pendulum

$$= \frac{1}{2}M\omega^2 A^2 = \frac{1}{2}M.\frac{g}{L}.A^2\ \left(\because \omega = \sqrt{\frac{g}{L}}\right)$$

36. **(b)** According to the Einstein's photoelectric equation,

$KE_{max} = hv_0 - \phi_0$

Initially, $hv = 0.4 + \phi_0$ ...(i)

and when the frequency of incident radiation is increased by 30% then

$1.3\,hv = 0.9 + \phi_0$ ...(ii)

From eqs. (i) and (ii)

$0.3\phi_0 = 0.9 - 1.3(0.4)$

$\therefore\ \phi_0 = \frac{0.38}{0.3} = 1.267\,\text{eV}$

37. **(d)** In LC parallel resonant circuit, at resonating frequency, current is minimum graph (4) correctly depicts.

38. **(a)** Energy of photon

$$E_p = \frac{hc}{\lambda_p} \Rightarrow \lambda_p = \frac{hc}{E_p}$$

$$E_e = mc^2 = pc \Rightarrow p = \frac{E_p}{c}\ [\therefore mc = p]$$

$\therefore\ \lambda_e = \frac{h}{p} = \frac{hc}{E_e}$

$\therefore\ E_p = E_e$ (Given)

$\therefore\ \lambda_p \propto \lambda_e.$

39. (b) Note : We have considered that the battery is kept disconnected from the capacitor. When dielectric is introduced inside the parallel plate capacitor, then potential difference.

$$V = \frac{V_0}{K}$$

Also, energy decreases, i.e., $U = \frac{U_0}{K}$

40. (b) According to question,

$$\rho = 40 \times 10^{-8}\,\Omega\text{m}$$

$$A = 8 \times 10^{-6}\,\text{m}^2;\; I = 0.2A$$

Resistance, $R = \frac{pI}{A}$

$$\Rightarrow \frac{R}{I} = \frac{\rho}{A} = \frac{40 \times 10^{-8}}{8 \times 10^{-6}} = 5 \times 10^{-2}$$

$\therefore$ potential gradient of the were

$$\frac{V}{I} = \frac{IR}{I} = 0.2 \times 5 \times 10^{-2} = 10^{-2}\ \text{V/m}$$

41. (c) According to question,

$$\omega_0 = \omega,\ \omega = \frac{\omega}{4};\ \theta = 2\pi n$$

using, $\omega^2 = \omega_0^2 - 2\alpha\theta$

Putting the given values

$$\left(\frac{\omega}{4}\right)^2 = \omega^2 - 2\alpha n(2\pi)$$

$$2\alpha n(2\pi) = \omega^2 - \frac{\omega^2}{16} \Rightarrow 2\pi n = \frac{15}{16}\left(\frac{\omega^2}{2\alpha}\right)$$

When the fan is switched off,

$$\omega = 0,\ \omega_0 = \omega,\ \theta = 2\pi n'$$

$$\Rightarrow 0 = \omega^2 - 2\alpha n'(2\pi)$$

$$\therefore 2\pi n' = \frac{\omega^2}{2\alpha} \text{ or, } n' = \frac{16}{15}n$$

42. (d) From conservation of angular momentum, as net torque on the system is zero

$$I_1\omega_1 = (I_1 + I_2)\omega_2$$

$$\Rightarrow \frac{\omega_2}{\omega_1} = \frac{I_1}{I_1 + I_2}$$

Energy lost $\Delta E = E_1 - E_2$

$$= \frac{1}{2}I_1\omega_1^2 - \frac{1}{2}(I_1 + I_2)\omega_2^2$$

$$= \frac{1}{2}\omega_1^2\left[I_1 - (I_1 + L_2)\frac{\omega_2^2}{\omega_1^2}\right]$$

$$= \frac{1}{2}\omega_1^2\left[I_1 - (I_1 + I_2)\frac{I_1^2}{(I_1 + I_2)^2}\right]$$

$$\left[\because \frac{\omega_2}{\omega_1} = \frac{I_1}{I_1 + I_2}\right]$$

$$= \frac{1}{2}\omega_1^2\left[\frac{I_1^2 + I_1 I_2 - I_1^2}{I_1 + I_2}\right]$$

$$\text{or, } \Delta E = \frac{1}{2}\left[\frac{I_1 I_2}{I_1 + I_2}\right]\omega_1^2$$

43. (a) Let the distance be x when velocity is u and acceleration α.
And the distance y when velocity is v and acceleration β.
If ω is the angular frequency, then
$\alpha = \omega^2 x$ and $\beta = \omega^2 y$
$\therefore \alpha + \beta = \omega^2(x + y)$ ... (i)
Also, $u^2 = \omega^2 A^2 - \omega^2 x^2$
and $v^2 = \omega^2 A^2 - \omega^2 y^2$
$\Rightarrow v^2 - u^2 = \omega^2(x^2 - y^2)$
$v^2 - u^2 = \omega^2(x - y)(x + y)$ ...(ii)
From eqs. (i) and (ii),
$v^2 - u^2 = (x - y)(\alpha + \beta)$

$$\therefore x - y = \frac{v^2 - u^2}{\alpha + \beta} \text{ or } y - x = \frac{u^2 - v^2}{\alpha + \beta}$$

44. (a) From Doppler's effect, when the observer is moving towards the source and source is stationary, then the apparent frequency

$$n' = n\left(\frac{v + v_0}{v}\right) \quad ...(i)$$

When the observer is moving away from the source and the source is stationary, then the apparent frequency.

$$n'' = -n\left(\frac{v - v_0}{v}\right) \quad ...(ii)$$

From eqs. (i) and (ii),

$$n' - n'' = \frac{n}{v}(v + v_0 - v + v_0) = \frac{2nv_0}{v}$$

45. **(b)** Let L_0 be the original length of the wire, after heating temperature T length becomes 'L'. α be the coefficient of thermal expension. Increase in the length of the rod

$\Delta L = \alpha L_0 T$

$L = L_0[1+\alpha T]$ ..... (i)

Also, Young's modulus,

$Y = \frac{FL_0}{A\Delta L}$ ..... (ii)

Using equation (i) and substituting in equation (ii), we get

$Y = \frac{F}{A}.\frac{L_0(1+\alpha T)}{\Delta L}$

or, $\Delta L = \frac{FL_0(1+\alpha T)}{A.Y}$ ...(iii)

From eqs. (i) and (ii),

$\frac{FL_0(1+\alpha t)}{AY} = \alpha L_0 T$

$\therefore$ F $= \frac{YA\alpha T}{(1+\alpha T})$

46. **(c)** Induced emf in coil P

$|e_p| = M.\frac{dI_Q}{dt}$

Putting $e_p = 15\text{ mV} = 15 \times 10^{-2}$ V

and $\frac{dI_Q}{dt} = 10$ A/s

$15 \times 10^{-3} = M \times 10$

or, $M = 15 \times 10^{-4}$H

Magnetic flux linked with coil Q

$\phi_Q = MI_p = 15\times10^{-4} \times 1.8$

$[\because\ I_p = 1.8\text{ A}]$

$= 27.0 \times 10^{-4}$

$= 2.7\times10^{-3} = 2.7$mWb

47. **(c)** In YDSE, position of a minima

$y = \frac{(2n-1)\lambda D}{d}$ ..... (i)

Here, $y = \frac{d}{2}, n = 2$

Substituting $y = \frac{d}{2}$ and $n = 2$ in eq. (i)

$\frac{d}{2} = \frac{D}{d}\left(\frac{2\times2-1}{2}\right)\lambda \Rightarrow \frac{d}{2} = \frac{D}{d}\frac{3}{2}\lambda$

$\therefore \lambda = \frac{d^2}{3D}$

48. **(c)** The process of superimposing the low frequency signal on a high frequency wave is called modulation.

49. **(d)** From question, $L = 3\text{ cm} = 3 \times 10^{-2}$ m

$A = 2\text{ cm}^2 = 2 \times 10^4\text{ m}^2$

$M = 3\text{ Am}^2$

Intensity of magnetisation, Im $= \frac{M}{L\times A}$

$= \frac{3\text{A-m}^2}{3\times2\times10^{-6}\text{m}^3}$

$= \frac{1}{2}\times10^6\text{ A/m} = 5\times10^5\text{ A/m}$

50. **(c)** Magnetic inducion inside the solenoid

$B = \frac{\mu_0 NI}{L}$ ..... (i)

Magnetic flux, $\phi = BA$

or, $\phi = \frac{\mu_0 NI.A}{L}$

Magnetic moment = $NIA = \frac{\phi L}{\mu_0}$

From question,

$L = 60$ cm and $\phi = 1.57\times10^{-6}$ Wb (given)

$M = \frac{1.57\times10^{-6}\times0.6}{4\times3.14\times10^{-7}} = 0.75\,A$

$\left[\because \mu_0 = 4\pi\times10^{-7}\right]$

CHEMISTRY

51. **(c)** Work done in a chemical reaction,

W = $-\Delta n_g$RT

Where, Δn_g = number of moles of gaseous products – number of moles of gaseous reactants.

Reaction involved in combustion of ethane is,

$$C_2H_6(g)+\frac{7}{2}O_2(g)\longrightarrow 2CO_2(g)+3H_2O(l)$$

$\therefore$ $\Delta n_g = 2-4.5=-2.5$

$W=(2.5\ \text{mol})\ (8.314\ \text{JK}^{-1}\text{mol}^{-1})\times 300\ \text{K}$

$=6235.5\ \text{J}=6.2355\ \text{KJ}$

1 mole of C_2H_6 = 30g of C_2H_6

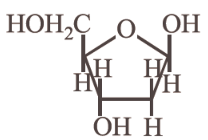
Work done during combustion of 30 g of C_2H_6 = 6.2355 kJ

$\therefore$ Work done during combustion of 90g of

$$C_2H_6 = \frac{6.2355\times 90}{30} = 18.7065\ \text{kJ}$$

$= 18.71$ kJ

52. **(c)** The sugar molecule present in DNA is 2′-deoxyribose.



β-D-deoxyribose used in DNA
or
D-2-deoxyribose

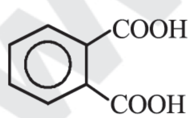
53. **(a)** Molality

$$(m)=\frac{\text{Number of moles of solute}}{\text{Mass of solvent (in kg)}}$$

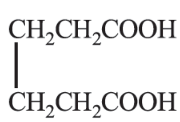
$$\Rightarrow \frac{\frac{15.2}{60}}{0.150}=\frac{0.2533}{0.15}$$

$\Rightarrow$ 1.689 mol kg^{-1}

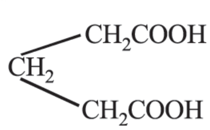
54. **(d)**



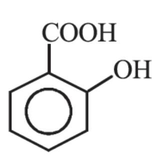
Phthalic acid ,



Adipic acid



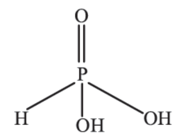
Glutaric acid ,



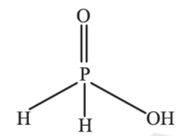
Salicylic acid

$\therefore$ Salicylic acid contains both –OH and –COOH groups.

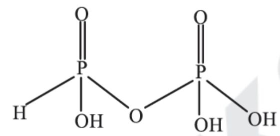
55. **(b)**



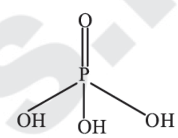
Orthophosphorus acid or phosphonic acid (H_3PO_3)
Oxidation state : +3



Hypophosphorus acid or phosphinic acid (H_3PO_2)
Oxidation state : +1



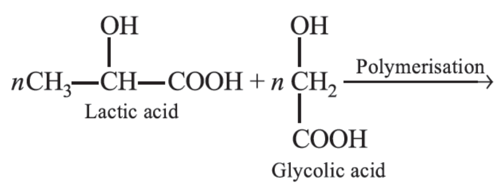
Pyrophosphorus acid
($H_4P_2O_5$)
Oxidation state : +3

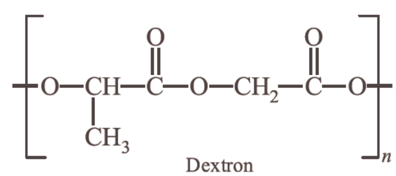


Orthophosphoric acid
(H_3PO_4)
Oxidation state : +5

56. **(a)** Due to the smaller size of lithium, it has the highest Hydration Enthalpy which compensate its I.E. and shows negative E° value. Therefore it acts as powerful reducing agent and hence weakest oxidising agent.

57. **(a)** Monomers used in preparation of dextron are lactic acid and glycolic acid.





Dextron

58. **(a)** All the hydrides, except water (H_2O) of group 16 elements acts as a reducing agents.

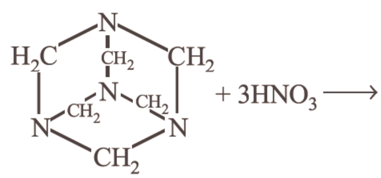
59. **(d)** Processes such as irradiation, addition of salts and heat, antioxidants, emulsifiers are used to preserve the food.

60. **(d)** Electron releasing groups increase electron density at N-atom hence, such substituents increase basic nature of aromatic amines. Option (a), (b), (c) are electron releasing group whereas (d) : C_6H_5 is EWG, thus decreases the basic strength.

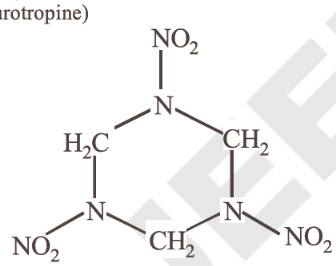
61. **(d)** (+) 2–methyl butane–1–ol and (–) 2–methyl butan–1–ol are enantiomer. They are non-superimposable mirror images of each other. Hence, they are optically active.
The optical activity of a compound can be confirmed by the value of specific rotation.

62. **(b)** Haematite – Fe_2O_3
Magnesite – $MgCO_3$
Magnetite – Fe_3O_4
Siderite – $FeCO_3$
$\therefore$ Magnesite is the mineral of magnesium (Mg).

63. **(c)** Urotropine gives highly explosive cyclonite on nitration.



Hexamethylene tetramine (urotropine)



Cyclotrimethylene trinitramine (cyclonite)

$+ 3CH_2O + NH_3$

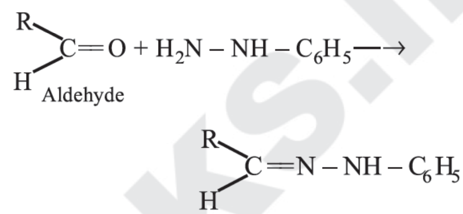
64. **(b)** Work done during compression,
$W = p_{ext}\,\Delta V$
Given, $p_{ext} = 100$ KPa, T = 300 K
$\Delta V = V_2 - V_1$
$= (10 - 1)\ dm^3 = 9\ dm^3$
$= 0.99\ m^3$
$\therefore\ W = 100\ KPa\ (0.99)\ m^3$
$= 99$ kJ.

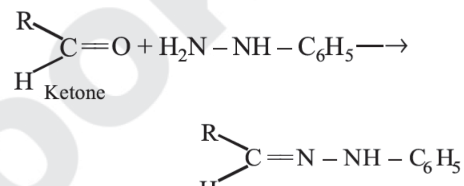
65. **(b)** Nitrogen because of its small size, high electronegativity, high ionisation energy, absence of vacant *d*–orbitals has tendency to form $p\pi - p\pi$ multiple bonds $N \equiv N$

66. **(b)** Statement (B) is incorrect. Hoffmann bromamide degradation is used to synthesise primary amine.

67. **(d)** Zirconium (Zr) with atomic number 40 and Hafnium (Hf) with atomic number 72 belongs to period 5th and 6th respectively.

68. **(b)** Aldehydes or ketones on treatment C_6H_5—NH—NH_2 (phenylhydrazine) gives phenylhydrazone. This is a nucleophilic addition reaction.





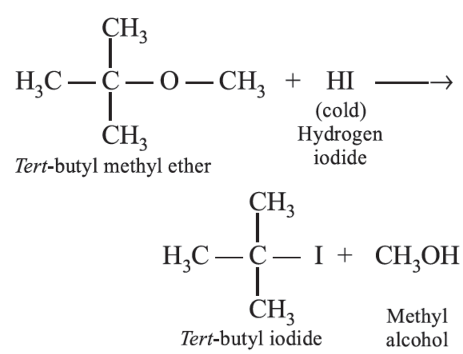
69. **(d)** The solubility of NaBr changes slightly with temperature.

70. **(b)** The reaction of ethanol with water:

$$2C_2H_5OH(l) + 2Na(s) \longrightarrow 2C_2H_5\bar{O}Na^+ + H_2(g)\uparrow$$

2 mole of Na (46 g) = 1 mole of H_2
$= 2\ g = 2 \times 10^{-3}$ kg

71. **(d)** The reaction between *tert*-butyl methyl ether with hydrogen iodide:



72. **(c)** Aluminium is refined by Hoope's process.

73. **(a)** Oxidation state of Mn in MnO_4^{2-} is +6.
Mn (+6) = $1s^2\,2s^2\,2p^6, 3s^2\,3p^6\,3d^1, 4s^0$
Hence, manganate ion MnO_4^{2-} is paramagnetic due to presence of unpaired electron. Also, MnO_4^{2-} is green in colour.

74. (a) Osmotic pressure, $\pi = CRT$ or $\pi = \frac{w}{MV}RT$

where, C = concentration of solution.

Given, w = 34.2 g, V = 1L, M = 342 g mol^{-1}

T = 20 °C, C = 20 + 273 = 293 °K

$\therefore \ \pi = \frac{w}{MV}RT$

$= \frac{342.2 \text{ g}}{342 \text{ g mol}^{-1}} \times \frac{0.082 \text{ L atm K}^{-1}\text{mol}^{-1} \times 293 \text{ K}}{1 \text{ L}}$

= 2.40 atm.

75. (a) In R–S configuration, priority sequence is decided by the atoms directly attached to the chiral carbon are arranged in decreasing atomic number.

From the given groups, sulphur (S) has the highest atomic number i.e., 16 therefore it has highest priority.

76. (b) Bithional is an antiseptic, which is mixed to medication soaps to impart antiseptic properties.

Whereas chloramphenicol is antibiotic, cimetidine is antacid and chlordiazepoxide is transquilizer.

77. (c) In the preparation of sulphuric acid (H_2SO_4) by lead chamber process, mixture containing SO_2 air and NO is treated with steam (H_2O). In this reaction, NO acts as a catalyst.

$$2SO_2 + \underset{\text{(from air)}}{O_2} + 2H_2O + \underset{\text{Catalyst}}{[NO]} \longrightarrow 2H_2SO_4 + \underset{\text{Catalyst}}{[NO]}$$

78. (b) Coordination number of Fe in $K_3[Fe(CN)_6]$ is 6 as it is bonded with six CN ligands.

Let x be the oxidation state of Cr

$\therefore \ x + 6(-1) = -3$

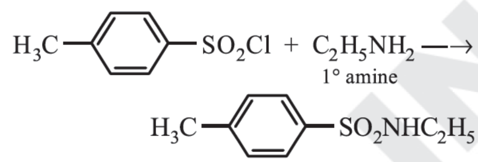
$\therefore \ x = +3$

79. (a) Pseudo first order reaction e.g., inversion of cane sugar is an example of

$$\underset{\substack{\text{Sucrose} \\ \text{(Cane sugar)}}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

The concentration of water remains constant

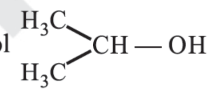
80. (a) 1° , 2° and 3° amines can be distinguished from each other by *p*-toluenesulphonyl chloride (Hinsberg reagent). Among which 1° amine on sulphonation gives a product, which is insoluble in acid.



N–alkyl toluene sulphon amide (Insoluble in alkali)

81. (c) Variation of rate constant k with temperature T(K) is given by Arrhenius equation.

$$k = Ae^{-E_a/RT} = \frac{A}{e^{Ea/RT}} \quad \text{...(i)}$$

82. (a) Isopropyl alcohol 

will give positive iodoform test.

83. (a) According to first law of thermodynamics, $\Delta U = q + W$

where, ΔU = Internal energy

q = Heat ; w = Work done

For isothermal process, $\Delta T = 0$, $\Delta U = 0$

$\therefore \ q = -W$

84. (b) Alkyl chlorides or bromides reacts with NaI in dry acetone to give alkyl iodide. This reaction is known as Finkelstein reaction.

$R{-}X + NaI \longrightarrow RI + NaX$ [X = Cl, Br]

e.g., $C_2H_5Br + NaI \longrightarrow C_2H_5I + NaBr$

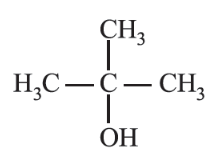
85. (c) Fullerenes are the allotropes of carbon structure having cage like with general formula, C_{2n} (e.g., C_{60}, C_{70} etc). C_{60} or the bucky ball consists of 60 C-atoms in which each C-atom in C_{60} is sp^2 -hybridised.

86. (b) S.I Unit of conductivity (κ) is Sm^{-1}

87. (a) Alk. $KMnO_4$ is called Baeyer's reagent.

88. (b) The chief consitituent of pyrex glass is SiO_2.

89. (c) For isomeric alcohols, the boiling point decreases with increase in branching of carbon chain. Therefore, tert butyl alcohol has lowest boiling point.



Tert-butyl alcohol

90. (c) Relation between heat of reaction ($\Delta Hr°$) and bond enthalpies of reactants and products is

$\Delta H_r = \Sigma BE_{reactants} - \Sigma BE_{products}$

$\therefore\ \Delta H°_{reaction} = \Sigma H°_{product\ bonds} - \Sigma H°_{reactant\ bonds}$

91. (a) Given, $k = 7 \times 10^{-4}\ s^{-1}$, $[A]_0 = 0.08$ M

$$t_{1/2} = \frac{0.693}{k} = \frac{0.0693}{7 \times 10^{-4}\ s} = 990\ s$$

92. (a) Bakelite is highly cross linked polymer. Which is used in making handles of cookers and frying pans, electrical goods, etc.

93. (b) Electron gain enthalpy becomes less negative on moving from chlorine to iodine. However, negative electron gain enthalpy of fluorine is less than that of chlorine due to small sized of fluorine atom. It has very high inter electronic repulsion in the relatively small 2*p* orbitals. Hence, incoming electron experience less attraction from the nucleus.

$\therefore$ Chlorine has the highest value of electron gain enthalpy.

94. (b) Half of the volume occupied in water is empty or unoccupied. Therefore, 10 cm^3 of the actual volume is occupied by water molecules present in 20 cm^3 of water.

95. (d) EAN = Z (atomic number of the metal) – number of electrons lost in the ion formation + number of electrons gained from the donor atoms of the ligands.

Complex	Oxidation state of metal ion	Atomic no.	Coordination no.	EAN
$[Pt(NH_3)_6]^{4+}$	+ 4	76	6	(78 – 4) + (6 × 2) = 86 (Rn)
$[Fe(CN)_6]^{4-}$	+ 2	26	6	(26 – 2) + (6 × 2) = 36 (Kr)
$[Zn(NH_3)_4]^{2+}$	+ 2	30	4	(30 – 2) + (4 × 2) = 36 (Kr)
$[Cu(NH_3)_4]^{2+}$	+ 2	29	4	(29 – 2) + (4 × 2) = 35 (Br)

$[Cu(NH_3)_4]^{2+}$ is an exception to EAN rule.

96. (d) The reaction involved for lead accumulator during discharging i.e., when cell is in the use are

At anode : $Pb(s) + HSO_4^-(aq) \longrightarrow PbSO_4(s) + H^+ + 2e^-$

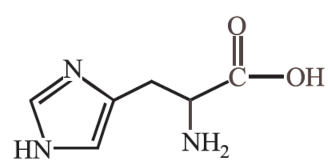
At cathode : $PbO_2(s) + 3H^+(aq) + HSO_4^-(aq) + 2e^- \longrightarrow PbSO_4(s) + 2H_2O(l)$

Overall reaction : $Pb(s) + PbO_2(s) + 2H^+ + 2\,HSO_4^-(aq) \longrightarrow 2PbSO_4(s) + 2H_2O(l)$

97. (d) Number of total ions present in the solution is known as van't Hoff factor.

Urea is a molecular solid hence, does not undergo association or dissociation therefore, has the lowest value of van't Hoff factor (i).

98. (a)



Histidine

It is basic in nature as it contains more number of $-NH_2$ groups than –COOH groups.

99. (a) Ar (Noble gas) does not form diatomic molecules. Due to presence of completely filled valence shell, these gases are highly stable.

100. (d) Stachyose contains 24 carbon atoms in its structure.

SECTION-B

MATHEMATICS

1. **(b)** We have, $\tan 2\theta = 1$.

$\Rightarrow \quad \tan 2\theta = \tan\frac{\pi}{4}. \quad \Rightarrow \quad 2\theta = n\pi + \frac{\pi}{4}.$

$\Rightarrow \quad \theta = \frac{n}{2}\pi + \frac{\pi}{8}.$

Also, the value of $\tan 2\theta$ is positive. So, θ lies in 1st and 3rd quadrants.

$\therefore \quad \theta = \frac{\pi}{8}$ & $\frac{9\pi}{8}$, are the two principal solutions.

2. **(a)** The objective function is given as, minimize, $z = 4x_1 + 5x_2$

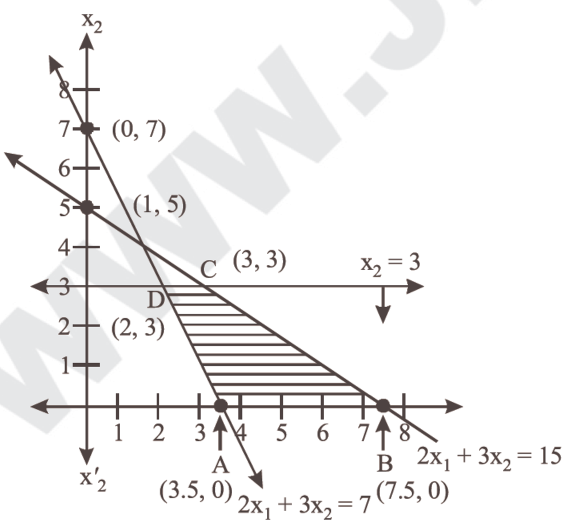
Subject to constraints, $2x_1 + x_2 \geq 7$, $2x_1 + 3x_2 \leq 15$, $x_2 \leq 3$ and $x_1, x_2 \geq 0$

For line $2x_1 + x_2 = 7$

x_1	0	1	2	3
x_2	7	5	3	1

For line $2x_1 + 3x_2 = 15$

x_1	0	3	6
x_2	5	3	1

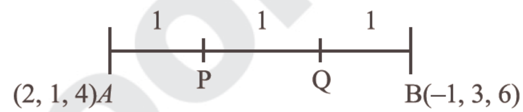


Now, the value of z at corner points are calculated as:

Corner points	$z = 4x_1 + 5x_2$
A(3.5, 0)	$z = 4 \times 3.5 + 5 \times 0 = 14$ (minimum)
B(7.5, 0)	$z = 4 \times 7.5 + 5 \times 0 = 30$
C(3, 3)	$z = 4 \times 3 + 5 \times 3 = 27$
D(2, 3)	$z = 4 \times 2 + 5 \times 3 = 23$

Hence, the minimum value of z is 14 at point (3.5, 0) which lies on X-axis.

3. **(d)** Let P & Q are the points with z-coordinates as z_1 and z_2 respectively which trisect the line segment AB.



Then, coordinates of P

$$= \left(\frac{1\times(-1)+2\times 2}{1+2}, \frac{1\times 3+2\times 1}{1+2}, \frac{1\times 6+2\times 4}{1+2}\right)$$

Now, z-coordinate of $P = \frac{1\times 6+2\times 4}{1+2}$

i.e. $z_1 = \frac{6+8}{3} = \frac{14}{3}$

And coordinates of Q

$$= \left(\frac{2\times(-1)+1\times 2}{2+1}, \frac{2\times 3+1\times 1}{2+1}, \frac{2\times 6+1\times 4}{2+1}\right)$$

So, z-coordinate of $Q = \frac{2\times 6+1\times 4}{2+1}$

i.e. $\quad z_2 = \frac{12+4}{3} = \frac{16}{3}$

Hence, $z_1 + z_2 = \frac{14}{3} + \frac{16}{3} = \frac{30}{3} = 10$

4. **(b)** Since, $f(x) = \frac{\log x}{x}$

After differentiating on both sides w.r.t.x, we get

$$f'(x) = \frac{x.\frac{1}{x} - \log x.1}{x^2} = \frac{1-\log x}{x^2}$$

For maximum or minimum value of $f(x)$, put $f'(x) = 0$

$$\Rightarrow \quad \frac{1-\log x}{x^2} = 0 \Rightarrow \log x = 1 \Rightarrow \quad x = e$$

Now, $f''(x) = \dfrac{3+2\log x}{x^3}$

$\therefore \quad f''(e) = -\dfrac{1}{e^3} < 0$

After substituting x = e in eq. (i), we get

$$f(e) = \frac{\log e}{e} = \frac{1}{e}$$

Hence, maximum value of f(x) is $\dfrac{1}{e}$ at x = e.

5. **(b)** $\displaystyle\int_0^1 x\tan^{-1}x\,dx$

$$= \left[\tan^{-1}x\int x\,dx\right]_0^1 - \int_0^1\left(\frac{d}{dx}\left(\tan^{-1}x\right)\int x\,dx\right)dx$$

$$= \left[\tan^{-1}x\,\frac{x^2}{2}\right]_0^1 - \int_0^1\left(\frac{1}{1+x^2}.\frac{x^2}{2}\right)dx$$

$$= \left(\frac{1}{2}\tan^{-1}1 - 0\right) - \frac{1}{2}\int_0^1\frac{1+x^2-1}{1+x^2}dx$$

$$= \frac{1}{2}\left(\frac{\pi}{4}\right) - \frac{1}{2}\int_0^1\left(1-\frac{1}{1+x^2}\right)dx$$

$$= \frac{\pi}{8} - \frac{1}{2}\left[x - \tan^{-1}x\right]_0^1$$

$$= \frac{\pi}{8} - \frac{1}{2}\left[1 - \tan^{-1}1 - 0 + 0\right]$$

$$= \frac{\pi}{8} - \frac{1}{2}\left[1 - \frac{\pi}{4}\right] = \frac{\pi}{4} - \frac{1}{2}$$

6. **(b)** The truth table is given below

p	q	~p	p ∨ q	~p ∧ q	(p ∨ q) ∧ ~q
T	T	F	T	F	F
T	F	F	T	F	F
F	T	T	T	T	T
F	F	T	F	F	F

$\therefore \quad (\sim p \wedge q) \equiv (p \vee q) \wedge \sim p$

7. **(a)** Given, $g(x) = f^{-1}(x)$

$f(g(x)) = x$

On differentiating both sides w.r.t. 'x', we get

$f'(g(x)).g'(x) = 1$

$$\therefore \quad \frac{1}{1+(g(x))^4}g'(x) = 1 \quad \left[\because\ f'(x) = \frac{1}{1+x^4}\right]$$

$\Rightarrow \quad g'(x) = 1 + [g(x)]^4$

8. **(b)** Consider $A = \begin{bmatrix} 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \end{bmatrix}$

So, $|A| = \begin{vmatrix} 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \end{vmatrix}$

$= 1(3\times(-1)-0) - 0(3\times(-1)-0-0) + 0(3\times2-5\times3)$

$= 1\times(-3) - 0 - 0 = -3$

Now, adj A

$$= \begin{bmatrix} (3\times(-1)-0) & -3\times(-1)-0) & (3\times2-5\times3) \\ -(0-0) & (1\times(-1)-0) & -(2\times1-5\times0) \\ (3\times0-0) & -(1\times0-0) & (3\times1-0) \end{bmatrix}^T$$

$$= \begin{bmatrix} -3 & 3 & -9 \\ 0 & -1 & -2 \\ 0 & 0 & 3 \end{bmatrix}$$

$$\text{adj } A = \begin{bmatrix} -3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \end{bmatrix}$$

Hence, $A^{-1} = \dfrac{1}{|A|}\text{adj } A = \dfrac{1}{-3}\begin{vmatrix} -3 & 0 & 0 \\ 0 & -1 & 0 \\ -9 & -2 & 3 \end{vmatrix}$

9. **(a)** $\displaystyle\int\frac{1}{\sqrt{9-16x^2}}dx$

$$= \int\frac{1}{\sqrt{3^2-(4x)^2}}dx = \frac{1}{4}\int\frac{1}{\sqrt{\left(\frac{3}{4}\right)^2-(x)^2}}dx$$

$$=\frac{1}{4}\sin^{-1}\frac{4x}{3}+c$$

$$\left[\because \int\frac{1}{\sqrt{a^2-x^2}}dx=\sin^{-1}\frac{x}{a}+c\right]$$

As, $\int\frac{1}{\sqrt{9-16x^2}}dx=\alpha\sin^{-1(\beta x)}+c$

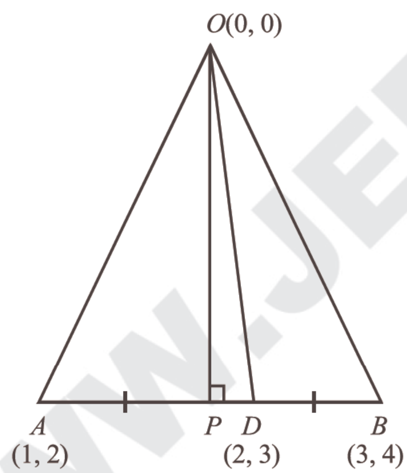
$\therefore \quad \alpha\sin^{-1}(\beta x)+c=\frac{1}{4}\sin^{-1}\left(\frac{4}{3}x\right)+c$

After comparing on both sides, we get

$$\alpha=\frac{1}{4} \text{ and } \beta=\frac{4}{3}$$

Hence, $\alpha+\frac{1}{\beta}=\frac{1}{4}+\frac{1}{\frac{4}{3}}=\frac{1}{4}+\frac{3}{4}=1$

10. (d)



Since, O(0, 0), A(1, 2) and B(3, 4) are the vertices of ΔOAB.
Consider that OP and OD are altitude and median of ΔOAB, respectively.
Then, Coordinates of D

$$=\left(\frac{1+3}{2},\frac{2+4}{2}\right)=(2,3)$$

So, equation of OD is $(y-0)=\left(\frac{3-0}{2-0}\right)(x-0)$

Hence, $y=\frac{3}{2}x \quad \Rightarrow 3x-2y=0$

Now, slope of OP $=\frac{-1}{\text{Slope of AB}}$

$$\frac{-1}{\left(\frac{3-1}{4-2}\right)}=-1 \text{ [As, OP} \perp \text{AB]}$$

$$=\frac{1}{\left(\frac{3-1}{4-2}\right)}=-1$$

$\therefore$ Equation of OP is $(y-0)=-1(x-0)$
$\therefore$ $y=-x \quad \Rightarrow x+y=0$
Hence, joint equation of OP and OD is:

$$(x+y)(3x-2y)=0$$

$\Rightarrow \quad 3x^2+xy-2y^2=0$

11. (c) Given, $f(x)=\left[\tan\left(\frac{\pi}{4}+x\right)\right]^{1/x}=K$

As, f(x) is continuous at $x=0$,

$\therefore \quad f(0)=\lim\limits_{x\to0}f(x)$

$$=\lim_{x\to0}\left[\tan\left(\frac{\pi}{4}+x\right)\right]^{1/x}$$

So, $K=\lim\limits_{x\to0}\left[\frac{1+\tan x}{1-\tan x}\right]^{1/x} \quad [1^\infty \text{ form}]$

$$=e^{\lim\limits_{x\to0}\left[\frac{1+\tan x}{1-\tan x}-1\right]\frac{1}{x}}$$

$$=e^{\lim\limits_{x\to0}\left(\frac{2\tan x}{1-\tan x}\right)\frac{1}{x}} \quad \left[\because \lim_{x\to0}\frac{\tan x}{x}=1\right]$$

Hence $K=e^{2.1\left(\frac{1}{1-0}\right)}=e^2$

12. (c) We have,

$$A(\text{adj}A)=\begin{bmatrix}10&0\\0&10\end{bmatrix}=10\begin{bmatrix}1&0\\0&1\end{bmatrix}=10I$$

As, $A(\text{adj}A)=|A|I$
After comparing on both sides, we get

$$|A|=10$$

13. **(b)** We have, $\frac{dy}{dx} = \tan\left(\frac{y}{x}\right) + \left(\frac{y}{x}\right)$ ...(i)

Since, it is homogeneous differential equation
After putting, y = Vx, we get

$$\frac{dy}{dx} = V + x\frac{dV}{dx}$$

$$V + x\frac{dV}{dx} = \tan V + V \quad \text{[From (i)]}$$

$\Rightarrow \quad x\frac{dV}{dx} = \tan V$

$\Rightarrow \quad \frac{1}{\tan V}dV = \frac{1}{x}dx$

After integrating on both sides, we get

$$\int \frac{1}{\tan V}dV = \int \frac{1}{x}dx$$

$\Rightarrow \quad \int \cot V\, dV = \log x + \log c$

$\Rightarrow \quad \log \sin V = \log(xc)$

$\Rightarrow \quad \sin v = xc$

Hence, $\sin\left(\frac{y}{x}\right) = xc$

14. **(c)** We have, $\sin^2 A + \sin^2 B = \sin^2 C$

$\Rightarrow \quad a^2 + b^2 = c^2$ (From Sine rule)

$\therefore \quad \Delta ABC$ is right angled triangle and $\angle ACB = 90°$

So, area of $(\Delta ACB) = \frac{1}{2}ab$

By Sine rule's we get

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$\Rightarrow \quad \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{10}{1}$

Hence, $a = 10 \sin A$
and $b = 10 \sin B$

Area of $\Delta ACB = \frac{1}{2}(10 \sin A)(10 \sin B)$ [From (i)]

$= 50 \sin A \sin B$

As, maximum value of $\sin A \sin B = \frac{1}{2}$

Hence, maximum value of area of ΔACB

$$= 50 \times \frac{1}{2} = 25$$

15. **(a)** We have x = f(t) and y = g(t)
After differentiating on both sides w.r.t 't', we get

$$\frac{dx}{dt} = f'(t) \text{ and } \frac{dy}{dt} = g'(t)$$

As, $\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$

$\Rightarrow \quad \frac{dy}{dx} = \frac{g'(t)}{f'(t)}$

Now, differentiating again both sides w.r.t. 'x', we get

$$\frac{d^2y}{dx^2} = \frac{f'(t).g''(t) - g'(t).f''(t)}{(f'(t))^2}.\frac{dt}{dx}$$

$$= \frac{f'(t).g''(t) - g'(t).f''(t)}{(f'(t))^2}.\frac{1}{f'(t)}$$

$$= \frac{f'(t).g''(t) - g'(t).f''(t)}{(f'(t))^3}$$

16. **(b)** Consider $(x_1, y_1, z_1) \equiv (-3, 2, -5)$
As, the line is equally inclined to coordinate axes.
$l = -1$, m = 1 and n = –1
Since, the equation of line passing through (x_1, y_1, z_1) and direction cosines l, m, n is

$$\frac{x - x_1}{l} = \frac{y - y_1}{m} = \frac{z - z_1}{n}$$

Hence, $\frac{x+3}{-1} = \frac{y-2}{1} = \frac{z+5}{-1}$

17. **(d)** We have, $\int_0^{\frac{\pi}{2}} \log \cos x\, dx = \frac{\pi}{2}\log\frac{1}{2}$ ...(i)

$$= \int_0^{\frac{\pi}{2}} \log \sec x\, dx = \int_0^{\frac{\pi}{2}} \log\left(\frac{1}{\cos x}\right)dx$$

$$= -\int_0^{\frac{\pi}{2}} \log(\cos x)\,dx = -\int_0^{\frac{\pi}{2}} \log(\cos x)\,dx$$

$$= -\frac{\pi}{2}\log\left(\frac{1}{2}\right) \qquad \text{[From (i)]}$$

$$= \frac{\pi}{2}\log 2$$

18. **(c)** Suppose X be a random variable which denotes the no. of heads in tossing a coin three times. X can take value 0, 1, 2, 3.

As, y = ₹2x. So, Y can take the values ₹0, ₹2, ₹4 and ₹6

$$\therefore \quad P(y=0) = P\,(0 \text{ head}) = \frac{1}{8}$$

$$P(y=2) = P\,(1 \text{ head}) = \frac{3}{8}$$

$$P(y=4) = P\,(2 \text{ heads}) = \frac{3}{8}$$

$$P(y=6) = P\,(3 \text{ heads}) = \frac{1}{8}$$

Hence, expected gain

$$= 0\left(\frac{1}{8}\right) + 2\left(\frac{3}{8}\right) + 4\left(\frac{1}{8}\right) + 6\left(\frac{1}{8}\right)$$

$$= \frac{6+12+6}{8} = 3$$

19. **(c)** The truth table is given below:

p	q	$\sim p$	$\sim q$	$\sim p \leftrightarrow p$	$q \to p$	$\sim q \to \sim p$	$p \vee (q \to p)$	$p \wedge \sim p$	$(q \to p) \vee (\sim p \leftrightarrow q)$
T	T	F	F	F	T	F	T	F	T
T	F	F	T	T	T	F	T	F	T
F	T	T	F	T	F	T	T	F	T
F	F	T	T	F	T	T	F	F	T

Hence, $(q \to p) \vee (\sim p \to q)$ is a tautology.

20. **(c)** Let $\mathbf{n_1}$ and $\mathbf{n_2}$ are normals to the planes

$\mathbf{r}.(m\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}}) + 3 = 0$ and

$\mathbf{r}.(2\hat{\mathbf{i}} - m\hat{\mathbf{j}} - \hat{\mathbf{k}}) - 5 = 0$, respectively.

Now, $\theta = \dfrac{\pi}{3}$ is angle between the planes.

$$\text{As,} \quad \cos\theta = \left|\frac{\mathbf{n_1}.\mathbf{n_2}}{|\mathbf{n_1}||\mathbf{n_2}|}\right|$$

$$\text{So,} \ \cos\frac{\pi}{3} = \frac{(m\hat{i} - \hat{j} + 2\hat{k}).(2\hat{i} - m\hat{j} - \hat{k})}{\left(\sqrt{m^2 + (-1)^2 + 2^2}\right)\left(\sqrt{2^2 + (-m)^2 + (-1)^2}\right)}$$

$$\Rightarrow \frac{1}{2} = \left|\frac{2m + m - 2}{\sqrt{m^2 + 1 + 4}\sqrt{4 + m^2 + 1}}\right| = \left|\frac{3m - 2}{\sqrt{(m^2 + 5)^2}}\right|$$

$$\Rightarrow \quad \pm\frac{1}{2} = \frac{3m - 2}{m^2 + 5}$$

$\Rightarrow \quad m^2 + 5 = 6m - 4 \quad$ or $\quad -m^2 - 5 = 6m - 4$

$\Rightarrow \quad m^2 - 6m - 9 = 0 \quad$ or $\quad m^2 + 6m + 1 = 0$

$\Rightarrow \quad (m - 3)^2 = 0 \quad$ or $\quad m^2 + 6m + 1 = 0$

As $m^2 + 6m + 1 = 0$ does not give any real values.

Hence, $(m - 3)^2 = 0 \ \Rightarrow m = 3$

21. **(c)** We have, O (0, 0, 0), P (2, 3, 4), Q (1, 2, 3) and R (x, y, z) are coplanar.

$$\text{So,} \begin{vmatrix} x-0 & y-0 & z-0 \\ 2-0 & 3-0 & 4-0 \\ 1-0 & 2-0 & 3-0 \end{vmatrix} = 0$$

$$\Rightarrow \begin{vmatrix} x & y & z \\ 2 & 3 & 4 \\ 1 & 2 & 3 \end{vmatrix} = 0$$

$\Rightarrow \quad x(9-8) - y(6-4) + z(4-3) = 0$

$\Rightarrow \quad x - 2y + z = 0$

22. **(a)** We have, pair of line is $px^2 - qy^2 = 0$ ...(i)

After comparing eq. (i) with $ax^2 + 2hxy + by^2 = 0$, we get $a = p$, $b = -q$, $h = 0$

As slopes of pair of lines represented by

$ax^2 + 2hxy + by^2 = 0$

are real and distinct iff $h^2 - ab > 0$

So, $0 + pq > 0$

Hence, $pq > 0$

23. **(c)** Consider **p, q, r, s, m** and **n** are the position vectors of P, Q, R, S, M and N be respectively.

As, M and N are mid-points of **PQ** and **RS** respectively

$$\text{So,} \quad \mathbf{m} = \frac{\mathbf{p} + \mathbf{q}}{2} \ \text{and} \ \mathbf{n} = \frac{\mathbf{r} + \mathbf{s}}{2} \qquad \text{...(i)}$$

Now, $\mathbf{PS} + \mathbf{QR}$

$= \mathbf{s} - \mathbf{p} + \mathbf{r} - \mathbf{q} = (\mathbf{r} + \mathbf{s}) - (\mathbf{p} + \mathbf{q})$

$= \mathbf{2n} - \mathbf{2m} = \mathbf{2\,MN}$ [From eq. (i)]

24. **(c)** We have, pair of lines

$$kx^2 + 5xy + y^2 = 0 \quad \text{...(i)}$$

After comparing eq. (i) with

$ax^2 + 2hx + by^2 = 0$, we get

$a = k, b = 1$ and $2h = 5$

Suppose m_1 and m_2 are two slopes of pair of lines.

Then $m_1 + m_2 = \frac{-2h}{b} = -5$ and $m_1 m_2 = \frac{a}{b} = k$

As, $(m_1 - m_2)^2 = (m_1 + m_2)^2 - 4m_1m_2$

$\Rightarrow \quad (1)^2 = (-5)^2 - 4k$

$\Rightarrow \quad 4k = 24 \Rightarrow k = 6$

25. **(c)** We have, vector $\mathbf{r}$ with dc's l, m, n is equally inclined to the coordinate axes.

So, $l = m = n$ ...(i)

As, $l^2 + m^2 + n^2 = 1$

$\therefore \quad l^2 + l^2 + l^2 = 1$ [from eq. (i)]

$\Rightarrow \quad 3l^2 = 1$

$\Rightarrow \quad l = \pm \frac{1}{\sqrt{3}}$

Therefore, $l = m = n = \pm\frac{1}{\sqrt{3}}$

$\therefore$ vector $\mathbf{r} = |\mathbf{r}|\left(\pm\frac{1}{\sqrt{3}}\hat{\mathbf{i}} \pm \frac{1}{\sqrt{3}}\hat{\mathbf{j}} \pm \frac{1}{\sqrt{3}}\hat{\mathbf{k}}\right)$

Hence, total number of required vectors $= 2^3 = 8$

26. **(a)** Consider $I = \int \frac{1}{(x^2+4)(x^2+9)}dx$

$$= \int \frac{1}{5}\left(\frac{1}{x^2+4} - \frac{1}{x^2+9}\right)dx$$

$$= \frac{1}{5}\left[\int \frac{1}{x^2+2^2}dx - \int \frac{1}{x^2+3^2}dx\right]$$

$$= \frac{1}{5}\left[\frac{1}{2}\tan^{-1}\frac{x}{2} - \frac{1}{3}\tan^{-1}\frac{x}{3}\right] + C$$

$$= \frac{1}{10}\tan^{-1}\frac{x}{2} - \frac{1}{15}\tan^{-1}\frac{x}{3} + C$$

We have, $I = A\tan^{-1}\frac{x}{2} + B\tan^{-1}\frac{x}{3} + C$

So, $A\tan^{-1}\frac{x}{2} + B\tan^{-1}\frac{x}{3} + C$

$$= \frac{1}{10}\tan^{-1}\frac{x}{2} - \frac{1}{15}\tan^{-1}\frac{x}{3} + C$$

After comparing on both sides, we get

$$A = \frac{1}{10} \text{ and } B = \frac{-1}{15}$$

Hence, $A - B = \frac{1}{10} + \frac{1}{15} = \frac{15+10}{150} = \frac{1}{6}$

27. **(a)** It is given that, α and β are the roots of the equation

$x^2 + 5|x| - 6 = 0$

Here, $|x|^2 + 6|x| - |x| - 6 = 0$

$\Rightarrow |x|(|x|+6) - 1(|x|+6) = 0$

$\Rightarrow (|x|+6)(|x|-1) = 0$

$|x| = -6, 1$

As, modulus is always positive.

Therefore, $|x| = 1 \Rightarrow x = \pm 1$

Consider, $\alpha = 1$ and $\beta = -1$

Hence,

$$\left|\tan^{-1}\alpha - \tan^{-1}\beta\right| = \left|\tan^{-1}1 - \tan^{-1}(-1)\right|$$

$$= \left|\frac{\pi}{4} - \left(-\frac{\pi}{4}\right)\right| = \left|\frac{\pi}{2}\right|$$

28. **(c)** We have, $x = a\left(t - \frac{1}{t}\right)$ and $y = a\left(t + \frac{1}{t}\right)$

Then, $y^2 - x^2 = \left[a^2\left(t + \frac{1}{t}\right)^2 - a^2\left(t - \frac{1}{t}\right)^2\right]$

$\Rightarrow \quad y^2 - x^2 = 4a^2$

After differentiating on both sides w.r.t. 'x', we get

$2y\frac{dy}{dx} - 2x = 0 \Rightarrow 2\left(y\frac{dy}{dx} - x\right) = 0$

Hence, $\frac{dy}{dx} = \frac{x}{y}$

29. **(c)** Suppose that slope of the curve $y=\sqrt{x-1}$ is m_1

$$\therefore m_1=\frac{dy}{dx}=\frac{d}{dx}\sqrt{x-1}\frac{1}{2\sqrt{x-1}}$$

slope of the line $2x+y-5=0$ is m_2

$$\therefore m_2=\frac{dy}{dx}=\frac{d}{dx}(5-2x)=-2$$

As, lines are perpendicular if $m_1m_2=-1$

So, $\frac{1}{2\sqrt{x-1}}.(-2)=-1 \Rightarrow \sqrt{x-1}=1$

$\Rightarrow x-1=1 \Rightarrow x=2$

After substituting $x=2$ in $y=\sqrt{x-1}$, we get $y=1$

Hence, required point is (2, 1).

30. **(d)** Consider, $I=\int\sqrt{\frac{x-5}{x-7}}dx$

$$=\int\sqrt{\frac{(x-5)(x-5)}{(x-7)(x-5)}}dx$$

$$=\int\frac{x-5}{\sqrt{x^2-12x+35}}dx$$

$$=\frac{1}{2}\int\frac{2x-12+2}{\sqrt{x^2-12x+35}}$$

$$=\frac{1}{2}\int\frac{2x-12}{\sqrt{x^2-12x+35}}dx+\int\frac{1}{\sqrt{x^2-12x+35}}dx$$

$$=\sqrt{x^2-12x+35}+\int\frac{1}{\sqrt{(x^2-12x+36-1)}}dx+C$$

$$=\sqrt{x^2-12x+35}+\int\frac{1}{\sqrt{(x-6)^2-1^2}}dx+C$$

$$I=\sqrt{x^2-12x+35}+\log\left|x-6+\sqrt{x^2-12x+35}\right|+C$$

As,

$$I=A\sqrt{x^2-12x+35}+\log\left|x-6+\sqrt{x^2-12x+35}+C\right|$$

Hence, $A=1$

31. **(b)** We have, mean = 18 and variance = 12

So, np = 18 and np q = 12

$$\therefore \frac{npq}{np}=\frac{12}{18}\Rightarrow q=\frac{2}{3}$$

Therefore, $p=1-q=1-\frac{2}{3}=\frac{1}{3}$

After putting, $p=\frac{1}{3}$ in np = 8, we get

$$n\left(\frac{1}{3}\right)=18\Rightarrow n=54$$

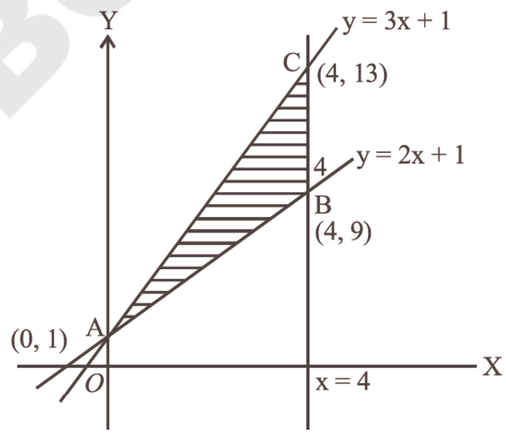
Hence, total number of possible value of X $=n+1=54+1=55$

32. **(d)** For line $y = 2x + 1$,

two points are (0, 1) and (4, 9)

For line $y = 3x + 1$,

two points are (0, 1) and (4, 13)



Hence, area of shaded region

$$=\frac{1}{2}\begin{vmatrix}x_1 & y_1 & 1\\ x_2 & y_2 & 1\\ x_3 & y_3 & 1\end{vmatrix}=\frac{1}{2}\begin{vmatrix}0 & 1 & 1\\ 4 & 9 & 1\\ 4 & 13 & 1\end{vmatrix}$$

$$=\frac{1}{2}\left[0-0+4(13-9)\right]=8\text{ sq units}$$

33. **(d)** Given, X is the number of defective pens obtained. Two pens are defective.

So, X have possible values 0, 1, 2

Now, $P(X=0)=\dfrac{{}^4C_2}{{}^6C_2}=\dfrac{4\times 3}{6\times 5}=\dfrac{6}{15}$

$$P(X=1)=\frac{{}^2C_1\times{}^4C_1}{{}^6C_2}=\frac{8}{15}$$

$$P(X=2)=\frac{{}^2C_2}{{}^6C_2}=\frac{1\times 2}{6\times 5}=\frac{1}{15}$$

$$E(X^2)=\frac{8}{15}+\frac{2^2}{15}=\frac{12}{15}=\frac{4}{5}$$

Standard deviation $=\sqrt{E(X^2)-[E(X)]^2}$

$$=\sqrt{\left(\frac{4}{5}\right)-\left(\frac{2}{3}\right)^2}$$

$$=\sqrt{\frac{16}{45}}=\frac{4}{3\sqrt{5}}$$

34. **(a)** Let r be the radius of spherical ball

$\because$ Volume of spherical ball $V=\dfrac{4}{3}\pi r^3$ ...(i)

Now, $288\pi=\dfrac{4}{3}\pi r^3$

$\Rightarrow r^3=72\times 3=8\times 27$

$\Rightarrow r=6$

After differentiating eq. (i) w.r.t. 't', we get

$$\frac{dV}{dt}=4\pi r^2\frac{dr}{dt}$$

$$\Rightarrow 4\pi=4\pi r^2\frac{dr}{dt}\quad\left[\because\frac{dV}{dt}=4\pi\,cm^3/s\right]$$

$$\Rightarrow 1=(6)^2\frac{dr}{dt}$$

$$\Rightarrow\frac{dr}{dt}=\frac{1}{36}$$

$\because$ Surface area of spherical ball, $s=4\pi r^2$

After differentiating on both sides, w.r.t. 't', we get

$$\frac{ds}{dt}=4\times 2\pi r\frac{dr}{dt}$$

$$\Rightarrow\frac{ds}{dt}=8\times\pi\times 6\times\frac{1}{36}$$

Hence, $\dfrac{ds}{dt}=\dfrac{4\pi}{3}cm^2/s$

35. **(b)** We have, $f(x)=\begin{cases}\log\left(\sec^2 x\right)^{\cot^2 x}, & \text{for } x\neq 0\\ k, & \text{for } x=0\end{cases}$

As, $f(x)$ is continuous at $x=0$

So, $f(0)=\lim\limits_{x\to 0}\left[\log\left(\sec^2 x\right)^{\cot^2 x}\right]$

$$=\lim_{x\to 0}\left[\cot^2 x\log\left(\sec^2 x\right)\right]$$

$$=\lim_{x\to 0}\frac{\log\left(1+\tan^2 x\right)}{\tan^2 x}=\lim_{x\to 0}\frac{1}{1+\tan^2 x}=1$$

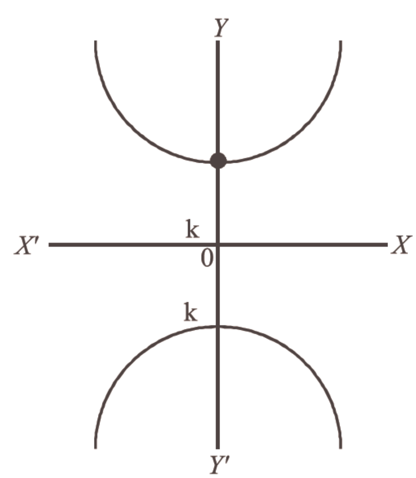
36. **(a)** After replacing '$\vee$' by '$\wedge$' and '$\wedge$' by '$\vee$', we get dual of the statement $\sim p\wedge(q\vee c)$ is $\sim p\vee(q\wedge t)$

37. **(a)** Let vertex of parabola be (0, k) as axis of parabola is Y-axis

So, equation of parabola is

$$(x-0)^2=4a(y-k)$$

$$\Rightarrow x^2=4ay-4ak$$



After, differentiating both sides w.r.t., 'x', we get

$$2x = 4a\frac{dy}{dx}$$

Therefore, $\frac{1}{2a} = \frac{1}{x}\frac{dy}{dx}$

Again differentiating on both sides w.r.t. 'x', we get

$$\frac{d}{dx}\left(\frac{1}{x},\frac{dy}{dx}\right) = \frac{d}{dx}\left(\frac{1}{2a}\right)$$

$$\Rightarrow \frac{1}{x}.\frac{d^2y}{dx^2} + \frac{dy}{dx}\left(-\frac{1}{x^2}\right) = 0$$

Hence, $x\frac{d^2y}{dx^2} - \frac{dy}{dx} = 0$

38. **(a)** $\int_0^3 [x]dx = \int_0^1 0\,dx + \int_1^2 1dx + \int_2^3 2\,dx$

$= [x]_1^2 + 2[x]_2^3$

$= (2-1) + 2(3-2) = 3$

39. **(c)** Objective function of a LPP defined over convex set attains its optimum value at atleast one of the corner points.

40. **(d)** Consider, $A = \begin{bmatrix} \alpha & 14 & -1 \\ 2 & 3 & 1 \\ 6 & 2 & 3 \end{bmatrix}$

So,

$|A| = \begin{bmatrix} \alpha & 14 & -1 \\ 2 & 3 & 1 \\ 6 & 2 & 3 \end{bmatrix} = \alpha(9-2) - 14(6-6) - 1(4-18)$

$= 7\alpha + 14$

As, inverse of matrix A does not exists.

Therefore, $|A| = 0$

$\Rightarrow \quad 7\alpha + 14 = 0$

Hence, $\alpha = -2$

41. **(a)** We have, $f(x) = \begin{cases} x, & \text{for } x \le 0 \\ 0, & \text{for } x > 0 \end{cases}$

LHL at $x = 0 = \lim_{x\to 0^-} f(x) = \lim_{x\to 0} x$

and RHL at $x = 0 = \lim_{x\to 0^+} f(x) = \lim_{x\to 0} 0 = 0$

Now, $f(0) = 0$

So, LHL = RHL = f(0)

Hence, f(x) is continuous at x = 0

Here, $f'(x) = 1$ for $x \le 0$,

0 for $x > 0$

Thus, f(x) is not differentiable at x = 0

42. **(a)** Equation of plane which passes through $\vec{a} = -\hat{i} + \hat{j} + 2\hat{k}$ as it is perpendicular to $\hat{n} = \hat{i} + \hat{j} + \hat{k}$ will be $\vec{r}.\hat{n} = \vec{a}.\hat{n}$

$\vec{r}.\left(\hat{i} + \hat{j} + \hat{k}\right) = \left(-\hat{i} + \hat{j} + 2\hat{k}\right).\left(\hat{i} + \hat{j} + \hat{k}\right)$

$= -1 + 1 + 2 = 2$

Hence, $\vec{r}.\left(\hat{i} + \hat{j} + \hat{k}\right) = 2$

43. **(b)** We have, probability that a person will develop immunity after vaccination is 0.8

Hence, probability that all 8 persons develop immunity = $(0.8)^8$

44. **(a)** The coordinates of given point is (2, 3, λ).

So, equation of the plane is

$$\vec{r}.\left(3\hat{i} + 2\hat{j} + 6\hat{k}\right) = 13$$

$\Rightarrow \left(x\hat{i} + y\hat{j} + z\hat{k}\right).\left(3\hat{i} + 2\hat{j} + 6\hat{k}\right) = 13$

$\Rightarrow 3x + 2y + 6z - 13 = 0$

Therefore, distance of the plane from the given point (2, 3, λ) will be

$$\left|\frac{3\times 2 + 2\times 3 + 6\times\lambda - 13}{\sqrt{3^2 + 2^2 + 6^2}}\right| = 5[\text{Given}]$$

$\Rightarrow \pm 5 = \frac{6\lambda - 1}{\sqrt{49}}$

$\Rightarrow \pm 35 = 6\lambda - 1$

$\Rightarrow 35 = 6\lambda - 1$ or $-35 = 6\lambda - 1$

Hence, $\lambda = 6, -\frac{17}{3}$

45. **(a)** $\cos^{-1}\left(\cot\frac{\pi}{2}\right) + \cos^{-1}\left(\sin\frac{2\pi}{3}\right)$

$= \cos^{-1}(0) + \cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$

$$= \cos^{-1}\left(\cos\frac{\pi}{2}\right) + \cos^{-1}\left(\cos\frac{\pi}{6}\right)$$

$$= \frac{\pi}{2} + \frac{\pi}{6} = \frac{2\pi}{3}$$

46. **(b)** Given, $x\,dy + 2y\,dx = 0$

$$\therefore \quad \frac{dy}{dy} + \frac{2dx}{x} = 0$$

After integrating on both sides, we get

$$\int \frac{1}{y}dy + 2\int \frac{1}{x}dx = \log C$$

$\Rightarrow \quad \log y + 2\log x = \log C$

$\Rightarrow \quad yx^2 = C$

If $x = 2$ then $y = 1$,

So, $C = 1 \times 2^2 = 4$

Hence, particular solution will be $x^2y = 4$.

47. **(d)** It is given that, A(2, 3, 5), B(–1, 3, 2) and $C(\lambda, 5, \mu)$ are three vertices of ΔABC.

Let D be the mid-point of BC

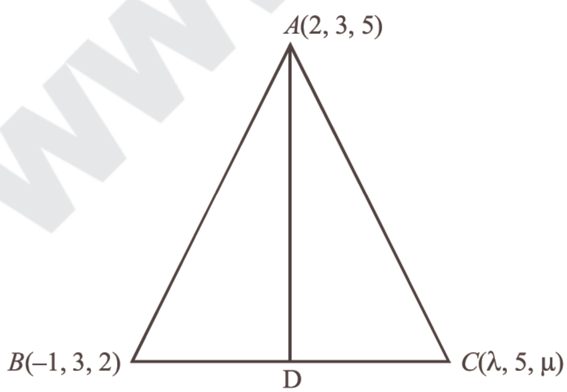
So, coordinates of D $= \left(\frac{\lambda-1}{2}, \frac{5+3}{2}, \frac{\mu+2}{2}\right)$

$$= \left(\frac{\lambda-1}{2}, 4, \frac{\mu+2}{2}\right)$$

So, direction ratios of

$$AD = \left(\frac{\lambda-1}{2} - 2, 4-3, \frac{\mu+2}{2} - 5\right)$$

$$= \left(\frac{\lambda-5}{2}, 1, \frac{\mu-8}{2}\right)$$



As, AD is equally inclined to both the coordinates axes.

Therefore, $\frac{\lambda-5}{2} = 1 = \frac{\mu-8}{2}$

$$\Rightarrow \quad \frac{\lambda-5}{2} = 1 \quad \Rightarrow \quad \lambda = 7$$

And, $1 = \frac{\mu-8}{2} \quad \Rightarrow \quad \mu = 10$

48. **(b)** $p(3 < x \le 5) = p(x=4) + p(x=5)$

$= (0.62 - 0.48) + (0.85 - 0.62)$

$= 0.14 + 0.23 = 0.37$

49. **(b)** Since, $\frac{x-1}{2} = \frac{y+1}{2} = \frac{z-1}{4} = \lambda$ ...(i)

and $\frac{x-3}{1} = \frac{y-6}{2} = \frac{z}{1}$ ...(ii)

Now, any point on the line (i) is $P(2\lambda+1, 2\lambda-1, 4\lambda+1)$

$\therefore \quad \frac{2\lambda+1-3}{1} = \frac{2\lambda-1-6}{2} = \frac{4\lambda+1}{1}$ [from (ii)]

So, $\quad 4\lambda - 4 = 2\lambda - 7 \quad \Rightarrow \quad 2\lambda = -3$

Hence, point of intersection P is

$$= \left(2\times\left(-\frac{3}{2}\right)+1, 2\times\left(-\frac{3}{2}\right)-1, 4\times\left(-\frac{3}{2}\right)+1\right)$$

$$\equiv (-2, -4, -5)$$

50. **(b)** Consider, $I = \int \frac{\sec^8 x}{\operatorname{cosec} x}dx = \int \frac{\sin x}{\cos^8 x}dx$

$$= \int \tan x.\sec^7 x\,dx$$

$$= \int \sec^6 x.\sec x \tan x\,dx$$

Let $\sec x = t \Rightarrow \sec x \,.\, \tan x\,dx = dt$,

So, $\quad I = \int t^6\,dt = \frac{t^7}{7} + c = \frac{\sec^7 x}{7} + c$

MHT-CET 2016

<u>**General Instructions**</u>

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. In potentiometer experiment, nul1 point is obtained at a particular point for a cell on potentiometer wire x cm long. If the length of the potentiometer wire is increased without changing the cell, the balancing length will (Driving source is not changed)
(a) increase (b) decrease
(c) not change (d) become zero

2. An iron rod is placed parallel to magnetic field of intensity 2000 Am^{-1}. The magnetic flux through the rod is 6×10^{-4} Wb and its cross-sectional area is 3 cm^2. The magnetic permeability of the rod in Wb $A^{-1}m^{-1}$ is
(a) 10^{-1} (b) 10^{-2} (c) 10^{-3} (d) 10^{-4}

3. Alternating current of peak value $\left(\frac{2}{\pi}\right)$ ampere flows through the primary coil of the transformer. The coefficient of mutual inductance between primary and secondary coil is 1 H. The peak emf induced in secondary coil is (Frequency of AC = 50 Hz)
(a) 100 V (b) 200 V (c) 300 V (d) 400 V

4. An electron of mass m has de-Broglie wavelength λ when accelerated through potential difference V. When proton of mass M, is accelerated through potential difference 9 V, the de-Broglie wavelength associated with it will be (Assume that wavelength is determined at low voltage)
(a) $\frac{\lambda}{3}\sqrt{\frac{M}{m}}$ (b) $\frac{\lambda}{3}\frac{M}{m}$ (c) $\frac{\lambda}{3}\sqrt{\frac{m}{M}}$ (d) $\frac{\lambda}{3}\frac{m}{M}$

5. Interference fringes are produced on a screen by using two light sources of intensities I and 9I. The phase difference between the beams is $\frac{\pi}{2}$ at point P and π at point Q on the screen. The difference between the resultant intensities at point P and Q is
(a) 2I (b) 4I (c) 6I (d) 8I

6. From Brewster's law, except for polished metallic surfaces, the polarising angle
(a) depends on wavelength and is different for different colours
(b) independent of wavelength and is different for different colours
(c) independent of wavelength and is same for different colours
(d) depends on wavelength and is same for different colours

7. Two particles X and Y having equal charges after being accelerated through same potential difference enter a region of uniform magnetic field and describe a circular paths of radii r_1 and r_2 respectively. The ratio of the mass of X to that of Y is
(a) $\frac{r_1}{r_2}$ (b) $\sqrt{\frac{r_1}{r_2}}$ (c) $\left[\frac{r_2}{r_1}\right]^2$ (d) $\left[\frac{r_1}{r_2}\right]^2$

8. When an electron in hydrogen atom revolves in stationary orbit, it
(a) does not radiate light though its velocity changes
(b) does not radiate light and velocity remains unchanged
(c) radiates light but its velocity is unchanged
(d) radiates light with the change of energy

9. The magnetic field (B) inside a long, solenoid having n turns per unit length and carrying current/when iron core is kept in it is (μ_0 = permeability of vacuum, x = magnetic susceptibility)
(a) $\mu_0 nl(1-\chi)$ (b) $\mu_0 nl\,\chi$
(c) $\mu_0 nl^2(1+\chi)$ (d) $\mu_0 nl(1+\chi)$

10. In balanced meter bridge, the resistance of bridge wire is 0.1. Ω cm. Unknown resistance X is connected in left gap and 6 Ω in right gap, null point divides the wire in the ratio 2:3. Find the current drawn from the battery of 5 V having negligible resistance
(a) 1 A (b) 1.5 A (c) 2A (d) 5 A

11. Three parallel plate air capacitors are connected in parallel. Each capacitor has plate area $\frac{A}{3}$ and the separation between the plates is d, $2d$ and $3d$ respectively. The equivalent capacity of combination is (ε_0 = absolute permittivity of free space)
(a) $\frac{7\varepsilon_0 A}{18d}$ (b) $\frac{11\varepsilon_0 A}{18d}$ (c) $\frac{13\varepsilon_0 A}{18d}$ (d) $\frac{17\varepsilon_0 A}{18d}$

12. In an oscillator, for sustained oscillations, Barkhausen criterion is $A\beta$ equal to (A = voltage gain without feedback and β = feedback factor)
(a) zero (b) $\frac{1}{2}$ (c) 1 (d) 2

13. Light of wavelength λ which is less than threshold wavelength is incident on a photosensitive material. If incident wavelength is decreased so that emitted photoelectrons are moving with same velocity, then stopping potential will
(a) increase (b) decrease
(c) be zero (d) become exactly half

14. A ray of light travelling through rarer medium is incident at very small angle i on a glass slab and after refraction its velocity is reduced by 20%. The angle of deviation is
(a) $\frac{i}{8}$ (b) $\frac{i}{5}$ (c) $\frac{i}{2}$ (d) $\frac{4i}{5}$

15. The maximum frequency of transmitted radio waves above which the radio waves are no longer reflected back by ionosphere is (N = maximum electron density of Ionosphere, g = acceleration due to gravity)
(a) gN (b) gN^2 (c) $g\sqrt{N}$ (d) g^2N^2

16. Wire having tension 225 N produces six beats per second when it is tuned with a fork. When tension changes to 256 N, it is tuned with the same fork, the number of beats remain unchanged. The frequency of the fork will be
(a) 186 Hz (b) 225 Hz (c) 256 Hz (d) 280 Hz

17. Assuming the expression for the pressure exerted by the gas on the walls of the container, it can be shown that pressure is
(a) $\left[\frac{1}{3}\right]^{rd}$ kinetic energy per unit volume of a gas
(b) $\left[\frac{2}{3}\right]^{rd}$ kinetic energy per unit volume of a gas
(c) $\left[\frac{3}{4}\right]^{th}$ kinetic energy per unit volume of a gas
(d) $\frac{3}{2}\times$ kinetic energy per unit volume of a gas

18. A mass m_1 connected to a horizontal spring performs SHM with amplitude A. While mass m_1 is passing through mean position, another mass m_2 is placed on it so that both the masses move together with amplitude A_1. The ratio of $\frac{A_1}{A}$ is ($m_2 < m_1$)
(a) $\left[\frac{m_1}{m_1+m_2}\right]^{\frac{1}{2}}$ (b) $\left[\frac{m_1+m_2}{m_1}\right]^{\frac{1}{2}}$
(c) $\left[\frac{m_2}{m_1+m_2}\right]^{\frac{1}{2}}$ (d) $\left[\frac{m_1+m_2}{m_2}\right]^{\frac{1}{2}}$

19. A particle moves along a circle of radius r with constant tangential acceleration. If the velocity of the particle is v at the end of second revolution, after the revolution has started, then the tangential acceleration is
(a) $\frac{v^2}{8\pi r}$ (b) $\frac{v^2}{6\pi r}$ (c) $\frac{v^2}{2\pi r}$ (d) $\frac{v^2}{2\pi r}$

20. Two strings A and B of same material are stretched by same tension. The radius of the string A is double the radius of string B. Transverse wave travels on string A with speed v_A and on string B with speed v_B. The ratio $\frac{v_A}{v_B}$ is
(a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) 2 (d) 4

21. Which of the following quantity does not change due to damping of oscillations?
(a) Angular frequency (b) Time period
(c) Initial phase (d) Amplitude

22. If the end correction of an open pipe is 0.8 cm, then the inner radius of that pipe will be
(a) $\frac{1}{3}$cm (b) $\frac{2}{3}$cm (c) $\frac{3}{2}$cm (d) 0.2 cm

23. A progressive wave is represented by $y = 12 \sin (5t - 4x)$ cm. On this wave, how far away are the two points having phase difference of 90°?
(a) $\frac{\pi}{2}$cm (b) $\frac{\pi}{4}$cm (c) $\frac{\pi}{8}$ (d) $\frac{\pi}{16}$

24. Two particles of masses m and 9m are separated by a distance r. At a point on the line joining them the gravitational field is zero. The gravitational potential at that point is
(G = universal constant of gravitation)
(a) $-\frac{4Gm}{r}$ (b) $-\frac{8Gm}{r}$
(c) $-\frac{16Gm}{r}$ (d) $-\frac{32Gm}{r}$

25. A black rectangular surface of area A emits energy E per second at 27°C. If length and breadth are reduced to $\frac{1}{3}^{rd}$ of initial value and temperature is raised to 327°C, then energy emitted per second becomes
(a) $\frac{4E}{9}$ (b) $\frac{7E}{9}$ (c) $\frac{10E}{9}$ (d) $\frac{16E}{9}$

26. For a gas $\frac{R}{C_V} = 0.4$, where R is the universal gas constant and C_V is molar specific heat at constant volume. The gas is made up of molecules which are
(a) rigid diatomic (b) monoatomic
(c) non-rigid diatomic (d) polyatomic

27. In vertical circular motion, the ratio of kinetic energy of a particle at highest point to that at lowest paint is
(a) 5 (b) 2 (c) 0.5 (d) 0.2

28. Two wires having same length and material are stretched by same force. Their diameters are in the ratio 1: 3. The ratio of strain energy per unit volume for these two wires (smaller to larger diameter) when stretched is
(a) 3:1 (b) 9 : 1 (c) 27:1 (d) 81:1

29. A ring and a disc roll on the horizontal surface without slipping, with same linear velocity. If both have same mass and total kinetic energy of the ring is 4 J, then total kinetic energy of the disc is
(a) 3 J (b) 4 J (c) 5 J (d) 6 J

30. When the observer moves towards the stationary source with velocity, v_1 the apparent frequency of emitted note is f_1. When the observer moves away from the source with velocity v_1, the apparent frequency is f_2. If v is the velocity of sound in air and $\frac{f_1}{f_2} = 2$, then $\frac{v}{v_1} = ?$
(a) 2 (b) 3 (c) 4 (d) 5

31. A liquid drop having surface energy E is spread into 512 droplets of same size. The final surface energy of the droplets is
(a) 2E (b) 4E (c) 8E (d) 12E

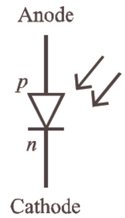
32. Let M be the mass and L be the length of a thin uniform rod. In first case, axis of rotation is passing through centre and perpendicular to the length of the rod. In second case, axis of rotation is passing through one end and perpendicular to the length of the rod. The ratio of radius of gyration in first case to second case is
(a) 1 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{1}{8}$

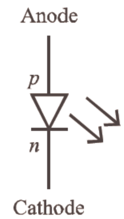
33. A simple pendulum of length l has maximum angular displacement θ. The maximum kinetic energy of the bob of mass m is (g = acceleration due to gravity)
(a) $mgl\,(1 + \cos\theta)$ (b) $mgl\,(1 + \cos^2\theta)$
(c) $mgl\,(1 - \cos 0)$ (d) $mgl\,(\text{cas}\ 0 - 1)$

34. Angular speed of hour hand of a clock in degree per second is
(a) $\frac{1}{30}$ (b) $\frac{1}{60}$ (c) $\frac{1}{120}$ (d) $\frac{1}{720}$

35. The value of gravitational acceleration g at a height h above the earth's surface is $\frac{g}{4}$, then (R = radius of earth)
(a) $h = R$ (b) $h = \frac{R}{2}$
(c) $h = \frac{R}{3}$ (d) $h = \frac{R}{4}$

36. The schematic symbol of light emitting diode (LED) is

(a) 

(b) 

(c) 

(d) 

37. The amount of work done in increasing the voltage across the plates of capacitor from 5 V to 10 V is W. The work done in increasing it from 10 V to 15 V will be
(a) W (b) $0.6\,W$ (c) $1.25\,W$ (d) $1.67\,W$

38. Magnetic flux passing through a coil is initially 4×10^{-4} Wb. It reduces to 10% of its original value in t second. If the emf induced is 0.72 mV then t in second is
(a) 0.3 (b) 0.4 (c) 0.5 (d) 0.6

39. Resolving power of telescope increases when
(a) wavelength of light decreases
(b) wavelength of light increases
(c) focal length of eye-piece increases
(d) focal length of eye-piece decreases

40. When light of wavelength λ is incident on photosensitive surface, the stopping potential is V. When light of wavelength 3λ is incident on same surface, the stopping potential is $\frac{V}{6}$. Threshold wavelength for the surface is
(a) 2λ (b) 3λ (c) 4λ (d) 5λ

41. The bob of a simple pendulum performs SHM with period T in air and with period T_1 in water Relation between T and T_1 is (neglect friction due to water, density of the material of the bob is $= \frac{9}{8} \times 10^3$ kgm^3, density of water = 1gcc^{-1})
(a) $T_1 = 3T$ (b) $T_1 = 2T$
(c) $T_1 = T$ (d) $T_1 = \frac{T}{2}$

42. In a capillary tube of radius R, a straight thin metal wire of radius r ($R > r$) is inserted symmetrically and one end of the combination is dipped vertically in water such that the lower end of the combination is at same level. The rise of water in the capillary tube is
[T = surface tension of water, ρ = density of water and g = gravitational acceleration]
(a) $\frac{T}{(R+r)\rho g}$ (b) $\frac{R\rho g}{2T}$
(c) $\frac{2T}{(R-r)\rho g}$ (d) $\frac{(R-r)\rho g}{T}$

43. When open pipe is closed from one end, then third overtone of closed pipe is higher in frequency by 150 Hz than second overtone of open pipe. The fundamental frequency of open end pipe will be
(a) 75 Hz (b) 150 Hz
(c) 225 Hz (d) 300 Hz

44. A disc of radius R and thickness $\frac{R}{6}$ has moment of inertia/about an axis passing through its centre and perpendicular to its plane. Disc is melted and recast into a solid sphere. The moment of inertia of a sphere about its diameter is
(a) $\frac{l}{5}$ (b) $\frac{l}{6}$ (c) $\frac{l}{32}$ (d) $\frac{l}{64}$

45. Let a steel bar of length l, breadth b and depth d be loaded at the centre by a load W. Then the sag of bending of beam is (Y = Young's modulus of material of steel)
(a) $\frac{Wl^3}{2bd^3Y}$ (b) $\frac{Wl^3}{4bd^3Y}$
(c) $\frac{Wl^2}{2bd^3Y}$ (d) $\frac{Wl^3}{4bd^2Y}$

46. In Bohr's theory of hydrogen atom, the electron jumps from higher orbit n to lower orbit p. The wavelength will be minimum for the transition
(a) $n = 5$ to $p = 4$ (b) $n = 4$ to $p = 3$
(c) $n = 3$ to $p = 2$ (d) $n = 2$ to $p = 1$

47. Two identical parallel plate air capacitors are connected in series to a battery of emf V. If one of the capacitor is completely filled with dielectric material of constant K, then potential difference of the other capacitor will become
(a) $\frac{K}{V(K+1)}$ (b) $\frac{KV}{K+1}$
(c) $\frac{K-1}{KV}$ (d) $\frac{V}{K(K+1)}$

48. The *L-C* parallel resonant circuit
(a) has a very high impedance
(b) has a very high current
(c) acts as resistance of very low value
(d) has zero impedance

49. A galvanometer of resistance 30 Ω is connected to a battery of emf 2 V with 1970 Ω resistance in series. A full scale deflection of 20 divisions is obtained in the galvanometer. To reduce the deflection to 10 divisions, the resistance in series required is
(a) 4030 Ω (b) 4000 Ω
(c) 3970 Ω (d) 2000 Ω

50. Two coherent sources P and Q produce interference at point A on the screen where there is a dark band which is formed between 4th bright band and 5th bright band. Wavelength of light used is 6000 Å. The path difference between *PA* and *QA* is
(a) 1.4×10^{-4} cm (b) 2.7×10^{-4} cm
(c) 4.5×10^{-4} cm (d) 6.2×10^{-4} cm

CHEMISTRY

51. If '*n*' represents total number of asymmetric carbon atoms in a compound, then the possible· number of optical isomers of the compound is
(a) $2n$ (b) n^2 (c) 2^n (d) $2n+2$

52. The equation that represents general van't Hoff equation is
(a) $\pi = \frac{n}{V}RT$ (b) $\pi = nRT$
(c) $\pi = \frac{V}{n}RT$ (d) $\pi = nVRT$

53. Which is the most stable allotrope of sulphur?
(a) Octahedral sulphur
(b) Monoclinic sulphur
(c) Plastic sulphur
(d) Colloidal sulphur

54. Select the correct statement for thermoplastic polymer.
(a) It does not become soft on heating under pressure
(b) It cannot be remoulded
(c) It is either linear or branched chain polymer
(d) It is a cross-linked polymer

55. How many Faradays of electricity are required to deposit 10 g of calcium from molten calcium chloride using inert electrodes?
(Molar mass of calcium = 40 g mol^{-1})
(a) 0.5 F (b) 1 F (c) 0.25 F (d) 2 F

56. Name the reagent that is used in leaching of gold.
(a) Carbon (b) Sodium cyanide
(c) Carbon monoxide (d) Iodine

57. Which of the following is an analgesic?
(a) Ofloxacin (b) Penicillin
(c) Aminoglycosides (d) Paracetamol

58. The compound which is not formed when a mixture of *n*-butyl bromide and ethyl bromide treated with sodium metal in the presence of dry ether is
(a) butane (b) octane
(c) hexane (d) ethane

59. What is the general molecular formula of the products obtained on heating lanthanoids (Ln) with sulphur?
(a) LnS (b) LnS_3 (c) Ln_3S_2 (d) Ln_2S_3

60. Butylated hydroxy anisole is a/an
(a) antioxidant (b) cleansing agent
(c) disinfectant (d) antihistamine

61. In the cell represented by
$Pb(s) \,|\, Pb^{2+}(1M) \,\|\, Ag^{+}(1M) \,|\, Ag(s)$, the reducing agent is
(a) Pb (b) Pb^{2+} (c) Ag (d) Ag^{+}

62. Which metal crystallises in a simple cubic structure?
(a) Polonium (b) Copper
(c) Nickel (d) Iron

63. The amine 'A' when treated with nitrous acid gives yellow oily substance. The amine A is
(a) triethylamine
(b) trimethylamine
(c) aniline
(d) methylphenylamine

64. The element that does not form acidic oxide is
(a) carbon (b) phosphorus
(c) chlorine (d) barium

65. While assigning *R, S* configuration, the correct order of priority of groups attached to chiral carbon atom is
(a) $CONH_2 > COCH_3 > CH_2OH > CHO$
(b) $CONH_2 > COCH_3 > CHO > CH_2OH$
(c) $COCH_3 > CONH_2 > CHO > CH_2OH$
(d) $CHO > CH_2OH > COCH_3 > CONH_2$

66. Bulletproof helmets are made from
(a) lexan (b) saran
(c) glyptal (d) thiokol

67. Which metal is refined by Mond's process?
(a) Titanium (b) Copper
(c) Nickel (d) Zinc

68. Isopropyl methyl ether when treated with cold hydrogen iodide gives
(a) isopropyl iodide and methyl iodide
(b) isopropyl alcohol and methyl iodide
(c) isopropyl alcohol and methyl alcohol
(d) isopropyl iodide and methyl alcohol

69. In face centred cubic unit cell, what is the volume occupied?
(a) $\frac{4}{3}\pi r^3$ (b) $\frac{8}{3}\pi r^3$
(c) $\frac{16}{3}\pi r^3$ (d) $\frac{64r^3}{3\sqrt{3}}$

70. Glucose on oxidation with bromine water yields gluconic acid. This reaction confirms the presence of
(a) six carbon atoms linked in straight chain
(b) secondary alcoholic group in glucose
(c) aldehyde group in glucose
(d) primary alcoholic group in glucose

71. How is sodium chromate converted into sodium dichromate in the manufacture of potassium dichromate from chromite ore?
(a) By the action of concentrated sulphuric acid
(b) By roasting with soda ash
(c) By the action of sodium hydroxide
(d) By the action of limestone

72. In dry cell, what acts as a negative electrode?
(a) Zinc (b) Graphite
(c) Ammonium chloride (d) Manganese dioxide

73. Select the compound which on treatment with nitrous acid liberates nitrogen.
(a) Nitroethane (b) Triethylamine
(c) Diethylamine (d) Ethylamine

74. 5.0 g of sodium hydroxide (molar mass 40 g mol^{-1}) is dissolved in little quantity of water and the solution is diluted upto 100 mL. What is the molarity of the resulting solution?
(a) 0.1 mol dm^{-3} (b) 1.0 mol dm^{-3}
(c) 0.125 mol dm^{-3} (d) 1.25 mol dm^{-3}

75. Which of the following compound when treated with dibenzyl cadmium yields benzyl methyl ketone?
(a) Acetone (b) Acetaldehyde
(c) Acetic acid (d) Acetyl chloride

76. Which halide of magnesium has highest ionic character?
(a) Chloride (b) Bromide
(c) Iodide (d) Fluoride

77. The reaction takes place in two steps as
(i) $NO_2Cl(g) \xrightarrow{k_1} NO_2(g) + Cl(g)$,
(ii) $NO_2Cl(g) + Cl(g) \xrightarrow{k_2} NO_2(g) + Cl_2(g)$
Identify the reaction intermediate.
(a) $NO_2Cl(g)$ (b) $NO_2(g)$
(c) $Cl_2(g)$ (d) $Cl(g)$

78. Which of the following amino acid is basic in nature?
(a) Valine (b) Tyrosine
(c) Arginine (d) Leucine

79. The relation between solubility of a gas in liquid at constant temperature and external pressure is stated by which law?
(a) Raoult's law
(b) van't Hoff- Boyle's law
(c) van't Hoff-Charles' law
(d) Henry's law

80. Which among the following phenolic compound is most acidic in nature?
(a) *p*-aminophenol (b) Phenol
(c) *m*-nitrophenol (d) *p*-nitrophenol

81. Which among the following solid is a non-polar solid?
(a) Hydrogen chloride
(b) Sulphur dioxide
(c) Water
(d) Carbon dioxide

82. Identify the metal that forms colourless compounds.
(a) Iron ($Z = 26$) (b) Chromium ($Z = 24$)
(c) Vanadium (Z = 23) (d) Scandium (Z = 21)

83. What is the highest oxidation state exhibited by group 17 elements?
(a) +1 (b) +3 (c) +5 (d) +7

84. Mathematical equation of first law of thermodynamics for isochoric process is
(a) $\Delta U = q_v$ (b) $\Delta U = q_v$
(c) $q = -W$ (d) $\Delta U = W$

85. Name the catalyst used in commercial method of preparation of phenol.
(a) Silica
(b) Calcium phosphate
(c) Anhydrous aluminium chloride
(d) Cobalt naphthenate

86. The rate constant and half-life of a first order reaction are related to each other as
(a) $t_{1/2} = \frac{0.693}{k}$ (b) $t_{1/2} = 0.693k$
(c) $k = 0.693t_{1/2}$ (d) $kt_{1/2} = \frac{1}{0.693}$

87. What is the combining ratio of glycerol and fatty acid when they combine to form triglyceride?
(a) 3 : 4 (b) 3 : 2 (c) 1 : 3 (d) 1 : 2

88. The molecular formula of Wilkinson's catalyst used in the hydrogenation of alkenes is
(a) $Co(CO)_8$ (b) $(Ph_3P)_3RhCl$
(c) $[Pt(NH_3)_2Cl_2]$ (d) $K[Ag(CN)_2]$

89. The criterion for a spontaneous process is
(a) $\Delta G > 0$ (b) $\Delta G < 0$
(c) $\Delta G = 0$ (d) $\Delta S_{total} < 0$

90. Brown ring test is used for detection of which radical?
(a) Ferrous (b) Nitrite
(c) Nitrate (d) Ferric

91. The reagent used in Wolff-Kishner reduction is
(a) $NH_2 - NH_2$ and KOH in ethylene glycol
(b) Zn – Hg / conc. HCl
(c) $NaBH_4$
(d) Na – Hg/H_2O

92. Which of the following is a neutral complex?
(a) $[Pt(NH_3)_2Cl_2]$ (b) $[Co(NH_3)_6]Cl_3$
(c) $[Ni(NH_3)_6]Cl_2$ (d) $K_4[Fe(CN)_6]$

93. Identify the compound amongst the following of which 0.1 M aqueous solution has highest boiling point.
(a) Glucose (b) Sodium chloride
(c) Calcium chloride (d) Ferric chloride

94. Which reagent is used in Etard reaction?
(a) Chromyl chloride (b) Ethanoyl chloride
(c) $SnCl_2$ and HCl (d) Cadmium chloride

95. The most abundant noble gas in atmosphere is
(a) neon (b) argon
(c) xenon (d) krypton

96. Identify an extensive property amongst the following.
(a) Viscosity (b) Heat capacity
(c) Density (d) Surface tension

97. Which of the following carboxylic acids is a tricarboxylic acid?
(a) Oxalic acid (b) Citric acid
(c) Succinic acid (d) Adipic acid

98. Average rate of reaction for the following reaction.
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ is written as
(a) $\frac{\Delta[SO_2]}{\Delta t}$ (b) $-\frac{\Delta[O_2]}{\Delta t}$
(c) $\frac{1}{2}\frac{\Delta[SO_2]}{\Delta t}$ (d) $\frac{\Delta[SO_3]}{\Delta t}$

99. What is the amount of work done when 0.5 mole of methane, CH_4 (g), is subjected to combustion at 300 K? (Given, R = 8.314 $JK^{-1} mol^{-1}$)
(a) –2494 J (b) –4988 J
(c) +4988 J (d) +2494 J

100. Primary nitroalkanes are obtained in good yield by oxidising aldoximes with the help of
(a) trifluoroperoxy acetic acid
(b) acidified potassium permanganate
(c) concentrated nitric acid
(d) potassium dichromate and dilute sulphuric acid

SECTION-B

MATHEMATICS

1. Let $X \sim B(n, p)$, if $E(X) = 5$, Var $(X) = 2.5$, then $p(X < 1)$ is equal to
(a) $\left(\frac{1}{2}\right)^{11}$ (b) $\left(\frac{1}{2}\right)^{10}$ (c) $\left(\frac{1}{2}\right)^{6}$ (d) $\left(\frac{1}{2}\right)^{9}$

2. Derivative of $\tan^{-1}\left(\frac{x}{\sqrt{1-x^2}}\right)$ with respect to $\sin^{-1}(3x - 4x^3)$ is
(a) $\frac{1}{\sqrt{1-x^2}}$ (b) $\frac{3}{\sqrt{1-x^2}}$
(c) 3 (d) $\frac{1}{3}$

3. The differential equation of the family of circles touching Y-axis at the origin is
(a) $\left(x^2+y^2\right)\frac{dy}{dx} - 2xy = 0$
(b) $\left(x^2-y^2\right) + 2xy\frac{dy}{dx} = 0$
(c) $\left(x^2-y^2\right)\frac{dy}{dx} - 2xy = 0$
(d) $\left(x^2+y^2\right)\frac{dy}{dx} + 2xy = 0$

4. If $A = \begin{bmatrix} 1 & 1 & 0 \\ 2 & 1 & 5 \\ 1 & 2 & 1 \end{bmatrix}$, then
$a_{11}A_{21} + a_{12}A_{22} + a_{13}A_{23}$ is equal to
(a) 1 (b) 0 (c) –1 (d) 2

5. If Rolle's theorem for $f(x) = e^x (\sin x - \cos x)$ is verified on $\left[\frac{\pi}{4}, \frac{5\pi}{4}\right]$, then the value of c is
(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{2}$ (c) $\frac{3\pi}{3}$ (d) π

6. The joint equation of lines passing through the origin and trisecting the first quadrant is
(a) $x^2 + \sqrt{3}xy - y^2 = 0$
(b) $x^2 - \sqrt{3}xy - y^2 = 0$
(c) $\sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$
(d) $3x^2 - y^2 = 0$

7. If $2\tan^{-1}(\cos x) = \tan^{-1}(2\operatorname{cosec} x)$, then $\sin x + \cos x$ is equal to

(a) $2\sqrt{2}$ (b) $\sqrt{2}$ (c) $\frac{1}{\sqrt{2}}$ (d) $\frac{1}{2}$

8. Direction cosines of the line $\frac{x+2}{2} = \frac{2y-5}{3}$, $z = -1$ are

(a) $\frac{4}{5}, \frac{3}{5}, 0$ (b) $\frac{3}{5}, \frac{4}{5}, \frac{1}{5}$

(c) $-\frac{3}{5}, \frac{4}{5}, 0$ (d) $\frac{4}{5}, -\frac{2}{5}, \frac{1}{5}$

9. $\int \frac{1}{\sqrt{8+2x-x^2}}dx$ is equal to

(a) $\frac{1}{3}\sin^{-1}\left(\frac{x-1}{3}\right)+c$ (b) $\sin^{-1}\left(\frac{x+1}{3}\right)+c$

(c) $\frac{1}{3}\sin^{-1}\left(\frac{x+1}{3}\right)+c$ (d) $\sin^{-1}\left(\frac{x-1}{3}\right)+c$

10. The approximate value of $f(x) = x^3 + 5x^2 - 7x + 9$ at $x = 1.1$ is

(a) 8.6 (b) 8.5 (c) 8.4 (d) 8.3

11. If random variable waiting time in minutes for bus and probability density function of x is given by

$$f(x) = \begin{cases} \frac{1}{5}, & 0 \le x \le 5 \\ 0, & \text{otherwise,} \end{cases}$$

then probability of waiting time not more than 4 minutes is equal to

(a) 0.3 (b) 0.8 (c) 0.2 (d) 0.5

12. In $\Delta ABC, (a-b)^2\cos^2\frac{C}{2} + (a+b)^2\sin^2\frac{C}{2}$ is equal to

(a) b^2 (b) c^2

(c) a^2 (d) $a^2 + b^2 + c^2$

13. Derivative of log $(\sec\theta + \tan\theta)$ with respect to $\sec\theta$ at $\theta = \frac{\pi}{4}$ is

(a) 0 (b) 1 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$

14. The joint equation of bisectors of angles between lines $x = 5$ and $y = 3$ is

(a) $(x-5)(y-3) = 0$

(b) $x^2 - y^2 - 10x + 6y + 16 = 0$

(c) $xy = 0$

(d) $xy - 5x - 3y + 15 = 0$

15. The point on the curve $6y = x^3 + 2$ at which y-coordinate is changing 8 times as fast as x-coordinate is

(a) (4,11) (b) (4,–11)

(c) (–4, 11) (d) (–4, –11)

16. If the function $f(x)$ defined by

$$f(x) = \begin{cases} x\sin\frac{1}{x}, & \text{for } x \neq 0 \\ k, & \text{for } x = 0 \end{cases}$$

is continuous at $x = 0$, then k is equal to

(a) 0 (b) 1 (c) –1 (d) $\frac{1}{2}$

17. If $y = e^m \sin^{-1} x$ and $(1-x^2) = Ay^2$, then A is equal to

(a) m (b) $-m$ (c) m^2 (d) $-m^2$

18. $\int\left(\frac{4e^x - 25}{2e^x - 5}\right)dx = Ax + B\log\left(2e^x - 5\right) + c$, then

(a) $A = 5$ and $B = 3$ (b) $A = 5$ and $B = -3$

(c) $A = -5$ and $B = 3$ (d) $A = -5$ and $B = -3$

19. $\dfrac{\tan^{-1}\left(\sqrt{3}\right) - \sec^{-1}(-2)}{\operatorname{cosec}^{-1}\left(-\sqrt{2}\right) + \cos^{-1}\left(-\frac{1}{2}\right)}$ is equal to

(a) $\frac{4}{5}$ (b) $-\frac{4}{5}$ (c) $\frac{3}{5}$ (d) 0

20. For what value of k, the function defined

by $f(x) = \begin{cases} \dfrac{\log(1+2x)\sin x^0}{x^2}, & \text{for } x \neq 0 \\ k, & \text{for } x = 0 \end{cases}$

is continuous at $x = 0$?

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{\pi}{90}$ (d) $\frac{90}{\pi}$

21. If $\log_{10}\left(\frac{x^2 - y^2}{x^2 + y^2}\right) = 2$, then $\frac{dy}{dx}$ is equal to

(a) $-\frac{99x}{101y}$ (b) $\frac{99x}{101y}$

(c) $-\frac{99y}{101x}$ (d) $\frac{99y}{101x}$

22. $\int_{-\pi/2}^{\pi/2} \log\left(\frac{2-\sin x}{2+\sin x}\right)$ is equal to

(a) 1 (b) 3 (c) 2 (d) 0

23. $\int\left(\frac{(x^2+2)a^{(x+\tan^{-1}x)}}{x^2+1}\right)dx$ is equal to

(a) $\log(a)a^{x+\tan^{-1}x}+c$ (b) $\frac{(x+\tan^{-1}x)}{\log a}+c$

(c) $\frac{a^{x+\tan^{-1}x}}{\log a}+c$ (d) $\log a(x+\tan^{-1}x)+c$

24. The degree and order of the differential equation

$\left[1+\left(\frac{dy}{dx}\right)^3\right]^{\frac{7}{3}}=7\left(\frac{d^2y}{dx^2}\right)$ respectively are

(a) 3 and 7 (b) 3 and 2
(c) 7 and 3 (d) 2 and 3

25. The acute angle between the line

$\vec{r}=(\hat{i}+2\hat{j}+\hat{k})+\lambda(\hat{i}+\hat{j}+\hat{k})$ and the plane

$\vec{r}\times(2\hat{i}-\hat{j}+\hat{k})=5$

(a) $\cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (b) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$

(c) $\tan^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (d) $\sin^{-1}\left(\frac{\sqrt{2}}{\sqrt{3}}\right)$

26. The area of the region bounded by the curve $y=2x-x^2$ and X-axis is

(a) $\frac{2}{3}$ sq units (b) $\frac{4}{3}$ sq units

(c) $\frac{5}{3}$ sq units (d) $\frac{8}{3}$ sq units

27. If $\int\frac{f(x)}{\log(\sin x)}dx=\log[\log\sin x]+c$, then $f(x)$ is equal to

(a) $\cot x$ (b) $\tan x$
(c) $\sec x$ (d) $\operatorname{cosec} x$

28. If A and B are foot of perpendicular drawn from point $Q(a, b, c)$ to the planes yz and zx, then equation of plane through the points A, B and O is

(a) $\frac{x}{a}+\frac{y}{b}-\frac{z}{c}=0$ (b) $\frac{x}{a}-\frac{y}{b}+\frac{z}{c}=0$

(c) $\frac{x}{a}-\frac{y}{b}-\frac{z}{c}=0$ (d) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=0$

29. If $a=\vec{a}=\hat{i}+\hat{j}-2\hat{k}, \vec{b}=2\hat{i}-\hat{j}+\hat{k}$ and $\vec{c}=3\hat{i}-\hat{k}$ and $\vec{c}=m\vec{a}+n\vec{b}$, then $m+n$ is equal to

(a) 0 (b) 1 (c) 2 (d) –1

30. $\int_0^{\frac{\pi}{2}}\left(\frac{\sqrt[n]{\sec x}}{\sqrt[n]{\sec x}+\sqrt[n]{\operatorname{cosec} x}}\right)dx$ is equal to

(a) $\frac{\pi}{2}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{4}$ (d) $\frac{\pi}{6}$

31. If the probability density function of a random variable X is given as

x_1	–2	–1	0	1	2
$P(X=x_1$	0.2	0.3	0.15	0.25	0.1

then $F(0)$ is equal to

(a) $P(X<0)$ (b) $P(X>0)$
(c) $1-P(X>0)$ (d) $1-(X<0)$

32. The particular solution of the differential equation $y(1+\log x)\frac{dx}{dy}-x\log x=0$, when, $x=e, y=e^2$ is

(a) $y=ex\log x$ (b) $ey=x\log x$
(c) $xy=e\log x$ (d) $y\log x=ex$

33. M and N are the mid-points of the diagonals AC and BD respectively of quadrilateral $ABCD$, then AB + AD + CB + CD is equal to

(a) 2 MN (b) 2 NM (c) 4 MN (d) 4 NM

34. If $\sin x$ is the integrating factor (IF) of the linear differential equation $\frac{dy}{dx}+Py=Q$ then P is

(a) $\log\sin x$ (b) $\cos x$
(c) $\tan x$ (d) $\cot x$

35. Which of the following equation does not represent a pair of lines?

(a) $x^2-x=0$ (b) $xy-x=0$
(c) $y^2-x+1=0$ (d) $xy+x+y+1=0$

36. Probability of guessing correctly atleast 7 out of 10 answers in a 'True' or 'False' test is equal to

(a) $\frac{11}{64}$ (b) $\frac{11}{32}$ (c) $\frac{11}{16}$ (d) $\frac{27}{32}$

37. Principal solutions at the equation $\sin 2x+\cos 2x=0$, where $\pi<x<2\pi$ are

(a) $\frac{7\pi}{9},\frac{11\pi}{8}$ (b) $\frac{9\pi}{8},\frac{13\pi}{8}$

(c) $\frac{11\pi}{8},\frac{15\pi}{8}$ (d) $\frac{15\pi}{8},\frac{19\pi}{8}$

38. It line joining points A and B having position vectors $6a - 4b + 4c$ and $-4c$ respectively and the line joining the points C and D having position vectors $-$ a $-$ 2b $-$ 3 c and a + 2b $-$ 5c intersect, then point of intersection is

(a) B (b) C (c) D (d) A

39. If $A=\begin{bmatrix}2 & 2\\ -3 & 2\end{bmatrix}, B\begin{bmatrix}0 & -1\\ 1 & 0\end{bmatrix}$, then $(B^{-1}A^{-1})^{-1}$ is equal to

(a) $\begin{bmatrix}2 & -2\\ 2 & 3\end{bmatrix}$ (b) $\begin{bmatrix}2 & 2\\ -2 & 3\end{bmatrix}$

(c) $\begin{bmatrix}2 & -3\\ 2 & 2\end{bmatrix}$ (d) $\begin{bmatrix}1 & -1\\ -2 & 3\end{bmatrix}$

40. If p : Every square is a rectangle. q : Every rhombus is a kite, then truth values of $p \to q$ and $p \leftrightarrow q$ are___and ___respectively.

(a) F, F (b) T, F (c) F, T (d) T, T

41. If $G(\mathbf{g})$, $H(\mathbf{h})$ and $(\mathbf{p})$ are centroid orthocentre and circumcentre of a triangle and $xp + yh + zg = 0$, then (x, y, z) is equal to

(a) 1, 1, –2 (b) 2, 1, –3
(c) 1, 3, –4 (d) 2, 3, –5

42. Which of the following quantified statement is true?

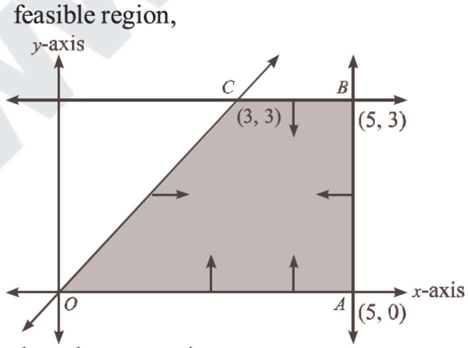
(a) The square of every real number is positive
(b) There exists a real number, whose square is negative
(c) There exists a real number, whose square is not positive
(d) Every real number is rational

43. The general solution of the equation $\tan^2 x = 1$ is

(a) $n\pi + \frac{\pi}{4}$ (b) $n\pi - \frac{\pi}{4}$

(c) $n\pi \pm \frac{\pi}{4}$ (d) $2n\pi \pm \frac{\pi}{4}$

44. The shaded part of given figure indicates in feasible region,



then the constraints are

(a) $x, y \geq 0, x + y \geq 0, x \geq 5, y \leq 3$
(b) $x, y \geq 0, x - y \geq 0, x \leq 5, y \leq 3$
(c) $x, y \geq 0, x - y \geq 0, x \leq 5, y \geq 3$
(d) $x, y \geq 0, x - y \leq 0, x \leq 5, y \leq 3$

45. Direction ratios of the line which is perpendicular to the lines with direction ratios –1, 2, 2 and 0, 2, 1 are

(a) 1, 1, 2 (b) 2, –1, 2
(c) –2, 1, 2 (d) 2, 1, –2

46. If matrix $A = \begin{bmatrix}1 & 2\\ 4 & 3\end{bmatrix}$, such that $AX = I$, then X is equal to

(a) $\frac{1}{5}\begin{bmatrix}1 & 3\\ 2 & -1\end{bmatrix}$ (b) $\frac{1}{5}\begin{bmatrix}4 & 2\\ 4 & -1\end{bmatrix}$

(c) $\frac{1}{5}\begin{bmatrix}-3 & 2\\ 4 & -1\end{bmatrix}$ (d) $\frac{1}{5}\begin{bmatrix}-1 & 2\\ -1 & 4\end{bmatrix}$

47. If $\vec{a} = \hat{i} - \hat{j} + \hat{k}, \vec{b} = 2\hat{i} + \lambda\hat{j} + \hat{k}, \vec{c} = \hat{i} - \hat{j} + 4\hat{k}$ and $\vec{a} \cdot \left(\vec{b} \times \vec{c}\right) = 10$, then λ is equal to

(a) 6 (b) 7 (c) 9 (d) 10

48. If random variable $x \sim b\left(n = 5, P = \frac{1}{3}\right)$, then $P(2 < X < 4)$ is equal to

(a) $\frac{80}{243}$ (b) $\frac{40}{243}$ (c) $\frac{40}{343}$ (d) $\frac{80}{343}$

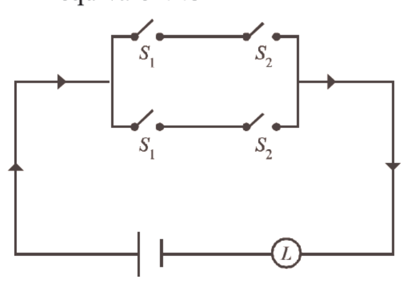
49. The objective function Z = $x_1 + x_2$, subject to the constraints are

$x_1 + x_2 \leq 10, -2x_1 + 3x_2 \leq 15, x_1 \leq 6, x_1, x_2 \geq 0,$

has maximum value ________________ of the feasible region.

(a) at only one point
(b) at only two points
(c) at every point of the segment joining two points
(d) at every point of the line joining two points equivalent to

50.



Symbolic form of the given switching circuit is equivalent to:

(a) $p \vee \sim q$ (b) $p \wedge \sim q$
(c) $p \leftrightarrow q$ (d) None of these

ANSWER KEYS & SOLUTIONS

(MHT-CET 2016)

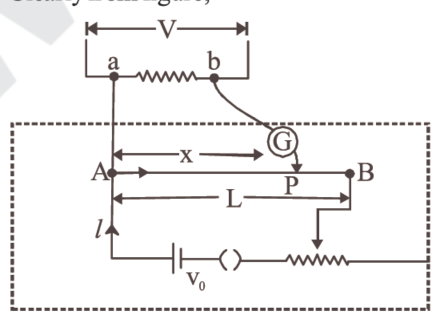
Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(a)	**11**	(b)	**16**	(a)	**21**	(c)	**26**	(a)	**31**	(c)	**36**	(b)	**41**	(a)	**46**	(a)
2	(c)	**7**	(a)	**12**	(c)	**17**	(b)	**22**	(b)	**27**	(d)	**32**	(b)	**37**	(d)	**42**	(c)	**47**	(b)
3	(b)	**8**	(a)	**13**	(a)	**18**	(a)	**23**	(c)	**28**	(b)	**33**	(c)	**38**	(c)	**43**	(d)	**48**	(a)
4	(c)	**9**	(d)	**14**	(b)	**19**	(a)	**24**	(c)	**29**	(a)	**34**	(c)	**39**	(a)	**44**	(a)	**49**	(c)
5	(c)	**10**	(a)	**15**	(c)	**20**	(c)	**25**	(d)	**30**	(b)	**35**	(a)	**40**	(d)	**45**	(b)	**50**	(b)
CHEMISTRY																			
51	(c)	**56**	(b)	**61**	(a)	**66**	(a)	**71**	(a)	**76**	(d)	**81**	(d)	**86**	(a)	**91**	(a)	**96**	(b)
52	(a)	**57**	(d)	**62**	(a)	**67**	(c)	**72**	(a)	**77**	(d)	**82**	(d)	**87**	(c)	**92**	(a)	**97**	(b)
53	(a)	**58**	(d)	**63**	(d)	**68**	(b)	**73**	(d)	**78**	(c)	**83**	(d)	**88**	(b)	**93**	(d)	**98**	(b)
54	(c)	**59**	(d)	**64**	(d)	**69**	(c)	**74**	(d)	**79**	(d)	**84**	(a)	**89**	(b)	**94**	(a)	**99**	(d)
55	(a)	**60**	(a)	**65**	(b)	**70**	(c)	**75**	(d)	**80**	(d)	**85**	(d)	**90**	(c)	**95**	(b)	**100**	(a)
SECTION-B																			
MATHEMATICS																			
1	(b)	**6**	(c)	**11**	(b)	**16**	(a)	**21**	(a)	**26**	(b)	**31**	(c)	**36**	(a)	**41**	(b)	**46**	(c)
2	(d)	**7**	(b)	**12**	(b)	**17**	(c)	**22**	(d)	**27**	(a)	**32**	(a)	**37**	(c)	**42**	(a)	**47**	(a)
3	(b)	**8**	(a)	**13**	(b)	**18**	(b)	**23**	(c)	**28**	(a)	**33**	(c)	**38**	(a)	**43**	(c)	**48**	(b)
4	(b)	**9**	(d)	**14**	(b)	**19**	(b)	**24**	(b)	**29**	(c)	**34**	(d)	**39**	(a)	**44**	(b)	**49**	(c)
5	(b)	**10**	(a)	**15**	(a)	**20**	(c)	**25**	(b)	**30**	(c)	**35**	(c)	**40**	(a)	**45**	(b)	**50**	(d)

SECTION-A

PHYSICS

1. (a) Clearly from figure,



Balancing length x

$$\frac{x}{L} = \frac{V}{V_0} \Rightarrow x = \frac{V \times L}{V_0}$$

here, V_0 = potential difference across potentiometer wire

V = potential to be measured

L = length of the potentiometer wire

$\because x \propto L$

$\therefore$ if length of potentiometer wire is increased the balancing length will also increases.

2. (c) Given, B_0 = magnetic field after insertion of iron rod - 2000 Am^{-1}

Magnetic flux, $\phi = 6 \times 10^{-4}$Wb

Area of cross-section, $A = 3\ cm^2 = 3 \times 10^{-4} m$
magnetic permeability of the rod,

$$\mu_r = \frac{B}{B_0} = \frac{\phi}{A \times B_0} [\because \phi = BA]$$

So, $\mu_r = \dfrac{B}{2000 Am^{-1}}$

$$\therefore \mu_r = \frac{6 \times 10^{-4} Wb}{3 \times 10^{-4} m^2} \times \frac{1}{2000 Am^{-1}}$$
$= 10^{-3} WbA^{-1}m^{-1}$

3. **(b)** From question, peak value of current

$$l_0 = \sqrt{2} \times l_{rms} = \frac{2}{\pi} A$$

Coefficient of mutual inductance M = 1 H
Induced emf in secondary coil

$$E_s = M.\frac{dl}{dt} \qquad [\because l = l_0 \sin \omega t]$$

$\Rightarrow E_s = M\, \omega l_0 \cos(\omega t)$

$$= 1 \times 2\pi \times 50 \times \frac{2}{\pi} \cos(2\pi \times 50 \times t)$$
$$(\because \omega = 2\pi n)$$

For t = 0, $E_s = 2\pi \times 50 \times \dfrac{2}{\pi} = 200V$

4. **(c)** From de-Broglie relation,

$$\lambda = \frac{h}{p} \Rightarrow \lambda = \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{2mqV}}$$

$$\Rightarrow \lambda \propto \frac{1}{\sqrt{qVm}}$$

For electron $\lambda_e \propto \dfrac{1}{\sqrt{eVm}}$ ...(i)

For proton, $\lambda_p = \dfrac{1}{\sqrt{e9VM}}$ ...(ii)

where, e is the charge on proton, potential difference = 9V and Mass of proton = m
From eqs. (i) and (ii)

$$\frac{\lambda_e}{\lambda_p} = \sqrt{\frac{9VMe}{eVm}} \Rightarrow \lambda_p = \frac{\lambda_e}{3}\sqrt{\frac{m}{M}}$$

5. **(c)** Resultant intensity of interferring wave at 'P'

$$I_p = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$$

For $\phi = \dfrac{\pi}{2}, I_p = I + 9I = 10I$

Again resultant intensity at 'Q'

$$I_Q = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$$

For $\phi = \pi, I_Q = I + 9I + (-2\sqrt{9(1)^2})$
$= 10I - 6I = 4I$
$\therefore$ Difference between the resultant intensity

$$\Delta I = I_P - I_Q = 10I - 4I = 6I$$

6. **(a)** According to Brewster's law, $\tan i_p = \mu$
Clearly, Polarising angle depends on wavelength and wavelength is different for different colours of light.

7. **(a)** Force acting on the particle inside magnetic field
$F_B = qvB \sin\theta$
This force F_B provides necessary centripetal force $\dfrac{mv^2}{r}$ for circular motion of the charged particle

$$\therefore \frac{mv^2}{r} = qvB \sin\theta$$

Now, for particles x and y and for $\theta = 90^o$

$$\frac{m_x v_x^2}{r_1} = qv_x B \qquad ...(i)$$

$$\frac{m_y v_y^2}{r_2} = qv_y B \qquad ...(ii)$$

From eqs. (i) and (ii)

$$\frac{m_x v_x}{m_y v_y} = \frac{r_1}{r_2} \Rightarrow \frac{m_x}{m_y} = \frac{r_1}{r_2} \left[\because \frac{v_x}{v_y} = 1\right]$$

8. **(a)** As per Bohr's quantisation principle, an electron revolving in a stationary orbit which has fixed energy, will not radiate light. Change in velocity, due to change in direction of electron revolving in stationary orbit.

9. **(d)** Magnetic field inside the solenoid $B = \mu_0 nI$
According to question, change in magnetic field due to insertion of iron core
$B' = \mu B$
$= \mu_0(1+\chi)B \qquad [\therefore \mu = \mu_0(1+\chi)]$
$\therefore B' = \mu_0(1+\chi)nI$

10. **(a)** For potentiometer,

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} = \frac{2}{3}\left(\because \frac{l_1}{l_2} = \frac{2}{3}\right)$$

$$\frac{x}{6} = \frac{2}{3} \Rightarrow x = 4\Omega m^{-1}$$

Total resistance = 6 + 4 = 10Ω
Resistance of wire 0.1 × 100 = 10Ω

$\therefore \frac{1}{R_{eff}} = \frac{1}{10} + \frac{1}{10} \Rightarrow R_{eff} = 5\Omega$

Current drawn from the battery

$I = \frac{V}{R} = \frac{5}{5} = 1A$

11. **(b)** As we know, capacitance of parallel plate capacitor $C = \frac{\varepsilon_0 A}{d}$

$\therefore$ Capacitance for

first capacitor, $C_1 = \frac{\varepsilon_0 A}{3d}$

second capacitor, $C_2 = \frac{\varepsilon_0 A}{6d}$

third capacitor, $C_3 = \frac{\varepsilon_0 A}{9d}$

Equivalent capacitance of capacitors C_1, C_2 and C_3 arranged in parallel,

$C_{eq} = C_1 + C_2 + C_3$

$= \frac{\varepsilon_0 A}{d}\left(\frac{1}{3} + \frac{1}{6} + \frac{1}{9}\right) = \frac{\varepsilon_0 A}{d} \times \frac{11}{18} = \frac{11\varepsilon_0 A}{18d}$

12. **(c)** According to Barkhausen criterion if A is the gain of the amplifying element in the circuit and B is the transfer function of the feedback path, then condition of sustained oscillation is $|\beta A| = 1$

13. **(a)** According to Einstein's photoelectric equation, $\frac{hc}{\lambda} = \phi + E$

Here

E = kinetic energy

ϕ = work function

If E is constant, then $\frac{1}{\lambda} \propto \phi$

$\therefore$ If wavelength λ is decreased, then stopping potential ϕ will increase such that $\frac{hc}{\lambda} - \phi = \text{constant}$

14. **(b)** As given in the question, at glass-air interface velocity is reduced by 20% of the velocity of light.

So, deviation δ will be = 20% of i

$= \frac{20 \times i}{100} = \frac{i}{5}$

15. **(c)** The maximum frequency of radio waves which when sent towards the layer of ionosphere gets reflected back by the ionosphare is given by $g\sqrt{N}$.

16. **(a)** The fundamental frequency of vibrating wire is given by

$f_1 = \frac{1}{2}\sqrt{\frac{T}{\mu}}$

Here, μ = mass of string per unit length.

T = tension in the wire

Let x be the frequency of tunning fork according to question

$(x - f) = \pm 6$

$\therefore f_1 = \frac{1}{2L}\sqrt{\frac{225}{\mu}}$ and $f_2 = \frac{1}{2L}\sqrt{\frac{256}{\mu}}$

$\therefore \frac{f_1}{f_2} = \frac{15}{16} \Rightarrow f_2 = \frac{16}{15} \times f_1$

$\Rightarrow f_2 = \frac{16}{15}(6 + x)$

Equating the two cases of f_1, we have

$(x + 6) = \frac{16}{15}(x - 6)$

$\therefore 15x + 90 = 16x - 96$

$\therefore x = 186\,Hz$

17. **(b)** As per kinetic theory of gases, the pressure exerted by the gas on the walls of container (p) is given by

$p = p_0 + p_1 + p_2$

i.e. $p = p_0 + \frac{1}{3}8v^2 + 3gh$

For a container,

$p_1 = \frac{1}{3}\rho v^2 = \frac{1}{3}\frac{m}{v}.v^2 \times \frac{2}{2} = \frac{2}{3}.\frac{1}{2}mv^2.\frac{1}{v}$

$= \frac{2}{3v}KE \qquad \left[\because KE = \frac{1}{2}mv^2\right]$

18. **(a)** For a given oscillating mass, potential energy is given by

$PE = \frac{1}{2}kx^2$

For a body oscillating at x = A, maximum energy is given by

$E_{max} = \frac{1}{2}kA^2$

Also at mean position x = 0.

So, E = 0

$\therefore \quad A \propto \frac{1}{\sqrt{m}} \qquad ...(i)$

When another mass m_2 is placed on mass m_1. Then, total mass becomes $(m_1 + m_2)$ and at this point E = 0 as x = 0.
When they reach at x = A,

$$A_1 \propto \frac{1}{\sqrt{m_1 + m_2}} \quad ...(ii)$$

Dividing eq. (ii) by eq. (i),

$$\frac{A_1}{A} = \left(\frac{m_1}{m_1 + m_2}\right)^{\frac{1}{2}}$$

19. (a) Using third equation of motion,
$v^2 = u^2 + 2as$ ...(i)
We have given
Initial velocity, u = 0
$S = 2 \times 2\pi r = 4\pi r$

So, $v^2 = 2a \times 4\pi r \Rightarrow a = \frac{V^2}{8\pi r}$ (using (i))

20. (c) The velocity of wave travelling on string (v) is given by

$$v = n\lambda = \frac{\lambda}{2L}\sqrt{\frac{T}{\mu}} \quad \left(\because n = \frac{1}{2L}\sqrt{\frac{T}{\mu}}\right)$$

Here, μ = mass per unit length

$$\therefore v = \sqrt{\frac{T}{m/l}} \Rightarrow v = \sqrt{\frac{Tl}{m}}$$

Young's modulus (Y) is given by,

$$Y = \frac{T \times l}{A\Delta L}$$

$$\therefore T \times l = YA\,\Delta L$$

$$\therefore V \propto \sqrt{A} \quad (A = \text{Area})$$

The radius of the string A is 2r and string B is r.

$$\therefore \frac{v_A}{v_B} = \sqrt{\frac{4r^2}{r^2}} = \sqrt{4} = 2$$

[$\because$ Y is same for both the strings.]

21. (c) The initial phase (ϕ) of a pendulum during damped oscillation remains unchanged.

22. (b) The relation between end correction $(\Delta\ell)$ and inner radius of the organ pipe (r) is given by
$\Delta l = 1.2 \times r$

$$\therefore r = \frac{\Delta l}{1.2} = \frac{0.8}{1.2} \quad [\because \Delta l = 0.8]$$

$$= \frac{2}{3} \text{ cm}$$

23. (c) We have given $y = 12\sin(5t - 4x)$ cm
Comparing this equation with standard equation of progressive wave, $y = A\sin(\omega t - kx)$
we get A = 12
$\omega = 5$
$\Rightarrow k = 4$

Here, $(\omega t - kx)$ is phase difference $= \frac{\pi}{2}$

$\therefore 5t - 4x = \frac{\pi}{2}$ When t = 0, $4x = \frac{\pi}{2}$

$\therefore x = \frac{\pi}{8}$ cm

24. (c)

Let P be the point where gravitational field is zero so,

$$\frac{Gm}{x^2} = \frac{G9m}{(r-x)^2} \Rightarrow \frac{1}{x^2} = \frac{9}{(r-x)^2}$$

$$\Rightarrow \sqrt{(r-x)^2} = \sqrt{9x^2} \Rightarrow r - x = 3x$$

$$\Rightarrow x = \frac{r}{4}$$

Now, gravitational potential at this point is

$$-\left(\frac{4Gm}{r} + \frac{G\,9m \times 4}{3r}\right) \quad \left[r - x = \frac{3r}{4}\right]$$

$$\Rightarrow -\left(\frac{4Gm + 12Gm}{r}\right) \Rightarrow -\left(\frac{16\,Gm}{r}\right)$$

25. (d) According to Stefan's Boltzmann law,

$$E = e\sigma A\left(T^4 - T_0^4\right)$$

When l and b are changed to $\frac{l}{3}$ and $\frac{b}{3}$, respectively.
Area becomes

$$\frac{l}{3} \times \frac{b}{3} = \frac{lb}{3} = \frac{A}{9} \quad (\because A = lb)$$

Now for two different cases

$$\frac{E'}{E} = \frac{A'}{A}\frac{(227 + 373)^4}{(27 + 273)^4} = \frac{1}{9}\left(\frac{600}{300}\right)^4$$

$$\therefore E' = \frac{1}{9} \times (2)^4 \times E \Rightarrow E' = \frac{16E}{9}$$

26. (a) We have given

$$\frac{R}{C_v} = 0.4 \quad ...(i)$$

Here, R = universal gas constant

C_v = molar specific heat at constant volume

We know that, $C_p - C_v = R$

$\therefore \dfrac{C_p - C_v}{C_v} = 0.4 \Rightarrow \dfrac{C_p}{C_v} = 0.4 + 1 = 1.4$

i.e. $\gamma = 1.4$

The gas is diatomic in nature.

27. (d) We know in vertical circle velocity of a particle at lowest point, $v_l = \sqrt{5gr}$

velocity of particle at highest point, $v_h = \sqrt{rg}$

So, KE at highest point of the vertical circle

$K_h = \dfrac{1}{2} m\, rg = \dfrac{mgr}{2}$

and KE at lowest point of the vertical circle

$(K_l) = \dfrac{1}{2} m\, 5gr = \dfrac{5mgr}{2}$

So, required ratio $\dfrac{K_h}{K_l} = \dfrac{\frac{mgr}{2}}{\frac{5mgr}{2}} = \dfrac{1}{5} = 0.2$

28. (b) Energy per unit volume in string is given by

$\dfrac{1}{2} \times \text{stress} \times \text{strain}$

i.e. $\dfrac{U}{V} = \dfrac{1}{2} \times \dfrac{F}{A} \times \dfrac{\Delta l}{l}$

$= \dfrac{1}{2} \times Y \times (\text{strain})^2$

$\therefore \quad \dfrac{U_S}{S_L} = \dfrac{Y_S}{Y_L} \times \left(\dfrac{\text{Stress}(S)}{\text{Strain}(L)}\right)^2$

$= \dfrac{A_L}{A_S} = \left(\dfrac{l}{l}\right)^2 \Rightarrow \dfrac{r_L^2}{r_S^2} = \dfrac{3^2}{1^2} = 9 : 1$

29. (a) For a rolling disc or ring kinetic energy is given by $KE = \dfrac{1}{2} mv^2 + \dfrac{1}{2} I\omega^2$

The ring and disc will have same translational kinetic energy, i.e. $\dfrac{1}{2} mv^2$

Rotational kinetic energy of the disc

$= \dfrac{1}{4} mR^2 \omega^2$

Rotational kinetic energy of ring

$= \dfrac{1}{2} mR^2 \omega^2$

As for ring, $4\,J = \dfrac{1}{2} mv^2 + \dfrac{1}{2} mR^2 \omega^2$

$(\because I = mR^2)$

For disc, $\dfrac{1}{2} mR^2 \omega^2 + \dfrac{1}{4} mR^2 \omega^2 = \left(\dfrac{4}{2} + \dfrac{4}{4}\right) J = 3J$

30. (b) We have given $\dfrac{f_1}{f_2} = 2$

f_1 = apparent frequency heard by the listener when velocity v_1 is towards the observer.

f_2 = apparent frequency heard by the listener when velocity v_1 is away from the observer.

Now, the apparent frequency of sound heard by the listener when observer is moving towards the source is given by

$$f_1 = \left(\frac{V}{V - V_1}\right) f_0 \qquad \text{...(i)}$$

Similarly when observer is moving away from the source, apparent frequency heard by the listener is given by

$$f_2 = \left(\frac{V}{V + V_1}\right) f_0$$

From eqs. (i) and (ii), we get

$$\frac{f_1}{f_2} = \frac{\left(\frac{V}{V - V_1}\right) f_0}{\left(\frac{V}{V + V_1}\right) f_0} = \frac{V + V_1}{V - V_1} \qquad \text{...(ii)}$$

$$\Rightarrow \frac{V + V_1}{V - V_1} = 2 \Rightarrow 2V - 2V_1 = V + V_1$$

$$\Rightarrow V = 3V_1 \Rightarrow \frac{V}{V_1} = 3$$

31. (c) Surface area of the liquid drop $A = 4\pi R^2$

Let E be the surface energy of liquid drop.

When the drop splits into 512 droplets, the surface area becomes

$A_2 = 512 \times 4\pi r^2$ [r = radius of smaller drop]

Comparing the volumes of bigger and all smaller droplets, we get

i.e. $\dfrac{4}{3} \pi R^3 = 512 \times \dfrac{4}{3} \pi r^3 \Rightarrow r = \dfrac{R}{8}$

Total area of smaller droplets is

$A_1 = 512 \times 4 \times \pi \times \left(\dfrac{R}{8}\right)^2 = 8A$

Change in surface area $A_2 - A_1$

$$= 4\pi\left(\frac{512 \times R^2}{64} - R^2\right)$$

$$= 4\pi\left(8R^2 - R^2\right) = 7R^2$$

Surface energy, E = AT [A = area, T = tension]

So, $\frac{E_n}{E_0} = \frac{A_1 \times T}{A \times T} = \frac{8A}{A} = 8$

$\therefore$ $E_n = 8E$

32. **(b)** Moment of inertia of a thin rod whose axis is passing through its middle point and perpendicular to its length is given by

$$I = \frac{ML^2}{12} \quad ...(i)$$

In terms of radius of gyration, it can be written as

$$I = MK_1^2 \quad ...(ii)$$

Comparing equation (i) and (ii), we get

$$MK_1^2 = \frac{ML^2}{12}$$

$$\Rightarrow \quad K_1 = \frac{L}{2\sqrt{3}} \quad ...(iii)$$

Moment of inertia of rod whose axis is passing through one of its end is given by

$$I = \frac{ML^2}{3} \quad ...(iv)$$

In terms of radius of gyration, it can be written as

$$I = MK_2^2 \quad ...(v)$$

Comparing equation (iv) and (v), we get

$$\frac{ML^2}{3} = MK_2^2$$

$$K_2 = \frac{L}{\sqrt{3}} \quad ...(vi)$$

Again taking the ratio of K_1 and K_2 from Eqs. (iii) and (vi),

We get $\frac{K_1}{K_2} = \frac{L \times \sqrt{3}}{2\sqrt{3} \times L} = \frac{1}{2}$

33. **(c)** Potential energy of pendulum, when bob is at rest, is given by

(PE) = mgl

When bob is displaced by small angular displacement θ, the pendulum will lose PE of bob which gets converted into kinetic energy (KE). So, from conservation of energy

Loss in PE = gain in KE

$\therefore$ KE = $mgl - mgl\cos\theta = mgl(1 - \cos\theta)$

34. **(c)** Total displacement of hour hand of a clock

$\theta = 2\pi = 360°$ ($\because \pi = 180°$)

Time required for this displacement,

t = 12 × 3600 s

So, angular speed, $\omega = \frac{\theta}{t} = \frac{360}{12 \times 3600} = \frac{1}{120}$ degree/s

35. **(a)** The value of acceleration due to gravity g at a height h is given by

$$g' = g\left(\frac{R_e}{R_e + h}\right)^2$$

Here, Re = radius of earth

g = acceleration due to gravity at earth surface.

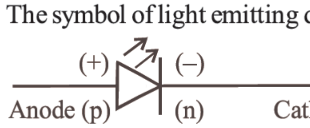
$$g' = \frac{g}{4} \text{ and } R_e = R$$

So, $\frac{g}{4} = g\left(\frac{R}{R+h}\right)^2$

$$\frac{1}{2} = \frac{R}{R+h}$$

$$\Rightarrow \quad 2R = R + h \quad \Rightarrow \quad R = h$$

36. **(b)** The symbol of light emitting diode (LED) is



37. **(d)** Work done in increasing the voltage from V_1 to V_2 is given by

$$= \frac{1}{2}C\left(V_2^2 - V_1^2\right)$$

putting the values, we get

$$= \frac{1}{2} \times C \times (10^2 - 5^2)$$

$$W = \frac{1}{2} \times C \times 75 = \frac{75C}{2} \quad ...(i)$$

Again work done when the plate voltage is increased from 10 V to 15 V is given by

$$W_1 = \frac{1}{2} \times C \times (15^2 - 10^2)$$

$$\Rightarrow \quad W_1 = \frac{1}{2} \times C \times 125 = \frac{125C}{2} \quad ...(ii)$$

Using eqs. (i) and (ii), we get

$$\frac{W}{W_1} = \frac{75C}{2 \times 125C} \times 2 \quad \Rightarrow \quad \frac{W_1}{W} = \frac{125}{75} = \frac{5}{3}$$

$$\Rightarrow W_1 = 1.67\,W$$

38. **(c)** We have given,
Initial flux $(\phi_1) = 4 \times 10^{-4}$ Wb

Final flux $(\phi_2) = \dfrac{4\times10^{-4}\times10}{100}$
$= 4 \times 10^{-5}$ Wb

Emf induced (e) is given by

$$e=\left|-\frac{d\phi}{dt}\right|$$

$$\Rightarrow\ 0.72\times10^{-3}=\frac{4\times10^{-4}-4\times10^{-5}}{t}$$

$$\Rightarrow\ t=\frac{4\times10^{-5}\times9}{72\times10^{-5}}=\frac{1}{2}=0.5\,s$$

39. **(a)** Resolving power of a telescope is given by

$$RP=\frac{d}{1.22\lambda}$$

As $RP\propto\dfrac{1}{\lambda}$

$\therefore$ On decreasing the wavelength of light, resolving power of a telescope increases.

40. **(d)** According to Einstein's photoelectric equation

$$\frac{hc}{\lambda}-\phi=eV$$

For wavelength λ, stopping potential is V
Now, equation becomes

$$\frac{hc}{\lambda}-\phi=ev \qquad ...(i)$$

For wavelength 3λ, stopping potential is $\dfrac{V}{6}$

Now equation becomes

$$\frac{hc}{3\lambda}-\phi=\frac{eV}{6}$$

$$\Rightarrow\ \frac{2hc}{\lambda}-\phi=ev \qquad ...(ii)$$

Subtracting (i) and (ii)

$$\frac{2hc}{\lambda}=eV+6\phi\Rightarrow\frac{hc}{\lambda}=eV+\phi$$

$$\frac{hc}{\lambda}=5\phi\ \text{ and }\ \phi=\frac{hc}{\lambda_0}$$

Thus, we get $\lambda_0=5\lambda$

41. **(a)** Time period of simple pendulum in water (T) is given by

$$T=2\pi\sqrt{\frac{l}{g_{eff}}}$$

[g_{eff} = acceleration due to gravity in water]
Effective value of acceleration due to gravity when bob is immersed in water, is given by

As we know, $g_{eff}=g\left(\dfrac{\sigma-\rho}{\sigma}\right)$

[Here, σ = density of bob, ρ = density of water]

$$=9.8\left(\frac{\frac{9}{8}\times10^3-10^3}{\frac{9}{8}\times10^3}\right)$$

$$=9.8\left(\frac{\frac{9}{8}-1}{\frac{9}{8}}\right)=9.8\left(\frac{1}{8}\times\frac{8}{9}\right)=\frac{9.8}{9}$$

So, $T_1=2\pi\sqrt{\dfrac{l\times9}{9.8}}\ \Rightarrow\ T_1=3T \qquad \left[\because T=2\pi\sqrt{\dfrac{\ell}{g}}\right]$

42. **(c)** Rise of water in the capillary tube (h) is given by

$$h=\frac{2T\cos\theta}{\rho g(R-r)}$$

In the given case,
$\cos\theta = 1$ as $\theta = 0°$

$$\therefore\ h=\frac{2T}{\rho g(R-r)}$$

43. **(d)** Fundamental frequency of organ pipe (f_0) is given by

$$f_0=\frac{V_0}{2l}$$

For 2nd overtone, $\dfrac{3}{2}f_0=\dfrac{3V_0}{2l}$

For a closed organ pipe, fundamental frequency is $f=\dfrac{V_0}{4l}$. Third overtone of closed organ pipe at one end is

$$f_3=\frac{7}{4}\frac{V_0}{l}$$

We have given, $\dfrac{7V_0}{4l}-\dfrac{3V_0}{2l}=150$

$$\Rightarrow\ \left(\frac{7}{4}-\frac{6}{4}\right)\frac{V_0}{l}=150$$

$$\Rightarrow\ \frac{V_0}{4l}=150\ \Rightarrow\ \frac{V_0}{2l}=300\,Hz$$

44. **(a)** M.O.I. of disc $I=\frac{MR^2}{2}$

When the disc is melted into solid sphere, then volume remains same.

$\therefore$ Volume of disc = Volume of solid sphere

$$\pi R^2\times\frac{R}{6}=\frac{4}{3}\pi r^3$$

$$\Rightarrow\ r^3=\frac{R^3}{8}\ \Rightarrow\ r=\frac{R}{2}$$

M.O.I. of solid sphere $\frac{2}{5}mr^2$.

$$=\frac{2}{5}\times m\times\frac{R^2}{4}=\frac{mR^2}{10}=\frac{I}{5}$$

[I = moment of inertia of disc = $\frac{MR^2}{2}$]

45. **(b)** The sag of bending of beam of length l loaded at free end by weight W is given by

$$\delta=\frac{WL^3}{48YI}$$

I = Moment of inertia of steel bar $=\frac{bd^3}{12}$

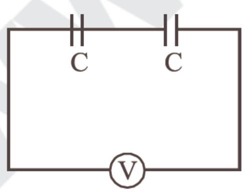
So, $\delta=\frac{WI^3}{48Ybd^3}\times 12=\frac{WI^3}{4Ybd^3}$

46. **(a)** According to Bohr's theory, the wavelength of radiation emitted is given by

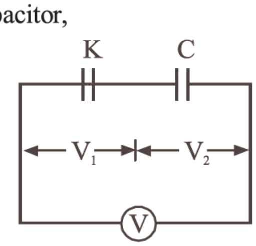
$$\frac{1}{\lambda}=R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$$

As the energy difference $\Delta E = E_5 - E_4$ is very small, so minimum wavelength will take place for transition of electron from n = 5 to $p = 4$.

47. **(b)** When dieletric is not inserted:-



When dielectric is inserted in one of the capacitor,



Given $V_1 + V_2 = V$

The capacitance of first capacitor becomes kC, so by charge conservation,

$(kC)V_1 = C\,V_2$ ...(ii)

$$\frac{V_1}{V_2}=\frac{1}{K}\Rightarrow\frac{V_1+V_2}{V_2}=\frac{1+K}{K}$$

$$\Rightarrow\ V_2=\left(\frac{KV}{1+K}\right)\qquad(\because V_1+V_2=V)$$

48. **(a)** For parallel resonance L-C circuit, the capacitive reaction is equal to inductive reactance.

The total impedance of the circuit increases to infinity means the circuit draws no current from the AC power source.

49. **(c)** Total current through the galvanometer is given by

$$I=\frac{V}{R_{eff}}=\frac{2}{1970+30}=\frac{2}{2000}$$

$$=10^{-3}A$$

As this current provides full scale deflection (i.e. 20 div).

To get the deflection of 10 divisions, value of resistance needed to connect can be obtained as

$$\theta=\frac{nI\,AB}{K}(\text{i.e.}\ \theta\propto I)$$

$$\Rightarrow\ \frac{\theta_1}{\theta_2}=\frac{I_1}{I_2}=2$$

$$\Rightarrow\ I_2=\frac{I_1}{2}=\frac{10^{-3}}{2}=5\times10^{-4}\,A$$

Now, $I=\frac{V}{R_{eff}+R_5}$

$$\Rightarrow\ R_5=\frac{V}{I}-R_{eff}=\frac{2}{5\times10^{-4}}-2000$$

$=4\times10^3-2000=2000\Omega$

So, the resistance of 1970 Ω is to be replaced by 1970 + 2000 = 3970 Ω.

50. **(b)** As $\Delta x=\frac{\lambda\delta}{2\pi}$

[Where, Δx = path difference]

For 4th dark fringe,

$$\delta=(2n+1)\pi$$

$$\Rightarrow\ \delta=(2\times4+1)\pi=9\pi$$

$$\Delta x=\frac{\lambda.9\pi}{2\pi}=\frac{9}{2}\lambda=\frac{9}{2}\times6\times10^{-7}$$

$= 2.7\times10^{-6}m = 2.7\times10^{-4}cm$

CHEMISTRY

51. (c) The number of optical isomers depends upon the number of asymmetric centres (n). Possible number of optical isomers of the compound is 2^n.

52. (a) van't Hoff equation is $\pi = \frac{n}{V} RT$

53. (a) Octahedral sulphur (rhombic or α-sulphur) is the most stable allotrope of sulphur.

54. (c) Thermoplastic polymers are the linear or slightly branched polymers in which the intermolecular forces of attraction are intermediate between elastomers and fibres.

55. (a) We require nF to deposit 1 mol or 40 g of Ca.
n = 2 (no. of e^- involved)
$\because$ 10 g Ca is deposited by 0.5 F.

56. (b) Leaching of gold is done with the help of their dissolution in NaCN or KCN or Cu.

57. (d) Paracetamol is an analgesic.

58. (d) When a mixture of n-butyl bromide and ethyl bromide is treated with sodium metal in the presence of dry ether, then ethane cannot be formed because reaction follows Wurtz- Fittig reaction. It is a type of coupling reaction.

$$CH_3CH_2CH_2CH_2Br + CH_3CH_2Br + 2Na \xrightarrow[\text{ether}]{\text{Dry}}$$
$$\underset{\text{Octane}}{C_4H_9-C_4H_9} + \underset{\text{Hexane}}{C_4H_9-C_2H_5} + \underset{\text{Butane}}{C_2H_5-C_2H_5}$$

59. (d) When lanthanoids (Ln) are heated with sulphur, then Ln_2S_3 are formed.

60. (a) Butylated hydroxy anisole is an antioxidant. The conjugated aromatic ring of BHA is able to stabilise free radicals.

61. (a) In the cell represented by
$Pb(s)\,|\,Pb^{2+}\,(1M)\,||\,Ag^+\,(1M)\,|\,Ag(s)$, the reducing agent is Pb because it readily gets oxidised to Pb^{2+}

62. (a)

63. (d) Secondary amines when treated with nitrous acid give yellow oily substance. So, amine 'A' is methylphenyl amine.

64. (d) The acidic oxides are formed by the non-metals (group 14-17) whereas basic oxides are formed by the metals of group 1 and group 2 elements. Ba belongs to group 2.

65. (b) The correct priority order for the groups attached to chiral carbon atom is
$CONH_2 > COCH_3 > CHO > CH_2OH$

66. (a) Bulletproof helmets are made up of lexan.

67. (c) The Mond's process is used for the purification of Ni.

68. (b) Isopropyl methyl ether when treated with cold hydrogen iodide gives isopropyl alcohol and methyl iodide.

$$(CH_3)_2CH-O-CH_3 + HI \longrightarrow (CH_3)_2CH-OH + CH_3I$$

69. (c) The volume occupied by the face centred cubic unit cell $= z_{eff} \times \frac{4}{3}\pi r^3$

$$= 4 \times \frac{4}{3}\pi r^3$$

$$= \frac{16}{3}\pi r^3$$

70. (c) Glucose on oxidation with bromine water yields gluconic acid. This reaction confirms the presence of aldehyde group in glucose.

$$\underset{\text{Glucose}}{\begin{matrix} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{matrix}} + [O] \xrightarrow{Br_2 + H_2O} \underset{\text{Gluconic acid}}{\begin{matrix} COOH \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{matrix}}$$

71. (a) By the action of concentrated sulphuric acid, sodium chromate gets converted into sodium dichromate in the manufacture of potassium dichromate.

72. (a) In a dry cell, zinc acts as a negative electrode.

73. (d) Primary amines on treatment with nitrous acid liberates nitrogen. Ethylamine ($C_2H_5NH_2$) is a primary amine. Hence, liberates nitrogen on treatment with nitrous acid.

$$C_2H_5NH_2 + HNO_2 \xrightarrow{NaNO_2 + HCl}$$

$$\underset{\text{Diazonium chloride}}{C_2H_5-\overset{+}{N} \equiv N\bar{C}l} \xrightarrow{H_2O} C_2H_5OH + N_2\uparrow + HCl$$

74. **(d)** Given, W (mass of solute) = 5.0 g
m (molar mass of solute) = 40 g mol^{-1}
Volume = 100 mL
Molarity is given as,

$$M = \frac{\text{Moles of solute}}{\text{Volume of solution (in L)}}$$

$$M = \frac{W \times 1000}{m \times \text{Volume of solution (in mL)}}$$

$$M = \frac{5.0\,g \times 1000}{40 \times 100} = 1.25\ mol\ dm^{-3}$$

75. **(d)** Acetyl chloride when treated with dibenzyl cadmium yeilds benzyl methyl ketone.

$$\underset{\text{Acetyl Chloride}}{2CH_3-\overset{\overset{\large O}{\|}}{C}-Cl} + \underset{\text{Dibenzyl Cadmium}}{(C_6H_5CH_2)_2Cd} \longrightarrow$$

$$\underset{\text{Benzylmethyl ketone}}{2CH_3-\overset{\overset{\large O}{\|}}{C}-CH_2-C_6H_5} + CdCl_2$$

Here, Ph = Phenyl group

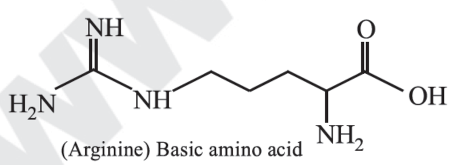
76. **(d)** Magnesium fluoride (MgF_2) has the highest ionic character.

77. **(d)** Cl(g) is the reaction intermediate involved in the formation of NO_2(g) and Cl_2(g).

$$NO_2Cl(g) \xrightarrow{k_1} NO_2(g) + Cl(g)$$

$$NO_2Cl(g) + Cl(g) \xrightarrow{k_2} NO_2(g) + Cl_2(g)$$

78. **(c)** Arginine amino acid is basic in nature.
(Basic due to the presence of 'NH' groups)



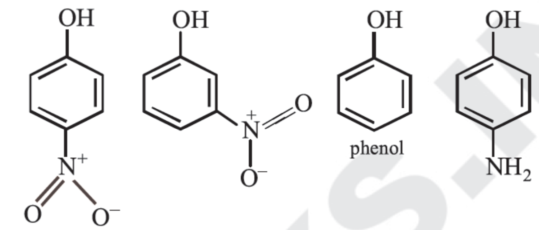
(Arginine) Basic amino acid

79. **(d)** The relationship between solubility of a gas in liquid at constant temperature and external pressure is given by Henry's law.
x ∝ Partial pressure of the gas, p

$$p = K_H x$$

Here, K_H = Henry's law constant
More the value of K_H, lower is the solubility of gas.

80. **(d)** The order for acidity in phenols depends upon the position of electron withdrawing groups. — NH_2 is an electron releasing group. Hence, it decreases the acidity of phenol.
p-nitrophenol > *m*-nitrophenol > phenol > *p*-aminophenol.



(–*I*-effect) (–*R*-effect) para nitro phenol; (Only –*I*-effect) meta nitro phenol; (+*I*-effect) (+*R*-effect) p–amino phenol

81. **(d)** Carbon dioxide is a non-polar solid because the bonds are linear and dipole moment point in opposite directions, cancel out the dipole moments, leaving a net polarity of zero.

$$:\ddot{O} = C = \ddot{O}:$$
$$\longleftarrow\!\!+ \quad +\!\!\longrightarrow (\mu = 0)$$

82. **(d)** For scandium (Z = 21)electronic configuration is $4s^2 3d^1$. After the removal of 3 electrons; (Sc^{3+}), acquires a stable configuration ($4s^0 d^0$).
Hence, it forms colourless compounds.

83. **(d)** The highest oxidation state exhibited by group 17 elements is + 7.

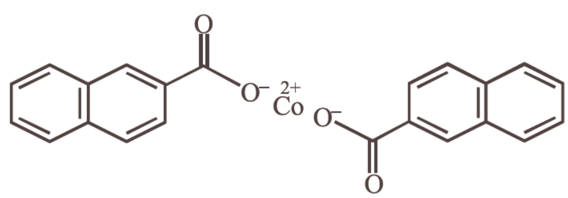
84. **(a)** For an isochoric process, ΔV = 0
In this process, Acc to the first law of thermodynamics

$$q = \Delta U - W$$
$$q = \Delta U - p\Delta V$$

As $\Delta V = 0$

$$q_V = \Delta U$$

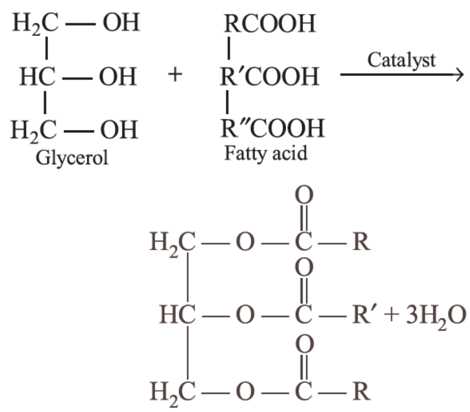
85. **(d)** Cobalt naphthenate is the catalyst used in the commercial method of preparation of phenol.



(Cobalt naphthenate)

86. **(a)** $t_{1/2} = \frac{0.693}{k}$

87. (c) One molecule of glycerol and three molecules of fatty acids combine to from a triglyceride.



Triglyceride

88. (b) The molecular formula of Wilkinson's catalyst is $(Ph_3P)_3\,RhCl$

89. (b) The criterion for a spontaneous process is $\Delta G < 0$.

90. (c) Brown ring test is used for the detection of nitrate radical.

91. (a) The reagent used in the Wolff-Kishner reduction is $NH_2—NH_2$ and KOH in ethylene glycol.

92. (a) $[Pt(NH_3)_2\,Cl_2]$ is a neutral complex. This complex does not have any charge. Thus, is neutral.

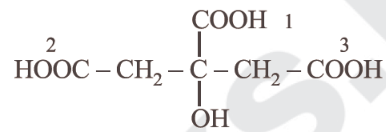
93. (d) As all the compounds have same concentration, i.e. 0.1 M. Thus, the compound that will break into the most parts has highest boiling point.
Glucose (1part, covalent; does not ionise)
Sodium chloride (1 Na, 1 Cl; ionises)
Calcium chloride (1Ca, 2Cl; ionises)
Ferric chloride (1Fe, 3Cl; ionises)

94. (a) Chromyl chloride is used in Etard reaction.

95. (b) Argon is the most abundant noble gas in the atmosphere.

96. (b) Heat capacity is an extensive property.

97. (b) Citric acid is a tricarboxylic acid.


Citric acid

98. (b) For reaction, $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

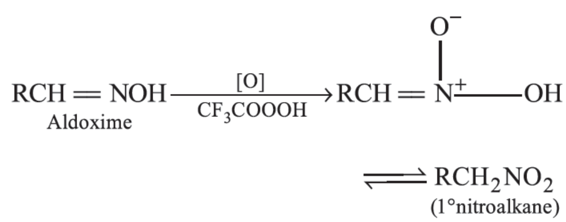
$$-\frac{1}{2}\frac{\Delta[SO_2]}{\Delta t} = \frac{-\Delta[O_2]}{\Delta t} = +\frac{1}{2}\frac{\Delta[SO_3]}{\Delta t}$$

So, average rate of reaction is written as

$$-\frac{\Delta[O_2]}{\Delta t}.$$

99. (d) $0.5CH_4(g) + O_2(g) \rightarrow 0.5CO_2(g) + H_2O(l)$
$\Delta n = 0.5 - 1.5 = -1$
Work done
$= -\Delta nRT = -(-1) \times 8.314 \times 300 = 2494$ J

100. (a) Primary nitroalkanes are obtained in good yield by oxidising aldoximes with the help of trifluoroperoxy acetic acid.



SECTION-B

MATHEMATICS

1. (b) Here, mean $E(X) = 5$
and variance, Var $(X) = 2.5$
$\Rightarrow \quad np = 5$ and $npq = 2.5$

$$\Rightarrow \quad 5q = 2.5 \Rightarrow \quad q = \frac{1}{2}$$

Also, $p + q = 1 \Rightarrow \quad p = 1 - \frac{1}{2} = \frac{1}{2} \because \ np = 5$

$$\Rightarrow \quad n \times \frac{1}{2} = 5 \Rightarrow n = 10$$

$p(X < 1) = p(X = 0) = {}^nC_r p^r q^{n-r}$

$$= {}^{10}C_0 \left(\frac{1}{2}\right)^0 \left(\frac{1}{2}\right)^{10-0} = 1 \times 1 \times \left(\frac{1}{2}\right)^{10} = \left(\frac{1}{2}\right)^{10}$$

2. (d) Let $u = \tan^{-1}\left(\frac{x}{\sqrt{1-x^2}}\right)$ and

$v = \sin^{-1}(3x - 4x^3)$
Now, put $x = \sin\theta \Rightarrow \theta = \sin^{-1}(x)$, then

$$u = \tan^{-1}\left(\frac{\sin\theta}{\sqrt{1-\sin^2\theta}}\right)$$

and $v = \sin^{-1}(3\sin\theta - 4\sin^3\theta)$

$\Rightarrow \quad u = \tan^{-1}\left(\dfrac{\sin\theta}{\cos\theta}\right)$ and $v = \sin^{-1}(\sin 3\theta)$

$\Rightarrow \quad u = \tan^{-1}(\tan\theta)$ and $v = \sin^{-1}(\sin 3\theta)$

$\Rightarrow \quad u = \theta$ and $v = 3\theta$

$\Rightarrow \quad u = \sin^{-1}x$ and $v = 3\sin^{-1}x.$

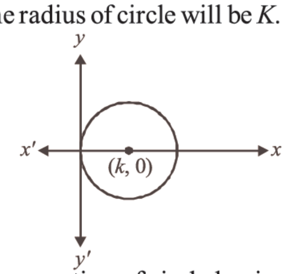
On differentiating both sides w.r.t. x, we get

$$\frac{du}{dx} = \frac{1}{\sqrt{1-x^2}} \text{ and } \frac{dv}{dx} = 3\times\frac{1}{\sqrt{1-x^2}}$$

$$\therefore \quad \frac{du}{dv} = \frac{\frac{du}{dx}}{\frac{dv}{dx}} = \frac{\frac{1}{\sqrt{1-x^2}}}{\frac{3}{\sqrt{1-x^2}}} = \frac{1}{3}$$

3. **(b)** Let centre of circle on X-axis be $(K, 0)$.

$\therefore$ the radius of circle will be K.



$\therefore$ the equation of circle having centre $(K, 0)$ and radius K is

$(x-K)^2 + (y-0)^2 = K^2$

$\Rightarrow \quad x^2 + K^2 - 2hx + y^2 = K^2$

$\Rightarrow \quad x^2 - 2Kx + y^2 = 0$ ...(i)

On differentiating both sides w.r.t x, we get

$$2x - 2K + 2y\frac{dy}{dx} = 0$$

$$\Rightarrow \quad K = x + y\frac{dy}{dx} \qquad \text{...(ii)}$$

From equations (i) & (ii) we get

$$x^2 - 2\left(x + y\frac{dy}{dx}\right)x + y^2 = 0$$

$$\Rightarrow \quad -x^2 + y^2 - 2xy\frac{dy}{dx} = 0$$

$$\Rightarrow \quad (x^2 - y^2) + 2xy\frac{dy}{dx} = 0$$

4. **(b)** Given, $A = \begin{bmatrix} 1 & 1 & 0 \\ 2 & 1 & 5 \\ 1 & 2 & 1 \end{bmatrix}$

Since, the sum of the product of element other than the corresponding cofactor is zero.

$\therefore \quad a_{11}A_{21} + a_{12}A_{22} + a_{13}A_{23} = 0$

5. **(b)** Given, $f(x) = e^x(\sin x - \cos x)$

$$\Rightarrow f'(x) = e^x\frac{d}{dx}(\sin x - \cos x) + (\sin x - \cos x)\frac{d}{dx}(e^x)$$

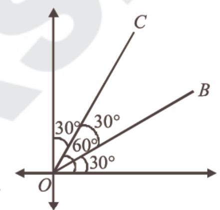
$= e^x(\cos x + \sin x) + (\sin x - \cos x)e^x = 2e^x \sin x$

We know that, if Rolle's theorem is verified, then their exist $c \in \left(\dfrac{\pi}{4}, \dfrac{5\pi}{4}\right)$, such that $f'(c) = 0$

$\therefore \quad 2e^c \sin c = 0 \Rightarrow \sin c = 0$

$$\Rightarrow \quad c = \frac{\pi}{2} \in \left(\frac{\pi}{4}, \frac{5\pi}{4}\right)$$

6. **(c)** In a trisection of lines in quadrant, angle 90° is divided into three parts and each part contain 30°, as shown in figure



$\therefore$ Equation of line OB is

$$y = \tan 30°\, x \Rightarrow y = \frac{1}{\sqrt{3}}x$$

$$x - \sqrt{3}y = 0$$

And equation of line OC is

$y = \tan 60°\, x \Rightarrow y = \sqrt{3}x \quad (\sqrt{3}x - y) = 0$

$\therefore$ Their combined equation is

$$(x - \sqrt{3}y)(\sqrt{3}x - y) = 0$$

$$\Rightarrow \quad \sqrt{3}x^2 - xy - 3xy + \sqrt{3}y^2 = 0$$

$$\Rightarrow \quad \sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$$

7. **(b)** Here, $2\tan^{-1}(\cos x) = \tan^{-1}(2\operatorname{cosec} x)$

$$\Rightarrow \quad \tan^{-1}\frac{2\cos x}{1-\cos^2 x} = \tan^{-1}\left(\frac{2}{\sin x}\right)$$

$$\Rightarrow \quad \frac{2\cos x}{1-\cos^2 x} = \frac{2}{\sin x} \Rightarrow \frac{\cos x}{\sin^2 x} = \frac{1}{\sin x}$$

$$\Rightarrow \quad \frac{\cos x}{\sin x} = 1 \qquad [\because \sin x \neq 0]$$

$$\Rightarrow \quad \cot x = 1 \Rightarrow x = \frac{\pi}{4}$$

Hence, $\sin x + \cos x = \sin\dfrac{\pi}{4} + \cos\dfrac{\pi}{4}$

$$= \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} = \sqrt{2}$$

8. **(a)** Equation of given line is

$$\frac{x+2}{2} = \frac{2y-5}{3}, \; z+1 = 0$$

or $$\frac{x+2}{2} = \frac{y-\frac{5}{2}}{\frac{3}{2}}, \; z+1 = 0$$

So, DR of given line are $< 2, \frac{3}{2}, 0 >$

As, $\sqrt{2^2 + \left(\frac{3}{2}\right)^2 + 0} = \sqrt{4 + \frac{9}{4}} = \sqrt{\frac{25}{4}} = \frac{5}{2}$

$\therefore$ DC of given line are $< \frac{2}{5/2}, \frac{3/2}{5/2}, 0 >$ or $< \frac{4}{5}, \frac{3}{5}, 0 >$

9. **(d)** $\int \frac{dx}{\sqrt{8 + 2x - x^2}} = \int \frac{dx}{\sqrt{8 + 1 - \left(x^2 - 2x + 1\right)}}$

$= \int \frac{dx}{\sqrt{3^2 - (x-1)^2}} = \sin^{-1}\left(\frac{x-1}{3}\right) + c$

10. **(a)** Since, $f(x) = x^3 + 5x^2 - 7x + 9$
After differentiating on both sides w.r.t. x, we get
$f'(x) = 3x^2 + 10x - 7$
As, $f(x + \Delta x) = f(x) + \Delta x f'(x)$
$= x^3 + 5x^2 - 7x + 9 + \Delta x \times (3x^2 + 10x - 7)$
After putting $x = 1$ and $\Delta x = 0.1$, we get
$f(1 + 0.1)$
$= 1^3 + 5(1)^2 - 7(1) + 9 + 0.1 \times (3 \times 1^2 + 10 \times 1 - 7)$
So, $f(1.1) = 1 + 5 - 7 + 9 + 0.1\,(3 + 10 - 7)$
$= 8 + 0.1(6) = 8.6$

11. **(b)** Since, $f(x) = \begin{cases} \frac{1}{5}, & 0 \le x \le 4 \\ 0, & \text{otherwise} \end{cases}$

So, $P(0 \le x \le 4)$

$= \int_0^4 f(x)\,dx = \int_0^4 \frac{1}{5}dx = \frac{1}{5}[x]_0^4$

$= \frac{1}{5}(4 - 0) = 0.8$

12. **(b)** $(a - b)^2 \cos^2 \frac{C}{2} + (a + b)^2 \sin^2 \frac{C}{2}$

$= (a^2 + b^2 - 2ab) \cos^2 \frac{C}{2} + (a^2 + b^2 + 2ab) \sin^2 \frac{C}{2}$

$= a^2\left(\cos^2 \frac{C}{2} + \sin^2 \frac{C}{2}\right) + b^2\left(\cos^2 \frac{C}{2} + \sin^2 \frac{C}{2}\right)$
$- 2ab\left(\cos^2 \frac{C}{2} - \sin^2 \frac{C}{2}\right)$

$= a^2 + b^2 - 2ab \cos C$

$\left[\because \cos^2 \frac{C}{2} - \sin^2 \frac{C}{2} = \cos C\right]$

$= a^2 + b^2 - 2ab\left(\frac{a^2 + b^2 - c^2}{2ab}\right) = c^2$

$\left[\because \cos C = \frac{a^2 + b^2 - c^2}{2ab}\right]$

13. **(b)** Let $u = \log(\sec\theta + \tan\theta)$ and $v = \sec\theta$
After differentiating on both sides w.r.t. θ, we get

$\frac{du}{d\theta} = \frac{1}{(\sec\theta + \tan\theta)}(\sec\theta\tan\theta + \sec^2\theta)$

$\frac{dv}{d\theta} = \sec\theta\tan\theta$

$\frac{du}{dv} = \frac{\frac{du}{d\theta}}{\frac{dv}{d\theta}} = \frac{\sec\theta(\tan\theta + \sec\theta)}{(\sec\theta + \tan\theta) \times \sec\theta\tan\theta} = \cot\theta$

Hence, $\frac{du}{dv}\Big|_{\left(\theta = \frac{\pi}{4}\right)} = \cot\frac{\pi}{4} = 1$

14. **(b)** The equation of the bisectors of the angle between the lines $(x = 5)$ and $(y = 3)$ is

$\frac{(x-5)}{\sqrt{1^2}} = \pm\frac{y-3}{\sqrt{1^2}} \Rightarrow \frac{x-5}{1} = \pm\frac{y-3}{1}$
$\Rightarrow x - 5 = +(y - 3)$ and $x - 5 = -(y - 3)$
$\Rightarrow (x - y - 2) = 0$ and $(x + y - 8) = 0$
Hence, combined equation of bisectors of angle between given lines is $(x - y - 2)(x + y - 8) = 0$
$\Rightarrow x^2 + xy - 8x - xy - y^2 + 8y - 2x - 2y - 16 = 0$
$\Rightarrow x^2 - y^2 - 10x + 6y + 16 = 0$

15. **(a)** Since, $6y = x^3 + 2$ ...(i)
and $\Delta y = 8\Delta x$
After differentiating on both sides of eq. (i) w.r.t. x, we get

$\frac{6dy}{dx} = 3x^2 \Rightarrow \frac{dy}{dx} = \frac{1}{2}x^2$

As, $\Delta y = \frac{dy}{dx}\Delta x \Rightarrow 8\Delta x = \frac{1}{2}x^2\Delta x$
So, $x^2 = 16 \Rightarrow x = \pm 4$
When $x = 4$, then $6y = (4)^3 + 2$
So, $6y = 66 \Rightarrow y = 11$
Hence, required point is (4, 11).

16. **(a)** Given, $f(x) = \begin{cases} x\sin\frac{1}{x}, & \text{for } x \ne 0 \\ k, & \text{for } x = 0 \end{cases}$

As, $f(x)$ is continuous at $x = 0$
So, LHL = RHL = f(0) ....(i)

Now, LHL $= \lim_{x \to 0^-} f(x) = \lim f(0 - h)$

$= \lim_{h \to 0}(0 - h)\sin\frac{1}{(0 - h)} = \lim_{h \to 0}(-h)\sin\left(-\frac{1}{h}\right)$

$= \lim_{h \to 0} h\sin\frac{1}{h} = 0 \times$ finite value lies between -1 and $1 = 0$

$\left[\because \lim_{h \to 0}\sin\frac{1}{h} = \text{finite value lies between } -1 \text{ and } 1\right]$
and $f(0) = k$

Now, from eq. (i), LHL $= f(0)$
$\Rightarrow 0 = k$
Hence, $k = 0$

17. **(c)** Given, $y = e^{m\sin^{-1}x}$ ...(i)
After differentiating on both sides w.r.t. x, we get

$$\frac{dy}{dx} = e^{m\sin^{-1}x}\frac{d}{dx}(m\sin^{-1}x)$$

$$\Rightarrow \frac{dy}{dx} = e^{m^{\sin^{-1}x}}\left(m\times\frac{1}{\sqrt{1-x^2}}\right)$$

$$\Rightarrow \sqrt{1-x^2}\frac{dy}{dx} = my \qquad \text{[From eq. (i)]}$$

After squaring on both sides, we get

$$\left(1-x^2\right)\left(\frac{dy}{dx}\right)^2 = m^2y^2$$

As, $\left(1-x^2\right)\left(\frac{dy}{dx}\right)^2 = Ay^2$
Hence, $A = m^2$

18. **(b)** Consider, $I = \int\left(\frac{4e^x-25}{2e^x-5}\right)dx$

$$= \int\frac{4e^x}{2e^x-5}dx - \int\frac{25}{2e^x-5}dx$$

$$= 4\int\frac{e^x}{2e^x-5}dx - 25\int\frac{e^{-x}}{2-5e^{-x}}dx$$

Let $2e^x - 5 = u$ and $2 - 5e^{-x} = v$
$\Rightarrow 2e^xdx = du$ and $5e^{-x}\,dx = dv$

$$\Rightarrow e^xdx = \frac{du}{2} \text{ and } e^{-x}dx = \frac{dv}{5}$$

So, $I = 4\int\frac{du}{2u} - 25\int\frac{du}{5v}$
$= 2\log u - 5\log v + c$
$= 2\log(2e^x - 5) - 5\log(2 - 5e^{-x}) + c$

$$= 2\log(2e^x-5) - 5\log\left(\frac{2e^x-5}{e^x}\right) + c$$

$= -3\log(2e^x - 5) + 5x + c$
Therefore, $I = 5x - 3\log(2e^x - 5) + c$
As, $I = Ax + B\log(2e^x - 5) + c$
Hence, $A = 5$ and $B = -3$

19. **(b)** $\dfrac{\tan^{-1}\left(\sqrt{3}\right)-\sec^{-1}(-2)}{\operatorname{cosec}^{-1}\left(-\sqrt{2}\right)+\cos^{-1}\left(-\frac{1}{2}\right)}$

$$= \frac{\tan^{-1}\left(\sqrt{3}\right)-\left(\pi-\sec^{-1}(2)\right)}{-\operatorname{cosec}^{-1}\left(\sqrt{2}\right)+\pi-\cos^{-1}\left(\frac{1}{2}\right)}$$

$$= \frac{\frac{\pi}{3}-\left(\pi-\frac{\pi}{3}\right)}{-\frac{\pi}{4}+\pi-\frac{\pi}{3}} = \frac{-\frac{\pi}{3}}{\frac{12\pi-3\pi-4\pi}{12}} = \frac{-\frac{\pi}{3}}{\frac{5\pi}{12}} = -\frac{4}{5}$$

20. **(c)** Since,

$$p(x) = \begin{cases}\dfrac{\log(1+2x)\sin x^\circ}{x^2}, & \text{for } x \neq 0\\ k, & \text{for } x = 0\end{cases}$$

$$= \begin{cases}\dfrac{\log(1+2x)\sin\frac{\pi x}{180}}{x^2}, & \text{for } x \neq 0\\ k, & \text{for } x = 0\end{cases}$$

As, $f(x)$ is continuous at $x = 0$
So, LHL $= f(0)$
$\because$ LHL $= \lim\limits_{x\to0^-} f(x) = \lim\limits_{h\to0} f(0-h)$

$$= \lim_{h\to0}\frac{\log(1+2(0-h)\sin\frac{\pi}{180^\circ}(0-h))}{(0-h)^2}$$

$$= \lim_{h\to0}\frac{\log(1-2h)\left\{-\sin\frac{\pi h}{180}\right\}}{h^2}$$

$$= \lim_{h\to0}(-2)\frac{\log(1-2h)}{-2h}x\lim_{h\to0}\frac{(-)\sin\frac{\pi h}{180}}{\frac{\pi h}{180}}\times\frac{\pi}{180}$$

$$= (-2)\times(-1)\times1\times\frac{\pi}{180} = \frac{\pi}{90}$$

$$\left[\because \lim_{x\to0}\log\frac{1+x}{x} = 1 \text{ and } \lim_{x\to0}\frac{\sin x}{x} = 1\right]$$

21. **(a)** Since, $\log_{10}\left(\frac{x^2-y^2}{x^2+y^2}\right) = 2$

$$\Rightarrow \left(\frac{x^2-y^2}{x^2+y^2}\right) = 10^2$$

$\Rightarrow x^2 - y^2 = 100(x^2 + y^2)$
After differentiating on both sides, we get

$$2x-2y\frac{dy}{dx}=100\left(2x+2y\frac{dy}{dx}\right)$$

$$\Rightarrow x-y\frac{dy}{dx}=100x+100y\frac{dy}{dx}$$

$$\Rightarrow 101y\frac{dy}{dx}=-99x \Rightarrow \frac{dy}{dx}=\frac{-99x}{101y}$$

22. **(d)** Let, $I=\int_{\frac{-\pi}{2}}^{\frac{\pi}{2}} \log\left(\frac{2-\sin x}{2+\sin x}\right)dx$

$$f(x)=\log\left(\frac{2-\sin x}{2+\sin x}\right) \therefore f(-x)=\log\left(\frac{2-\sin(-x)}{2+\sin(-x)}\right)$$

$$=\log\left(\frac{2+\sin x}{2-\sin x}\right)=-\log\left(\frac{2-\sin x}{2+\sin x}\right)=-f(x)$$

So, $f(x)$ is an odd function.

Hence, $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} f(x)dx=0$

$\left[\because \text{If } f(x) \text{ is an odd function, then } \int_{-a}^{a} f(x)dx=0\right]$

23. **(c)** Consider, $I=\int\frac{(x^2+2)a^{(x+\tan^{-1}x)}}{x^2+1}dx$

Let $x+\tan^{-1}x=t$

$$\Rightarrow\left(1+\frac{1}{1+x^2}\right)dx=dt \Rightarrow \frac{2+x^2}{1+x^2}dx=dt$$

So, $I=\int a^t dt=\frac{a^t}{\log a}+c$

$$=\frac{a^{x+\tan^{-1}x}}{\log a}+c$$

24. **(b)** The given differential equation is

$$\left[1+\left(\frac{dy}{dx}\right)\right]^{\frac{7}{3}}=7\left(\frac{d^2y}{dx^2}\right)$$

After cubing on both sides, we get

$$\left[1+\left(\frac{dy}{dx}\right)^3\right]^7=7^3\left(\frac{d^2y}{dx^2}\right)^3$$

As, highest order derivative is 2, and its degree is 3.
Hence, degree = 3 and order = 2

25. **(b)** The angle between the line

$\vec{r}=\vec{a}+\lambda\vec{b}$ and the plane $\vec{r}\cdot\hat{n}=d$ is given by

$$\sin\theta=\frac{\hat{n}\cdot\vec{b}}{|\hat{n}||\vec{b}|}$$

The equation of given line is

$\vec{r}=(\hat{i}+2\hat{j}+\hat{k})+\lambda(\hat{i}+\hat{j}+\hat{k})$ and equation of plane is

$\vec{r}\cdot(2\hat{i}-\hat{j}+\hat{k})=5$

As, $\vec{b}=\hat{i}+\hat{j}+\hat{k}$ and $\hat{n}=2\hat{i}-\hat{j}+\hat{k}$

So, $\sin\theta=\frac{(2\hat{i}-\hat{j}+\hat{k})\cdot(\hat{i}+\hat{j}+\hat{k})}{|2\hat{i}-\hat{j}+\hat{k}|\,|\hat{i}+\hat{j}+\hat{k}|}$

$$=\frac{2-1+1}{\sqrt{2^2+(-1)^2+(1)^2}\sqrt{1^2+1^2+1^2}}$$

$$=\frac{2}{\sqrt{4+1+1}\sqrt{1+1+1}}=\frac{2}{\sqrt{6}\sqrt{3}}=\frac{\sqrt{2}}{3}$$

Hence, $\theta=\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$

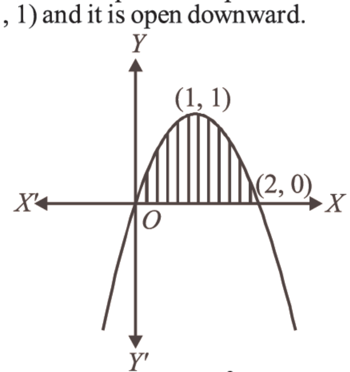
26. **(b)** The equation of given curve is $y=2x-x^2$

$\Rightarrow x^2-2x=-y$

$\Rightarrow x^2-2x+1=-y+1$

$\Rightarrow (x-1)^2=-(y-1)$

Which is the equation of parabola whose vertex is (1, 1) and it is open downward.



$y=2x-x^2$

For intersection of the parabola with the X-axis, put $y=0$, then we get

$0=2x-x^2$

$\Rightarrow x(2-x)=0$

$\Rightarrow x=0, 2$

Hence, area of bounded region between the curve and X-axis

$=\int_0^2 y\,dx$

$$=\int_0^2 (2x-x^2)dx=\left[\frac{2x^2}{2}-\frac{x^3}{3}\right]_0^2$$

$$=\left[4-\frac{8}{3}-0-0\right]=\frac{4}{3} \text{ sq units.}$$

27. **(a)** Since, $\int \frac{f(x)}{\log(\sin x)}dx = \log[\log\sin x]+c$

After differentiating on both sides, we get

$$\frac{f(x)}{\log(\sin x)} = \frac{1}{\log\sin x}\frac{d}{dx}(\log\sin x)+0$$

$$\Rightarrow \frac{f(x)}{\log(\sin x)} = \frac{1}{\log\sin x}\times\frac{1}{\sin x}\times\cos x$$

$\Rightarrow f(x) = \cot x$

28. **(a)** It is given that, the foot of perpendicular from point $Q(a,b,c)$ to the yz plane is $A(0,b,c)$ and the foot of perpendicular from point Q to the zx plane is $B(a,0,c)$.

Let the equation of plane passing through the point (0, 0, 0) be $Ax + By + Cz = 0$ ......(i)

As it is passing through the point $A(0, b, c)$ and B(a, 0, c).

So, $0 + Bb + Cc = 0$ and $Aa + 0 + Cc = 0$

$\Rightarrow Cc = Bb$ and $Cc = -Aa$

Therefore, $-Aa = -Bb = Cc = k$

$$\Rightarrow A = -\frac{k}{a}, B = -\frac{k}{b} \text{ and } C = \frac{k}{c}$$

$$-\frac{k}{a}x - \frac{k}{b}y + \frac{k}{c}z = 0 \text{ [From Eq. (i)]}$$

$$\Rightarrow -\frac{x}{a} - \frac{y}{b} + \frac{z}{c} = 0 \text{ or } \frac{x}{a} + \frac{y}{b} - \frac{z}{c} = 0$$

29. **(c)** Given, $\vec{a} = \hat{i} + \hat{j} - 2\hat{k}, \vec{b} = 2\hat{i} - \hat{j} + \hat{k}, \vec{c} = 3\hat{i} - \hat{k}$

and $\vec{c} = m\vec{a} + n\vec{b}$

As, $3\hat{i} - \hat{k} = m(\hat{i} + \hat{j} - 2\hat{k}) + n(2\hat{i} - \hat{j} + \hat{k})$

$\Rightarrow 3\hat{i} - \hat{k} = (m + 2n)\hat{i} + (m - n)\hat{j} + (-2m + n)\hat{k}$

After equating the coefficient of $\hat{i}, \hat{j}$ and $\hat{k}$, on both sides respectively, we get

$3 = m + 2n$, $0 = m - n$ and $-1 = -2m + n$

$\Rightarrow 3 = n + 2n \Rightarrow n = 1$

$\Rightarrow m = 1$ and $n = 1$

$\Rightarrow m + n = 1 + 1 = 2$

30. **(c)** Let $I = \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\sec x}}{\sqrt[n]{\sec x} + \sqrt[n]{\operatorname{cosec} x}}dx$ ...(i)

$$= \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\sec\left(\frac{\pi}{2} - x\right)}}{\sqrt[n]{\sec\left(\frac{\pi}{2} - x\right)} + \sqrt[n]{\operatorname{cosec}\left(\frac{\pi}{2} - x\right)}}dx$$

$$= \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\operatorname{cosec} x}}{\sqrt[n]{\operatorname{cosec} x} + \sqrt[n]{\sec x}}dx \quad \text{...(ii)}$$

After adding eq. (i) and (ii), we get

$$2I = \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\sec x} + \sqrt[n]{\operatorname{cosec} x}}{\sqrt[n]{\sec x} + \sqrt[n]{\operatorname{cosec} x}}dx$$

$$\Rightarrow 2I = \int_0^{\frac{\pi}{2}} dx = [x]_0^{\frac{\pi}{2}}$$

$$\Rightarrow 2I = \frac{\pi}{2} \text{ Hence, } I = \frac{\pi}{4}$$

31. **(c)** Since, cumulative distribution function $F(x) = P(X \le x)$

So, $F(0) = P(X \le 0)$

$= P(X = 0) + P(X = -1) + P(X = -2)$

$= 0.15 + 0.3 + 0.2 = 0.65$

(a) $P(X < 0) = P(X = -1) + P(X = -2)$

$= 0.3 + 0.2 = 0.5$

Therefore, $P(X < 0) \ne F(0)$

(b) $P(X > 0) = P(X = 1) + P(X = 2)$

$= 0.25 + 0.1 = 0.35$

Thus, $P(X > 0) \ne F(0)$

(c) $1 - P(x > 0) = 1 - 0.35 = 0.65$

Hence, $1 - P(X > 0) = F(0)$

32. **(a)** The given differential equation is

$$y(1 + \log x)\left[\frac{dx}{dy}\right] - x\log x = 0$$

$$\Rightarrow \frac{(1+\log x)dx}{x\log x} = \frac{dy}{y} \Rightarrow \left(\frac{1}{x\log x} + \frac{1}{x}\right)dx = \frac{1}{y}dy$$

After integrating on both sides, we get

$$\int\left(\frac{1}{x\log x} + \frac{1}{x}\right)dx = \int\frac{1}{y}dy$$

Let $\log x = t \Rightarrow \frac{1}{x}dx = dt$

So, $\int\frac{1}{t}dt + \int\frac{1}{x}dx = \int\frac{1}{y}dy$

$\Rightarrow \log t + \log x = \log y + \log c$

$\Rightarrow \log tx = \log yc \Rightarrow tx = yc \Rightarrow x\log x = yc$

When $x = e$ then $y = e^2$

Therefore, $e\log e = e^2c$

$$\Rightarrow e \times 1 = e^2c \Rightarrow c = \frac{1}{e}$$

Hence, $x\log x = \frac{y}{e} \Rightarrow y = ex\log x$

33. **(c)** Suppose that the position vectors of A, B, C, D, M and N are **a, b, c, d, m** and **n** respectively.

As, M and N are the mid-points of AC and BD.

So, $\mathbf{m} = \frac{\mathbf{a}+\mathbf{c}}{2}$ and $\mathbf{n} = \frac{\mathbf{b}+\mathbf{d}}{2}$

Then, $\mathbf{AB} + \mathbf{AD} + \mathbf{CB} + \mathbf{CD}$

$= (\mathbf{b} - \mathbf{a}) + (\mathbf{d} - \mathbf{a}) + (\mathbf{b} - \mathbf{c}) + (\mathbf{d} - \mathbf{c})$

$= 2(\mathbf{b} + \mathbf{d}) - 2(\mathbf{a} + \mathbf{c})$

$= 2 \times 2\mathbf{n} - 2 \times 2\mathbf{m} = 4(\mathbf{n} - \mathbf{m}) = 4\mathbf{MN}$

$\Rightarrow 4\lambda + 1 - 7 - 2 - \lambda = 10$

$\Rightarrow 3\lambda = 18 \Rightarrow \lambda = 6$

34. **(d)** Since, IF of $\frac{dy}{dx} + Py = Q$ is given by

IF $= e^{\int p dx}$

So, $\sin x = e^{\int p dx}$

After differentiating on both sides, we get

$\cos x = e^{\int p dx} \cos x = \sin x\, P \Rightarrow P = \cot x$

35. **(c)** (a) $x^2 - x = 0 \Rightarrow x(x-1) = 0$

$\Rightarrow x = 0$ and $x = 1$,

This represent a pair of lines.

(b) $xy - x = 0 \Rightarrow x(y-1) = 0$

$\Rightarrow x = 0,\ y = 1$,

This represent a pair of lines.

(c) $y^2 - x + 1 = 0$

$\Rightarrow y^2 = (x-1)$,

This represent a parabola.

Which does not represent a pair of lines.

(d) $xy + x + y + 1 = 0$

$\Rightarrow x(y+1) + (y+1) = 0 \Rightarrow (y+1)(x+1) = 0$

$\Rightarrow \quad y = -1$ and $x = -1$

This represent a pair of lines.

36. **(a)** In every true and false question, probability of guessing correctly, $p = \frac{1}{2}$ and probability of guessing wrongly, $q = \frac{1}{2}$.

Here, $n = 10$

$\therefore$ The probability of atleast 7 correctly guessing

$= P(X \geq 7)$

$= P(X = 7) + P(X = 8) + P(X = 9) + P(X = 10)$

$$= {}^{10}C_7\left(\frac{1}{2}\right)^7\left(\frac{1}{2}\right)^3 + {}^{10}C_8\left(\frac{1}{2}\right)^8\left(\frac{1}{2}\right)^2 + {}^{10}C_9\left(\frac{1}{2}\right)^9\left(\frac{1}{2}\right)^1 + {}^{10}C_{10}\left(\frac{1}{2}\right)^{10}$$

$\left[\because P(x = r) = {}^nC_r\, p^r q^{n-r}\right]$

$$= 120\left(\frac{1}{2}\right)^{10} + 45\left(\frac{1}{2}\right)^{10} + 10\left(\frac{1}{2}\right)^{10} + 1\left(\frac{1}{2}\right)^{10}$$

$$= \frac{120 + 45 + 10 + 1}{2^{10}} = \frac{176}{1024} = \frac{11}{64}$$

37. **(c)** The given equation is $\sin 2x + \cos 2x = 0$

$\Rightarrow \sin 2x = -\cos 2x \Rightarrow \tan 2x = -1$

$[\because \pi < x < 2\pi \Rightarrow 2\pi < 2x < 4\pi]$

$\Rightarrow \quad 2x = 2\pi + \frac{3\pi}{4}, 2\pi + \left(\frac{3\pi}{2} + \frac{\pi}{4}\right)$

$\Rightarrow \quad 2x = \frac{11\pi}{8}, \frac{15\pi}{4} \Rightarrow x = \frac{11\pi}{8}, \frac{15\pi}{8}$

38. **(a)** Coordinates of points A and B are given as $(6, -4, 4)$ and $(0, 0, -4)$ and coordinates of points C and D are given as $(-1, -2, -3)$ and $(1, 2, -5)$.

Now, equation of line which passes through $(0, 0, -4)$ and $(6, -4, 4)$ is

$\frac{x-0}{6} = \frac{y-0}{-4} = \frac{z+4}{4+4} = k$ [Let]

$\Rightarrow \quad x = 6k,\ y = -4k$ and $z = 8k - 4$ ...(i)

The equation of line which passes through $(-1, -2, -3)$ and $(1, 2, -5)$ is

$\frac{x+1}{1+1} = \frac{y+2}{2+2} = \frac{z+3}{-5+3}$

$\Rightarrow \quad \frac{x+1}{2} = \frac{y+2}{4} = \frac{3+3}{-2}$ ...(ii)

As, two lines intersect, so point $(6k, -4k, 8k-4)$ satisfy eq. (ii), we get

$\frac{6k+1}{2} = \frac{-4k+2}{4} = \frac{8k-4+3}{-2}$

$\Rightarrow \quad 6k+1 = -2k+1 = -(8k-1)$

$\Rightarrow \quad 6k+1 = -2k+1 \Rightarrow 8k = 0$

$\Rightarrow \quad k = 0$

$\therefore \quad x = 6 \times 0,\ y = -4 \times 0$ and $z = 8 \times 0 - 4$

$\Rightarrow \quad x = 0,\ y = 0$ and $z = -4$

This is equal to the B coordinate.

39. **(a)** It is given that $A = \begin{bmatrix} 2 & 2 \\ -3 & 2 \end{bmatrix}, B = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$

As, $(B^{-1}A^{-1})^{-1} = (A^{-1})^{-1}(B^{-1})^{-1} = AB$

$[\because (AB)^{-1} = B^{-1}A^{-1}]$

$[\because (A^{-1})^{-1} = A^{-1}]$

$$= \begin{bmatrix} 2 & 2 \\ -3 & 2 \end{bmatrix}\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 0+2 & -2+0 \\ 0+2 & 3+0 \end{bmatrix} = \begin{bmatrix} 2 & -2 \\ 2 & 3 \end{bmatrix}$$

40. **(a)** Given, statement p is true (T) and statement q is false (F).

So, $p \to q \equiv T \to F = F$ and $p \leftrightarrow q \equiv T \leftrightarrow F = F$

41. **(b)** Since, orthocentre, centroid and circumcentre of a triangle are collinear whereas centroid divides orthocentre and circumcentre in the ratio of 2 : 1.

By internally division formula,

$$\frac{2\mathbf{p} + 1\mathbf{h}}{2+1} = \mathbf{g}$$

$\Rightarrow \quad 2\mathbf{p} + \mathbf{h} - 3\mathbf{g} = 0$

As, $x\,\mathbf{p} + y\,\mathbf{h} + z\,\mathbf{g} = 0$

Hence, $x = 2$, $y = 1$ and $z = -3$

42. **(a)** The true quantified statement is 'the square of every real number is positive'.

43. **(c)** Since, $\tan^2 x = 1$

$\Rightarrow \tan^2 x = 1^2$

$\Rightarrow \tan^2 x = \tan^2 \dfrac{\pi}{4} \Rightarrow \quad x = n\pi \pm \dfrac{\pi}{4}$

44. **(b)** In the given figure, OC line passes through (0, 0) and (3, 3).

So, equation of line is $y = x$.

Also, shaded portion of this line is towards the X-axis, so $x - y \geq 0$.

In the given figure, line AB is parallel to Y-axis.

$\therefore$ Equation of line AB is $x = 5$, also shaded portion of this line is towards the origin, so $x - 5 \leq 0$ or $x \leq 5$.

In the given figure, line BC is parallel to X-axis. Therefore, equation of line BC is $y = 3$. Also, shaded portion of this line is towards the origin, so $y - 3 \leq 0$ or $y \leq 3$.

Also, the shaded region lies in first quadrant, so $x \geq 0$ and $y \geq 0$.

Hence, constraints of given shaded region are $x, y \geq 0, x - y \geq 0, x \leq 5, y \leq 3$.

45. **(b)** Let direction ratios of a line are (a, b, c).

As, line is perpendicular to the direction ratios $(-1, 2, 2)$ and $(0, 2, 1)$.

$\therefore a \times -1 + b \times 2 + c \times 2 = 0$ and $a \times 0 + b \times 2 + c \times 1 = 0$

$\Rightarrow \quad -a + 2b + 2c = 0$ and $0a + 2b + c = 0$

$$\Rightarrow \quad \frac{a}{2-4} = \frac{-b}{-1-0} = \frac{c}{-2-0}$$

$$\Rightarrow \quad \frac{a}{-2} = \frac{b}{1} = \frac{c}{-2} \text{ or } \frac{a}{2} = \frac{b}{-1} = \frac{c}{2}$$

Hence, direction ratios of a line are $(2, -1, 2)$.

46. **(c)** Given, $A = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}$

and $AX = I$

$\Rightarrow \quad X = A^{-1}I \Rightarrow X = A^{-1}$

Then, $A^{-1} = \dfrac{1}{|A|}\begin{bmatrix} 3 & -2 \\ -4 & 1 \end{bmatrix}$

$$= \frac{1}{3-8}\begin{bmatrix} 3 & -2 \\ -4 & 1 \end{bmatrix} = \frac{1}{-5}\begin{bmatrix} 3 & -2 \\ -4 & 1 \end{bmatrix}$$

$$= \frac{1}{5}\begin{bmatrix} -3 & 2 \\ 4 & -1 \end{bmatrix}$$

47. **(a)** Given, $a = \hat{i} + \hat{j} + \hat{k}$, $b = 2\hat{i} + \lambda\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} + 4\hat{k}s$

As, $\vec{a} \cdot (\vec{b} \times \vec{c}) = 10$

$$\Rightarrow \begin{vmatrix} 1 & 1 & 1 \\ 2 & \lambda & 1 \\ 1 & -1 & 4 \end{vmatrix} = 10$$

$\Rightarrow \quad 1(4\lambda + 1) - 1(8 - 1) + 1(-2 - \lambda) = 10$

$\Rightarrow \quad 4\lambda + 1 - 7 - 2 - \lambda = 10$

$\Rightarrow \quad 3\lambda = 18 \Rightarrow \lambda = 6$

48. **(b)** Since, $X \sim B = \left(n = 5, p = \dfrac{1}{3}\right)$

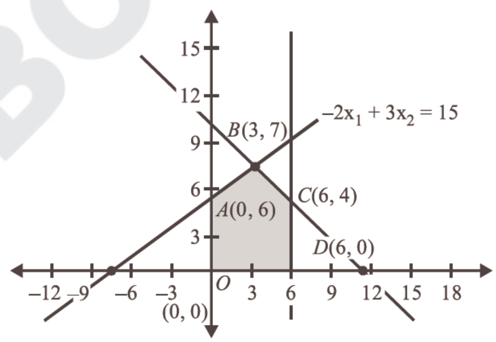
$\because \quad p + q = 1 \Rightarrow \dfrac{1}{3} + q = 1 \Rightarrow q = \dfrac{2}{3}$

$\therefore \quad p(2 < X < 4) = p(X = 3)$

$$= {}^5C_3\left(\frac{1}{3}\right)^3\left(\frac{2}{3}\right)^2 = 10 \times \frac{4}{3^5} = \frac{40}{243}$$

49. **(c)** Since, objective function is $Z = x_1 + x_2$ and given constraints are

$x_1 + x_2 \leq 10, -2x_1 + 3x_2 \leq 15, x_1 \leq 6, x_1, x_2 \geq 0.$



Now, the point of intersection of lines $x_1 + x_2 = 10$ and $-2x_1 + 3x_2 = 15$ is $B(3, 7)$ and point of intersection of lines $x_1 = 6$ and $x_1 + x_2 = 10$ is $C(6, 4)$

Here, the feasible region is $OABCD$. The corner points of the feasible region are $O(0, 0)$, $A(0, 6)$, $B(3, 7)$, $C(6, 4)$ and $D(6, 0)$.

At $O(0,0)$	$Z = 0 + 0 = 0$
At $A(0,6)$	$Z = 0 + 6 = 6$
At $B(3,7)$	$Z = 3 + 7 = 10$
At $C(6,4)$	$Z = 6 + 4 = 10$
At $D(6,0)$	$Z = 6 + 0 = 6$

Hence, Z is maximum at each point of the segment joining two points $B(3, 7)$ and $C(6, 4)$

50. **(d)** Here S_1 represent by p and S_2 represent by q. So, given circuit is represented as

$(p \wedge q) \vee (p \wedge q)$.

This is not equivalent to any of the given options.

Mock Test-1

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 seconds in every circular loop. The average velocity and average speed for each circular loop respectively, is
(a) 0, 10 m/s (b) 10 m/s, 10 m/s
(c) 10 m/s, 0 (d) 0, 0

2. The distance of the centres of moon and earth is D. The mass of earth is 81 times the mass of the moon. At what distance from the centre of the earth, the gravitaional force will be zero?
(a) $\frac{D}{2}$ (b) $\frac{2D}{3}$ (c) $\frac{4D}{3}$ (d) $\frac{9D}{10}$

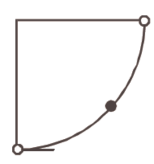
3. In kinetic theory of gases, it is assumed that molecules
(a) have same mass but can have different volume
(b) have same volume but mass can be different
(c) have different mass as well as volume
(d) have same mass but negligible volume.

4. Beats are the result of
(a) diffraction
(b) destructive interference
(c) constructive and destructive interference
(d) superposition of two waves of nearly equal frequency

5. A capacitor of capacitance C is charged to a potential V. If it carries a charge Q, then the energy stored in it is
(a) $\frac{1}{2}CV$ (b) QV
(c) $\frac{1}{2}QV^2$ (d) $\frac{1}{2}QV$

6. An elastic string of unstretched length L and force constant k is stretched by a small length x. It is further stretched by another small length y. The work done in the second stretching is :
(a) $\frac{1}{2}ky^2$ (b) $\frac{1}{2}k(x^2+y^2)$
(c) $\frac{1}{2}k(x+y)^2$ (d) $\frac{1}{2}ky(2x+y)$

7. A particle starts with S.H.M. from the mean position as shown in figure below. Its amplitude is A and its time period is T. At one time, its speed is half that of the maximum speed. What is this displacement at that time ?

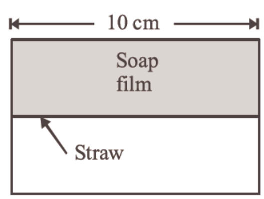


(a) $\frac{\sqrt{2}\,A}{3}$ (b) $\frac{\sqrt{3}\,A}{2}$
(c) $\frac{2A}{\sqrt{3}}$ (d) $\frac{3A}{\sqrt{2}}$

8. 100% modulation in FM means
(a) actual frequency deviation > maximum allowed frequency deviation
(b) actual frequency deviation = maximum allowed frequency deviation
(c) actual frequency deviation ≥ maximum allowed frequency deviation
(d) actual frequency deviation < maximum allowed frequency deviation

9. In an a.c. circuit, the r.m.s. value of current, I_{rms} is related to the peak current, I_0 by the relation
(a) $I_{rms} = \sqrt{2}\, I_0$ (b) $I_{rms} = \pi I_0$
(c) $I_{rms} = \frac{1}{\pi} I_0$ (d) $I_{rms} = \frac{1}{\sqrt{2}} I_0$

10. A soap film of surface tension 3×10^{-2} formed in a rectangular frame can support a straw as shown in Fig. If $g = 10\ ms^{-2}$, the mass of the straw is
(a) 0.006 g
(b) 0.06 g
(c) 0.6 g
(d) 6 g



11. For which of the following substances, the magnetic susceptibility is independent of temperature?
(a) diamagnetics only
(b) paramagnetics only
(c) ferromagnetics only
(d) diamagnetics and paramagnetics both

12. If the distance between nuclei is 2×10^{-13} cm, the density of nuclear material is
(a) 3.21×10^{-12} kg/m^3 (b) 1.6×10^{-3} kg/m^3
(c) 2×10^{9} kg/m^3 (d) 1×10^{17} kg/m^3

13. Which metal will be suitable for a photoelectric cell using light of wavelength 4000Å. The work functions of sodium and copper are respectively 2.0 eV and 4.0 eV.
(a) Sodium (b) Copper
(c) Both (d) None of these

14. A system consists of three particles, each of mass m and located at (1, 1), (2, 2) and (3, 3). The co-ordinates of the centre of mass are
(a) (1, 1) (b) (2, 2) (c) (3, 3) (d) (6, 6)

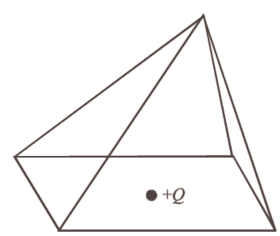
15. Which one of the following statements is true?
(a) A scalar quantity is the one that is conserved in a process.
(b) A scalar quantity is the one that can never take negative values.
(c) A scalar quantity is the one that does not vary from one point to another in space.
(d) A scalar quantity has the same value for observers with different orientations of the axes.

16. A car moves at a speed of 20 ms^{-1} on a banked track and describes an arc of a circle of radius $40\sqrt{3}$ m. The angle of banking is ($g = 10\ ms^{-2}$)
(a) 25° (b) 60° (c) 45° (d) 30°

17. The length of elastic string, obeying Hooke's law is ℓ_1 metres when the tension is 4N and ℓ_2 metres when the tension is 5N. The length in metres when the tension is 9N is –
(a) $5\ell_1 - 4\ell_2$ (b) $5\ell_2 - 4\ell_1$
(c) $9\ell_1 - 8\ell_2$ (d) $9\ell_2 - 8\ell_1$

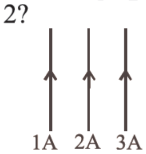
18. A moving coil galvanometer has resistance of $10\,\Omega$ and full scale deflection of 0.01 A. It can be converted into voltmeter of 10 V full scale by connecting into resistance of
(a) 9.90 Ω in series (b) 10 Ω in series
(c) 990 Ω in series (d) 0.10 Ω

19. A point charge $+Q$ is positioned at the center of the base of a square pyramid as shown. The flux through one of the four identical upper faces of the pyramid is
(a) $\frac{Q}{16\varepsilon_0}$
(b) $\frac{Q}{4\varepsilon_0}$
(c) $\frac{Q}{8\varepsilon_0}$
(d) None of these



20. The dimensions of impulse are
(a) $[MLT^{-1}]$ (b) $[MLT^2]$
(c) $[ML^0T^{-2}]$ (d) $[ML^{-1}T^{-3}]$

21. Three wires are situated at the same distance. A current of 1A, 2A, 3A flows through these wires in the same direction. What is ratio of F_1/F_2, where F_1 are force on 1 and F_2 on 2?
(a) 7/8
(b) 1
(c) 9/8
(d) None of these

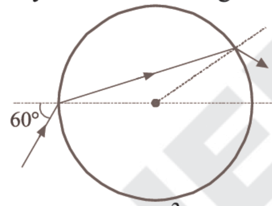


22. The escape velocity of a body on the surface of the earth is 11.2 km/s. If the earth's mass increases to twice its present value and the radius of the earth becomes half, the escape velocity would become
(a) 44.8 km/s (b) 22.4 km/s
(c) 11.2 km/s (d) 5.6 km/s

23. For measuring voltage of any circuit, potentiometer is preferred to voltmeter because
(a) the potentiometer is cheap and easy to handle.
(b) calibration in the voltmeter is sometimes wrong .
(c) the potential draws no current during measurement.
(d) range of the voltmeter is not as wide as that of the potentiometer.

24. The ratio of the energy of an X-ray photon of wavelength 1 Å to that of visible light of wavelength 5000 Å is
(a) 1 : 5000 (b) 5000 : 1
(c) $1 : 25 \times 10^6$ (d) 25×10^6

25. A ray is incident at an angle 60° on a sphere which is made of material having refractive index $= \sqrt{3}$, find angle by which the emergent ray is deviated



(a) 30°
(b) 15°
(c) 45°
(d) 60°

26. A radioactive sample contains 10^{-3} kg each of two nuclear species A and B with half-life 4 days and 8 days respectively. The ratio of the amounts of A and B after a period of 16 days is
(a) 1 : 2 (b) 4 : 1 (c) 1 : 4 (d) 2 : 1

27. A hammer weighing 3 kg strikes the head of a nail with a speed of 2 ms^{-1} drives it by 1 cm into the wall. The impulse imparted to the wall is
(a) 6Ns (b) 3Ns (c) 2Ns (d) 12 Ns

28. A particle of mass 0.2 kg is moving in a circle of radius 1 m with $f = (2/\pi)\ sec^{-1}$, then its angular momentum is :
(a) 0.8 kg-m^2/s (b) 2 kg-m^2/s
(c) 8 kg-m^2/s (d) 16 kg-m^2/s

29. A pipe open at both ends has a fundamental frequency f in air. The pipe is dipped vertically in water so that half of it is in water. The fundamental frequency of the air column is now :
(a) 2f (b) f (c) $\frac{f}{2}$ (d) $\frac{3f}{4}$

30. What is cyclotron frequency of an electron with an energy of 100 e V in the magnetic field of 1×10^{-4} weber / m^2 if its velocity is perpendicular to magnetic field?
(a) 0.7 MHz (b) 2.8 MHz
(c) 1.4 MHz (d) 2.1 MHz

31. The current I passed in any instrument in alternating current circuit is $I = 2 \sin \omega t$ amp and potential difference applied is given by $V = 5 \cos \omega t$ volt then power loss in instrument is
(a) 2.5 watt (b) 5 watt
(c) 10 watt (d) zero

32. Eddy currents in the core of transformer can't be developed by
(a) increasing the number of turns in secondary coil
(b) taking laminated transformer
(c) making step down transformer
(d) using a weak a.c. at high potential

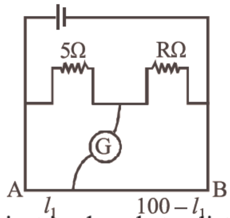
33. A body of mass 2 kg is placed on a horizontal surface having kinetic friction 0.4 and static friction 0.5. If the force applied on the body is 2.5 N, then the frictional force acting on the body will be [$g = 10\ ms^{-2}$]
(a) 8 N (b) 10 N (c) 20 N (d) 2.5 N

34. In a photoelectric experiment, with light of wavelength λ, the fastest electron has speed v. If the exciting wavelength is changed to 5λ/4, the speed of the fastest emitted electron will become
(a) $v\sqrt{\frac{5}{4}}$ (b) $v\sqrt{\frac{5}{3}}$
(c) less than $v\sqrt{\frac{5}{3}}$ (d) greater than $v\sqrt{\frac{5}{3}}$

35. The major contribution of magnetism in substances is due to
(a) orbital motion of electrons
(b) spin motion of electrons
(c) equally due to orbital and spin motions of electrons
(d) hidden magnets

36. The resistances in the two arms of the meter bridge are 5Ω and RΩ, respectively. When the resistance R is shunted with an equal resistance, the new balance point is at $1.6\, l_1$. The resistance 'R' is :

(a) 10Ω
(b) 15Ω
(c) 20Ω
(d) 25Ω



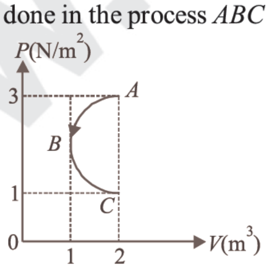
37. When an object is placed at a distance of 25 cm from a mirror, the magnification is m_1. The object is moved 15cm further away with respect to the earlier position, and the magnification becomes m_2. If $m_1/m_2 = 4$, the focal length of the mirror is :
(a) 10 cm (b) 30 cm (c) 15 cm (d) 20 cm

38. A current I flows along the length of an infinitely long, straight, thin walled pipe. Then
(a) the magnetic field at all points inside the pipe is the same, but not zero
(b) the magnetic field is zero only on the axis of the pipe
(c) the magnetic field is different at different points inside the pipe
(d) the magnetic field at any point inside the pipe is zero

39. A body moves a distance of 10 m along a straight line under the action of a force of 5 newtons. If the work done is 25 joules, the angle which the force makes with the direction of motion of body is
(a) 0° (b) 30° (c) 60° (d) 90°

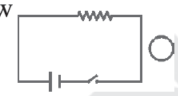
40. In P-V diagram shown in figure ABC is a semi-circle. The work done in the process ABC is

(a) 4 J
(b) $\frac{-\pi}{2}$ J
(c) $\frac{\pi}{2}$ J
(d) zero



41. Water is flowing continuously from a tap having an internal diameter 8×10^{-3} m. The water velocity as it leaves the tap is 0.4 ms^{-1}. The diameter of the water stream at a distance 2×10^{-1} m below the tap is close to:
(a) 7.5×10^{-3} m (b) 9.6×10^{-3} m
(c) 3.6×10^{-3} m (d) 5.0×10^{-3} m

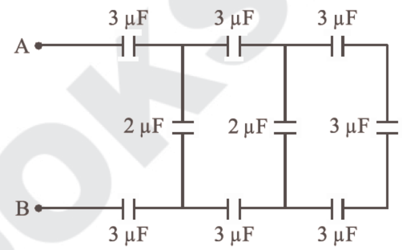
42. Consider the situation shown in figure. If the switch is closed and after some time it is opened again, the closed loop will show



(a) a clockwise current
(b) an anticlockwise current
(c) an anticlockwise current and then clockwise
(d) a clockwise current and then an anticlock wise current.

43. The equivalent capacitance between A and B is (in μF)

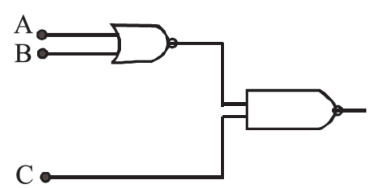
(a) 25
(b) $\frac{84}{25}$
(c) 9
(d) 1



44. Moment of inertia does not depend upon
(a) angular velocity of body
(b) shape and size
(c) mass
(d) position of axis of rotation

45. A sound source emits frequency of 180 Hz when moving towards a rigid wall with speed 5 m/s and an observer is moving away from wall with speed 5 m/s. Both source and observer moves on a straight line which is perpendicular to the wall. The number of beats per second heard by the observer will be [Speed of sound = 355 m/s]
(a) 5 beats/s (b) 10 beats/s
(c) 6 beats/s (d) 8 beats/s

46. To get an output 1 from the circuit shown in the figure, the input must not be



(a) A = 0, B = 0, C = 1 (b) A = 1, B = 0, C = 0
(c) A = 1, B = 0, C = 1 (d) A = 1, B = 1, C = 0

47. The ratio of the largest to shortest wavelengths in Brackett series of hydrogen spectra is
(a) 25/9 (b) 17/6
(c) 9/5 (d) 4/3

48. Which one did Rutherford consider to be supported by the results of experiments in which α-particles were scattered by gold foil?
(a) The nucleus of an atom is held together by forces which are much stronger than electrical or gravitational forces
(b) The force of repulsion between an atomic nucleus and an α-particle varies with distance according to inverse square law
(c) α-particles are nuclei of Helium atoms
(d) Atoms can exist with a series of discrete energy levels

49. A simple pendulum attached to the ceiling of a stationary lift has a time period T. The distance y covered by the lift moving upwards varies with time t as $y = t^2$ where y is in metres and t in seconds. If $g = 10\ m/s^2$, the time period of pendulum will be

(a) $\sqrt{\frac{4}{5}}T$ (b) $\sqrt{\frac{5}{6}}T$ (c) $\sqrt{\frac{5}{4}}T$ (d) $\sqrt{\frac{6}{5}}T$

50. A glass capillary tube of inner diameter 0.28 mm is lowered vertically into water in a vessel. The pressure to be applied on the water in the tube so that water level in the tube is same as that in the vessel (in N/m^2) is (surface tension of water = 0.07 N/m, atmospheric pressure = $10^5\ N/m^2$) :
(a) 10^3 (b) 99×10^3
(c) 100×10^3 (d) 101×10^3

CHEMISTRY

51. The unit J Pa^{-1} is equivalent to
(a) m^3 (b) cm^3
(c) dm^3 (d) None of these

52. A compound X of formula C_3H_8O yields a ketone C_3H_6O on oxidation. To which of the following class of compounds would X belong?
(a) Aldehyde (b) Tertiary alcohol
(c) Secondary alcohol (d) Alkene

53. The element with which of the following outer electron configuration may exhibit the largest number of oxidation states in its compounds :
(a) $3d^5 4s^2$ (b) $3d^8 4s^2$
(c) $3d^7 4s^2$ (d) $3d^6 4s^2$

54. The metal oxide which cannot be reduced to metal by carbon is
(a) Fe_2O_3 (b) Al_2O_3 (c) PbO (d) ZnO

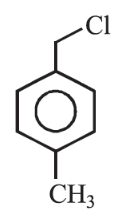
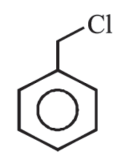
55. In Arrhenius plot, intercept is equal to
(a) $\frac{-E_a}{R}$ (b) ln A
(c) ln K (d) $\log_{10}A$

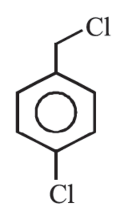
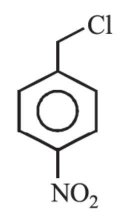
56. Benzene reacts with $CH_3COCl + AlCl_3$ to give
(a) chlorobenzene (b) toluene
(c) benzyl chloride (d) acetophenone

57. Which of the following is the incorrect statement?
(a) NaCl has 6 : 6 coordination and CsCl has 8 : 8 coordination.
(b) In Na_2O each oxide ion is coordinated by $8Na^+$ ions and each Na^+ ion by 4 oxide ions
(c) CsCl structure transform to NaCl structure on heating
(d) In CaF_2 structure each F^- ion is coordinated by 4 Ca^{2+} and vice-versa.

58. Which of the following statements is not valid for oxoacids of phosphorus?
(a) Orthophosphoric acid is used in the manufacture of triple superphosphate.
(b) Hypophosphorous acid is a diprotic acid.
(c) All oxoacids contain tetrahedral four coordinated phosphorus.
(d) All oxoacids contain atleast one P = O and one P — OH group

59. Which of the following is most reactive towards S_N2 reaction?

(a)  (b) 

(c)  (d) 

60. The equivalent conductance at infinite dilution of a weak acid such as HF
(a) can be determined by extrapolation of measurements of dilute solutions of HCl, HBr and HI.
(b) can be determined by measurement of very dilute HF solutions.
(c) can be determined from measurements of dilute solutions of NaF, NaCl and HCl.
(d) is an undefined quantity.

61. Which functional group participates in disulphide bond formation in proteins?
(a) Thioester (b) Thioether
(c) Thiol (d) Thiolactone

62. Secondary amines could be prepared by
(a) reduction of nitriles
(b) Hofmann bromamide reaction
(c) reduction of amides
(d) reduction of isonitriles

63. Among $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$ and $[NiBr_4]^{2-}$ species, the hybridisation state of Ni atoms are respectively:
(a) sp^3, ds^2p, dsp^2 (b) sp^3, dsp^2, sp^3
(c) dsp^2, sp^3, sp^3 (d) sp^3, sp^3, dsp^2

64. Specific conductance of a 0.1 N KCl solution at 23ºC is 0.012 ohm^{-1} cm^{-1}. Resistance of cell containing the solution at same temperature was found to be 55 ohm. The cell constant is
(a) 0.0616 cm^{-1} (b) 0.66 cm^{-1}
(c) 6.60 cm^{-1} (d) 660 cm^{-1}

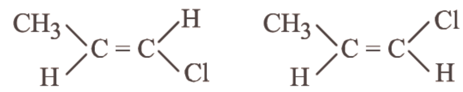
65. The rate constant for the reaction
$2N_2O_5 \longrightarrow 4NO_2 + O_2$, is 3.0×10^{-5} sec^{-1}. If the rate is 2.40×10^{-5} mol litre^{-1} sec^{-1}, then the concentration of N_2O_5 (in mol litre^{-1}) is
(a) 1.4 (b) 1.2 (c) 0.04 (d) 0.8

66. Cryolite is
(a) Na_3AlF_6 and used in the electrolysis of alumina for decreasing electrical conductivity.
(b) Na_3AlF_6 and used in the electrolysis of alumina for lowering the melting point of alumina.
(c) Na_3AlF_6 and used in the electrolytic purification of alumina.
(d) Na_3AlF_6 and used in the electrolysis of alumina.

67. Which of the following does not contain a hydrophilic structure ?
(a) Linseed oil (b) Lanolin
(c) Glycogen (d) Rubber

68. Which one of the following is not correct for an ideal solution?
(a) It must obey Raoult's law
(b) $\Delta H = 0$
(c) $\Delta H = \Delta V \neq 0$
(d) All are correct

69. Which of the following is correct set of physical properties of the geometrical isomers ?



I II

	Dipole moment	B.P.	M.P.	Stability
(a)	I > II	I > II	II > I	I > II
(b)	II > I	II > I	II > I	II > I
(c)	I > II	I > II	I > II	I > II
(d)	II > I	II > I	I > II	I > II

70. Baking powder contains :
(a) $NaHCO_3$, Ca $(H_2PO_2)_2$ and starch
(b) $NaHCO_3$, $Ca(H_2PO_2)_2$
(c) $NaHCO_3$, starch
(d) $NaHCO_3$

71. Which reaction is not feasible?
(a) $2KI + Br_2 \rightarrow 2KBr + I_2$
(b) $2KBr + I_2 \rightarrow 2KI + Br_2$
(c) $2KBr + Cl_2 \rightarrow 2KCl + Br_2$
(d) $2H_2O + 2F_2 \rightarrow 4HF + O_2$

72. Teflon and neoprene are
(a) copolymers
(b) condensation polymers
(c) homopolymers
(d) monomers

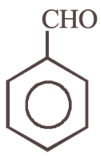
73. Which of the following reagents will convert *p*-methylbenzenediazonium chloride into *p*-cresol?
(a) Cu powder (b) H_2O
(c) H_3PO_2 (d) C_6H_5OH

74. According to IUPAC nomenclature sodium nitroprusside is named as:
(a) Sodium pentacyanonitrosylferrate (III)
(b) Sodium nitroferrocyanide
(c) Sodium nitroferricyanide
(d) Sodium pentacyanonitrosylferrate (II)

75. One mole of calcium phosphide on reaction with excess water gives
(a) one mole of phosphine
(b) two moles of phosphoric acid
(c) two moles of phosphine
(d) one mole of phosphorus pentoxide

76. The rate constant of a reaction is 3.00×10^3 L mol^{-1} sec^{-1}. The order of this reaction will be:
(a) 0 (b) 1 (c) 2 (d) 3

77. Which of the following statements is not true ?
(a) Paramagnetic substances are weakly attracted by magnetic field.
(b) Ferromagnetic substances cannot be magnetised permanently.
(c) The domains in antiferromagnetic substances are oppositely oriented with respect to each other.
(d) Pairing of electrons cancels their magnetic moment in the diamagnetic substances.

78. 

$+ CH_3CHO \xrightarrow{\text{dil. NaOH}} \underset{\text{(Major)}}{A}$. A. will be –
(a) $C_6H_5\overset{\overset{OH}{|}}{C}H-CH_2CHO$
(b) $C_6H_5CH=CH-CHO$
(c) $C_6H_5CH_2CH_2CHO$
(d) Both (b) & (c)

79. A blue colouration is not obtained when
(a) ammonium hydroxide dissolves in copper sulphate
(b) copper sulphate solution reacts with $K_4[Fe(CN)_6]$
(c) ferric chloride reacts with sod. ferrocyanide
(d) anhydrous $CuSO_4$ is dissolved in water

80. Which of the following statements is not correct?
(a) Physical adsorption is due to van der Waal's forces.
(b) Chemical adsorption first decreases with increase in temperature.
(c) Physical adsorption is reversible.
(d) Adsorption energy for a chemical adsorption is generally greater than that of physical adsorption.

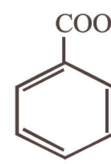
81. When 0.01 mole of a cobalt complex is treated with excess silver nitrate solution, 4.305 g silver chloride is precipitated. The formula of the complex is
(a) $[Co(NH_3)_3Cl_3]$
(b) $[Co(NH_3)_5Cl]Cl_2$
(c) $[Co(NH_3)_6]Cl_3$
(d) $[Co(NH_3)_4Cl_2]NO_3$

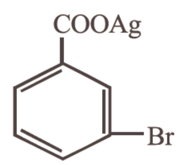
82. Match the columns

	Column-I (Type of solid)		**Column-II (Example of solid)**
A.	Molecular solid	I.	Ag
B.	Ionic solid	II.	SiC
C.	Metallic solid	III.	CCl_4
D	Covalent solid	IV.	MgO

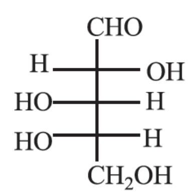
(a) A–IV, B – III, C – I, D – II
(b) A – II, B – IV, C – I, D – III
(c) A –III, B –II, C – I, D – IV
(d) A – III, B –IV, C – I, D – II

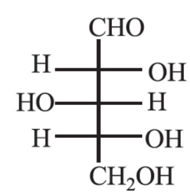
83. HBr reacts with $CH_2 = CH - OCH_3$ under anhydrous conditions at room temperature to give
(a) $BrCH_2-CH_2-OCH_3$
(b) $H_3C-CH(Br)-OCH_3$
(c) CH_3CHO and CH_3Br
(d) $BrCH_2CHO$ and CH_3OH

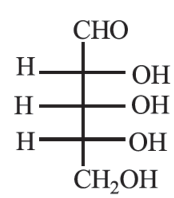
84. Silver benzoate reacts with bromine to form
(a) 
(b) 

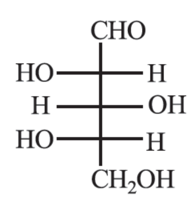
(c) 

(d) C_6H_5Br

85. Which L-sugar on oxidation gives an optically active dibasic acid (2 COOH groups)?
(a) 

(b) 

(c) 

(d) 

86. A solution containing components A and B follows Raoult's law when
(a) A – B attraction force is greater than A – A and B – B
(b) A – B attraction force is less than A – A and B – B
(c) A – B attraction force remains same as A–A and B –B
(d) volume of solution is different from sum of volume of solute and solvent

87. Find the charge in coulombs required to convert 0.2 mole VO_3^{-2} into VO_4^{-3}.
(a) 1.93×10^4 (b) 9.65×10^4
(c) 1.93×10^5 (d) 9.65×10^5

88. The alcohol which does not give a stable compound on dehydration is
(a) ethyl alcohol (b) methyl alcohol
(c) n-Propyl alcohol (d) n-Butyl alcohol

89. The simplest way to check whether a system is colloidal or not is by
(a) Tyndall effect
(b) Brownian movement
(c) Electrodialysis
(d) Measuring particle size

90. CFC which is a main reason behind air pollution, is produced by
(a) sewage pollutant (b) aerosols
(c) industrial remains (d) all the three

91. Which of the following halide is 2° ?
(a) Isopropyl chloride (b) Isobutyl chloride
(c) *n*-propyl chloride (d) *n*-butyl chloride

92. The equilibrium constant for a reaction $A + 2B \rightleftharpoons 2C$ is 40. The equilibrium constant for reaction

$C \rightleftharpoons B + \frac{1}{2}A$ is

(a) 40 (b) $\left[\frac{1}{40}\right]^2$

(c) $\frac{1}{40}$ (d) $\left[\frac{1}{40}\right]^{1/2}$

93. Best method for preparing primary amines from alkyl halides without changing the number of carbon atoms in the chain is
(a) Hoffmann bromamide reaction
(b) Gabriel phthalimide synthesis
(c) Sandmeyer reaction
(d) reaction with NH_3

94. Sulpha drugs are used for
(a) precipitating bacteria
(b) removing bacteria
(c) decreasing the size of bacteria
(d) stopping the growth of bacteria

95. When petroleum is heated gradually, the first batch of vapours evolved will be rich in
(a) kerosene (b) petroleum ether
(c) diesel (d) lubricating oil

96. On boiling an aqueous solution of $KClO_3$ with I_2 the products obtained are
(a) $KIO_3 + Cl_2$
(b) $KCl + I_2O_5$
(c) $KIO_4 + Cl_2$
(d) No reaction takes place

97. In the reaction :

$CH_3OH \xrightarrow{\text{oxidation}} A \xrightarrow{NH_3} B$; A and B respectively are
(a) HCHO, $HCOONH_4$
(b) HCOOH, $HCOONH_4$
(c) HCOOH, $HCONH_2$
(d) HCHO, $HCONH_2$

98. The chemistry of lithium is very similar to that of magnesium even though they are placed in different groups. Its reason is
(a) Both are found together in nature
(b) Both have nearly the same size
(c) Both have similar electronic configuration
(d) The ratio of their charge and size (i.e. charge density) is nearly the same

99. Consider the equation $Z = \frac{PV}{RT}$. Which of the following statements is correct?
(a) When Z > 1, real gases are easier to compress than the ideal gas
(b) When Z=1, real gases get compressed easily
(c) When Z=1, real gases are difficult to compress
(d) When Z>1, real gases are difficult to compress

100. How many propagation reactions occur simultaneously in a binary copolymerization process?
(a) 2 (b) 4 (c) 1 (d) 3

SECTION-B

MATHEMATICS

1. Let n (U) = 700, n (A) = 200, n (B) = 300, n (A $\cap$ B) = 100, then n (A' $\cap$ B') is equal to
(a) 400 (b) 600
(c) 300 (d) None of these

2. The domain and range of the relation R given by R = $\{(x, y) : y = x + \frac{6}{x}$; where x, y $\in$ N and x < 6$\}$ is
(a) {1, 2, 3}, {7, 5} (b) {1, 2}, {7, 5}
(c) {2, 3}, {5} (d) None of these

3. If $3f(x) - f\left(\frac{1}{x}\right) = \log x^4$, then $f(e^{-x})$ is
(a) $1+x$ (b) $1/x$ (c) x (d) $-x$

4. The range of the function $f(x) = \sqrt{3x^2 - 4x + 5}$ is
(a) $\left(-\infty, \sqrt{\frac{11}{3}}\right]$ (b) $\left(-\infty, \sqrt{\frac{11}{5}}\right)$
(c) $\left[\sqrt{\frac{11}{3}}, \infty\right)$ (d) $\left(\sqrt{\frac{11}{5}}, \infty\right)$

5. The value of
$\tan A + \tan(60° + A) - \tan(60° - A)$ is
(a) tan 3A (b) 2 tan 3A
(c) 3 tan 3A (d) None of these

6. For which real values of x and y, the equation
$\sec^2\theta = \frac{4xy}{(x+y)^2}$ is possible ?
(a) $x = y$ (b) $x > y$
(c) $x < y$ (d) None of these

7. If S_n denotes the sum of first n terms of an $A.P.$, whose first term is a and $\frac{S_{nx}}{S_x}$ is independent of x, then S_p =
(a) P^3 (b) P^2a (c) Pa^2 (d) a^3

8. The locus of the moving point whose coordinates are given by $(e^t + e^{-t}, e^t - e^{-t})$ where t is a parameter, is
(a) $xy = 1$ (b) $x + y = 2$
(c) $x^2 - y^2 = 4$ (d) $x^2 - y^2 = 2$

9. The length of the tangent drawn from any point on the circle $x^2 + y^2 + 2fy + \lambda = 0$ to the circle $x^2 + y^2 + 2fy + \mu = 0$, where $\mu > \lambda > 0$, is
(a) $\sqrt{\mu - \lambda}$ (b) $\sqrt{\mu + \lambda}$
(c) $\sqrt{\mu^2 - \lambda^2}$ (d) m+1

10. Find the length of intercept on the line $4y = 3x - 48$ by the parabola $y^2 = 64x$.
(a) 9 (b) 1600 (c) $\frac{1600}{9}$ (d) $\frac{9}{1600}$

11. From eighty cards numbered 1 to 80, two cards are selected randomly. The probability that both the cards have the numbers divisible by 4 is given by
(a) $\frac{21}{316}$ (b) $\frac{19}{316}$
(c) $\frac{1}{4}$ (d) None of these

12. If z is a complex number such that $z + |z| = 8 + 12i$, then the value of $|z^2|$ is equal to
(a) 228 (b) 144 (c) 121 (d) 169

13. If $5x + 1 > -24$ and $5x - 1 < 24$, then $x \in (-a, a)$. The value of 'a' is
(a) 2 (b) 3 (c) 4 (d) 5

14. The tens digits of 1! + 2! + 3 ! + ... + 49! is
(a) 1 (b) 2 (c) 3 (d) 4

15. In the binomial expansion $(a + bx)^{-3} = \frac{1}{8} + \frac{9}{8}x + ...$, then the value of a and b are :
(a) $a = 2, b = 3$ (b) $a = 2, b = -6$
(c) $a = 3, b = 2$ (d) $a = -3, b = 2$

16. If $\frac{d}{dx}\left(\frac{1 + x^4 + x^8}{1 + x^2 + x^4}\right) = ax^3 + bx$, then
(a) $a = 4, b = 2$ (b) $a = 4, b = -2$
(c) $a = -2, b = 4$ (d) None of these

17. The mean weight per student in a group of seven students is 55 kg. If the individual weights of six students are 52, 58, 55, 53, 56 and 54, then the weight of the seventh student is
(a) 55 kg (b) 60 kg (c) 57 kg (d) 50 kg

18. Let $f(x)=[x]^2+[x+1]-3$ where $[x]=$ the greatest integer function. Then
(a) $f(x)$ is a many-one and into function
(b) $f(x)=0$ for infinite number of values of x
(c) $f(x)=0$ for only two real values
(d) Both (a) and (b)

19. If $A=\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ a & b & -1\end{bmatrix}$ and I is the unit matrix of order 3, then $A^2+2A^4+4A^6$ is equal to
(a) $7A^8$ (b) $7A^7$ (c) 8I (d) 6I

20. If $f(x)=\begin{cases}\dfrac{3\sin \pi x}{5x}, & x\neq 0\\ 2k, & x=0\end{cases}$ is continuous at $x=0$, then the value of k is equal to
(a) $\dfrac{3\pi}{10}$ (b) $\dfrac{3\pi}{5}$ (c) $\dfrac{\pi}{10}$ (d) $\dfrac{3\pi}{2}$

21. Which one of the following statements is correct in respect of the curve $4y-x^2-8=0$?
(a) The curve is increasing in $(-4, 4)$
(b) The curve is increasing in $(-4, 0)$
(c) The curve is increasing in $(0, 4)$
(d) The curve is decreasing in $(-4, 4)$

22. The value of the integral
$$\int_2^e \left\{\frac{1}{\log_e x}-\frac{1}{(\log_e x)^2}\right\}dx \text{ is}$$
(a) $e-\log_e 2$ (b) $e-\log_2 e$
(c) $e-2\log_2 e$ (d) $e-\log_e 4$

23. The solution of $\dfrac{dy}{dx}=|x|$ is :
(a) $y=\dfrac{x|x|}{2}+c$ (b) $y=\dfrac{|x|}{2}+c$
(c) $y=\dfrac{x^2}{2}+c$ (d) $y=\dfrac{x^3}{2}+c$

24. If A, B and C are the vertices of a triangle whose position vectors are $\vec{a}, \vec{b}$ and $\vec{c}$ respectively and G is the centroid of the ΔABC, then $\overrightarrow{GA}+\overrightarrow{GB}+\overrightarrow{GC}$ is
(a) $\vec{0}$ (b) $\vec{a}+\vec{b}+\vec{c}$
(c) $\dfrac{\vec{a}+\vec{b}+\vec{c}}{3}$ (d) $\dfrac{\vec{a}-\vec{b}-\vec{c}}{3}$

25. The determinant $\begin{vmatrix}x & \sin\theta & \cos\theta\\ -\sin\theta & -x & 1\\ \cos\theta & 1 & x\end{vmatrix}$ is independent of
(a) x only (b) θ only
(c) x and θ both (d) None of these

26. The normal to the curve $x=a(1+\cos\theta)$, $y=a\sin\theta$ at 'θ' always passes through the fixed point
(a) (a, a) (b) (0, a) (c) (0, 0) (d) (a, 0)

27. Which of the following is not the area of the region bounded by $y=e^x$ and $x=0$ and $y=e$?
(a) $e-1$ (b) $\int_1^e \ln(e+1-y)dy$
(c) $e-\int_0^1 e^x\,dx$ (d) $\int_1^e \ln\,y\,dy$

28. If two events A and B are such that $P(\overline{A})=0.3$, $P(B)=0.4$ and $P(A\cap\overline{B})=0.5$ then $P\left(\dfrac{B}{A\cup\overline{B}}\right)=$
(a) 0.9 (b) 0.5 (c) 0.6 (d) 0.25

29. If ω $(\neq 1)$ be a cube root of unity and $(1+\omega^2)^n=(1+\omega^4)^n$, then the least positive value of n is
(a) 2 (b) 3 (c) 5 (d) 6

30. If ${}^nC_r$ denotes the number of combination of n things taken r at a time, then the expression ${}^nC_{r+1}+{}^nC_{r-1}+2\times{}^nC_r$ equals
(a) ${}^{n+1}C_{r+1}$ (b) ${}^{n+2}C_r$
(c) ${}^{n+2}C_{r+1}$ (d) ${}^{n+1}C_r$

31. The number of integral terms in the expansion of $(3^{1/2} + 2^{1/2})^{500}$ is

(a) 128 (b) 129 (c) 251 (d) 512

32. The points (4, 7, 8), (2, 3, 4), (–1, –2, 1) and (1, 2, 5) are the vertices of a

(a) parallelogram (b) rhombus
(c) rectangle (d) square

33. Let the sequence $<b_n>$ of real numbers satisfies the recurrence relation $b_{n+1} = \frac{1}{3}\left(2b_n + \frac{125}{b_n^2}\right), b_n \neq 0.$

Then find $\lim_{n\to\infty} b_n$.

(a) 10 (b) 15 (c) 5 (d) 25

34. Let p and q be any two logical statements and $r : p \to (\sim p \vee q)$. If r has a truth value F, then the truth values of p and q are respectively :

(a) F, F (b) T, T (c) T, F (d) F, T

35. The inverse of $f(x) = \frac{2}{3}\,\frac{10^x - 10^{-x}}{10^x + 10^{-x}}$ is

(a) $\frac{1}{3}\log_{10}\frac{1+x}{1-x}$ (b) $\frac{1}{2}\log_{10}\frac{2+3x}{2-3x}$

(c) $\frac{1}{3}\log_{10}\frac{2+3x}{2-3x}$ (d) $\frac{1}{6}\log_{10}\frac{2-3x}{2+3x}$

36. If $\tan^{-1}\frac{x}{\pi} < \frac{\pi}{3}, x \in N,$ then the maximum value of x is

(a) 2 (b) 5
(c) 7 (d) None of these

37. If $A = \begin{bmatrix} 0 & 1 & 3 \\ 1 & 2 & 3 \\ 3 & a & 1 \end{bmatrix}$ and $A^{-1} = \begin{bmatrix} 1/2 & -1/2 & 1/2 \\ -4 & 3 & c \\ 5/2 & -3/2 & 1/2 \end{bmatrix},$

then the value of a + c is equal to

(a) 1 (b) 0
(c) 2 (d) none of these

38. Let $y = x^3 - 8x + 7$ and $x = f(t)$. If $\frac{dy}{dt} = 2$ and $x = 3$ at $t = 0$, then the value of $\frac{dx}{dt}$ at $t = 0$ is

(a) $\frac{2}{19}$ (b) $\frac{3}{5}$ (c) $\frac{-1}{17}$ (d) $\frac{5}{16}$

39. The projection of the vector $\hat{i} - 2\hat{j} + \hat{k}$ on the vector $4\hat{i} - 4\hat{j} + 7\hat{k}$ is equal to :

(a) $\frac{19}{9}$ (b) $\frac{9}{19}$ (c) $\frac{\sqrt{3}}{19}$ (d) $\frac{19}{\sqrt{3}}$

40. The equation of the plane which makes with co-ordinate axes, a triangle with its centroid (α, β, γ) is

(a) $\alpha x + \beta y + \gamma z = 3$ (b) $\alpha x + \beta y + \gamma z = 1$

(c) $\frac{x}{\alpha} + \frac{y}{\beta} + \frac{z}{\gamma} = 3$ (d) $\frac{x}{\alpha} + \frac{y}{\beta} + \frac{z}{\gamma} = 1$

41. If $\begin{vmatrix} 2a & x_1 & y_1 \\ 2b & x_2 & y_2 \\ 2c & x_3 & y_3 \end{vmatrix} = \frac{abc}{2} \neq 0$, then the area of the triangle whose vertices are $\left(\frac{x_1}{a}, \frac{y_1}{a}\right), \left(\frac{x_2}{b}, \frac{y_2}{b}\right)$ and $\left(\frac{x_3}{c}, \frac{y_3}{c}\right)$ is

(a) $\frac{1}{4}abc$ (b) $\frac{1}{8}abc$

(c) $\frac{1}{4}$ (d) $\frac{1}{8}$

42. The angle at which the curve $y = ke^{kx}$ intersects the y-axis is :

(a) $\tan^{-1}(k^2)$ (b) $\cot^{-1}(k^2)$

(c) $\sin^{-1}\left(\frac{1}{\sqrt{1+k^4}}\right)$ (d) $\sec^{-1}\sqrt{1+k^4}$

43. The value of $\int_0^{\pi} x(\sin^4 x \cos^4 x)\,dx$ is

(a) $\frac{3\pi^2}{64}$ (b) $\frac{3\pi^2}{128}$

(c) $\frac{3\pi^2}{256}$ (d) None of these

44. Shamli wants to invest ₹50,000 in saving certificates and PPF. She wants to invest atleast ₹ 15,000 in saving certificates and at least ₹ 20,000 in PPF. The rate of interest on saving certificates is 8% p.a. and that on PPF is 9% p.a. Formulation of the above problem as LPP to determine maximum yearly income, is

(a) Maximize $Z = 0.08x + 0.09y$
Subject to, $x + y \le 50{,}000$, $x \ge 15000$, $y \ge 20{,}000$

(b) Maximize $Z = 0.08x + 0.09y$
Subject to, $x + y \le 50{,}000$, $x \ge 15000$, $y \le 20{,}000$

(c) Maximize $Z = 0.08x + 0.09y$
Subject to, $x + y \le 50{,}000$, $x \le 15000$, $y \ge 20{,}000$

(d) Maximize $Z = 0.08x + 0.09y$
Subject to, $x + y \le 50{,}000$, $x \le 15000$, $y \le 20{,}000$

45. Suppose X follows a binomial distribution with parameters n and p, where $0 < p < 1$, if $P(X = r)/P(X = n - r)$ is independent of n and r, then

(a) $p = \frac{1}{2}$ (b) $p = \frac{1}{3}$

(c) $p = \frac{1}{4}$ (d) None of these

46. $\int \frac{x + \sqrt[3]{x^2} + \sqrt[6]{x}}{x(1 + \sqrt[3]{x})} dx$ is equal to

(a) $\frac{3}{2}x^{2/3} + 6\tan^{-1} x^{1/6} + C$

(b) $\frac{3}{2}x^{2/3} - 6\tan^{-1} x^{1/6} + C$

(c) $-\frac{3}{2}x^{2/3} + 6\tan^{-1} x^{1/6} + C$

(d) None of these

47. The d.r. of normal to the plane through (1, 0, 0), (0, 1, 0) which makes an angle $\pi/4$ with plane $x + y = 3$ are

(a) $1, \sqrt{2}, 1$ (b) $1, 1, \sqrt{2}$

(c) $1, 1, 2$ (d) $\sqrt{2}, 1, 1$

48. The differential equation of all parabolas having their axes of symmerty coinciding with the axis of X is

(a) $y\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0$

(b) $x\frac{d^2x}{dy^2} + \left(\frac{dx}{dy}\right)^2 = 0$

(c) $y\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$

(d) None of these

49. Let f(x) be a continuous function such that the area bounded by the curve $y = f(x)$, x-axis and the lines

$x = 0$ and $x = a$ is $\frac{a^2}{2} + \frac{a}{2}\sin a + \frac{\pi}{2}\cos a$, then

$f\left(\frac{\pi}{2}\right) =$

(a) 1 (b) $\frac{1}{2}$

(c) $\frac{1}{3}$ (d) None of these

50. If X is a binomial Variate and P(X) is the probability function then the value of X for which the value of p(X) is the maximum, given $n = 9$, $p = \frac{1}{5}$ is

(a) 3 or 2 (b) 2 or 1
(c) 4 or 2 (d) none of these

Mock Test-2

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  ***Section-A:** Physics & Chemistry - 50 Questions each and*
  ***Section-B:** Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

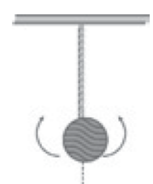
1. The maximum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is
(a) 60 (b) 30 (c) 15 (d) 25

2. A ring of mass *m* and radius *r* is melted and then moulded into a sphere. The moment of inertia of the sphere will be
(a) more than that of the ring
(b) less than that of the ring
(c) equal to that of the ring
(d) None of these

3. The young's modulus of a wire of length l and radius r is y N/m^2. If the length and radius are reduced to $\ell/2$ and r/2, then its young's modulus will be
(a) y/2 (b) y (c) 2y (d) 4y

4. When the light is incident at the polarizing angle on the transparent medium, then the completely polarized light is
(a) refracted light
(b) reflected light
(c) refracted and reflected light
(d) neither reflected nor refracted light

5. A simple pendulum is made of a body which is a hollow sphere containing mercury suspended by means of a wire. If a little mercury is drained off, the period of pendulum will



(a) remain unchanged
(b) increase
(c) decrease
(d) become erratic

6. Which of the following is not correct about relative magnetic permeability (μ_r)?
(a) It is a dimensionsless pure ratio.
(b) For vacuum medium its value is one.
(c) For ferromagnetic materials $\mu_r >> 1$
(d) For paramagnetic materials $\mu_r < 1$.

7. A non-linear polyactomic gas molecule (like NH_3) have how much degree of freedom?
(a) 5 (b) 6 (c) 4 (d) 3

8. A transverse wave is represented by $y = A \sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity?

(a) $\frac{\pi A}{2}$ (b) πA (c) $2\pi A$ (d) A

9. In an induction coil the current increases from 0 to 6 amp in 0.3 sec by which induced emf of 30 volt is produced in it then the value of coefficient of self inductance of coil will be
(a) 3 H (b) 2 H
(c) 1 H (d) 1.5 H

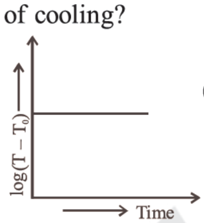
10. The X-rays of wavelength 0.5 Å are scattered by a target. What will be the energy of incident X-rays, if these are scattered at an angle of 72º ?
(a) 12.41 keV (b) 6.2 keV
(c) 18.6 keV (d) 24.82 keV

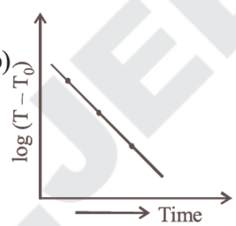
11. The centre of mass of two particles lies on the line
(a) joining the particles
(b) perpendicular to the line joining the particles
(c) at any angle to this line
(d) None of these

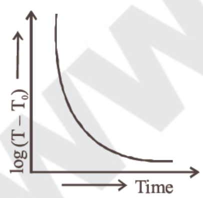
12. A transistor has three impurity regions. All the three regions have different doping levels. In order of increasing doping level, the regions are
(a) emitter, base and collector
(b) collector, base and emitter
(c) base, emitter and collector
(d) base, collector and emitter

13. If a_r and a_t represent radial and tangential accelerations, the motion of particle will be uniformly circular, if
(a) $a_r = 0$ and $a_t = 0$ (b) $a_r = 0$ but $a_t \neq 0$
(c) $a_r \neq 0$ and $a_t = 0$ (d) $a_r \neq 0$ and $a_t \neq 0$

14. Which of the given graphs proves Newton's law of cooling?

(a)


(b)


(c)


(d) None of these

15. The mass number of He is 4 and that for sulphur is 32. The radius of sulphur nuclei is larger than that of helium by
(a) $\sqrt{8}$ (b) 4 (c) 2 (d) 8

16. In a Young's double slit experiment, the separation of the two slits is doubled. To keep the same spacing of fringes, the distance D of the screen from the slits should be made
(a) $\frac{D}{2}$ (b) $\frac{D}{\sqrt{2}}$ (c) $2D$ (d) $4D$

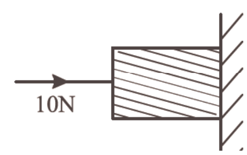
17. A pipe of length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250 Hz. The velocity of sound in air is 340 m/s.
(a) 12 (b) 8 (c) 6 (d) 4

18. Joule – second is a unit of
(a) energy
(b) torque
(c) power
(d) angular momentum

19. Magnetic lines of force due to a bar magnet do not intersect because
(a) a point always has a single net magnetic field
(b) the lines have similar charges and so repel each other
(c) the lines always diverge from a single force
(d) the lines need magnetic lenses to be made to interest

20. A Carnot engine whose sink is at 300 K has an efficiency of 40%. By how much should the temperature of source be increased so as to increase, its efficiency by 50% of original efficiency ?
(a) 325 K (b) 250 K (c) 380 K (d) 275 K

21. A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2. The weight of the block is
(a) 20 N
(b) 50 N
(c) 100 N
(d) 2 N



22. In an oscillating LC circuit with $L = 50$ mH and $C = 4.0$ μF, the current is initially a maximum. How long will it take before the capacitor is fully discharged for the first time :
(a) 7×10^{-4} s (b) 14×10^{-4} s
(c) 28×10^{-4} s (d) none

23. Pre-emphasis in FM system is done to
(a) compress modulating signal
(b) expand modulating signal
(c) amplify lower frequency component of the modulating signal
(d) amplify higher frequency component of the modulating signal

24. A body of mass m moving with velocity 3 km/h collides with a body of mass 2 m at rest. Now the coalesced mass starts to move with a velocity

(a) 1 km/h (b) 2 km/h
(c) 3 km/h (d) 4 km/h

25. The horizontal component of the earth's magnetic field is 3.6×10^{-5} tesla where the dip angle is 60°. The magnitude of the earth's magnetic field is

(a) 2.8×10^{-4} tesla (b) 2.1×10^{-4} tesla
(c) 7.2×10^{-5} tesla (d) 3.6×10^{-5} tesla

26. If $\vec{A} = 4\hat{i} + 6\hat{j}$ and $\vec{B} = 2\hat{i} + 3\hat{j}$. Then

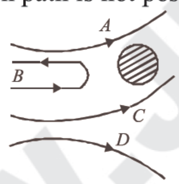
(a) $\vec{A}.\vec{B} = 29$

(b) $\vec{A} \times \vec{B} = \vec{0}$

(c) $\dfrac{|\vec{B}|}{|\vec{A}|} = \dfrac{2}{1}$

(d) angle between $\vec{A}$ and $\vec{B}$ is 30°

27. In the Rutherford experiment, α-particles are scattered from a nucleus as shown. Out of the four paths, which path is not possible?



(a) *D*
(b) *B*
(c) *C*
(d) *A*

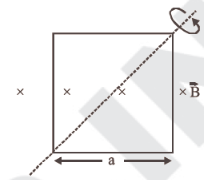
28. Two simple harmonic motions are represented by the equations $y_1 = 0.1 \sin\left(100\pi t + \dfrac{\pi}{3}\right)$ and $y_2 = 0.1 \cos \pi t$. The phase difference of the velocity of particle 1 with respect to the velocity of particle 2 is

(a) $\dfrac{\pi}{3}$ (b) $\dfrac{-\pi}{6}$ (c) $\dfrac{\pi}{6}$ (d) $\dfrac{-\pi}{3}$

29. The wavefronts of a light wave travelling in vacuum are given by x + y + z = c. The angle made by the direction of propagation of light with the X-axis is

(a) 0° (b) 45°
(c) 90° (d) $\cos^{-1}(1/\sqrt{3})$

30. A square loop of side a is rotating about its diagonal with angular velocity ω in a perpendicular magnetic field $\vec{B}$. It has 10 turns. The emf induced is



(a) $B a^2 \omega \sin \omega t$
(b) $B a^2 \omega \cos \omega t$
(c) $5\sqrt{2}\, B a^2$
(d) $10 B a^2 \omega \sin \omega t$

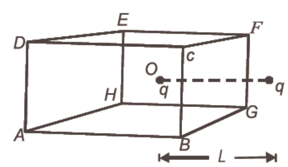
31. A prism has a refracting angle of 60°. When placed in the position of minimum deviation, it produces a deviation of 30°. The angle of incidence is

(a) 30° (b) 45° (c) 15° (d) 60°

32. An object of mass 10 kg moves at a constant speed of 10 ms^{-1}. A constant force, that acts for 4 sec on the object, gives it a speed of 2 ms^{-1} in opposite direction. The force acting on the object is

(a) –3 N (b) –30 N (c) 3 N (d) 30 N

33. A charged particle *q* is placed at the centre *O* of cube of length *L* (*A B C D E F G H*). Another same charge *q* is placed at a distance *L* from *O*. Then the electric flux through *ABCD* is



(a) $q/4\pi \in_0 L$
(b) zero
(c) $q/2\pi \in_0 L$
(d) $q/3\pi \in_0 L$

34. Spherical wavefronts, emanating from a point source, strike a plane reflecting surface. What will happen to these wave fronts, immediately after reflection?

(a) They will remain spherical with the same curvature, both in magnitude and sign.
(b) They will become plane wave fronts.
(c) They will remain spherical, with the same curvature, but sign of curvature reversed.
(d) They will remain spherical, but with different curvature, both in magnitude and sign.

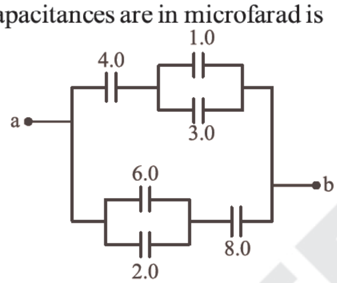
35. Of the two eggs which have identical sizes, shapes and weights, one is raw, and other is half boiled. The ratio between the moment of inertia of the raw to the half boiled egg about central axis is

(a) one (b) greater than one
(c) less than one (d) not comparable

36. A current carrying conductor placed in a magnetic field experiences maximum force when angle between current and magnetic field is
(a) $3\pi/4$ (b) $\pi/2$ (c) $\pi/4$ (d) zero

37. In a photoelectric effect measurement, the stopping potential for a given metal is found to be V_0 volt when radiation of wavelength λ_0 is used. If radiation of wavelength $2\lambda_0$ is used with the same metal then the stopping potential (in volt) will be
(a) $\frac{V_0}{2}$ (b) $2V_0$
(c) $V_0 + \frac{hc}{2e\lambda_0}$ (d) $V_0 - \frac{hc}{2e\lambda_0}$

38. The equivalent capacitance between *a* and *b* for the combination of capacitors shown in figure where all capacitances are in microfarad is

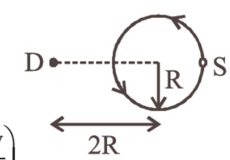


(a) 6.0 μF
(b) 4.0 μF
(c) 2.0 μF
(d) 3.0 μF

39. A capillary tube is immersed vertically in water and the height of the water column is x. When this arrangement is taken into a mine of depth d, the height of the water column is y. If R is the radius of earth, the ratio $\frac{x}{y}$ is:
(a) $\left(1-\frac{d}{R}\right)$ (b) $\left(1-\frac{2d}{R}\right)$
(c) $\left(\frac{R-d}{R+d}\right)$ (d) $\left(\frac{R+d}{R-d}\right)$

40. The resistance of an ammeter is 13 Ω and its scale is graduated for a current upto 100 amps. After an additional shunt has been connected to this ammeter it becomes possible to measure currents upto 750 amperes by this meter. The value of shunt-resistance is
(a) 2 Ω (b) 0.2 Ω (c) 2 kΩ (d) 20 Ω

41. A whistle S of frequency f revolves in a circle of radius R at a constant speed v. What is the ratio of largest and smallest frequency detected by a detector D at rest at a distance 2R from the centre of circle as shown in figure ?
(take c as speed of sound)



(a) $\left(\frac{c+v}{c-v}\right)$
(b) $\sqrt{2}\left(\frac{c+v}{c-v}\right)$
(c) $\sqrt{2}$
(d) $\frac{(c+v)}{c\sqrt{2}}$

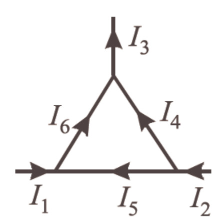
42. A spherical ball of iron of radius 2 mm is falling through a column of glycerine. If densities of glycerine and iron are respectively 1.3×10^3 kg/m^3 and 8×10^3 kg/m^3. η for glycerine $= 0.83$ Nm^{-2} sec, then the terminal velocity is
(a) 0.7 m/s (b) 0.07 m/s
(c) 0.007 m/s (d) 0.0007 m/s

43. A potentiometer wire of length L and a resistance r are connected in series with a battery of e.m.f. E_0 and a resistance r_1. An unknown e.m.f. E is balanced at a length l of the potentiometer wire. The e.m.f. E will be given by :
(a) $\frac{E_0 r}{(r+r_1)}.\frac{l}{L}$ (b) $\frac{E_0 l}{L}$
(c) $\frac{LE_0 r}{(r+r_1)l}$ (d) $\frac{LE_0 r}{l r_1}$

44. Two vibrating tuning forks producing waves given by
$y_1 = 27\sin 600\pi t$ and $y_2 = 27\sin 604\pi t$ are held near the ear of a person, how many beats will be heard in three seconds by him ?
(a) 4 (b) 2 (c) 6 (d) 12

45. Two bodies of masses 4 kg and 9 kg are separated by a distance of 60 cm. A 1 kg mass is placed in between these two masses. If the net force on 1 kg is zero, then its distance from 4 kg mass is
(a) 26 cm (b) 30 cm (c) 28 cm (d) 24 cm

46. The diagram below shows a junction with currents labeled I_1 to I_6. Which of the following statements is correct?

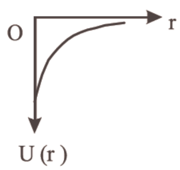


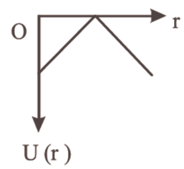
(a) $I_1 + I_3 = I_6 + I_4$
(b) $I_1 + I_2 = I_6 + I_4$
(c) $I_4 + I_3 = I_6$
(d) $I_2 = I_6 + I_4$

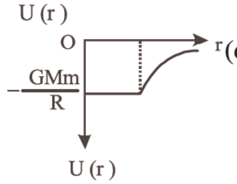
47. When a 8 kg mass is hung vertically on a light spring that obeys Hooke's law, the spring stretches by 4 cm. The work required to be done by an external agent in stretching this spring by 8 cm will be ($g = 9.8\ m/sec^2$)

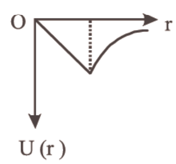
(a) 4.2 joule (b) 6.2 joule
(c) 5.2 joule (d) 3.2 joule

48. A shell of mass M and radius R has a point mass m placed at a distance r from its centre. The graph of gravitational potential energy U(r) vs distance r will be

(a)


(b)


(c)


(d)


49. In an L-C-R series circuit connected to an AC source, $V = V_0 \sin\left(100\pi t + \frac{\pi}{6}\right)$. Given $V_R = 40V$, $V_L = 40V$ and $V_C = 10V$. Resistance $R = 4\Omega$. Peak value of current in the circuit is

(a) $10\sqrt{2}A$ (b) $15\sqrt{2}A$
(c) $20\sqrt{2}A$ (d) $25\sqrt{2}A$

50. A film of water is formed between two straight parallel wires of length 10 cm each separated by 0.5 cm. If their separation is increased by 1 mm while still maintaining their parallelism, how much work will have to be done? (Surface tension of water $= 7.2 \times 10^{-2}$ N/m)

(a) 7.22×10^{-6} J (b) 1.44×10^{-5} J
(c) 2.88×10^{-5} J (d) 5.76×10^{-5} J

CHEMISTRY

51. The end product (C) in the following sequence of reactions is

$$HC \equiv CH \xrightarrow[20\%\ H_2SO_4]{1\%\ HgSO_4} A \xrightarrow[H_2O]{CH_3MgX} B \xrightarrow{[O]} (C)$$

(a) acetic acid (b) isopropyl alcohol
(c) acetone (d) ethanol

52. Octahedral complex of Cr(III) will be

(a) sp^3d^2 in case of weak field ligand
(b) d^2sp^3 in case of strong field ligand
(c) d^2sp^3 always
(d) sp^3d^2 always

53. Collision theory is applicable to

(a) first order reactions
(b) zero order reactions
(c) bimolecular reactions
(d) intra-molecular reactions

54. Which one of these is not compatible with arenes?

(a) Greater stability
(b) Delocalisation of π-electrons
(c) Electrophilic additions
(d) Resonance

55. Which set of following characteristics for ZnS crystal is correct?

(a) Coordination number (4 : 4); *ccp*; Zn^{2+} ion in the alternate tetrahedral voids
(b) Coordination number (6 : 6); *hcp*; Zn^{2+} ion in all tetrahedral voids.
(c) Coordination number (6 : 4); *hcp*; Zn^{2+} ion in all octahedral voids
(d) Coordination number (4 : 4); *ccp*; Zn^{2+} ion in all tetrahedral voids.

56. The correct order of decreasing polarisability of following ions is

(a) Cl^-, Br^-, I^-, F^- (b) F^-, I^-, Br^-, Cl^-
(c) F^-, Cl^-, Br^-, I^- (d) I^-, Br^-, Cl^-, F^-

57. For a first order reaction, A $\to$ products the concentration of A changes from 0.1 M to 0.025 M in 40 minutes.
The rate of reaction when the concentration of A is 0.01 M is :

(a) 1.73×10^{-5} M/min
(b) 3.47×10^{-4} M/min
(c) 3.47×10^{-5} M/min
(d) 1.73×10^{-4} M/min

58. One litre oxygen gas at S.T.P will weigh

(a) 1.43 g (b) 2.24 g
(c) 11.2 g (d) 22.4 g

59. Which of the following is not the property of natural rubber?
(a) Low tensile strength
(b) High water absorption capacity
(c) Soft and sticky
(d) High elasticity

60. Which of the following will not give iodoform test?
(a) Isopropyl alcohol
(b) Ethanol
(c) Ethanal
(d) Benzyl alcohol

61. A deep brown gas is formed by mixing two colourless gases which are
(a) NO_2 and O_2 (b) N_2O and NO
(c) NO and O_2 (d) NH_3 and HCl

62. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of water for this aqueous solution is
(a) 76.00 torr (b) 752.40 torr
(c) 759.00 torr (d) 7.60 torr

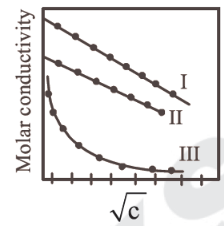
63. 16 g of oxygen and 3 g of hydrogen are mixed and kept at 760 mm of Hg pressure and 0° C. The total volume occupied by the mixture will be nearly
(a) 22.4 litres (b) 33.6 litres
(c) 448 litres (d) 44800 mL

64. An organic amino compound reacts with aqueous nitrous acid at low temperature to produce an oily nitrosoamine. The compound is
(a) CH_3NH_2
(b) $CH_3CH_2NH_2$
(c) $CH_3CH_2NHCH_2CH_3$
(d) $(CH_3CH_2)_3N$

65. Chemical formula for iron (III) hexacyanoferrate (II) is
(a) $Fe[Fe(CN)_6]$ (b) $Fe_3[Fe(CN)_6]$
(c) $Fe_3[Fe(CN)_6]_4$ (d) $Fe_4[Fe(CN)_6]_3$

66. In which of the following hydrogen is most acidic?
(a) Acetylene (b) Methane
(c) Ethane (d) Ethylene

67. A graph was plotted between molar conductivity of various electrolytes (NaCl, HCl and NH_4OH) and $\sqrt{c}\,(\text{in mol L}^{-1})$. Correct set is :



(a) I (NaCl), II (HCl), III, (NH_4OH)
(b) I (HCl), II (NaCl), III, (NH_4OH)
(c) I (NH_4OH), II (NaCl), III, (HCl)
(d) I (NH_4OH), II (HCl), III, (NaCl)

68. In the metallurgy of zinc, the reducing agent employed in reducing the zinc oxide to crude zinc metal in the last stage is
(a) Al (b) Li
(c) Coke (d) Water gas

69. Metals like Pt and Pd can adsorb large volume of hydrogen under specific conditions. Such adsorbed hydrogen by the metal is known as
(a) occluded hydrogen
(b) absorbed hydrogen
(c) reactive hydrogen
(d) atomic hydrogen

70. If concentration of reactants is increased by 'x', then k becomes
(a) $\ln\frac{k}{x}$ (b) $\frac{k}{x}$ (c) $k+x$ (d) k

71. At anode in the electrolysis of fused NaCl
(a) Na^+ is oxidized (b) Cl^- is oxidized
(c) Cl is reduced (d) Na is reduced

72. The correct decreasing order of priority of functional groups is
(a) $-SO_3H$, $-OH$, $-COCl$, $>C=C<$
(b) $-COOH$, $-SO_3H$, $-COOR$, $-OH$
(c) $-C\equiv C$, $-NH_2$, $-OH$, $>C=O$
(d) $-CN$, $-CONH_2$, $>C=O$, $-OH$

73. The main element of smog is
(a) O_3 and PAN (b) O_3
(c) PAN (d) PPN and PBN

74. Which of the following monosaccharide is a pentose ?

(a) Galactose (b) Glucose
(c) Fructose (d) Arabinose

75. 1-Chlorobutane on reaction with alcoholic potash gives

(a) 1-butene (b) 1-butanol
(c) 2-butene (d) 2-butanol

76. Which group contains coloured ions out of

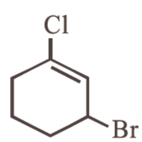
1. Cu^{2+} 2. Ti^{4+} 3. Co^{2+} 4. Fe^{2+}

(a) 1, 2, 3, 4 (b) 1, 3, 4
(c) 2, 3 (d) 1, 2

77. In a solid lattice the cation has left a lattice site and is located at an interstitial position, the lattice defect is :

(a) Interstitial defect (b) Valency defect
(c) Frenkel defect (d) Schottky defect

78. The IUPAC name of the compound shown below is :



(a) 3-bromo-1-chlorocyclohexene
(b) 1-bromo-3-chlorocyclohexene
(c) 2-bromo-6-chlorocyclohex-1-ene
(d) 6-bromo-2-chlorocyclohexene

79. Phosphine is not obtained by which of the following reaction

(a) White P is heated with NaOH
(b) Red P is heated with NaOH
(c) Ca_3P_2 reacts with water
(d) Phosphorus trioxide is boiled with water

80. A drug that is antipyretic as well as analgesic is

(a) chloropromazine hydrochloride
(b) para- acetamidophenol
(c) chloroquin
(d) penicillin

81. Out of TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$ (Z of Ti = 22, Co = 27, Cu = 29, Ni = 28), the colourless species are:

(a) Cu_2Cl_2 and $NiCl_4^{2-}$
(b) TiF_6^{2-} and Cu_2Cl_2
(c) CoF_6^{3-} and $NiCl_4^{2-}$
(d) TiF_6^{2-} and CoF_6^{3-}

82. Equal moles of water and urea are taken in a flask. What is mass percentage of urea in the solution ?

(a) 7.692% (b) 769.2%
(c) 76.92% (d) 0.7692%

83. Surface tension of lyophilic sols is

(a) lower than that of H_2O.
(b) more than that of H_2O.
(c) equal to that of H_2O.
(d) either less or more than H_2O depending upon the nature of disperse phase.

84. The reaction of $KMnO_4$ and HCl results in

(a) oxidation of Mn in $KMnO_4$ and production of Cl_2
(b) reduction of Mn in $KMnO_4$ and production of H_2
(c) oxidation of Mn in $KMnO_4$ and production of H_2
(d) reduction of Mn in $KMnO_4$ and production of Cl_2

85. Chlorination of toluene in the presence of light and heat followed by treatment with aqueous NaOH gives

(a) *o*-Cresol
(b) *p*-Cresol
(c) 2,4-Dihydroxytoluene
(d) Benzoic acid

86. Consider the following complex $[Co(NH_3)_5CO_3]ClO_4$. The coordination number, oxidation number, number of *d*-electrons and number of unpaired *d*-electrons on the metal are respectively

(a) 6, 3, 6, 0 (b) 7, 2, 7, 1
(c) 7, 1, 6, 4 (d) 6, 2, 7, 3

87. In the diazotization of arylamines with sodium nitrite and hydrochloric acid, an excess of hydrochloric acid is used primarily to
(a) supress the concentration of free aniline available for coupling.
(b) supress hydrolysis of phenol.
(c) ensure a stoichiometric amount of nitrous acid.
(d) neutralise the base liberated.

88. Which ore contains both iron and copper?
(a) Cuprite (b) Chalcocite
(c) Chalcopyrite (d) Malachite

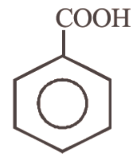
89. According to Le-Chatelier's principle, adding heat to a solid $\rightleftharpoons$ liquid equilibrium will cause the
(a) temperature to increase
(b) temperature to decrease
(c) amount of liquid to decrease
(d) amount of solid to decrease.

90. Consider the following statements for condensation polymerization -
I. Bifunctional or polyfunctional monomers
II. Loss of each kind of functional group in each step for bifunctional species
III. Always accompanied by the release of a byproduct molecule
IV. Monofunctional or polyfunctional monomers
Which of the following are true?
(a) I and II (b) I, II and III
(c) I and III (d) III and IV

91. Aldehydes and ketones are distinguished by which of the following test ?
(a) Lucas test
(b) Tollen's test
(c) $KMnO_4$ solution (Baeyer's test)
(d) None of these

92. 'Z' in the following sequence of reactions is

$$C_6H_6 \xrightarrow[\Delta]{HNO_3/H_2SO_4} W \xrightarrow{Zn/HCl} X \xrightarrow[HCl]{NaNO_2} Y \xrightarrow{H_2O/H_3PO_2} Z$$

(a) 

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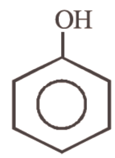
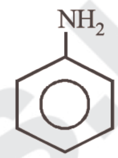
(c) 

(d) 

93. Alum helps in purifying water by
(a) forming Si complex with clay particles.
(b) sulphate part which combines with the dirt and removes it.
(c) aluminium which coagulates the mud particiles.
(d) making mud water soluble.

94. In a solid 'AB' having the NaCl structure, 'A' atoms occupy the corners of the cubic unit cell. If all the face-centered atoms along one of the axes are removed, then the resultant stoichiometry of the solid is
(a) AB_2 (b) A_2B (c) A_4B_3 (d) A_3B_4

95. Among the following actinide pairs, the maximum oxidation states is shown by
(a) U and Np (b) Np and Pu
(c) Pu and Am (d) U and Pa

96. Which one of the following reaction occurs at the cathode?
(a) $2OH^- \longrightarrow H_2O + O + 2e^-$
(b) $Ag \longrightarrow Ag^+ + e^-$
(c) $Fe^{2+} \longrightarrow Fe^{3+} + e^-$
(d) $Cu^{2+} + 2e^- \longrightarrow Cu$

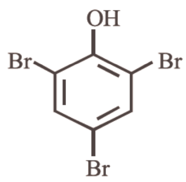
97. Lead pipes are not suitable for drinking water because
(a) a layer of lead dioxide is deposited over pipes
(b) lead reacts with air to form litharge
(c) lead reacts with water containing air to form $Pb(OH)_2$
(d) lead forms basic lead carbonate

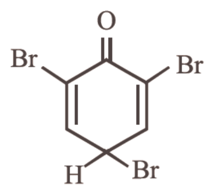
98. Imino acid among these compounds is

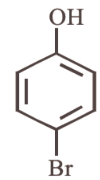
(a) serine (b) proline

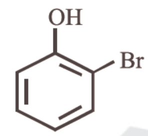
(c) tyrosine (d) lysine

99. What is the structure of the major product when phenol is treated with bromine water ?

(a) 

(b) 

(c) 

(d) 

100. The presence or absence of hydroxyl group on which carbon atom of sugar differentiates RNA and DNA?

(a) 1st (b) 2nd (c) 3rd (d) 4th

SECTION-B

MATHEMATICS

1. In a class of 100 students, 55 students have passed in mathematics and 67 students have passed in physics. Then the number of students who have passed in physics only is

(a) 22 (b) 33 (c) 10 (d) 45

2. If $f(x) = x$ and $g(x) = |x|$, then $(f + g)(x)$ is equal to

(a) 0 for all $x \in R$ (b) $2x$ for all $x \in R$

(c) $\begin{cases} 2x, \text{for } x \geq 0 \\ 0, \text{ for } x < 0 \end{cases}$ (d) $\begin{cases} 0, \text{ for } x \geq 0 \\ 2x, \text{ for } x < 0 \end{cases}$

3. Let A = {x, y, z} and B = {a, b, c, d}. Then, which one of the following is not a relation from A to B?

(a) {(x, a), (x, c)} (b) {(y, c), (y, d)}

(c) {(z, a), (z, d)} (d) {(z, b), (y, b), (a, d)}

4. A, B, C are the angles of a triangle, then

$\sin^2 A + \sin^2 B + \sin^2 C - 2\cos A \cos B \cos C =$

(a) 1 (b) 2 (c) 3 (d) 4

5. If the coefficients of rth, $(r + 1)$th, and $(r + 2)$th terms in the the binomial expansion of $(1 + y)^m$ are in A.P., then m and r satisfy the equation

(a) $m^2 - m(4r - 1) + 4r^2 - 2 = 0$

(b) $m^2 - m(4r + 1) + 4r^2 + 2 = 0$

(c) $m^2 - m(4r + 1) + 4r^2 - 2 = 0$

(d) $m^2 - m(4r - 1) + 4r^2 + 2 = 0$

6. Two tangents PQ and PR drawn to the circle $x^2 + y^2 - 2x - 4y - 20 = 0$ from point P (16, 7). If the centre of the circle is C then the area of quadrilateral PQCR is

(a) 75 sq. unit (b) 73 sq. unit

(c) 72 sq. unit (d) 74 sq. unit

7. Two dice are thrown together. Then the probability, that the sum of numbers appearing on them is a prime number, is

(a) $\frac{5}{12}$ (b) $\frac{7}{18}$ (c) $\frac{13}{36}$ (d) $\frac{11}{36}$

8. If z and ω are two non-zero complex numbers such that $|z\omega| = 1$ and $Arg(z) - Arg(\omega) = \frac{\pi}{2}$, then $\bar{z}\omega$ is equal to

(a) $-i$ (b) 1 (c) -1 (d) i.

9. If $\frac{2}{9!} + \frac{2}{3!7!} + \frac{1}{5!5!} = \frac{2^a}{b!}$, where $a, b \in$ N, then the ordered pair (a, b) is

(a) (9, 10) (b) (10, 9) (c) (7, 10) (d) (10, 7)

10. If the third term in the expansion of $[x + x^{\log_{10} x}]^5$ is 10^6, then x may be

(a) 1 (b) $\sqrt{10}$ (c) 10 (d) $10^{-2/5}$

11. Find the equation of set points P such that $PA^2 + PB^2 = 2K^2$, where A and B are the points (3, 4, 5) and (–1, 3, –7), respectively :

(a) $K^2 - 109$ (b) $2K^2 - 109$

(c) $3K^2 - 109$ (d) $4K^2 - 10$

12. $\lim_{x \to 0} (\operatorname{cosec} x)^{1/\log x}$ is equal to :

(a) 0 (b) 1

(c) $\frac{1}{e}$ (d) None of these

13. If p and q are two statement then $(p \leftrightarrow \sim q)$ is true when –

(a) p and q both are true

(b) p and q both are false

(c) p is false and q is true

(d) None of these

14. Let $f : [4, \infty) \to [1, \infty)$ be a function defined by $f(x) = 5^{x(x-4)}$, then $f^{-1}(x)$ is

(a) $2 - \sqrt{4 + \log_5 x}$ (b) $2 + \sqrt{4 + \log_5 x}$

(c) $\left(\frac{1}{5}\right)^{x(x-4)}$ (d) None of these

15. The sum of the infinite series

$\cot^{-1} 2 + \cot^{-1} 8 + \cot^{-1} 18 + \cot^{-1} 32 + \ldots$ is

(a) π (b) $\frac{\pi}{2}$

(c) $\frac{\pi}{4}$ (d) None of these

16. If $A = \begin{bmatrix} 1 & 0 \\ 1/2 & 1 \end{bmatrix}$, A^{400} is equal to

(a) $\begin{pmatrix} 1 & 0 \\ 50 & 1 \end{pmatrix}$ (b) $\begin{pmatrix} 1 & 0 \\ (1/2)^{100} & 1 \end{pmatrix}$

(c) $\begin{pmatrix} 1 & 0 \\ 25 & 1 \end{pmatrix}$ (d) None of these

17. If the determinant

$$\Delta = \begin{vmatrix} a & b & (ax+b)/x \\ b & c & bx+c \\ ax+b & bx+c & 0 \end{vmatrix} = 0,$$

then a, b, c are in :

(a) A.P. (b) G.P.

(c) H.P. (d) None of the above

18. If $f(x) = \frac{1}{1-x}$, then the points of discontinuity of the function $f[f\{f(x)\}]$ are

(a) $\{0, -1\}$ (b) $\{0, 1\}$

(c) $\{1, -1\}$ (d) None of these

19. The area enclosed between the curves $y = ax^2$ and $x = ay^2$ $(a > 0)$ is 1 sq. unit, then the value of a is

(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{1}{2}$ (c) 1 (d) $\frac{1}{3}$

20. $\int \frac{dx}{\cos x - \sin x}$ is equal to

(a) $\frac{1}{\sqrt{2}} \log \left| \tan\left(\frac{x}{2} + \frac{3\pi}{8}\right) \right| + C$

(b) $\frac{1}{\sqrt{2}} \log \left| \cot\left(\frac{x}{2}\right) \right| + C$

(c) $\frac{1}{\sqrt{2}} \log \left| \tan\left(\frac{x}{2} - \frac{3\pi}{8}\right) \right| + C$

(d) $\frac{1}{\sqrt{2}} \log \left| \tan\left(\frac{x}{2} - \frac{\pi}{8}\right) \right| + C$

21. $\frac{d^n}{dx^n}(\log x) =$

(a) $\frac{(n-1)!}{x^n}$ (b) $\frac{n!}{x^n}$

(c) $\frac{(n-2)!}{x^n}$ (d) $(-1)^{n-1} \frac{(n-1)!}{x^n}$

22. Let $ABCD$ be a parallelogram. If $\overrightarrow{AB} = \hat{i} + 3\hat{j} + 7\hat{k}$, $\overrightarrow{AD} = 2\hat{i} + 3\hat{j} + -5\hat{k}$ and $\vec{p}$ is a unit vector parallel to $\overrightarrow{AC}$, then $\vec{p}$ is equal to

(a) $\frac{1}{3}(2\hat{i} + \hat{j} + 2\hat{k})$ (b) $\frac{1}{3}(2\hat{i} - 2\hat{j} + \hat{k})$

(c) $\frac{1}{7}(3\hat{i} + 6\hat{j} + 2\hat{k})$ (d) $\frac{1}{7}(6\hat{i} + 2\hat{j} + 3\hat{k})$

23. The two lines $x = ay + b$, $z = cy + d$ and $x = a'y + b'$, $z = c'y + d'$ will be perpendicular, if and only if

(a) $aa' + cc' + 1 = 0$

(b) $aa' + bb' + cc' + 1 = 0$

(c) $aa' + bb' + cc' = 0$

(d) $(a + a')(b + b') + (c + c') = 0.$

24. The equation of the tangent to the curve $y = e^{-|x|}$ at the point where the curve cuts the line $x = 1$ is

(a) $e(x + y) = 1$ (b) $y + ex = 1$

(c) $y + x = e$ (d) None of these

25. Maximize $Z = 4x + 6y$, subject to $3x + 2y \le 12$, $x + y \ge 4$, $x, y \ge 0$, is

(a) 16 at (4,0) (b) 24 at (0, 4)

(c) 24 at (6, 0) (d) 36 at (0, 6)

26. The gradient of the curve passing through (4, 0) is given by $\frac{dy}{dx} - \frac{y}{x} + \frac{5x}{(x+2)(x-3)} = 0$ if the point (5, a) lies on the curve, then the value of a is

(a) $\frac{67}{12}$ (b) $5 \sin \frac{7}{12}$

(c) $5 \log \frac{7}{12}$ (d) None of these

27. For a biased dice, the probability for the different faces to turn up are

Face	1	2	3	4	5	6
P	0.10	0.32	0.21	0.15	0.05	0.17

The dice is tossed and it is told that either the face 1 or face 2 has shown up, then the probability that it is face 1, is

(a) $\frac{16}{21}$ (b) $\frac{1}{10}$ (c) $\frac{5}{16}$ (d) $\frac{5}{21}$

28. $\int_0^2 [x^2]dx$ is

(a) $2 - \sqrt{2}$ (b) $2 + \sqrt{2}$

(c) $\sqrt{2} - 1$ (d) $-\sqrt{2} - \sqrt{3} + 5$

29. If $0 \le x \le \pi$ and $81^{\sin^2 x} + 81^{\cos^2 x} = 30$, then $x =$

(a) $\pi/6$ (b) $\pi/2$ (c) $\pi/4$ (d) $3\pi/4$

30. If $x = 1 + a + a^2 + ...$to infinity and $y = 1 + b + b^2 + ...$to infinity, where a, b are proper fractions, then $1 + ab + a^2b^2 + ...$to infinity is equal :

(a) $\frac{xy}{x + y - 1}$ (b) $\frac{xy}{x - y - 1}$

(c) $\frac{xy}{x - y + 1}$ (d) $\frac{xy}{x + y + 1}$

31. The slopes of the lines which make an angle 45° with the line $3x - y = -5$ are

(a) $1, -1$ (b) $\frac{1}{2}, -1$ (c) $1, \frac{1}{2}$ (d) $-2, \frac{1}{2}$

32. If $P \equiv (x, y)$, $F_1 \equiv (3, 0)$, $F_2 \equiv (-3, 0)$ and $16x^2 + 25y^2 = 400$, then $PF_1 + PF_2$ equals

(a) 8 (b) 6 (c) 10 (d) 12

33. Product of real roots of the equation $t^2x^2 + |x| + 9 = 0$

(a) is always positive (b) is always negative

(c) does not exist (d) None of these

34. If $f(z) = \frac{7 - z}{1 - z^2}$, where $z = 1 + 2i$, then $|f(z)|$ is equal to :

(a) $\frac{|z|}{2}$ (b) $|z|$

(c) $2|z|$ (d) None of these

35. The solution set of the inequality $5^{x+2} > \left(\frac{1}{25}\right)^{1/x}$ is

(a) (–2, 0) (b) (–2, 2)

(c) (–5, 5) (d) (0, ∞)

36. The number of ways in which first, second and third prizes can be given to 5 competitors is
(a) 10 (b) 60 (c) 15 (d) 125

37. The number of dissimilar terms in the expansion of $(a+b)^n$ is n + 1, therefore number of dissimilar terms in the expansion of $(a+b+c)^{12}$ is
(a) 13 (b) 39 (c) 78 (d) 91

38. If $y=\left(1+\frac{1}{x}\right)\left(1+\frac{2}{x}\right)\left(1+\frac{3}{x}\right).....\left(1+\frac{n}{x}\right)$ and $x \neq 0$, then $\frac{dy}{dx}$ when $x=-1$ is
(a) $n!$ (b) $(n-1)!$
(c) $(-1)^n(n-1)!$ (d) $(-1)^n n!$

39. Mean of 100 items is 49. It was discovered that three items which should have been 60, 70, 80 were wrongly read as 40, 20, 50 respectively. The correct mean is
(a) 48 (b) $82\frac{1}{2}$ (c) 50 (d) 80

40. If $f(x)=\sin x+\cos x$, $g(x)=x^2-1$, then $g(f(x))$ is invertible in the domain
(a) $\left[0,\frac{\pi}{2}\right]$ (b) $\left[-\frac{\pi}{4},\frac{\pi}{4}\right]$
(c) $\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$ (d) $[0,\pi]$

41. The matrix $A=\begin{bmatrix}-5 & -8 & 0\\ 3 & 5 & 0\\ 1 & 2 & -1\end{bmatrix}$ is
(a) idempotent matrix (b) involutory matrix
(c) nilpotent matrix (d) None of these

42. Consider the system of equations :
$x+ay=0$, $y+az=0$ and $z+ax=0$. Then the set of all real values of 'a' for which the system has a unique solution is:
(a) $R-\{1\}$ (b) $R-\{-1\}$
(c) $\{1,-1\}$ (d) $\{1,0,-1\}$

43. If $y=\frac{(a-x)\sqrt{a-x}-(b-x)\sqrt{x-b}}{\sqrt{a-x}+\sqrt{x-b}}$, then $\frac{dy}{dx}$ wherever it is defined is
(a) $\frac{x+(a+b)}{\sqrt{(a-x)(x-b)}}$ (b) $\frac{2x-a-b}{2\sqrt{a-x}\sqrt{x-b}}$
(c) $-\frac{(a+b)}{2\sqrt{(a-x)(x-b)}}$ (d) $\frac{2x+(a+b)}{2\sqrt{(a-x)(x-b)}}$

44. $\int\frac{(1+x)e^x}{\cot(xe^x)}dx$ is equal to
(a) $\log\left|\cos(xe^x)\right|+C$ (b) $\log\left|\cot(xe^x)\right|+C$
(c) $\log\left|\sec(xe^{-x})\right|+C$ (d) $\log\left|\sec(xe^x)\right|+C$

45. If $(\vec{a}\times\vec{b})^2+(\vec{a}.\vec{b})^2=676$ and $|\vec{b}|=2$ then $|\vec{a}|$ is equal to
(a) 13 (b) 26
(c) 39 (d) None of these

46. The area enclosed between the curves $y^2=x$ and $y=|x|$ is
(a) 1/6 (b) 1/3 (c) 2/3 (d) 1

47. A coin is tossed 7 times. The probability that at least 4 consecutive heads appear is
(a) $\frac{3}{16}$ (b) $\frac{5}{32}$ (c) $\frac{3}{32}$ (d) $\frac{1}{8}$

48. $f(x)=(\sin^2 x)e^{-2\sin^2 x}$; max. $f(x)$ – min. $f(x)$ =
(a) $\frac{1}{e^2}$ (b) $\frac{1}{2e}-\frac{1}{e^2}$
(c) 1 (d) None of these

49. The solution of $\frac{dy}{dx}=\frac{e^x(\sin^2 x+\sin 2x)}{y(2\log y+1)}$ is
(a) $y^2(\log y)-e^x\sin^2 x+c=0$
(b) $y^2(\log y)-e^x\cos^2 x+c=0$
(c) $y^2(\log y)+e^x\cos^2 x+c=0$
(d) None of these

50. $\int_0^{\pi} x f(\sin x)dx$ is equal to
(a) $\pi\int_0^{\pi} f(\cos x)dx$ (b) $\pi\int_0^{\pi} f(\sin x)dx$
(c) $\frac{\pi}{2}\int_0^{\pi/2} f(\sin x)dx$ (d) $\pi\int_0^{\pi/2} f(\cos x)dx$

Mock Test-3

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. Which of the following relationship between the acceleration and displacement x of a particle involve SHM?

(a) $a = 2x$ (b) $a = 4x^2$
(c) $a = -5x$ (d) $a = -3x^2$

2. What will be the maximum speed of a car on a road turn of radius 30 m if the coefficient of friction between the tyres and the road is 0.4 (Take g = 9.8 m/s^2)

(a) 10.84 m/s (b) 9.84 m/s
(c) 8.84 m/s (d) 6.84 m/s

3. When a body undergoes a linear tensile strain it experiences a lateral contraction also. The ratio of lateral contraction to longitudinal strain is known as

(a) Young's modulus (b) Bulk modulus
(c) Poisson's ratio (d) Hooke's law

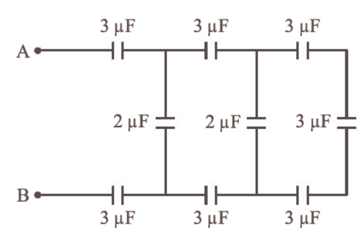
4. When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is

(a) $\frac{1}{4}I_0$ (b) $\frac{1}{2}I_0$
(c) I_0 (d) zero

5. If the electric flux entering and leaving a closed surface are 6×10^6 and 9×10^6 respectively, then the charge inside the surface of permittivity of free space ε_0 is

(a) $\varepsilon_0 \times 10^6$ (b) $-\varepsilon_0 \times 10^6$
(c) $-2\varepsilon_0 \times 10^6$ (d) $3\varepsilon_0 \times 10^6$

6. The equivalent capacitance between A and B is (in μF)



(a) 25
(b) $\frac{84}{25}$
(c) 9
(d) 1

7. A voltmeter essentially consists of

(a) a high resistance, in series with a galvanometer
(b) a low resistance, in series with a galvanometer
(c) a high resistance in parallel with a galvanometer
(d) a low resistance in parallel with a galvanometer

8. A nucleus splits into two nuclear parts which have their velocity ratio equal to 5 : 1. What will be the ratio of their nuclear radius?

(a) $5^{1/3} : 1$ (b) $1 : 5^{1/3}$ (c) $3^{1/2} : 1$ (d) $1 : 3^{1/2}$

9. In a stream line (laminar flow) the velocity of flow at any point in the liquid

(a) does not vary with time
(b) may vary in direction but not in magnitude
(c) may vary in magnitude but not in direction
(d) may vary both in magnitude and direction

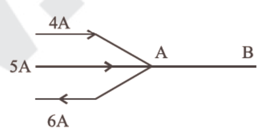
10. When two quantities are divided, the relative error in the result is given by
(a) the product of the relative error in the individual quantities
(b) the quotient of the relative error in the individual quantities
(c) the difference of the relative error in the individual quantities
(d) the sum of the relative error in the individual quantities

11. $\overline{A}$ and $\overline{B}$ are two vectors and θ is the angle between them, if $|\overline{A}\times\overline{B}| = \sqrt{3}(\overline{A}.\overline{B})$, the value of θ is
(a) 45° (b) 30° (c) 90° (d) 60°

12. In semiconductors, at room temperature
(a) the conduction band is completely empty
(b) the valence band is partially empty and the conduction band is partially filled
(c) the valence band is completely filled and the conduction band is partially filled
(d) the valence band is completely filled

13. For an AM wave, the maximum voltage was found to be 10 V and minimum voltage was 4 V. The modulation index of the wave is
(a) 0.33 (b) 0.43 (c) 0.56 (d) 0.64

14. The four wires from a larger circuit intersect at junction A as shown. What is the magnitude and direction of the current between points A and B ?
(a) 2 A from A to B
(b) 2A from B to A
(c) 3A from A to B
(d) 2A from B to A



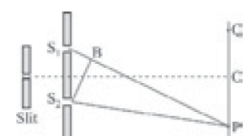
15. Two identical particles are located at $\vec{x}$ and $\vec{y}$ with reference to the origin of three dimensional co-ordinate system. The position vector of centre of mass of the system is given by
(a) $\vec{x}-\vec{y}$ (b) $\frac{\vec{x}+\vec{y}}{2}$
(c) $(\vec{x}-\vec{y})$ (d) $\frac{\vec{x}-\vec{y}}{2}$

16. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm^2 and length = 20 cm. If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is
($\mu_0 = 4\pi\times10^{-7}$ Tm A^{-1})
(a) $2.4\pi\times10^{-5}$ H (b) $4.8\pi\times10^{-4}$ H
(c) $4.8\pi\times10^{-5}$ H (d) $2.4\pi\times10^{-4}$ H

17. An organ pipe open at one end is vibrating in first overtone and is in resonance with another pipe open at both ends and vibrating in third harmonic. The ratio of length of two pipes is
(a) 1 : 2 (b) 4 : 1 (c) 8 : 3 (d) 3 : 8

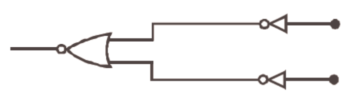
18. The angular velocity of the earth with which it has to rotate so that acceleration due to gravity on 60° latitude becomes zero is (Radius of earth = 6400 km, at the poles g = 10 ms^{-2})
(a) 2.5×10^{-3} rad/s (b) 5.0×10^{-1} rad/s
(c) 10×10^{1} rad/s (d) 7.8×10^{-2} rad/s

19. In the figure is shown Young's double slit experiment. Q is the position of the first bright fringe on the right side of O, P is the 11th fringe on the other side, as measured from Q. If the wavelength of the light used is 6000×10^{-10}m, then S_1B will be equal to



(a) 6×10^{-6} m (b) 6.6×10^{-6}m
(c) 3.138×10^{-7} m (d) 3.144×10^{-7} m

20. Figure consists of two NOT gates followed by a NOR gate. This combination is equivalent to a single



(a) NAND gate (b) AND gate
(c) OR gate (d) XOR gate

21. A particle describe a horizontal circle of radius 0.5 m with uniform speed. The centripetal force acting is 10 N. The work done in describing a semicircle is
(a) zero (b) 5 J (c) 5 π J (d) 10 π J

22. A current of 5 ampere is flowing in a wire of length 1.5 metres. A force of 7.5 N acts on it when it is placed in a uniform magnetic field of 2 tesla. The angle between the magnetic field and the direction of the current is
(a) 30° (b) 45° (c) 60° (d) 90°

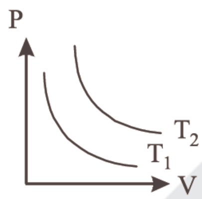
23. A particle describes uniform circular motion in a circle of radius 2 m, with the angular speed of 2 rad s^{-1}. The magnitude of the change in its velocity in $\frac{\pi}{2}$ s is

(a) $0\ m\ s^{-1}$ (b) $2\sqrt{2} ms^{-1}$
(c) $8\ m\ s^{-1}$ (d) $4\ m\ s^{-1}$

24. A 100 turns coil of area of cross section 200 cm^2 having 2 Ω resistance is held perpendicular to a magnetic field of 0.1 T. If it is removed from the magnetic field in one second, the induced charge produced in it is

(a) 0.2 C (b) 2 C (c) 0.1 C (d) 1 C

25. The adjoining figure shows graph of pressure and volume of a gas at two tempertures T_1 and T_2. Which of the following inferences is correct?



(a) $T_1 > T_2$
(b) $T_1 = T_2$
(c) $T_1 < T_2$
(d) None of these

26. A machine gun has a mass 5 kg. It fires 50 gram bullets at the rate of 30 bullets per minute at a speed of 400 ms^{-1}. What force is required to keep the gun in position?

(a) 10 N (b) 5 N (c) 15 N (d) 30 N

27. In an experiment to measure the internal resistance of a cell, by a potentiometer, it is found that the balance point is at a length of 2 m, when the cell is shunted by a 5 Ω resistance and is at a length of 3 m when the cell is shunted by a 10 Ω resistance. The internal resistance of the cell is then

(a) 1.5 Ω (b) 10 Ω (c) 15 Ω (d) 1 Ω

28. For transmission of e.m.wave of audible frequency, these waves are superimposed with waves of

(a) frequency less than 20 Hz
(b) frequency less than 10 KHz.
(c) frequency in the audible range.
(d) radio-frequency.

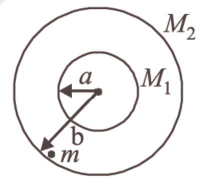
29. The binding energy of deuteron is 2.2 MeV and that of ${}_2^4He$ is 28 MeV. If two deuterons are fused to form one ${}_2^4He$, then the energy released is

(a) 23.6 MeV (b) 19.2 MeV
(c) 30.2 MeV (d) 25.8 MeV

30. A glass slab of thickness 4 cm contains the same number of waves as 5 cm of water when both are traversed by the same monochromatic light. If the refractive index of water is 4/3, what is that of glass?

(a) 5/3 (b) 5/4 (c) 16/15 (d) 1.5

31. Two concentric uniform shells of mass M_1 and M_2 are as shown in the figure. A particle of mass m is located just within the shell M_2 on its inner surface. Gravitational force on 'm' due to M_1 and M_2 will be



(a) zero (b) $\frac{GM_1m}{b^2}$

(c) $\frac{G(M_1+M_2)m}{b^2}$ (d) None of these

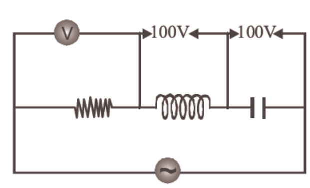
32. The ionization energy of hydrogen atom is 13.6 eV. Following Bohr's theory, the energy corresponding to a transition between 3rd and 4th orbit is

(a) 3.40 eV (b) 1.51 eV
(c) 0.85 eV (d) 0.66 eV

33. A 100 N force acts horizontally on a block of 10 kg placed on a horizontal rough surface of coefficient of friction $\mu = 0.5$. If the acceleration due to gravity (g) is taken as 10 ms^{-2}, the acceleration of the block (in ms^{-2}) is

(a) 2.5 (b) 10 (c) 5 (d) 7.5

34. In the circuit given below, what will be the reading of the voltmeter?



200V, 100Hz

(a) 300 V (b) 900 V (c) 200 V (d) 400 V

35. If the moment of inertia of a disc about an axis tangential and parallel to its surface be I, then what will be the moment of inertia about the axis tangential but perpendicular to the surface?

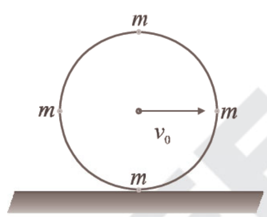
(a) $\frac{6}{5}I$ (b) $\frac{3}{4}I$ (c) $\frac{3}{2}I$ (d) $\frac{5}{4}I$

36. A simple pendulum performs S.H.M. about x = 0 with an amplitude a, and time period T. The speed of the pendulum at x = a/2 will be

(a) $\pi\frac{a\sqrt{3}}{T}$ (b) $\frac{\pi a\sqrt{3}}{2T}$

(c) $\frac{\pi a}{T}$ (d) $\frac{3\pi^2 a}{T}$

37. A ring of mass m and radius R has four particles each of mass m attached to the ring as shown in figure. The centre of ring has a speed v_0. The kinetic energy of the system is



(a) mv_0^2

(b) $3mv_0^2$

(c) $5mv_0^2$

(d) $6mv_0^2$

38. A bar magnet of magnetic moment M and length L is cut into two equal parts each of length L/3. The magnetic moment of each part will be

(a) M (b) M/4 (c) $\sqrt{2}$ M (d) M/3

39. Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show

(a) anti ferromagnetism
(b) no magnetic property
(c) diamagnetism
(d) paramagnetism

40. Consider two hot bodies B_1 and B_2 which have temperatures 100°C and 80°C respectively at $t = 0$. The temperature of the surroundings is 40°C. The ratio of the respective rates of cooling R_1 and R_2 of these two bodies at $t = 0$ will be

(a) $R_1 : R_2 = 3 : 2$ (b) $R_1 : R_2 = 5 : 4$
(c) $R_1 : R_2 = 2 : 3$ (d) $R_1 : R_2 = 4 : 5$

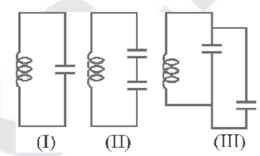
41. Find the minimum thickness of a film which will strongly reflect the light of wavelength 598 nm. The refractive index of the material of the film is 1.25.

(a) 118 nm (b) 120 nm
(c) 218 m (d) 225 mm

42. Water rises in a capillary tube to a certain height such that the upward force due to surface tension is balanced by 7.5×10^{-4} N force due to the weight of the liquid. If the surface tension of water is 6×10^{-2} Nm^{-1}, the inner circumference of the capillary tube must be

(a) 1.25×10^{-2} m (b) 0.50×10^{-2} m
(c) 6.5×10^{-2} m (d) 12.5×10^{-2} m

43. Figure shows three oscillating LC circuit with identical inductors and capacitors. If t_1, t_2, t_3 are the time taken by the circuits I, II, III for fully discharge, then



(a) $t_1 > t_2 > t_3$ (b) $t_1 < t_2 < t_3$
(c) $t_2 < t_1 < t_3$ (d) $t_3 = \sqrt{t_1 t_2}$

44. Two sources P and Q produce notes of frequency 660 Hz each. A listener moves from P to Q with a speed of 1 ms^{-1}. If the speed of sound is 330 m/s, then the number of beats heard by the listener per second will be

(a) zero (b) 4 (c) 8 (d) 2

45. A liquid does not wet the sides of a solid, if the angle of contact is

(a) Zero
(b) Obtuse (more than 90°)
(c) Acute (less than 90°)
(d) 90° (right angle)

46. A steel ring of radius r and cross sectional area A is fitted onto a wooden disc of radius R (R > r). If the Young's modulus of steel is Y, then the force with which the steel ring is expanded is

(a) A Y (R/r) (b) A Y (R – r)/r
(c) (Y/A)[(R – r)/r] (d) Y r/A R

47. An ideal gas is initially at P_1, V_1 is expanded to P_2, V_2 and then compressed adiabatically to the same volume V_1 and pressure P_3. If W is the net work done by the gas in complete process which of the following is true ?

(a) $W > 0$; $P_3 > P_1$ (b) $W < 0$; $P_3 > P_1$
(c) $W > 0$; $P_3 < P_1$ (d) $W < 0$; $P_3 < P_1$

48. A coaxial cable consists of a thin inner conductor fixed along the axis of a hollow outer conductor. The two conductors carry equal currents in opposites directions. Let B_1 and B_2 be the magnetic fields in the region betweem the conductors and outside the conductor, respectively Then,

(a) $B_1 \neq 0, B_2 \neq 0$ (b) $B_1 = B_2 = 0$
(c) $B_1 \neq 0, B_2 = 0$ (d) $B_1 = 0, B_2 \neq 0$

49. A drop of water is placed on a glass plate. A double convex lens having radius of curvature of each surface is 20 cm is placed on it. The focal length of water is $(\mu_w = 4/3)$

(a) -20 cm (b) 60 cm
(c) 20 cm (d) -60 cm

50. A source of light is placed at a distance of 50 cm from a photocell and the stopping potential is found to be V_0. If the distance between the light source and photocell is made 25 cm, the new stopping potential will be
(a) $2V_0$ (b) $V_0/2$ (c) V_0 (d) $4V_0$

CHEMISTRY

51. Which one of the following complexes will most likely absorb visible light?
(At nos. Sc = 21, Ti = 22, V = 23, Zn = 30)
(a) $[Sc(H_2O)_6]^{3+}$ (b) $[Ti(NH_3)_6]^{4+}$
(c) $[V(NH_3)_6]^{3+}$ (d) $[Zn(NH_3)_6]^{2+}$

52. Calcination is used in metallurgy for removal of
(a) moisture (b) water and CO_2
(c) CO_2 and H_2S (d) H_2O and H_2S

53. If the rate of a gaseous reaction is independent of pressure, the order of reaction is:
(a) 0 (b) 1 (c) 2 (d) 3

54. Which amino acid is achiral?
(a) Alanine (b) Valine
(c) Proline (d) None of these

55. 1-Phenylethanol can be prepared by reaction of benzaldehyde with
(a) methyl bromide
(b) ethyl iodide and magnesium
(c) methyl bromide and aluminium bromide
(d) methyl iodide and magnesium

56. The acidic, basic or amphoteric nature of Mn_2O_7, V_2O_5 and CrO are respectively
(a) acidic, acidic and basic
(b) basic, amphoteric and acidic
(c) acidic, amphoteric and basic
(d) acidic, basic and amphoteric

57. The number of P – O – P bonds in cyclic metaphosphoric acid is
(a) zero (b) two (c) three (d) four

58. In the electrochemical reaction
$$2Fe^{3+} + Zn \longrightarrow Zn^{2+} + 2Fe^{2+},$$
on increasing the concentration of Fe^{2+}
(a) increases cell emf
(b) increases the current flow
(c) decreases the cell emf
(d) alters the pH of the solution

59. The general formula $C_nH_{2n}O_2$ could be for open chain
(a) carboxylic acids (b) diols
(c) dialdehydes (d) diketones

60. In a cubic lattice A atom occupy all the corners. If B atom occupy one of the opposite face, and atom C occupy the remaining faces. The simplest formulae of the compound is
(a) ABC_3 (b) ABC_2 (c) ABC (d) AB_2C

61. Out of the following isomeric alcohols containing five carbon atoms, the alcohol that exhibits optical isomerism is
(a) 1-pentanol
(b) 2-pentanol
(c) 3-pentanol
(d) 2-methyl-2-butanol

62. Reaction of alkyl halides with aromatic compounds in presence of anhydrous $AlCl_3$ is known as :
(a) Friedel Craft reaction
(b) Corey house synthesis
(c) Kolbe's synthesis
(d) Beckmann rearrangement

63. The molar ionic conductances of the octahedral complexes:
(I) $PtCl_4.5NH_3$ (II) $PtCl_4.4NH_3$
(III) $PtCl_4.3NH_3$ (IV) $PtCl_4.2NH_3$
Follow the order
(a) I < II < III < IV (b) IV < III < II < I
(c) III < IV < II < I (d) IV < III < I < II

64. Which one of the following binary liquid systems shows positive deviation from Raoult's law?
(a) Benzene-toluene
(b) Carbon disulphide-acetone
(c) Phenol-aniline
(d) Chloroform-acetone

65. Calcium carbide when treated with water gives:
(a) ethylene (b) methane
(c) acetylene (d) ethane

66. The standard reduction potentials at 298K for the following half reactions are given against each

$$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s); -0.762\ V$$
$$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s); -0.740\ V$$
$$2H^+(aq) + 2e^- \rightleftharpoons H_2(g); 0.00\ V$$
$$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq); 0.770\ V$$

Which is the strongest reducing agent?

(a) Zn (s) (b) Cr (s)
(c) $H_2(g)$ (d) $Fe^{3+}(aq)$

67. Which polymer is used for making magnetic recording tapes?

(a) Dacron (b) Acrilan
(c) Glyptal (d) Bakelite

68. Carbylamine reaction is used for the detection of

(a) aliphatic 2° amines.
(b) aliphatic 1° amines.
(c) aromatic 1° amines.
(d) Both (b) and (c).

69. Which one of the following is not applicable to the phenomenon of adsorption?

(a) $\Delta H > 0$ (b) $\Delta G < 0$
(c) $\Delta S < 0$ (d) $\Delta H < 0$

70. For a reaction, activation energy $(E_a) = 0$ and rate constant $(k) = 3.2 \times 10^6\ s^{-1}$ at 300 K. What is the value of the rate constant at 310 K

(a) $3.2 \times 10^{-12}\ s^{-1}$ (b) $3.2 \times 10^6\ s^{-1}$
(c) $6.4 \times 10^{12}\ s^{-1}$ (d) $6.4 \times 10^6\ s^{-1}$

71. Which one of the following is a non-benzenoid aromatic compound?

(a) Aniline (b) Benzoic acid
(c) Naphthalene (d) Tropolone

72. Which of the following is the key step in the manufacture of sulphuric acid ?

(a) Burning of sulphur or sulphide ores in air to generate SO_2
(b) Conversion of SO_2 to SO_3 by the reaction with oxygen in presence of catalyst.
(c) Absorption of SO_3 in H_2SO_4 to give oleum.
(d) Both (b) and (c)

73. On the basis of data given below,

$E^\ominus_{Sc^{3+}/Sc^{2+}} = -0.37$, $E^\ominus_{Mn^{3+}/Mn^{2+}} = +1.57$

$E^\ominus_{Cr^{2+}/Cr} = -0.90$, $E^\ominus_{Cu^{2+}/Cu} = 0.34$

Which of the following statements is incorrect?

(a) Sc^{3+} has good stability due of $[Ar]3d^04s^0$ configuration.
(b) Mn^{3+} is more stable than Mn^{2+}.
(c) Cr^{2+} is reducing in nature.
(d) Copper does not give H_2 on reaction with dil. H_2SO_4.

74. The decomposition of a substance follows first order kinetics. Its concentration is reduced to 1/8th of its initial value in 24 minutes. The rate constant of the decomposition process is

(a) $1/24\ min^{-1}$
(b) $\frac{0.692}{24}\ min^{-1}$
(c) $\frac{2.303}{24} \log\left(\frac{1}{8}\right) min^{-1}$
(d) $\frac{2.303}{24} \log\left(\frac{8}{1}\right) min^{-1}$

75. In Bosch's process, which gas is utilised for the production of hydrogen gas ?

(a) Producer gas (b) Water gas
(c) Coal gas (d) None of these

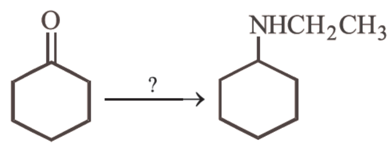
76. In the commercial electrochemical process for aluminium extraction the electrolyte used is

(a) $Al(OH)_3$ in NaOH solution
(b) An aqueous solution of $Al_2(SO_4)_3$
(c) A molten mixture of Al_2O_3 and Na_3AlF_6
(d) A molten mixture of Al_2O_3 and $Al(OH)_3$

77. A system absorbs 10 kJ of heat and does 4 kJ of work. The internal energy of the system

(a) increases by 6 kJ
(b) decreases by 6 kJ
(c) decreases by 14 kJ
(d) increases by 14 kJ

78. Reagents capable of converting cyclohexanone to N-ethyl cyclohexylamine is



(a) CH_3CH_2Br and NH_3

(b) $CH_3CH_2NH_2$ and H_2/Pt

(c) $CH_3CH = O$ and NH_3

(d) $LiAlH_4$ followed by H_2O and then CH_3CH_2Br

79. Which one is the most likely structure of $CrCl_3.\ 6H_2O$ if 1/3 of total chlorine of the compound is precipitated by adding $AgNO_3$

(a) $CrCl_3.6H_2O$

(b) $[Cr(H_2O)_3Cl_3].(H_2O)_3$

(c) $[CrCl_2(H_2O)_4]Cl.2H_2O$

(d) $[CrCl(H_2O)_5]Cl_2.H_2O$

80. The rate of reaction of which of the following is not affected by pressure

(a) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$

(b) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

(c) $N_2 + O_2 \rightleftharpoons 2NO$

(d) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

81. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acid strength is

(a) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$

(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$

(c) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$

(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

82. Which of the following statements about amorphous solids is incorrect ?

(a) They melt over a range of temperature

(b) They are anisotropic

(c) There is no orderly arrangement of particles

(d) They are rigid and incompressible

83. Cloud or fog is a colloidal system in which the dispersed phase and the dispersion medium are

(a) gas, liquid (b) liquid, gas

(c) liquid, liquid (d) solid, liquid

84. Which of the following ions will exhibit colour in aqueous solutions?

(a) La^{3+} (Z = 57) (b) Ti^{3+} (Z = 22)

(c) Lu^{3+} (Z = 71) (d) Sc^{3+} (Z = 21)

85. Which of the following cannot be made by using Williamson's synthesis?

(a) Methoxybenzene

(b) Benzyl *p*-nitrophenyl ether

(c) Methyl tertiary butyl ether

(d) Di-tert-butyl ether

86. 1 M, 2.5 litre NaOH solution is mixed with another 0.5 M, 3 litre NaOH solution. Then find out the molarity of resultant solution

(a) 0.80 M (b) 1.0 M

(c) 0.73 M (d) 0.50 M

87. In the manufacture of bromine from sea water, the mother liquor containing bromides is treated with

(a) carbon dioxide (b) chlorine

(c) iodine (d) sulphur dioxide

88. The oxidation potentials of A and B are +2.37 and +1.66 V respectively. In chemical reactions

(a) A will be replaced by B.

(b) A will replace B.

(c) A will not replace B.

(d) A and B will not replace each other.

89. Adenosine is an example of

(a) nucleotide (b) nucleoside

(c) purine base (d) pyrimidine base

90. Which of the folliowing metal oxides is anti-ferromagnetic in nature?

(a) MnO (b) TiO_2 (c) VO_2 (d) CrO_2

91. Which one of the following is the correct order of acidic strength?

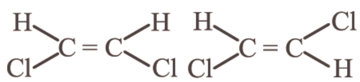
(a) $CF_3COOH > CHCl_2COOH > HCOOH > C_6H_5CH_2COOH > CH_3COOH$

(b) $CH_3COOH > HCOOH > CF_3COOH > CHCl_2COOH > C_6H_5CH_2COOH$

(c) $HCOOH > C_6H_5CH_2COOH > CF_3COOH > CHCl_2COOH > CH_3COOH$

(d) $CF_3COOH > CH_3COOH > HCOOH > CHCl_2COOH > C_6H_5CH_2COOH$

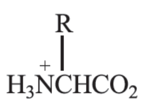
92. The following compounds differ in



(a) configuration (b) conformation
(c) structure (d) chirality

93. Assume that a particular amino acid has an isoelectric point of 6.0. In a solution at pH 1.0, which of the following species will predominate?

(a)  (b) 

(c)  (d) 

94. Which one of the following forms micelles in aqueous solution above certain concentration?

(a) Dodecyltrimethylammonium chloride
(b) Glucose
(c) Urea
(d) Pyridinium chloride

95. The relationship between the dissociation energy of N_2 and N_2^+ is :

(a) Dissociation energy of N_2^+ > dissociation energy of N_2
(b) Dissociation energy of N_2 = dissociation energy of N_2^+
(c) Dissociation energy of N_2 > dissociation energy of N_2^+
(d) Dissociation energy of N_2 can either be lower or higher than the dissociation energy of N_2^+

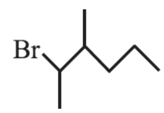
96. Which has the maximum number of molecules among the following ?

(a) 44 g CO_2 (b) 48 g O_3
(c) 8 g H_2 (d) 64 g SO_2

97. Which one of the following statement is *not true*?

(a) In vulcanization the formation of sulphur bridges between different chains make rubber harder and stronger.
(b) Natural rubber has the *trans* -configuration at every double bond
(c) Buna-S is a copolymer of butadiene and styrene
(d) Natural rubber is a 1, 4 - polymer of isoprene

98. Which compound undergoes nucleophilic substitution with NaCN at the fastest rate?

(a)  (b) 

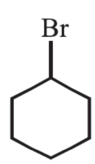
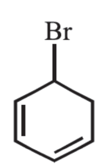
(c)  (d) 

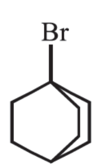
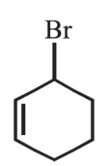
99. Antibiotics that are effective against Gram-positive or Gram-negative bacteria X. Antibiotics that are effective against a single organism or disease are Y

What is X and Y ?

(a) X = Broad spectrum antibiotics.
Y = Narrow spectrum antibiotics.
(b) X = Broad spectrum antibiotics.
Y = Limited spectrum antibiotics.
(c) X = Narrow spectrum antibiotics.
Y = Limited spectrum antibiotics.
(d) X = Narrow spectrum antibiotics.
Y = Broad spectrum antibiotics.

100. Rate of S_N2 will be negligible in :

(a)  (b) 

(c)  (d) 

SECTION-B

MATHEMATICS

1. If $y = \cos^2 x + \sec^2 x$, then

(a) $y \le 2$ (b) $y \le 1$

(c) $y \ge 2$ (d) $1 < y < 2$

2. If A is the set of even natural numbers less than 8 and B is the set of prime numbers less than 7, then the number of relations from A to B is

(a) 2^9 (b) 9^2 (c) 3^2 (d) $2^9 - 1$

3. 20 teachers of a school either teach mathematics or physics. 12 of them teach mathematics while 4 teach both the subjects. Then the number of teachers teaching physics only is

(a) 12 (b) 8

(c) 16 (d) None of these

4. In a G.P. of positive terms, if any term is equal to the sum of the next two terms then the common ratio of the G.P. is

(a) $\sin 18°$ (b) $2\cos 18°$

(c) $\cos 18°$ (d) $2\sin 18°$

5. Let $A(2,-3)$ and $B(-2, 1)$ be vertices of a triangle ABC. If the centroid of this triangle moves on the line $2x+3y=1$, then the locus of the vertex C is the line

(a) $3x-2y=3$ (b) $2x-3y=7$

(c) $3x+2y=5$ (d) $2x+3y=9$

6. The equation of the parabola having axis parallel to y-axis and which passes through the points $(0,4)$, $(1,9)$ and $(4,5)$ is

(a) $y = \frac{-19}{12}x^2 + \frac{79}{12}x + 4$

(b) $y = \frac{-19}{12}x^2 + \frac{79}{12}x - 4$

(c) $y = \frac{19}{12}x^2 + \frac{79}{12}x + 4$

(d) None of these

7. $\left(\frac{-1+\sqrt{-3}}{2}\right)^{100} + \left(\frac{-1-\sqrt{-3}}{2}\right)^{100}$ is equal to

(a) 2 (b) 0 (c) -1 (d) 1

8. The number of ordered pairs (x, y) satisfying $3^x \cdot 5^y = 75$ and $3^y \cdot 5^x = 45$ is

(a) 0 (b) 1

(c) 3 (d) None of these

9. The number of ways in which an examiner can assign 30 marks to 8 questions, giving not less than 2 marks to any question, is :

(a) ${}^{30}C_7$ (b) ${}^{21}C_8$ (c) ${}^{21}C_7$ (d) ${}^{30}C_8$

10. If number of terms in the expansion of $(x-2y+3z)^n$ is 45 then n =

(a) 7 (b) 8 (c) 9 (d) 6^{10}

11. The ratio in which the line joining $(2,4,5)$, $(3,5,-4)$ is divided by the yz plane, is

(a) $2:3$ (b) $3:2$ (c) $-2:3$ (d) $4:-3$

12. The integer n for which

$\lim_{x\to 0}\frac{(\cos x - 1)(\cos x - e^x)}{x^n}$ is a finite non-zero number is

(a) 1 (b) 2 (c) 3 (d) 4

13. Which of the following is the inverse of the proposition? "If a number is a prime then it is odd."

(a) If a number is not a prime then it is odd

(b) If a number is not a prime then it is not odd

(c) If a number is not odd then it is not a prime

(d) If a number is not odd then it is a prime

14. The marks of some students were listed out of 75. The SD of marks was found to be 9. Subsequently the marks were raised to a maximum of 100 and variance of new marks was calculated. The new variance is

(a) 144 (b) 122

(c) 81 (d) None of these

15. If $f(x) = \frac{x}{x-1}$, then $\underbrace{(fofo........of)}_{19 \text{ times}}(x)$ is equal to:

(a) $\frac{x}{x-1}$ (b) $\left(\frac{x}{x-1}\right)^{19}$

(c) $\frac{19x}{x-1}$ (d) x

16. Let $A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$ and $(A+I)^{50} - 50A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, find abc + abd + bcd + acd
(a) 0 (b) –1
(c) 1 (d) None of these

17. If in a triangle ABC, $\begin{vmatrix} 1 & \sin A & \sin^2 A \\ 1 & \sin B & \sin^2 B \\ 1 & \sin C & \sin^2 C \end{vmatrix} = 0$ then the triangle is
(a) equilateral or isosceles
(b) equilateral or right-angled
(c) right angled or isosceles
(d) None of these

18. The value of p for which the function

$$f(x) = \begin{cases} \dfrac{(4^x - 1)^3}{\sin \dfrac{x}{p} \log\left[1 + \dfrac{x^2}{3}\right]}, & x \neq 0 \\ 12(\log 4)^3, & x = 0 \end{cases}$$

may be continuous at $x = 0$, is
(a) 1 (b) 2
(c) 3 (d) None of these

19. If $((\vec{a} \times \vec{b}) \times (\vec{c} \times \vec{d})).(\vec{a} \times \vec{d}) = 0$, then which of the following is always true ?
(a) $\vec{a}, \vec{b}, \vec{c}, \vec{d}$ are necessarily coplanar
(b) either $\vec{a}$ or $\vec{d}$ must lie in the plane of $\vec{b}$ and $\vec{c}$
(c) either $\vec{b}$ or $\vec{c}$ must lie in the plane of $\vec{a}$ and $\vec{d}$
(d) either $\vec{a}$ or $\vec{b}$ must lie in the plane of $\vec{c}$ and $\vec{d}$

20. $\int \dfrac{dx}{\cos x + \sqrt{3} \sin x}$ equals
(a) $\log \tan\left(\dfrac{x}{2} + \dfrac{\pi}{12}\right) + C$
(b) $\log \tan\left(\dfrac{x}{2} - \dfrac{\pi}{12}\right) + C$
(c) $\dfrac{1}{2} \log \tan\left(\dfrac{x}{2} + \dfrac{\pi}{12}\right) + C$
(d) $\dfrac{1}{2} \log \tan\left(\dfrac{x}{2} - \dfrac{\pi}{12}\right) + C$

21. Under what condition do $\left\langle \dfrac{1}{\sqrt{2}}, \dfrac{1}{2}, k \right\rangle$ represent direction cosines of a line?
(a) $k = \dfrac{1}{2}$ (b) $k = -\dfrac{1}{2}$
(c) $k = \pm\dfrac{1}{2}$ (d) k can take any value

22. The function $f(x) = \sin x - kx - c$, where k and c are constants, decreases always when
(a) $k > 1$ (b) $k \geq 1$ (c) $k < 1$ (d) $k \leq 1$

23. $\displaystyle\int_3^8 \frac{2 - 3x}{x\sqrt{1 + x}} dx =$
(a) $2\log\left(\dfrac{3}{2e^3}\right)$ (b) $\log\left(\dfrac{3}{e^3}\right)$
(c) $4\log\left(\dfrac{3}{e^3}\right)$ (d) None of these

24. Corner points of the feasible region for an LPP are (0, 2) (3, 0) (6, 0), (6, 8) and (0, 5). Let F = 4x + 6y be the objective function.
The minimum value of F occurs at
(a) (0, 2) only
(b) (3, 0) only
(c) the mid-point of the line segment joining the points (0, 2) and (3, 0) only
(d) any point on the line segment joining the points (0, 2) and (3, 0)

25. If $y = \tan^{-1}\left(\dfrac{\log_e(e/x^2)}{\log_e(ex^2)}\right) + \tan^{-1}\left(\dfrac{3 + 2\log_e x}{1 - 6\log_e x}\right)$, then $\dfrac{d^2y}{dx^2}$ is
(a) 2 (b) 1 (c) 0 (d) –1

26. Three persons, A, B and C, fire at a target in turn, starting with A. Their probability of hitting the target are 0.4, 0.3 and 0.2 respectively. The probability of two hits is
(a) 0.024 (b) 0.188 (c) 0.336 (d) 0.452

27. The area enclosed by the curve $x^2y = 36$, the x-axis and the lines x = 6 and x = 9 is
(a) 6 (b) 1 (c) 4 (d) 2

28. A random variable X assumes values which are rational numbers of the form $\frac{n}{n+1}$ and $\frac{n+1}{n}$, where n = 1, 2, 3, ...

If $P\left(X = \frac{n}{n+1}\right) = P\left(X = \frac{n+1}{n}\right) = \left(\frac{1}{2}\right)^{n+1}$, then :

(a) $P(X < 1) = P(X > 1)$

(b) $P(\frac{1}{2} < X < 1) < P(X > 1)$

(c) $P(X > \frac{3}{2}) < P(X < 1)$

(d) All above are correct

29. A card is drawn at random from a pack of 100 cards numbered 1 to 100. The probability of drawing a number which is a square, is

(a) $\frac{1}{10}$ (b) $\frac{1}{100}$ (c) $\frac{9}{10}$ (d) $\frac{90}{100}$

30. The sum of 11 terms of an A.P. whose middle term is 30,
(a) 320 (b) 330 (c) 340 (d) 350

31. The intercept cut off by a line from y-axis twice than that from x-axis, and the line passes through the point (1, 2). The equation of the line is
(a) $2x + y = 4$ (b) $2x + y + 4 = 0$
(c) $2x - y = 4$ (d) $2x - y + 4 = 0$

32. The length of intercept, the circle $x^2 + y^2 + 10x - 6y + 9 = 0$ makes on the x-axis is :
(a) 2 (b) 4 (c) 6 (d) 8

33. If $\left(7 - 4\sqrt{3}\right)^{x^2 - 4x + 3} + \left(7 + 4\sqrt{3}\right)^{x^2 - 4x + 3} = 14$, then the value of x is given by

(a) $2, 2 \pm \sqrt{2}$ (b) $2 \pm \sqrt{3}, 3$
(c) $3 \pm \sqrt{2}, 2$ (d) None of these

34. The number of solution of $\log_{\sin x} 2^{\tan x} > 0$ in the interval $\left(0, \frac{\pi}{2}\right)$ is

(a) 0 (b) 1 (c) 2 (d) 3

35. How many numbers lying between 500 and 600 can be formed with the help of the digits 1, 2, 3, 4, 5, 6 when the digits are not be repeated?

(a) 20 (b) 40 (c) 60 (d) 80

36. The coefficient of x^2 term in the binomial expansion of $\left(\frac{1}{3}x^{1/2} + x^{-1/4}\right)^{10}$ is :

(a) $\frac{70}{243}$ (b) $\frac{60}{423}$

(c) $\frac{50}{13}$ (d) None of these

37. For the function

$f(x) = \frac{x^{100}}{100} + \frac{x^{99}}{99} + ... \frac{x^2}{2} + x + 1,$

$f'(1) = mf'(0)$, where m is equal to
(a) 50 (b) 0 (c) 100 (d) 200

38. If the function $f : R \to A$ given by is

$f(x) = \frac{x^2}{x^2 + 1}$ is surjection, then A is

(a) [0, 1) (b) (0, 1) (c) (0, 1] (d) [0, 1]

39. If $x^2 + y^2 + z^2 = r^2$, then

$\tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{yz}{xr} + \tan^{-1}\frac{xz}{yr} =$

(a) π (b) $\frac{\pi}{2}$

(c) 0 (d) None of these

40. If $A = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$ then $\lim_{n \to \infty} \frac{1}{n} A^n$ is

(a) a null matrix (b) an identity matrix

(c) $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ (d) None of these

41. If a system of equation $-ax+y+z=0$

$$x-by+z=0$$
$$x+y-cz=0 \quad (a, b, c \neq -1)$$

has a non-zero solution then

$$\frac{1}{1+a}+\frac{1}{1+b}+\frac{1}{1+c}=$$

(a) 0 (b) 1 (c) 2 (d) 3

42. The function f(x) = $[x]^2-[x^2]$ (where [y] is the greatest integer function less than or equal to y), is discontinuous at :

(a) all integers
(b) all integers except 0 and 1
(c) all integers except 0
(d) all integers except 1

43. The maximum value of $\frac{\ln x}{x}$ in $(2,\infty)$ is

(a) 1 (b) e (c) 2/e (d) 1/e

44. If $y=f(x)$ makes +ve intercept of 2 and 0 unit on x and y axes and encloses an area of 3/4 square unit with the axes then $\int_0^2 xf'(x)dx$ is

(a) 3/2 (b) 1 (c) 5/4 (d) –3/4

45. For the LPP Min $z=x_1+x_2$ such that inequalities $5x_1+10x_2\geq 0$, $x_1+x_2\leq 1$, $x_2\leq 4$ and $x_1, x_2\geq 0$

(a) There is a bounded solution
(b) There is no solution
(c) There are infinitie solution
(d) None of these

46. $\int \frac{(x^2-1)}{x\sqrt{x^4+3x^2+1}}dx$ is equal to

(a) $\log\left|x+\frac{1}{x}+\sqrt{x^2+\frac{1}{x^2}+3}\right|+C$

(b) $\log\left|x-\frac{1}{x}+\sqrt{x^2+\frac{1}{x^2}-3}\right|+C$

(c) $\log\left|x+\sqrt{x^2+3}\right|+C$

(d) None of these

47. Two spheres of radii 3 and 4 cut orthogonally The radius of common circle is

(a) 12 (b) $\frac{12}{5}$ (c) $\frac{\sqrt{12}}{5}$ (d) $\sqrt{12}$

48. A curve passing through (2, 3) and satisfying the differential equation $\int_0^x ty(t)\,dt=x^2y(x), (x>0)$ is

(a) $x^2+y^2=13$ (b) $y^2=\frac{9}{2}x$

(c) $\frac{x^2}{8}+\frac{y^2}{18}=1$ (d) $xy=c$

49. $\int_1^{e^{37}} \frac{\pi\sin(\pi\log_e x)}{x}dx$ is equal to

(a) 2 (b) 20 (c) $\frac{2}{\pi}$ (c) 2π

50. The vectors $\overrightarrow{AB}=3\hat{i}+5\hat{j}+4\hat{k}$ and $\overrightarrow{AC}=5\hat{i}-5\hat{j}+2\hat{k}$ are the sides of a triangle ABC. The length of the median through A is :

(a) $\sqrt{13}$ units (b) $2\sqrt{5}$ units
(c) 5 units (d) 10 units

Mock Test- 4

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. The dimensional formula of angular velocity is
(a) $[MLT^{-1}]$ (b) $[M^0L^0T]$
(c) $[ML^0T^{-2}]$ (d) $[M^0L^0T^{-1}]$

2. A ball of mass 150 g, moving with an acceleration 20 m/s^2, is hit by a force, which acts on it for 0.1 sec. The impulsive force is
(a) 0.5 N (b) 0.1 N (c) 0.3 N (d) 1.2 N

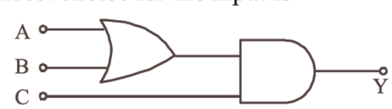
3. When the base current in a transistor is changed from 30 μA to 80 μA, the collector current is changed from 1.0 mA to 3.5 mA. Find the current gain β.
(a) 30 (b) 40 (c) 45 (d) 50

4. In an L.C.R. series a.c. circuit, the current
(a) is always in phase with the voltage
(b) always lags the generator voltage
(c) always leads the generator voltage
(d) None of these

5. For an A.M. wave, the maximum and minimum amplitude is found to be 20V and 4V. Find the modulation index(m).
(a) 3/5 (b) 5/3 (c) 2/3 (d) 3/2

6. Let V and E denote the gravitational potential and gravitational field at a point. It is possible to have
(a) V = 0 and E = 0 (b) V = 0 and E $\neq$ 0
(c) V $\neq$ 0 and E = 0 (d) All of the above

7. To get output 1 for the following circuit, the correct choice for the input is



(a) A = 0, B = 1, C = 0 (b) A = 1, B = 0, C = 0
(c) A = 1, B = 1, C = 0 (d) A = 1, B = 0, C = 1

8. The Poisson's ratio of a material is 0.5. If a force is applied to a wire of this material, there is a decrease in the cross-sectional area by 4%. The percentage increase in the length is :
(a) 1% (b) 2% (c) 2.5% (d) 4%

9. If two waves of same frequency and same amplitude, on superposition, produce a resultant disturbance of the same amplitude, the wave differ in phase by
(a) π (b) $2\pi/3$ (c) $\pi/2$ (d) $\pi/3$

10. A hoop rolls down an inclined plane. The fraction of its total kinetic energy that is associated with rotational motion is
(a) 1 : 2 (b) 1 : 3 (c) 1 : 4 (d) 2 : 3

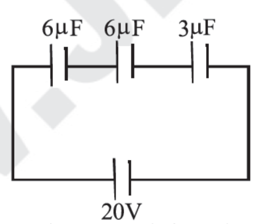
11. An unpolarised beam of intensity $2a^2$ passes through a thin polaroid. Assuming zero absorption in the polaroid, the intensity of emergent plane polarised light will be
(a) $2a^2$ (b) a^2 (c) $\sqrt{2}\,a^2$ (d) $\dfrac{a^2}{\sqrt{2}}$

12. Demagnetisation of magnets can be done by
(a) rough handling
(b) heating
(c) magnetising in the opposite direction
(d) All the above

13. The Kirchhoff's first law ($\Sigma i = 0$) and second law ($\Sigma iR = \Sigma E$), where the symbols have their usual meanings, are respectively based on
(a) conservation of charge, conservation of momentum
(b) conservation of energy, conservation of charge
(c) conservation of momentum, conservation of charge
(d) conservation of charge, conservation of energy

14. At 10° C the value of the density of a fixed mass of an ideal gas divided by its pressure is x. At 110°C this ratio is:
(a) x (b) $\frac{383}{283}x$
(c) $\frac{10}{110}x$ (d) $\frac{283}{383}x$

15. The capacitor, whose capacitance is 6, 6 and 3μF respectively are connected in series with 20 volt line. Find the charge on 3μF.



(a) 30 μC
(b) 60 μC
(c) 15 μC
(d) 90 μC

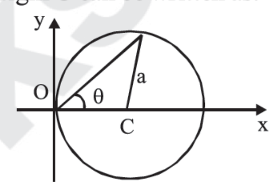
16. At what distance from a long straight wire carrying a current of 12 A will the magnetic field be equal to $3 \times 10^{-5}\ Wb/m^2$?
(a) 8×10^{-2} m (b) 12×10^{-2} m
(c) 18×10^{-2} m (d) 24×10^{-2} m

17. If N_0 is the original mass of the substance of half-life period $t_{1/2} = 5$ years, then the amount of substance left after 15 years is
(a) $N_0/8$ (b) $N_0/16$ (c) $N_0/2$ (d) $N_0/4$

18. A rectangular coil of 100 turns and size 0.1 m × 0.05 m is placed perpendicular to a magnetic field of 0.1 T. The induced e.m.f. when the field drops to 0.05 T in 0.05s is
(a) 0.5V (b) 1.0V (c) 1.5V (d) 2.0V

19. The fundamental radio antenna is a metal rod which has a length equal to
(a) λ in free space at the frequency of operation
(b) λ/2 in free space at the frequency of operation
(c) λ/4 in free space at the frequency of operation
(d) 3λ/4 in free space at the frequency of operation

20. A particle is moving in a circular path of radius a, with a constant velocity v as shown in the figure. The centre of circle is marked by 'C'. The angular momentum from the origin O can be written as:

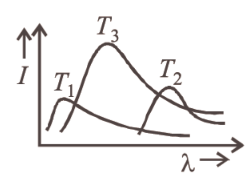


(a) va (1 + cos 2θ)
(b) va (1 + cos θ)
(c) va cos 2θ
(d) va

21. A bullet of mass 'a' and velocity 'b' is fired into a large block of wood of mass 'c'. The bullet gets embedded into the block of wood. The final velocity of the system is
(a) $\frac{b}{a+b} \times c$ (b) $\frac{a+b}{c} \times a$
(c) $\frac{a}{a+c} \times b$ (d) $\frac{a+c}{a} \times b$

22. A rain drop of radius 0.3 mm has a terminal velocity in air = 1 m/s. The viscosity of air is 8×10^{-5} poise. The viscous force on it is
(a) 45.2×10^{-4} dyne (b) 101.73×10^{-5} dyne
(c) 16.95×10^{-4} dyne (d) 16.95×10^{-5} dyne

23. The plots of intensity versus wavelength for three black bodies at temperatures T_1, T_2 and T_3 respectively are as shown. Their temperature are such that



(a) $T_1 > T_2 > T_3$
(b) $T_1 > T_3 > T_2$
(c) $T_2 > T_3 > T_1$
(d) $T_3 > T_2 > T_1$

24. The ratio of intensities of two waves is 9 : 1. They are producing interference. The ratio of maximum and minimum intensities will be
(a) 10 : 8 (b) 9 : 1 (c) 4 : 1 (d) 2 : 1

25. The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is :
(a) 1 : 2 (b) $1 : 2\sqrt{2}$
(c) 1 : 4 (d) 1 : 2

26. If x, v and a denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time?

(a) aT/x (b) $aT+2\pi v$

(c) aT/v (d) $a^2T^2+4\pi^2v^2$

27. If in a circular coil A of radius R, current I is flowing and in another coil B of radius 2R a current 2I is flowing, then the ratio of the magnetic fields B_A and B_B, produced by them will be

(a) 1 (b) 2 (c) 1/2 (d) 4

28. The Young's modulus of the material of a wire is $2\times10^{10}\,Nm^{-2}$. If the elongation strain is 1%, then the energy stored in the wire per unit volume in Jm^{-3} is

(a) 10^6 (b) 10^8 (c) 2×10^6 (d) 2×10^8

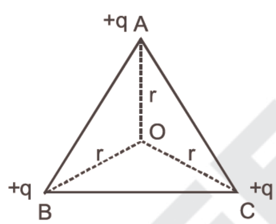
29. ABC is an equilateral triangle. Charges +q are placed at each corner as shown as fig. The electric intensity at centre O will be

(a) $\dfrac{1}{4\pi\epsilon_o}\dfrac{q}{r}$

(b) $\dfrac{1}{4\pi\epsilon_o}\dfrac{q}{r^2}$

(c) $\dfrac{1}{4\pi\epsilon_o}\dfrac{3q}{r^2}$

(d) zero



30. A spring of spring constant 5×10^3 N/m is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5 cm is

(a) 18.75 J (b) 25.00 J (c) 6.25 J (d) 12.50 J

31. A ray is incident at an angle of incidence i on one surface of a prism of small angle A and emerges normally from the opposite surface. If the refractive index of the material of prism is μ, the angle of incidence i is nearly equal to

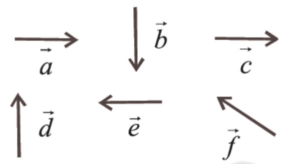
(a) $\dfrac{A}{\mu}$ (b) $\dfrac{A}{2\mu}$ (c) μA (d) $\dfrac{\mu A}{2}$

32. Two particles of mass m_1 and m_2 ($m_1>m_2$) attract each other with a force inversely proportional to the square of the distance between them. If the particles are initially held at rest and then released, the centre of mass will

(a) move towards m_1 (b) move towards m_2

(c) remains at rest (d) None of these

33. Six vectors, $\vec{a}$ through $\vec{f}$ have the magnitudes and directions indicated in the figure. Which of the following statements is true?



(a) $\vec{b}+\vec{c}=\vec{f}$ (b) $\vec{d}+\vec{c}=\vec{f}$

(c) $\vec{d}+\vec{e}=\vec{f}$ (d) $\vec{b}+\vec{e}=\vec{f}$

34. When the current in a coil changes from 8 amp to 2 amp in 3×10^{-2} seconds, the emf induced in the coil is 2 volt. The self inductance of the coil is

(a) 10 mH (b) 20 mH (c) 5 mH (d) 1 mH

35. At a certain place, horizontal component is $\sqrt{3}$ times the vertical component. The angle of dip at this place is

(a) 0 (b) π/3 (c) π/6 (d) π/8

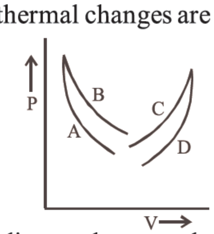
36. Four curves A, B, C and D are drawn in the figure for a given amount of a gas. The curves which represent adiabatic and isothermal changes are

(a) C and D respectively

(b) D and C respectively

(c) A and B respectively

(d) B and A respectively



37. In Young's experiment, the distance between the slits is reduced to half and the distance between the slit and screen is doubled, then the fringe width

(a) will not change

(b) will become half

(c) will be doubled

(d) will become four times

38. Two thin, long, parallel wires, separated by a distance 'd' carry a current of 'i' A in the same direction. They will

(a) repel each other with a force of $\mu_0 i^2/(2\pi d)$

(b) attract each other with a force of $\mu_0 i^2/(2\pi d)$

(c) repel each other with a force of $\mu_0 i^2/(2\pi d^2)$

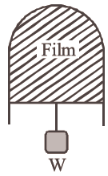
(d) attract each other with a force of $\mu_0 i^2/(2\pi d^2)$

39. If specific resistance of a potentiometer wire is 10^{-7} Ωm, the current flow through it is 0.1 A and the cross-sectional area of wire is 10^{-6} m^2 then potential gradient will be

(a) 10^{-2} volt/m (b) 10^{-4} volt/m

(c) 10^{-6} volt/m (d) 10^{-8} volt/m

40. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of 1.5×10^{-2} N (see figure). The length of the slider is 30 cm and its weight negligible. The surface tension of the liquid film is



(a) 0.0125 Nm^{-1}
(b) 0.1 Nm^{-1}
(c) 0.05 Nm^{-1}
(d) 0.025 Nm^{-1}

41. A car is negotiating a curved road of radius R. The road is banked at an angle θ. the coefficient of friction between the tyres of the car and the road is μ_s. The maximum safe velocity on this road is :

(a) $\sqrt{gR^2\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$ (b) $\sqrt{gR\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$

(c) $\sqrt{\frac{g}{R}\left(\frac{\mu_s+\tan\theta}{1-\mu_2\tan\theta}\right)}$ (d) $\sqrt{\frac{g}{R^2}\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$

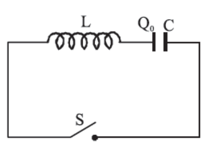
42. Two capillary of length L and 2L and of radius R and 2R are connected in series. The net rate of flow of fluid through them will be (given rate to the flow through single capillary, $X = \frac{\pi PR^4}{8\eta L}$)

(a) $\frac{8}{9}X$ (b) $\frac{9}{8}X$ (c) $\frac{5}{7}X$ (d) $\frac{7}{5}X$

43. Sound waves of length λ travelling with velocity v in a medium enter into another medium in which their velocity is 4 v. The wavelength in 2nd medium is

(a) 4λ (b) λ (c) λ/4 (d) 16λ

44. At $t < 0$, the capacitor is charged and the switch is opened. At $t = 0$ the switch is closed. The shortest time T at which the charge on the capacitor will be zero is given by :



(a) $\pi\sqrt{LC}$ (b) $\frac{3}{2}\pi\sqrt{LC}$

(c) $\frac{\pi}{2}\sqrt{LC}$ (d) $2\pi\sqrt{LC}$

45. A block of mass 0.1kg is held against a wall applying a horizontal force of 5 N on the block. If the coefficient of friction between the block and the wall is 0.5, the magnitude of the frictional force acting on the block is:

(a) 2.5 N (b) 0.98 N
(c) 4.9 N (d) 0.49 N

46. When ultraviolet light of energy 6.2 eV incidents on a aluminimum surface, it emits photoelectrons. If work function for aluminium surface is 4.2 eV, then kinetic energy of emitted electrons is

(a) 3.2×10^{-19} J (b) 3.2×10^{-17} J
(c) 3.2×10^{-16} J (d) 3.2×10^{-11} J

47. An object is placed at a distance of 40 cm in front of a concave mirror of focal length 20 cm. The image produced is

(a) real, inverted and smaller in size
(b) real, inverted and of same size
(c) real and erect
(d) virtual and inverted

48. Two simple pendulums of length 1 m and 4 m respectively are both given small displacement in the same direction at the same instant. They will be again in phase after the shorter pendulum has completed number of oscillations equal to :

(a) 2 (b) 7 (c) 5 (d) 3

49. The ionisation potential of H-atom is 13.6 V. When it is excited from ground state by monochromatic radiations of 970.6 Å, the number of emission lines will be (according to Bohr's theory)

(a) 10 (b) 8 (c) 6 (d) 4

50. A particle moves in a circle of radius 30 cm. Its linear speed is given by : v = 2t, where t in second and v in m/s. Find out its radial and tangential acceleration at t = 3 sec respectively.

(a) 220 m/sec^2, 50 m/sec^2
(b) 110 m/sec^2, 5 m/sec^2
(c) 120 m/sec^2, 2 m/sec^2
(d) 110 m/sec^2, 10 m/sec^2

CHEMISTRY

51. Which of the following statements is true?
(a) $HClO_4$ is a weaker acid than $HClO_3$
(b) HNO_3 is a stronger acid than HNO_2
(c) H_3PO_3 is a stronger acid than H_2SO_3
(d) In aqueous medium HF is a stronger acid than HCl

52. How many unit cells are present in a cube-shaped ideal crystal of NaCl of mass 1.00 g?
[Atomic masses : Na = 23, Cl = 35.5]
(a) 2.57×10^{21} unit cells
(b) 5.14×10^{21} unit cells
(c) 1.28×10^{21} unit cells
(d) 1.71×10^{21} unit cells

53. How many primary carbon atoms are there in $CH_3CH_2CH(CH_3)C(CH_3)_2CH_2CH_2CH_3$?
(a) 3 (b) 4 (c) 5 (d) 6

54. $CH_3CHO \xrightarrow[5\,°C]{10\%\ NaOH} \xrightarrow{\Delta} \xrightarrow[Ni]{H_2} (A)$;

Product (A) of the reaction is:
(a) Propanol (b) Ethanol
(c) Butanol (d) Pentanol

55. Excess of copper in toxic proportions in plants and animals can be removed by chelating with
(a) EDTA (b) ethane-1, 2-amine
(c) oxalate ion (d) D-penicillamine

56. $3A \rightarrow 2B$, rate of reaction $\frac{d[B]}{dt}$ is equal to

(a) $-\frac{3}{2}\frac{d[A]}{dt}$ (b) $-\frac{2}{3}\frac{d[A]}{dt}$

(c) $-\frac{1}{3}\frac{d[A]}{dt}$ (d) $+2\frac{d[A]}{dt}$

57. In the given pairs of alkyl-halide, in which pair the first compound is more reactive than second compound towards S_N2 reaction?
(a) $(CH_3)_2CHBr$ or $CH_3-CH_2-CH_2-Br$
(b) $CH_3-CH_2-CH_2-Br$ or $CH_3-CH_2-CH_2-I$
(c) $Ph-Br$ or $CH_3-CH_2-CH_2-Br$
(d) $CH_2=CH-CH_2-Cl$ or $H_2C=CH-Cl$

58. In a cubic closed packed structure of mixed oxides, the lattice is made up of oxide ion, 20% of tetrahedral voids are occupied by divalent X^{2+} ions and 50% of the octahedral voids are occupied by trivalent Y^{3+} ions. The formula of the oxide is
(a) $X.Y_2O_4$ (b) $X_4Y_5O_{10}$
(c) $X_5Y_4O_{10}$ (d) X_2YO_4

59. What is X and Y in the given reactions ?
$2X_2(g) + 2H_2O(l) \rightarrow 4H^+(aq) + 4X^-(aq) + O_2(g)$
$Y_2(g) + H_2O(l) \rightarrow HY(aq) + HOY(aq)$
(a) X = Cl, Y = F (b) X = Cl, Y = Br
(c) X = F, Y = Cl (d) X = I, Y = F

60. The structural feature which distinguishes proline from natural α-amino acids?
(a) Proline is optically inactive
(b) Proline contains aromatic group
(c) Proline is a dicarboxylic acid
(d) Proline is a secondary amine

61. Ethyl alcohol is used as a preservative for chloroform because it
(a) prevents aerial oxidation of chloroform
(b) prevents decomposition of chloroform
(c) decomposes phosgene to CO and Cl_2
(d) removes phosgene by converting it to ethyl carbonate

62. A compound of a metal ion $M^{x+}(Z = 24)$ has a spin only magnetic moment of $\sqrt{15}$ Bohr magnetons. The number of unpaired electrons in the compound are
(a) 2 (b) 4 (c) 5 (d) 3

63. Specific conductance of 0.1 M HNO_3 is 6.3×10^{-2} ohm^{-1} cm^{-1}. The molar conductance of the solution is
(a) 100 ohm^{-1} cm^2 (b) 515 ohm^{-1} cm^2
(c) 630 ohm^{-1} cm^2 (d) 6300 ohm^{-1} cm^2

64. 2-Butyne contains :
(a) *sp* hybridised carbon atoms only
(b) sp^3 hybridised carbon atoms only
(c) Both *sp* and sp^2 hybridised carbon atoms
(d) Both *sp* and sp^3 hybridised carbon atoms

65. The reducing power of divalent species decreases in the order
(a) Ge > Sn > Pb (b) Sn > Ge > Pb
(c) Pb > Sn > Ge (d) None of these

66. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mol of water is vapourised at 1 bar pressure and 100°C, (given : molar enthalpy of vapourisation of water at 1 bar and 373 K = 41 kJ mol^{-1} and R = 8.3 J mol^{-1} K^{-1}) will be
(a) 41.00 kJ mol^{-1} (b) 4.100 kJ mol^{-1}
(c) 3.7904 kJ mol^{-1} (d) 37.904 kJ mol^{-1}

67. The molecule having smallest bond angle is :
(a) H_2O (b) H_2S (c) NH_3 (d) H_2Te

68. A galvanic cell is composed of two hydrogen electrodes, one of which is a standard one. In which of the following solutions should the other electrode be immersed to get maximum e.m.f. :
(a) 0.1 M HCl (b) 0.1 M H_2SO_4
(c) 0.1 M NH_4OH (d) 0.01 MHCOOH

69. The following set of reactions are used in refining zirconium.

Zr (impure) + $2I_2 \xrightarrow{523K} ZrI_4 \xrightarrow{1800K}$ Zr (pure) + $2I_2$

This method is known as
(a) Distillation
(b) Liquation
(c) Hall-Heroult method
(d) Van Arkel method

70. Buna-N synthetic rubber is a copolymer of :
(a) $H_2C=CH-CH=CH_2$ and $H_5C_6-CH=CH_2$
(b) $H_2C=CH-CN$ and $CH_2=CH-CH=CH_2$
(c) $H_2C=CH-CN$ and $H_2C=CH-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH_2$
(d) $H_2C=CH-\overset{\displaystyle Cl}{\overset{|}{C}}=CH_2$ and
$H_2C=CH-CH=CH_2$

71. By which one of the following reaction ketones cannot be prepared?
(a) Hydration of alkynes
(b) Hydrolysis of gem-dihalides
(c) Dry distillation of calcium carboxylates
(d) Stephen's reaction

72. The number of ions produced by the complex $[Cr(NH_3)_4Cl_2]ClO_3$ is
(a) 2 (b) 3 (c) 4 (d) 6

73. Saline hydrides react explosively with water, such fires can be extinguished by
(a) water (b) carbon dioxide
(c) sand (d) None of these

74. Which of the following is not a disproportionation reaction?
(a) $P_4 + 5OH^- \longrightarrow H_2PO_2^- + PH_3$
(b) $Cl_2 + OH^- \longrightarrow Cl^- + HClO$
(c) $2H_2O_2 \longrightarrow 2H_2O + O_2$
(d) $PbO_2 + H_2O \longrightarrow PbO + H_2O_2$

75. When bromination of aniline is carried out by protecting $-NH_2$. The product is
(a) *o*-bromoaniline
(b) 2, 4, 6 tribromoaniline
(c) *p*-bromoaniline
(d) mixture of *o*-and *p*-bromoanilines

76. In the following sequence of reactions,

$$CH_3CH_2OH \xrightarrow{P+I_2} A \xrightarrow[\text{ether}]{Mg} B \xrightarrow{HCHO} C \xrightarrow{H_2O} D$$

the compound D is

(a) propanal (b) butanal
(c) *n*-butyl alcohol (d) *n*-propyl alcohol.

77. Which of the following statements about a catalyst is/are true ?

(a) A catalyst accelerates the reaction by bringing down the free energy of activation.
(b) A catalyst also takes part in the reaction mechanism.
(c) A catalyst makes the reaction more feasible by making the ΔG^o more negative.
(d) A catalyst makes the equilibrium constant of the reaction more favourable for the forward reaction.

78. The reaction $A \rightarrow B$ follows first order kinetics. The time taken for 0.8 mole of A to produce 0.6 mole of B is 1 hour. What is the time taken for conversion of 0.9 mole of A to produce 0.675 mole of B?

(a) 2 hours (b) 1 hour
(c) 0.5 hour (d) 0.25 hour

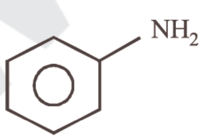
79. When salicylic acid is treated with acetic anhydride we get

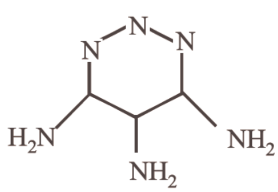
(a) aspirin (b) paracetamol
(c) salol (d) none of these

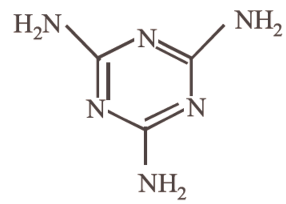
80. Identify incorrect statement :

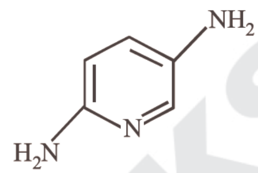
(a) Cu_2O is colourless.
(b) Copper (I) compounds are colourless except when colour results from charge transfer.
(c) Copper (I) compounds are diamagnetic.
(d) Cu_2S is black.

81. Which of the following compound is used for preparation of melamine formaldehyde polymer ?

(a) 

(b) 

(c) 

(d) 

82. A match box exhibits

(a) cubic geometry
(b) monoclinic geometry
(c) tetragonal geometry
(d) orthorhombic geometry.

83. The nodal plane in the π-bond of ethene is located in

(a) the molecular plane.
(b) a plane parallel to the molecular plane.
(c) a plane perpendicular to the molecular plane which bisects the carbon - carbon σ -bond at right angle.
(d) a plane perpendicular to the molecular plane which contains the carbon - carbon σ -bond.

84. If the elevation in boiling point of a solution of non-volatile, non-electrolytic and non associating solute in a solvent ($K_b = x$ K kg mol^{-1}) is y K, then the depression in freezing point of solution of same concentration would be (K_f of the solvent = z K kg mol^{-1})

(a) $\frac{2xz}{y}$ (b) $\frac{yz}{x}$ (c) $\frac{xz}{y}$ (d) $\frac{yz}{2x}$

85. Na_2SO_3 and $NaHCO_3$ may be distinguished by treating their aqueous solution with :

(a) MgO (b) $MgSO_4$
(c) litmus solution. (d) dil. acid

86. Two separate bulbs contain ideal gases A and B. The density of gas A is twice that of gas B. The molecular mass of A is half that of gas B. The two gases are at the same temperature. The ratio of the pressure of A to that of gas B is :

(a) 2 (b) 1/2 (c) 4 (d) 1/4

87. The migration of colloidal solute particles in a colloidal solution, when an electric current is applied to the solution is known as:
(a) Brownian movement
(b) Electroosmosis
(c) Electrophoresis
(d) Electrodialysis

88. Arrange Ce^{+3}, La^{+3}, Pm^{+3} and Yb^{+3} in increasing order of their ionic radii.
(a) $Yb^{+3} < Pm^{+3} < Ce^{+3} < La^{+3}$
(b) $Ce^{+3} < Yb^{+3} < Pm^{+3} < La^{+3}$
(c) $Yb^{+3} < Pm^{+3} < La^{+3} < Ce^{+3}$
(d) $Pm^{+3} < La^{+3} < Ce^{+3} < Yb^{+3}$.

89. Which of the following will be most stable diazonium salt $RN_2^+X^-$?
(a) $CH_3N_2^+X^-$ (b) $C_6H_5N_2^+X^-$
(c) $CH_3CH_2N_2^+X^-$ (d) $C_6H_5CH_2N_2^+X^-$

90. The equilibrium constant for the following general reaction is 10^{30}. Calculate E° for the cell at 298 K.

$$2X_2(s) + 3Y^{2+}(aq) \longrightarrow 2X_2^{3+}(aq) + 3Y(s)$$

(a) $+0.105$ V (b) $+0.2955$ V
(c) 0.0985 V (d) -0.2955 V

91. Flux is used to :
(a) Remove silica.
(b) Remove silica and undesirable metal oxides.
(c) Remove all impurities from ores.
(d) Reduce metal oxide.

92. The rate of reaction between A and B increases by a factor of 100, when the concentration of A is increased 10 folds, the order of reaction with respect to A is
(a) 10 (b) 1 (c) 4 (d) 2

93. Phenacetin is used as
(a) antipyretic (b) antiseptic
(c) antimalarial (d) tranquillizer

94. The correct order of magnetic moments (spin only values in B.M.) among is
(a) $[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$
(b) $[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$
(c) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$
(d) $[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$
(Atomic nos. : Mn = 25, Fe = 26, Co = 27)

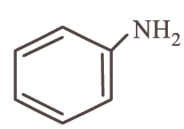
95. Which one of the following is a non-steroidal hormone?
(a) Estradiol (b) Prostaglandin
(c) Progesterone (d) Estrone

96. All form ideal solution except
(a) C_6H_6 and $C_6H_5CH_3$
(b) C_2H_6 and C_2H_5I
(c) C_6H_5Cl and C_6H_5Br
(d) C_2H_5I and C_2H_5OH.

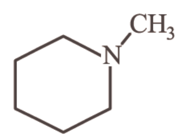
97. An aromatic ether is not cleaved by HI even at 525 K. The compound is
(a) $C_6H_5OCH_3$ (b) $C_6H_5OC_6H_5$
(c) $C_6H_5OC_3H_7$ (d) Tetrahydrofuran

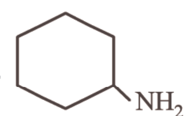
98. In $CH_3CH_2CH_2I$, the C–I bond is formed by the overlapping of
(a) $2sp^3 - 2p_z$ orbitals (b) $2sp^3 - 3p_z$ orbitals
(c) $2sp^3 - 4p_z$ orbitals (d) $2sp^3 - 5p_z$ orbitals

99. Among the following compounds, the increasing order of their basic strength is :

(I) 

(II) 

(III) 

(IV) 

(a) (I) < (II) < (IV) < (III)
(b) (I) < (II) < (III) < (IV)
(c) (II) < (I) < (IV) < (III)
(d) (II) < (I) < (III) < (IV)

100. $MF + XeF_4 \longrightarrow$ 'A' (M^+ = Alkali metal cation)
The state of hybridisation of the central atom in 'A' and shape of the species are:
(a) sp^3d, TBP
(b) sp^3d^3, distorted octahedral
(c) sp^3d^3, pentagonal planar
(d) No compound formed at all

SECTION-B

MATHEMATICS

1. In a battle 70% of the combatants lost one eye, 80% an ear, 75% an arm, 85% a leg, x % lost all the four limbs. The minimum value of x is

(a) 10 (b) 12

(c) 15 (d) None of these

2. The relation R defined on the set A= {1, 2, 3, 4, 5} by R= $\{(x, y) : |x^2 - y^2| < 16\}$ is given by

(a) {(1, 1), (2, 1), (3, 1), (4, 1), (2, 3)}

(b) {(2, 2), (3, 2), (4, 2), (2, 4)}

(c) {(3, 3), (3, 4), (5, 4), (4, 3), (3, 1)}

(d) None of these

3. If $f(x + y) = f(x) + 2y^2 + kxy$ and $f(a) = 2, f(b) = 8$, then $f(x)$ is of the form

(a) $2x^2$ (b) $2x^2 + 1$

(c) $2x^2 - 1$ (d) x^2

4. Which pairs of function is identical ?

(a) $f(x) = \sqrt{x^2}$, $g(x) = x$

(b) $f(x) = \sin^2 x + \cos^2 x$; $g(x) = 1$

(c) $f(x) = \dfrac{x}{x}$, $g(x) = 1$

(d) None of these

5. If $A = 1 + r^a + r^{2a} + r^{3a} + ...\infty$

and $B = 1 + r^b + r^{2b} + r^{3b} + ...\infty$, then $\dfrac{a}{b}$ is equal to

(a) $\log_B (A)$ (b) $\log_{1-B}(1 - A)$

(c) $\log_{\frac{B-1}{B}}\left(\dfrac{A-1}{A}\right)$ (d) None of these

6. The bisector of the acute angle formed between the lines $4x - 3y + 7 = 0$ and $3x - 4y + 14 = 0$ has the equation :

(a) $x + y + 3 = 0$ (b) $x - y - 3 = 0$

(c) $x - y + 3 = 0$ (d) $3x + y - 7 = 0$

7. Two circles $S_1 = x^2 + y^2 + 2g_1x + 2f_1y + c_1 = 0$ and $S_2 = x^2 + y^2 + 2g_2x + 2f_2y + c_2 = 0$ cut each other orthogonally, then :

(a) $2g_1g_2 + 2f_1f_2 = c_1 + c_2$

(b) $2g_1g_2 - 2f_1f_2 = c_1 + c_2$

(c) $2g_1g_2 + 2f_1f_2 = c_1 - c_2$

(d) $2g_1g_2 - 2f_1f_2 = c_1 - c_2$

8. A point is selected at random from the interior of a circle. The probability that the point is close to the centre, then the boundary of the circle, is

(a) $\dfrac{3}{4}$ (b) $\dfrac{1}{2}$

(c) $\dfrac{1}{4}$ (d) None of these

9. The xy-plane divides the line joining the points (–1, 3, 4) (2, – 5, 6)

(a) internally in the ratio 2 : 3

(b) externally in the ratio 2 : 3

(c) internally in the ratio 3 : 2

(d) externally in the ratio 3 : 2

10. $\lim\limits_{x \to 0} \left(\dfrac{a^x + b^x + c^x}{3}\right)^{\lambda/x}$; $(a, b, c, \lambda > 0)$ is equal to–

(a) 1; if $\lambda = 1$ (b) abc; if $\lambda = 1$

(c) abc ; if $\lambda = 1/3$ (d) $(abc)^{2/3}$; if $\lambda = 2$

11. Solution of $2^x + 2^{|x|} \geq 2\sqrt{2}$ is

(a) $(-\infty, \log_2(\sqrt{2} + 1))$

(b) $(0, \infty)$

(c) $\left(\dfrac{1}{2}, \log_2(\sqrt{2} - 1)\right)$

(d) $(-\infty, \log_2(\sqrt{2} - 1)] \cup \left[\dfrac{1}{2}, \infty\right)$

12. The number of seven digit integers, with sum of the digits equal to 10 and formed by using the digits 1, 2 and 3 only, is

(a) 55 (b) 66 (c) 77 (d) 88

13. For positive numbers x, y, z the numerical value of the determinant $\begin{vmatrix} 1 & \log_x y & \log_x z \\ \log_y x & 3 & \log_y z \\ \log_z x & \log_z y & 5 \end{vmatrix}$ is

(a) 0 (b) log x log y log z

(c) 1 (d) 8

14. Negation of the statement $(p \wedge r) \rightarrow (r \vee q)$ is
(a) $\sim(p \wedge r) \rightarrow \sim(r \vee q)$
(b) $(\sim p \vee \sim r) \vee (r \vee q)$
(c) $(p \wedge r) \wedge (r \wedge q)$
(d) $(p \wedge r) \wedge (\sim r \wedge \sim q)$

15. If $f(x) = \begin{cases} \dfrac{\sqrt{1+kx} - \sqrt{1-kx}}{x} & \text{for } -1 \le x < 0 \\ 2x^2 + 3x - 2, & \text{for } 0 \le x \le 1 \end{cases}$ is continuous at x = 0, then k =
(a) –4 (b) –3 (c) –2 (d) –1

16. The area enclosed between the curve $y = \log_e(x+e)$ and the coordinate axes is
(a) 1 (b) 2 (c) 3 (d) 4

17. The differential equation of the family of curves for which the length of the normal is equal to a constant k, is given by:
(a) $y^2 \dfrac{dy}{dx} = k^2 - y^2$
(b) $\left(y \dfrac{dy}{dx}\right)^2 = k^2 - y^2$
(c) $y\left(\dfrac{dy}{dx}\right)^2 = k^2 + y^2$
(d) $\left(y \dfrac{dy}{dx}\right)^2 = k^2 + y^2$

18. $\displaystyle\int \frac{x^{n-1}}{x^{2n} + a^2} dx =$
(a) $\dfrac{1}{na}\tan^{-1}\left(\dfrac{x^n}{a}\right) + C$ (b) $\dfrac{n}{a}\tan^{-1}\left(\dfrac{x^n}{a}\right) + C$
(c) $\dfrac{n}{a}\sin^{-1}\left(\dfrac{x^n}{a}\right) + C$ (d) $\dfrac{n}{a}\cos^{-1}\left(\dfrac{x^n}{a}\right) + C$

19. The sum of the rational terms in the expansion of $(\sqrt{2} + 3^{1/5})^{10}$ is equal to
(a) 40 (b) 41 (c) 42 (d) 0

20. Let R be a relation defined by a R b, a ≥ b where a and b are real number then R is :
(a) reflexive, symmetric and transitive
(b) reflexive, transitive but not symmetric
(c) symmetric, transitive but not reflexive
(d) neither transitive nor reflexive but symmetric

21. If $y = m \log x + nx^2 + x$ has its extreme values at $x = 2$ and $x = 1$, then $2m + 10n =$
(a) –1 (b) –4 (c) –2 (d) –3

22. If ABCDEF is a regular hexagon and $\overrightarrow{AB} + \overrightarrow{AC} + \overrightarrow{AD} + \overrightarrow{AE} + \overrightarrow{AF} = k\overrightarrow{AD}$, then find the value of k.
(a) 2 (b) 3 (c) 4 (d) 5

23. The projection of line joining (3, 4, 5) and (4, 6, 3) on the line joining (–1, 2, 4) and (1, 0, 5) is –
(a) $\dfrac{4}{3}$ (b) $\dfrac{2}{3}$ (c) $\dfrac{8}{3}$ (d) $\dfrac{1}{3}$

24. If $x + iy = \dfrac{3}{\cos\theta + i\sin\theta + 2}$ then $4x - x^2 - y^2$ reduces to :
(a) 2 (b) 3 (c) 4 (d) 5

25. The matrix $A = \begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix}$ is
(a) idempotent matrix (b) involutory matrix
(c) nilpotent matrix (d) None of these

26. If $x = \exp\left\{\tan^{-1}\left(\dfrac{y - x^2}{x^2}\right)\right\}$, then $\dfrac{dy}{dx}$ equals
(a) $2x[1 + \tan(\log x)] + x\sec^2(\log x)$
(b) $x[1 + \tan(\log x)] + \sec^2(\log x)$
(c) $2x[1 + \tan(\log x)] + x^2\sec^2(\log x)$
(d) $2x[1 + \tan(\log x)] + \sec^2(\log x)$

27. The value of $\displaystyle\int_{e^{-1}}^{e} \frac{dt}{t(1+t)}$ is equal to
(a) 0 (b) $\log\left(\dfrac{e}{1+e}\right)$
(c) $\log\left(\dfrac{1}{1+e}\right)$ (d) $\log(1+e)$

28. A coin is tossed thrice. If E be the event of showing at least two heads and F be the event of showing head in the first throw, then find $P\left(\frac{E}{F}\right)$.

(a) $\frac{4}{3}$ (b) $\frac{3}{4}$ (c) $\frac{1}{4}$ (d) $\frac{1}{2}$

29. An aeroplane flying horizontally 1 km above the ground is observed at an elevation of 60° and after 10 s the elevation is observed to be 30°. The uniform speed of the aeroplane in kilometre per hour is

(a) $60\sqrt{3}$ (b) 240
(c) $240\sqrt{3}$ (d) 480

30. If the nth term of an arithmetic progression is 3n + 7, then what is the sum of its first 50 terms?
(a) 3925 (b) 4100 (c) 4175 (d) 8200

31. Let A (1, k), B(1, 1) and C (2, 1) be the vertices of a right angled triangle with AC as its hypotenuse. If the area of the triangle is 1square unit, then the set of values which '*k*' can take is given by
(a) $\{-1, 3\}$ (b) $\{-3, -2\}$
(c) $\{1, 3\}$ (d) $\{0, 2\}$

32. If the ellipse $\frac{x^2}{4}+\frac{y^2}{1}=1$ meet the ellipse $\frac{x^2}{1}+\frac{y^2}{a^2}=1$ in four distinct points and $a = b^2 - 10b + 25$ then which of the following is true ?
(a) $4 < b < 6$ (b) $b < 4$
(c) $b > 6$ (d) Both (b) and (c)

33. Let $f(x)=\sqrt{x-1}+\sqrt{x+24-10\sqrt{x-1}}$; $1 < x < 26$ be real valued function. Then $f'(x)$ for $1 < x < 26$ is

(a) 0 (b) $\frac{1}{\sqrt{x-1}}$
(c) $2\sqrt{x-1}-5$ (d) None of these

34. In a test of Statistics marks were awarded out of 40. The average of 15 students was 38. Later it was decided to give marks out of 50. The new average marks will be
(a) 40 (b) 47.5 (c) 95 (d) 41.5

35. If all the solutions of $a^{\cos x}+a^{-\cos x}=6\,(a>1)$ are real, then the set of values of a is :

(a) $[3+2\sqrt{2}, +\infty)$ (b) (6 12)
(c) $[1 \quad 3+2\sqrt{2}]$ (d) None of these

36. Four couples (husband and wife) decide to form a committee of four members. Find the number of different committees that can be formed in which no couple finds a place.
(a) 12 (b) 14 (c) 16 (d) 24

37. Let $f:(4, 6)\to(6, 8)$ be a function defined by $f(x)=x+\left[\frac{x}{2}\right]$ (where [.] denotes the greatest integer function), then $f^{-1}(x)$ is equal to

(a) $x-\left[\frac{x}{2}\right]$ (b) $-x-2$
(c) $x-2$ (d) $\frac{1}{x+\left[\frac{x}{2}\right]}$

38. If $f(x)=\begin{cases} xe^{-\left(\frac{1}{|x|}+\frac{1}{x}\right)} & , x\neq 0 \\ 0 & , x=0 \end{cases}$ then f(x) is

(a) discontinuous every where
(b) continuous as well as differentiable for all x
(c) continuous for all x but not differentiable at $x=0$
(d) neither differentiable nor continuous at $x=0$

39. Let f be a positive function if

$I_1=\int_{1-k}^{k} xf\{x(1-x)\}\,dx$ and $I_2=\int_{1-k}^{k} f\{x(1-x)\}\,dx$

where $2k-1>0$, then $I_1 : I_2$ is equal to

(a) 2 (b) k (c) $\frac{1}{2}$ (d) 1

40. For any vector $\vec{a}$, the value of $(\vec{a}\times\hat{i})^2+(\vec{a}\times\hat{j})^2+(\vec{a}\times\hat{k})^2$ is equal to

(a) $3\vec{a}^2$ (b) $\vec{a}^2$ (c) $2\vec{a}^2$ (d) $4\vec{a}^2$

41. For the LPP Min $z=x_1+x_2$ such that inequalities $5x_1+10x_2\geq 0$, $x_1+x_2\leq 1$, $x_2\leq 4$ and $x_1, x_2\geq 0$

(a) There is a bounded solution
(b) There is no solution
(c) There are infinitie solution
(d) None of these

42. There are n letters and n addressed envelopes, the probability that all the letters are not kept in the right envelope, is

(a) $\frac{1}{n!}$ (b) $1-\frac{1}{n!}$
(c) $1-\frac{1}{n}$ (d) None of these

43. $\int\frac{dx}{x\sqrt{1-x^3}}=a\ln\left(\frac{\sqrt{1-x^3}+b}{\sqrt{1-x^3}+1}\right)+k$, then :

(a) $b=1, a=1$ (b) $b=-1$, and $a=\frac{1}{3}$
(c) $b=1$, $a=-\frac{2}{3}$ (d) $b=1$ and $a=-\frac{1}{3}$

44. A point on the parabola $y^2=18x$ at which the ordinate increases at twice the rate of the abscissa is

(a) $\left(\frac{9}{8},\frac{9}{2}\right)$ (b) $(2,-4)$
(c) $\left(\frac{-9}{8},\frac{9}{2}\right)$ (d) $(2,4)$

45. Which of the following is the greatest?

(a) ${}^{31}C_0{}^2-{}^{31}C_1{}^2+{}^{31}C_2{}^2-\ldots-{}^{31}C_{31}{}^2$
(b) ${}^{32}C_0{}^2-{}^{32}C_1{}^2+{}^{32}C_1{}^2-\ldots+{}^{32}C_{32}{}^2$
(c) ${}^{32}C_0{}^2+{}^{32}C_1{}^2+{}^{32}C_2{}^2-\ldots+{}^{32}C_{32}{}^2$
(d) ${}^{34}C_0{}^2-{}^{34}C_1{}^2+{}^{34}C_2{}^2-\ldots+{}^{34}C_{32}{}^2$

46. If $\tan^{-1}\frac{x}{\pi}<\frac{\pi}{3}$, $x\in N$, then the maximum value of x is

(a) 2 (b) 5
(c) 7 (d) None of these

47. If A is a square matrix such that $(A-2I)(A+I)=O$, then $A^{-1}=$

(a) $\frac{A-I}{2}$ (b) $\frac{A+I}{2}$
(c) $2(A-I)$ (d) $2A+I$

48. The integral factor of differential equation

$(x^2+1)\frac{dy}{dx}+2xy=x^2-1$ is

(a) x^2+1 (b) $\frac{2x}{x^2+1}$
(c) $\frac{x^2-1}{x^2+1}$ (d) None of these

49. Area bounded by the curves $y=e^x$, $y=e^{-x}$ and the straight line $x=1$ is (in sq. units)

(a) $e+\frac{1}{e}$ (b) $e+\frac{1}{e}+2$
(c) $e+\frac{1}{e}-2$ (d) $e-\frac{1}{e}+2$

50. The distance from the point (3, 4, 5) to the point where the line $\frac{x-3}{1}=\frac{y-4}{2}=\frac{z-5}{2}$ meets the plane $x+y+z=17$ is

(a) 1 (b) 2 (c) 3 (d) $\sqrt{2}$

Mock Test-5

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. The magnetic field at a point due to a current carrying conductor is directly proportional to
(a) resistance of the conductor
(b) thickness of the conductor
(c) current flowing through the conductor
(d) distance from the conductor

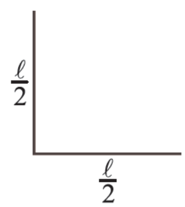
2. The work done in placing a charge of 8×10^{-18} coulomb on a condenser of capacity 100 micro-farad is
(a) 16×10^{-32} joule (b) 3.1×10^{-26} joule
(c) 4×10^{-10} joule (d) 32×10^{-32} joule

3. Light of wavelength 6000 Å falls on a single slit of width 0.1 mm. The second minimum will be formed for the angle of diffraction of
(a) 0.08 radian (b) 0.06 radian
(c) 0.12 radian (d) 0.012 radian

4. A body executing linear simple harmonic motion has a velocity of 3 m/s when its displacement is 4 cm and a velocity of 4 m/s when its displacement is 3 cm. What is the amplitude of oscillation ?
(a) 5 cm (b) 7.5 cm
(c) 10 cm (d) 12.5 cm

5. If the mass of earth is eighty times the mass of a planet and diameter of the planet is one fourth that of earth, then acceleration due to gravity on the planet would be
(a) 7.8 m/s^2 (b) 9.8 m/s^2
(c) 6.8 m/s^2 (d) 2.0 m/s^2

6. A steel wire of length ℓ has a magnetic moment M. It is bent in L-shape (Figure). The new magnetic moment is



(a) M
(b) $\frac{M}{\sqrt{2}}$
(c) $\frac{M}{2}$
(d) 2M

7. At a certain place, the angle of dip is 30º and the horizontal component of earth's magnetic field is 0.50 oerested. The earth's total magnetic field (in oerested) is
(a) $\sqrt{3}$ (b) 1 (c) $\frac{1}{\sqrt{3}}$ (d) $\frac{1}{2}$

8. In an LR-circuit, the inductive reactance is equal to the resistance R of the circuit. An e.m.f. $E = E_0$ cos(ωt) applied to the circuit. The power consumed in the circuit is
(a) $\frac{E_0^2}{R}$ (b) $\frac{E_0^2}{2R}$ (c) $\frac{E_0^2}{4R}$ (d) $\frac{E_0^2}{8R}$

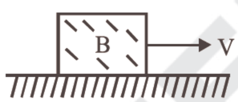
9. Why is the Wheatstone bridge better than the other methods of measuring resistances?
(a) It does not involve Ohm's law
(b) It is based on Kirchoff's law
(c) It has four resistor arms
(d) It is a null method

10. The gap between the frequency of the side bands in an amplitude modulated wave is
(a) twice that of the carrier signal
(b) twice that of the message signal
(c) the same as that of the message signal
(d) the same as that of the carrier signal

11. The density of a material in CGS system is 8 g / cm^3. In a system of a unit in which unit of length is 5 cm and unit of mass is 20 g, the density of material is
(a) 8 (b) 20 (c) 50 (d) 80

12. Excitation energy of a hydrogen like ion in its excitation state is 40.8 eV. Energy needed to remove the electron from the ion in ground state is
(a) 54.4 eV (b) 13.6 eV
(c) 40.8 eV (d) 27.2 eV

13. A block B is pushed momentarily along a horizontal surface with an initial velocity V. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time



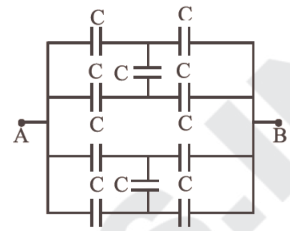
(a) $\frac{g\mu}{V}$ (b) $\frac{g}{V}$
(c) $\frac{V}{g}$ (d) $\frac{V}{g(\mu)}$

14. Two identical spheres of gold are in contact with each other. The gravitational attraction between them is
(a) directly proportional to the square of the radius
(b) directly proportional to the cube of the radius
(c) directly proportional to the fourth power of the radius
(d) inversely proportional to the square of the radius

15. The coefficient of performance of a refrigerator is 5. If the inside temperature of freezer is -20°C, then the temperature of the surroundings to which it rejects heat is
(a) 41°C (b) 11°C (c) 21°C (d) 31°C

16. In Young's double slit experiment, the slits are 3 mm apart. The wavelength of light used is 5000 Å and the distance between the slits and the screen is 90 cm. The fringe width in mm is
(a) 1.5 (b) 0.015 (c) 2.0 (d) 0.15

17. The effective capacitance of combination of combination of equal capacitors between points A and B shown in figure is

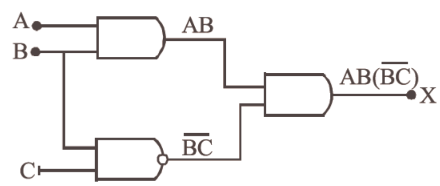


(a) C
(b) 2C
(c) 3C
(d) $\frac{C}{2}$

18. In a photoelectric experiment the stopping potential for the incident light of wavelength 4000Å is 2 volt. If the wavelength be changed to 3000 Å, the stopping potential will be
(a) 2 V (b) zero
(c) less than 2 V (d) more than 2 V

19. When the current in a coil changes from 2 amp. to 4 amp. in 0.05 sec., an e.m.f. of 8 volt is induced in the coil. The coefficient of self inductance of the coil is
(a) 0.1 henry (b) 0.2 henry
(c) 0.4 henry (d) 0.8 henry

20. The correct option for getting X = 1 from the given circuit is:



(a) A = B = C = 1 (b) A = B = 1 & C = 0
(c) A = C = 1 & B = 0 (d) A = 0 & B = C = 1

21. The linear velocity of a rotating body is given by:
$$\vec{v} = \vec{\omega} \times \vec{r}$$
If $\vec{\omega} = \hat{i} - 2\hat{j} + 2\hat{k}$ and $\vec{r} = 4\hat{j} - 3\hat{k}$, then the magnitude of $\vec{v}$ is
(a) $\sqrt{29}$ units (b) $\sqrt{31}$ units
(c) $\sqrt{37}$ units (d) $\sqrt{41}$ units

22. A ship of mass 3×10^7 kg initially at rest, is pulled by a force of 5×10^4 N through a distance of 3m. Assuming that the resistance due to water is negligible, the speed of the ship is
(a) 1.5 m/sec. (b) 60 m/sec.
(c) 0.1 m/sec. (d) 5 m/sec.

23. A particle of mass 2 kg is moving such that at time t, its position, (in meter) is given by $\vec{r}(t) = 5\hat{i} - 2t^2\hat{j}$. The angular momentum of the particle at $t = 2s$ about the origin (in kg m^{-2} s^{-1}) is :

(a) $-80\hat{k}$ (b) $(10\hat{i} - 16\hat{j})$
(c) $-40\hat{k}$ (d) $40\hat{k}$

24. A metallic wire of length 2.0 m is elongated by 2.0 mm. Area of cross-section of the wire is 4.0 mm^2. The elastic potential energy stored in the wire in elongated condition is [young's modulus of the metallic wire is $= 2 \times 10^{11}$ N/m^2]

(a) 8.23 (b) 0.83 (c) 6.23 (d) 0.63

25. An ideal gas A and a real gas B have their volumes increased from V to $2V$ under isothermal conditions. The increase in internal energy

(a) will be same in both A and B
(b) will be zero in both the gases
(c) of B will be more than that of A
(d) of A will be more than that of B

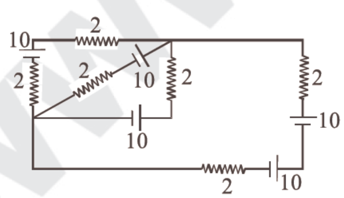
26. An electron moving with kinetic energy 6×10^{-16} joules enters a field of magnetic induction 6×10^{-3} weber/m^2 at right angle to its motion. The radius of its path is

(a) 3.42 cm (b) 4.23 cm
(c) 5.17 cm (d) 7.7 cm

27. An iron rod of length 2m and cross-sectional area of 50 mm^2 stretched by 0.5 mm, when a mass of 250 kg is hung from its lower end. Young's modulus of iron rod is

(a) 19.6×10^{20} N/m^2 (b) 19.6×10^{18} N/m^2
(c) 19.6×10^{10} N/m^2 (d) 19.6×10^{15} N/m^2

28. All batteries are having emf 10 volt and internal resistance negligible. All resistors are in ohms. Calculate the current in the right most 2Ω resistor.



(a) $\frac{25}{12}$A (b) $\frac{25}{6}$A

(c) $\frac{12}{25}$A (d) $\frac{6}{25}$A

29. A mass of 20 kg moving with a speed of 10m/s collides with another stationary mass of 5 kg. As a result of the collision, the two masses stick together. The kinetic energy of the composite mass will be

(a) 600 (b) 800 (c) 1000 (d) 1200

30. A radioactive source of half-life 2 hours emits radiation of intensity which is 64 times the permissible safe level. The minimum time in hours after which it would be possible to work safely with the source is

(a) 12 (b) 8 (c) 6 (d) 24

31. A hospital uses an ultrasonic scanner to locate tumours in a tissue. The operating frequency of the scanner is 4.2 MHz. The speed of sound in a tissue is 1.7 km/s. The wavelength of sound in tissue is close to

(a) 4×10^{-4}m (b) 8×10^{-4}m
(c) 4×10^{-3}m (d) 8×10^{-3}m

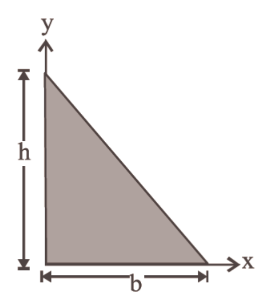
32. A particle executes simple harmonic motion between x = – A and x = + A. The time taken for it to go from O to A/2 is T_1 and T_1 and to go from A/2 to A is T_2. Then

(a) $T_1 < T_2$ (b) $T_1 > T_2$
(c) $T_1 = T_2$ (d) $T_1 = 2T_2$

33. The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

(a) $I_0 + ML^2/2$ (b) $I_0 + ML^2/4$
(c) $I_0 + 2ML^2$ (d) $I_0 + ML^2$

34. The centre of mass of triangle shown in figure has coordinates



(a) $x = \frac{h}{2}, y = \frac{b}{2}$

(b) $x = \frac{b}{2}, y = \frac{h}{2}$

(c) $x = \frac{b}{3}, y = \frac{h}{3}$

(d) $x = \frac{h}{3}, y = \frac{b}{3}$

35. A particle P is moving in a circle of radius 'a' with a uniform speed v. C is the centre of the circle and AB is a diameter. When passing through B the angular velocity of P about A and C are in the ratio:

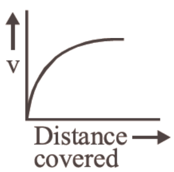
(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 4 : 1

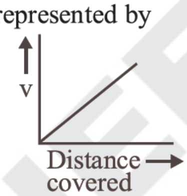
36. When light passing through rotating nicol is observed, no change in intensity is seen. What inference can be drawn ?
(a) The incident light is unpolarized.
(b) The incident light is circularly polarized.
(c) The incident light is unpolarized or circularly polarized.
(d) The incident light is unpolarized or circularly polarized or combination of both.

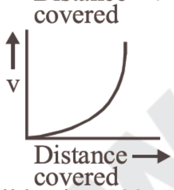
37. An infinitely long thin straight wire has uniform linear charge density of $\frac{1}{3}$ cm^{-1}. Then, the magnitube of electric intensity at a point 18 cm away is: (Given $\varepsilon_0 = 8.8 \times 10^{12} C^2 Nm^{-2}$)
(a) 0.33×10^{11} NC^{-1} (b) 3×10^{11} NC^{-1}
(c) 0.66×10^{11} NC^{-1} (d) 1.32×10^{11} NC^{-1}

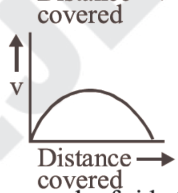
38. In an oscillation of L-C circuit, the maximum charge on the capacitor is Q. The charge on the capacitor, when the energy is stored equally between the electric and magnetic field is
(a) $\frac{Q}{2}$ (b) $\frac{Q}{\sqrt{2}}$ (c) $\frac{Q}{\sqrt{3}}$ (d) $\frac{Q}{3}$

39. A lead shot of 1 mm diameter falls through a long column of glycerine. The variation of its velocity v with distance covered is represented by

(a) 

(b) 

(c) 

(d) 

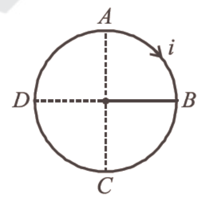
40. A coil having 500 square loops each of side 10 cm is placed normal to a magnetic field which increases at the rate of 1 Wb/m^2. The induced e.m.f. is
(a) 0.1 V (b) 5.0 V (c) 0.5 V (d) 1.0 V

41. An ideal gas is found to obey an additional law VP^2 = constant. The gas is initially at temperature T and volume V. When it expands to a volume 2 V, the temperature becomes
(a) $T/\sqrt{2}$ (b) 2 T
(c) $2T\sqrt{2}$ (d) 4 T

42. A tuning fork of known frequency 256 Hz makes 5 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per second when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was
(a) $(256+2)$ Hz (b) $(256-2)$ Hz
(c) $(256-5)$ Hz (d) $(256+5)$ Hz

43. Water flows in a stream line manner through a capillary tube of radius a, the pressure difference being P and the rate flow Q. If the radius is reduced to $\frac{a}{2}$ and the pressure is increased to 2P, the rate of flow becomes
(a) 4Q (b) Q (c) $\frac{Q}{2}$ (d) $\frac{Q}{8}$

44. A circular coil *ABCD* carrying a current *i* is placed in a uniform magnetic field. If the magnetic force on the segment *AB* is $\vec{F}$, the force on the remaining segment *BCDA* is



(a) $\vec{F}$ (b) $-\vec{F}$ (c) $3\vec{F}$ (d) $-3\vec{F}$

45. The refractive indices of glass and water with respect to air are $\frac{1}{2}$ and $\frac{1}{\sqrt{3}}$ respectively. Then the refractive index of glass with respect to water is
(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{\sqrt{3}}{2}$ (c) $\frac{2}{\sqrt{3}}$ (d) 2

46. A certain number of spherical drops of a liquid of radius 'r' coalesce to form a single drop of radius 'R' and volume 'V'. If 'T' is the surface tension of the liquid, then :
(a) energy $= 4VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released
(b) energy $= 3VT\left(\frac{1}{r}+\frac{1}{R}\right)$ is absorbed
(c) energy $= 3VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released
(d) energy is neither released nor absorbed

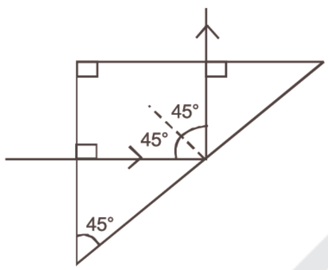
47. Two bodies A and B are placed in an evacuated vessel maintained at a temperature of 27ºC. The temperature of A is 327ºC and that of B is 227ºC. The ratio of heat loss from A and B is about
(a) 2 : 1 (b) 1 : 2 (c) 4 : 1 (d) 1 : 4

48. When the road is dry and the coefficient of the friction is μ, the maximum speed of a car in a circular path is 10 ms^{-1}. If the road becomes wet and $\mu' = \frac{\mu}{2}$, what is the maximum speed permitted?

(a) 5 ms^{-1} (b) 10 ms^{-1}

(c) $10\sqrt{2}$ ms^{-1} (d) $5\sqrt{2}$ ms^{-1}

49. A light ray is incident perpendicularly to one face of a 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45°, we conclude that the refractive index n



(a) $n > \frac{1}{\sqrt{2}}$

(b) $n > \sqrt{2}$

(c) $n < \frac{1}{\sqrt{2}}$

(d) $n < \sqrt{2}$

50. A whistle of frequency 385 Hz rotates in a horizontal circle of radius 50 cm at an angular speed of 20 radians s^{-1}. The lowest frequency heard by a listener a long distance away at rest with respect to the centre of the circle, given velocity of sound equal to 340 ms^{-1}, is

(a) 396 Hz (b) 363 Hz (c) 374 Hz (d) 385 Hz

CHEMISTRY

51. The radii of Na^+ and Cl^- ions are 95 pm and 181 pm respectively. The edge length of NaCl unit cell is

(a) 276 pm (b) 138 pm

(c) 552 pm (d) 415 pm

52. Aluminium oxide may be electrolysed at 1000°C to furnish aluminium metal (At. Mass = 27 amu; 1 Faraday = 96,500 Coulombs). The cathode reaction is $Al^{3+} + 3e^- \rightarrow Al$

To prepare 5.12 kg of aluminium metal by this method would require

(a) 5.49×10^7 C of electricity.

(b) 1.83×10^7 C of electricity.

(c) 5.49×10^4 C of electricity.

(d) 5.49×10^1 C of electricity.

53. Among the following, the wrong statement is

(a) PMMA is plexiglass

(b) SBR is natural rubber

(c) PTFE is teflon

(d) LDPE is low density polythene

54. Hydride ion transfer takes place in:

(a) Frankland method

(b) Wurtz reaction

(c) Cannizzaro reaction

(d) Wolff-Kishner reduction

55. The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 B.M. The correct one is

(a) d^5 (in strong ligand field)

(b) d^3 (in weak as well as in strong fields)

(c) d^4 (in weak ligand fields)

(d) d^4 (in strong ligand fields)

56. Which of these does not influence the rate of reaction ?

(a) Nature of the reactants

(b) Concentration of the reactants

(c) Temperature of the reaction

(d) Molecularity of the reaction

57. 3-Hexyne reacts with Na/liq. NH_3 to produce

(a) cis-3-Hexene (b) trans-3-Hexene

(c) 3-Hexylamine (d) 2-Hexylamine

58. Total volume of atoms present in a face-centred cubic unit cell of a metal is (r is atomic radius)

(a) $\frac{12}{3}\pi r^3$ (b) $\frac{16}{3}\pi r^3$

(c) $\frac{20}{3}\pi r^3$ (d) $\frac{24}{3}\pi r^3$

59. Which one of the following pairs is isostructural (i.e., having the same shape and hybridization)?

(a) $[BCl_3 \text{ and } BrCl_3^-]$

(b) $[NH_3 \text{ and } NO_3^-]$

(c) $[NF_3 \text{ and } BF_3]$

(d) $[BF_4^- \text{ and } NH_4^+]$

60. Consider the following sequence of reactions :

$$\text{Compound}[A] \xrightarrow{\text{Reduction}} [B] \xrightarrow{HNO_2} CH_3CH_2OH$$

The compound [A] is

(a) CH_3CH_2CN (b) CH_3NO_2
(c) CH_3NC (d) CH_3CN

61. $\left[Fe(H_2O)_6\right]^{2+}$ and $\left[Fe(CN)_6\right]^{4-}$ differ in :

(a) geometry, magnetic moment
(b) geometry, hybridization
(c) magnetic moment, colour
(d) hybridization, number of *d*-electrons

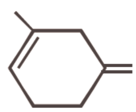
62. Which of the following is chalcopyrite?

(a) $CuFeS_2$ (b) FeS_2
(c) $KMgCl_3.6H_2O$ (d) $Al_2O_3.2H_2O$

63. If x is the specific resistance of the solution and N is the normality of the solution, the equivalent conductivity of the solution is given by

(a) $\dfrac{1000\,x}{N}$ (b) $\dfrac{1000}{Nx}$

(c) $\dfrac{1000N}{x}$ (d) $\dfrac{Nx}{1000}$

64.  is oxidised by heating with alkaline $KMnO_4$ to give

(a) $CH_2O + CH_3CO(CH_2)_4COOH$
(b) $CO_2 + CH_3COCH_2COCH_2CH_2COOH$
(c) $CH_2O + CH_3COCH_2COCH_2CH_2COOH$
(d) the corresponding tetrol

65. The reagent commonly used to determine hardness of water titrimetrically is

(a) oxalic acid
(b) sodium thiosulphate
(c) sodium citrate
(d) disodium salt of EDTA

66. The charge on colloidal particles is due to

(a) presence of electrolyte.
(b) very small size of particles.
(c) adsorption of ions from the solution.
(d) none of these.

67. The E° at 25° C for the following reaction is 0.22 V. Calculate the equilibrium constant at 25° C :

$$H_2(g) + 2AgCl(s) \longrightarrow 2Ag(s) + 2HCl(aq)$$

(a) 2.8×10^7 (b) 5.2×10^8
(c) 5.2×10^6 (d) 5.2×10^3

68. The reason for not storing XeF_6 in a glass or a quartz vessel is that

(a) it forms an explosive having the formula XeO_2F_2
(b) it forms an explosive having the formula $XeOF_4$
(c) it forms XeO_2 which is explosive substance
(d) it forms XeO_6^{4-} which is explosive in nature

69. The rate of a first order reaction is 1.5×10^{-2} mol L^{-1} min^{-1} at 0.5 M concentration of the reactant. The half life of the reaction is

(a) 0.383 min (b) 23.1 min
(c) 8.73 min (d) 7.53 min

70. Bauxite ore is made up of $Al_2O_3 + SiO_2 + TiO_2 + Fe_2O_3$. This ore is treated with conc. NaOH solution at 500 K and 35 bar pressure for few hours and filtered hot. In the filtrate the species present is/are

(a) $NaAl(OH)_4$ only
(b) $Na_2Ti(OH)_6$ only
(c) $NaAl(OH)_4$ and Na_2SiO_3
(d) Na_2SiO_3 only

71. Which one of the following is employed as a tranquilizer?

(a) Naproxen
(b) Tetracycline
(c) Chlorpheninamine
(d) Equanil

72. Primary amines can be distinguished from secondary and tertiary amines by reacting with

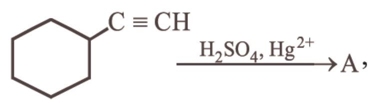
(a) Chloroform and alcoholic KOH
(b) Methyl iodide
(c) Chloroform alone
(d) Zinc dust

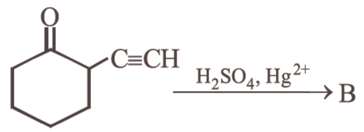
73. In HS^-, I^-, RNH_2 and NH_3, order of proton accepting tendency will be

(a) $I^- > NH_3 > RNH_2 > HS^-$
(b) $HS^- > RNH_2 > NH_3 > I^-$
(c) $RNH_2 > NH_3 > HS^- > I^-$
(d) $NH_3 > RNH_2 > HS^- > I^-$

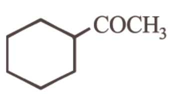
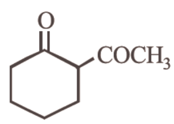
74. One litre hard water contains 12.00 mg Mg^{2+}. Milli-equivalents of washing soda required to remove its hardness is :

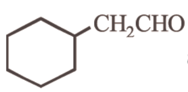
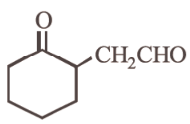
(a) 1 (b) 12.16
(c) 1×10^{-3} (d) 12.16×10^{-3}

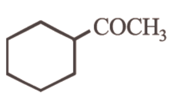
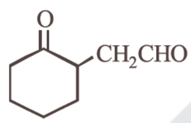
75. 

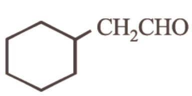
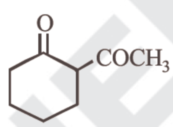


The respective compounds A and B are

(a)  and 

(b)  and 

(c)  and 

(d)  and 

76. $A + H_2O \longrightarrow B + HCl$

$B + H_2O \longrightarrow C + HCl$

Compound (A), (B) and (C) will be respectively

(a) $PCl_5, POCl_3, H_3PO_3$

(b) $PCl_5, POCl_3, H_3PO_4$

(c) $SOCl_2, POCl_3, H_3PO_3$

(d) $PCl_3, POCl_3, H_3PO_4$

77. Camphor is often used in molecular mass determination because

(a) it is readily available
(b) it has a very high cryoscopic constant
(c) it is volatile
(d) it is solvent for organic substances

78. The dichromate ion is in equilibrium with chromate ion in aqueous solution as :

$Cr_2O_7^{2-}(aq) + H_2O \rightleftharpoons 2CrO_4^{2-}(aq) + 2H^+(aq)$

The oxoanion has

(a) same oxidizing property in acidic and alkaline solutions.
(b) better oxidizing property in acidic solution.
(c) better oxidizing property in alkaline solution.
(d) no oxidizing property in acidic or alkaline solution.

79. The correct sequence which shows decreasing order of the ionic radii of the elements is

(a) $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$

(b) $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$

(c) $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$

(d) $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$

80. Which of the following will give a pair of enantiomorphs?

(a) $[Cr(NH_3)_6][Co(CN)_6]$

(b) $[Co(en)_2Cl_2]Cl$

(c) $[Pt(NH_3)_4][PtCl_6]$

(d) $[Co(NH_3)_5Cl]NO_2$

81. In the following reaction

$C_2H_5OC_2H_5 + 4[H] \xrightarrow{\text{Red P + HI}} 2X + H_2O$, X is

(a) ethane (b) ethylene
(c) butane (d) propane

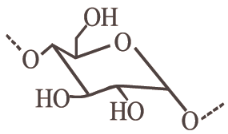
82. The solubility of a specific non-volatile salt is 4 g in 100 g of water at 25°C. If 2.0 g. 4.0 g and 6.0 g of the salt added to100 g of water at 25°C, in system X, Y and Z. The vapour pressure would be in the order

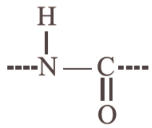
(a) $X < Y < Z$ (b) $X > Y > Z$
(c) $Z > X = Y$ (d) $X > Y = Z$

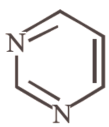
83. The gas which is least adsorbed on charcoal (under identical conditions) is

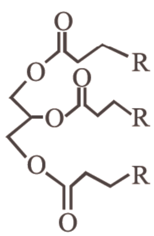
(a) HCl (b) O_2 (c) CO_2 (d) NH_3

84. Which one of the following chemical units is certainly to be found in an enzyme?

(a) 

(b) 

(c) 

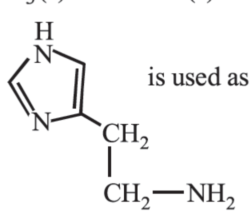
(d) 

85. The reaction of Lucas reagent is fastest with:
(a) $(CH_3)_2CHOH$ (b) $CH_3(CH_2)_2OH$
(c) CH_3CH_2OH (d) $(CH_3)_3COH$

86. Amalgams are
(a) always in liquid state.
(b) highly coloured alloys.
(c) alloys which have a great resistance to abrasion.
(d) alloys which contain Hg as one of the constituents.

87. Which of the following is most stable?
(a) Ph_3C^+ (b) Ph_2CH^+
(c) $PhCH_2^+$ (d) Tropylium cation

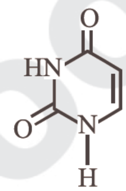
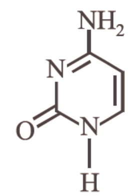
88. For which of the following changes, $\Delta H \neq \Delta U$
(a) $N_2(g)+O_2(g) \rightarrow 2NO(g)$
(b) $H_2(g)+Cl_2(g) \longrightarrow 2HCl(g)$
(c) $C(s)+O_2(g) \longrightarrow CO_2(g)$
(d) $CaCO_3(s) \longrightarrow CaO(s)+CO_2(g)$

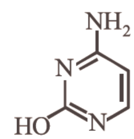
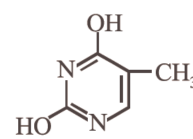
89. The drug  is used as :
(a) Antacid (b) Analgesic
(c) Antimicrobial (d) Antiseptic

90. Mark the correct statement
(a) Methylamine is slightly acidic.
(b) Methylamine is less basic than ammonia.
(c) Methylamine is a stronger base than ammonia.
(d) Methylamine forms salts with alkalies.

91. Aryl halides can not be prepared by the reaction of aryl alcohols with PCl_3, PCl_5 or $SOCl_2$ because
(a) phenols are highly stable compounds.
(b) carbon-oxygen bond in phenols has a partial double bond character.
(c) carbon-oxygen bond is highly polar.
(d) all of these.

92. Which of the following structures represents thymine ?

(a)  (b) 

(c)  (d) 

93. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$. Given that $\Lambda^\circ_{Al^{3+}}$ and $\Lambda^\circ_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions?

(a) $\frac{1}{3}\Lambda^\circ_{Al^{3+}} + \frac{1}{2}\Lambda^\circ_{SO_4^{2-}}$

(b) $2\Lambda^\circ_{Al^{3+}} + 3\Lambda^\circ_{SO_4^{2-}}$

(c) $\Lambda^\circ_{Al^{3+}} + \Lambda^\circ_{SO_4^{2-}}$

(d) $\left(\Lambda^\circ_{Al^{3+}} + \Lambda^\circ_{SO_4^{2-}}\right) \times 6$

94. 2-Bromopentane is heated with potassium ethoxide in ethanol. The major product obtained is
(a) 2-ethoxypentane (b) pentene-1
(c) *trans*-2-pentene (d) *cis*-pentene-2

95. In any period, the valency of an element with respect to oxygen
(a) increases one by one from IA to VIIA
(b) decreases one by one from IA to VIIA
(c) increases one by one from IA to IVA and then decreases from VA to VIIA one by one
(d) decreases one by one from IA to IVA and then increases from VA to VIIA one by one

96. In face centred cubic lattice, a unit cell is shared equally by how many unit cells
(a) 2 (b) 4 (c) 6 (d) 8

97. Which one of the following reactions of xenon compounds is not feasible?
(a) $3XeF_4 + 6H_2O \longrightarrow 2Xe + XeO_3 + 12HF + 1.5O_2$
(b) $2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$
(c) $XeF_6 + RbF \longrightarrow Rb[XeF_7]$
(d) $XeO_3 + 6HF \longrightarrow XeF_6 + 3H_2O$

98. Which of the following is an example of S_N2 reaction?
(a) $CH_3Br + OH^- \longrightarrow CH_3OH + Br^-$
(b) $CH_3-\underset{\underset{Br}{|}}{CH}-CH_3 + OH^- \longrightarrow CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$
(c) $CH_3CH_2OH \xrightarrow{-H_2O} CH_2=CH_2$
(d) $(CH_3)_3C-Br + OH^- \longrightarrow (CH_3)_3COH + Br^-$

99. Isopropyl alcohol is obtained by reacting which of the following alkenes with concentrated H_2SO_4 followed by boiling with H_2O?
(a) Ethylene (b) Propylene
(c) 2-Methylpropene (d) Isoprene

100. Which of the following monomers form biodegradable polymers?
(a) 3-hydroxybutanoic acid + 3-hydroxypentanoic acid
(b) Glycine + amino caproic acid
(c) Ethylene glycol + phthalic acid
(d) Both (a) and (b)

SECTION-B

MATHEMATICS

1. If $n(A) = 1000$, $n(B) = 500$ and if $n(A \cap B) \geq 1$ and $n(A \cup B) = p$, then
(a) $500 \leq p \leq 1000$ (b) $1001 \leq p \leq 1498$
(c) $1000 \leq p \leq 1498$ (d) $1000 \leq p \leq 1499$

2. Let $f(x) = x$, $g(x) = \frac{1}{x}$ and $h(x) = f(x)\, g(x)$. Then, $h(x) = 1$ if and only if
(a) x is a real number
(b) x is a rational number
(c) x is an irrational number
(d) x is a non-zero real number

3. The set of values of x for which $\frac{\tan 3x - \tan 2x}{1 + \tan 3x \tan 2x} = 1$ is :
(a) ϕ
(b) 4
(c) $\left\{n\pi + \frac{\pi}{4} : n = 1, 2, 3, ...\right\}$
(d) $\left\{2n\pi + \frac{\pi}{4} : n = 1, 2, 3, ...\right\}$

4. If a, b, c, d are distinct integers in A. P., such that $d^2 = a^2 + b^2 + c^2$, then a + b + c + d is :
(a) 0 (b) 1
(c) 2 (d) None of these

5. The lines $x + 2y - 5 = 0$, $2x - 3y + 4 = 0$, $6x + 4y - 13 = 0$
(a) are concurrent
(b) form a right angled triangle
(c) form an isosceles triangle
(d) form an equilateral triangle

6. The area of an equilateral triangle inscribed in the circle $x^2 + y^2 + 2gx + 2fy + c = 0$ is
(a) $\frac{3\sqrt{3}}{2}\left(g^2 + f^2 - c\right)$
(b) $\frac{3\sqrt{3}}{4}\left(g^2 + f^2 - c\right)$
(c) $\frac{3\sqrt{3}}{4}\left(g^2 + f^2 + c\right)$
(d) None of these

7. If $z_1 = \sqrt{2}\left[\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right]$ and $z_2 = \sqrt{3}\left[\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right]$, then $|z_1 z_2|$ is equal to $\sqrt{m}$. Value of m is
(a) 6 (b) 3 (c) 2 (d) 5

8. Find the 7th term from the end in the expansion of $\left(x - \frac{2}{x^2}\right)^{10}$.
(a) $^{10}C_4$ (b) $^{10}C_4.2^4x$
(c) $2^4.x^2$ (d) $^{10}C_4.2^4\left(\frac{1}{x^2}\right)$

9. The roots of the equation $abc^2x^2 + 3a^2cx + b^2cx - 6a^2 - ab + 2b^2 = 0$ are
(a) non-real
(b) rational if a, b, c, are rational
(c) irrational if a, b, c are rational
(d) None of these

10. The limit of the series $\sum_{r=1}^{n} \frac{r}{1+r^2+r^4}$ as n approaches infinity, is
(a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{1}{3}$ (d) 1

11. The mean and median of 100 items are 50 and 52 respectively. The value of largest item is 100. It was later found that it is 110 and not 100. The true mean and median are
(a) 50.10, 51.5 (b) 50.10, 52
(c) 50, 51.5 (d) None of these

12. The probability that in the random arrangement of the letters of the word 'UNIVERSITY', the two I's does not come together is
(a) $\frac{4}{5}$ (b) 1/5 (c) 1/10 (d) 9/10

13. The determinant $\begin{vmatrix} a^2+2a & 2a+1 & 1 \\ 2a+1 & a+2 & 1 \\ 3 & 3 & 1 \end{vmatrix}$ is
(a) > 0 if a > 1 (b) = 0 if a = 1
(c) < 0 if a < 1 (d) all of these

14. If $\left.\begin{aligned} f(x) &= \sin x, \text{ when x is rational} \\ &= \cos x, \text{ when x is irrational} \end{aligned}\right\}$
Then the function is
(a) discontinuous at $x = n\pi + \pi/4$
(b) continuous at $x = n\pi + \pi/4$
(c) discontinuous at all x
(d) None of these

15. If $A = \frac{1}{3}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ a & 2 & b \end{bmatrix}$ is an orthogonal matrix, then
(a) a = – 2, b = – 1 (b) a = 2, b = 1
(c) a = 2, b = – 1 (d) a = – 2, b = 1

16. Find the angle between the tangent to the curve $y^2 = 2ax$ at the points where $x = a/2$.
(a) 180° (b) 90°
(c) 0° (d) None of these

17. If the area enclosed by $y^2 = 4ax$ is $\frac{1}{3}$ sq. unit, then the roots of the equation $x^2 + 2x = a$, are
(a) –4 and 2 (b) 2 and 4
(c) –2 and –4 (d) 8 and –8

18. If $[\sin^{-1}\cos^{-1}\sin^{-1}\tan^{-1}x] = 1$, where [.] denotes the greatest integer function, then x belongs to the interval
(a) [tan sin cos 1, tan sin cos sin 1]
(b) (tan sin cos 1, tan sin cos sin 1)
(c) [–1, 1]
(d) [sin cos tan 1, sin cos sin tan 1]

19. The solution to of the differential equation $(x+1)\frac{dy}{dx} - y = e^{3x}(x+1)^2$ is
(a) $y = (x+1)e^{3x} + c$
(b) $3y = (x+1) + e^{3x} + c$
(c) $\frac{3y}{x+1} = e^{3x} + c$
(d) $ye^{-3x} = 3(x+1) + c$

20. A father has 3 children with at least one boy. The probability that he has 2 boys and 1 girl is
(a) 1/4 (b) 1/3
(c) 2/3 (d) None of these

21. If $\int \frac{dx}{x+x^7} = p(x)$ then, $\int \frac{x^6}{x+x^7}dx$ is equal to
(a) $\ln|x| - p(x) + c$ (b) $\ln|x| + p(x) + c$
(c) $x - p(x) + c$ (d) $x + p(x) + c$

22. The distance between the planes $x+2y-2z+1=0$ and $2x+4y-4z+5=0$ is

(a) 2 units (b) $\frac{1}{4}$ units

(c) $\frac{1}{2}$ units (d) 4 units

23. If $\vec{a}=2\hat{i}-2\hat{j}+\hat{k}$ and $\vec{c}=-\hat{i}+2\hat{k}$ then $|\vec{c}|.\ \vec{a}$ is equal to :

(a) $2\sqrt{5}\,\hat{i}+2\sqrt{5}\,\hat{j}+\sqrt{5}\,\hat{k}$

(b) $2\sqrt{5}\,\hat{i}-2\sqrt{5}\,\hat{j}+\sqrt{5}\,\hat{k}$

(c) $\sqrt{5}\,\hat{i}+\sqrt{5}\,\hat{j}+\sqrt{5}\,\hat{k}$

(d) $\sqrt{5}\,\hat{i}+2\sqrt{5}\,\hat{j}+\sqrt{5}\,\hat{k}$

24. If $f(x)=2\sin^{-1}\sqrt{1-x}+\sin^{-1}(2\sqrt{x(1-x)})$, where $x\in\left(0,\frac{1}{2}\right)$, then $f'(x)$ is

(a) $\frac{2}{\sqrt{x(1-x)}}$ (b) zero

(c) $-\frac{2}{\sqrt{x(1-x)}}$ (d) π

25. If R be a relation < from A = {1, 2, 3, 4} to B = {1, 3, 5} i.e.,

(a, b) $\in R \Leftrightarrow$ a < b, then RoR^{-1} is

(a) {(1, 3), (1, 5), (2, 3), (2, 5), (3, 5), (4, 5)}

(b) {(3, 1), (5, 1), (3, 2), (5, 2), (5, 3), (5, 4)}

(c) {(3, 3), (3, 5), (5, 3), (5, 5)}

(d) {(3, 3), (3, 4), (4, 5)}

26. If S(p, q, r) = (~p) ∨ [~(q ∧ r)] is a compound statement, then S(~p, ~q, ~r) is

(a) ~S(p, q, r) (b) S(p, q, r)

(c) p ∨ (q ∧ r) (d) p ∨ (q ∨ r)

27. The co-ordinates of the points A and B are (2 , 3, 4) and (–2, 5, –4) respectively. If a point P moves so that $PA^2 - PB^2 = k$ where k is a constant, then the locus of P is

(a) $-8x+4y-16z+16=k$

(b) $-8x-4y-16z-16=k$

(c) $-8x+4y-16z-16=k$

(d) None of these

28. Let A be a set of n (≥ 3) distinct elements. The number of triplets (x, y, z) of the elements of A in which at least two coordinates are equal is

(a) ${}^nP_3$ (b) $n^3-{}^nP_3$

(c) $3n^2$ (d) $3n^2(n-1)$

29. The horizontal distance between two towers is 60 metres and the angular depression of the top of the first tower as seen from the top of the second. is 30°. If the height of the second tower be 150 metres, then the height of the first tower is

(a) $150-60\sqrt{3}$m (b) 90m

(c) $150-20\sqrt{3}$m (d) None of these

30. Let the perpendiculars from any point on the line 7x + 56y = 0 upon 3x + 4y = 0 and 5x – 12y = 0 be p and p', then

(a) 2p = p' (b) p = 2p'

(c) p = p' (d) None of these

31. The length of the latus rectum of the parabola which has focus at (–1, 1) and the directrix is 4x + 3y – 24 = 0 is

(a) 4 (b) 6 (c) 8 (d) 10

32. If $z=\frac{7-i}{3-4i}$ then $z^{14}=$

(a) 2^7 (b) 2^7i (c) $2^{14}i$ (d) -2^7i

33. Number of integral values of x satisfying the inequality $\left(\frac{3}{4}\right)^{6x+10-x^2}<\frac{27}{64}$ is

(a) 5 (b) 6 (c) 7 (d) 8

34. In a ΔABC, $\frac{\sin A}{\sin C}=\frac{\sin(A-B)}{\sin(B-C)}$, then a^2, b^2, c^2 are such that

(a) they are in G.P. (b) they are in H.P.

(c) they are in A.P. (d) $b^2=a^2+c^2$

35. Three numbers are in G.P. such that their sum is 38 and their product is 1728. The greatest number among them is :

(a) 18 (b) 16

(c) 14 (d) None of these

36. Find the number of integral solution of the equation $x+y+z=20$ and $x>-1, y>-2$ and $z>-3$.

(a) ${}^{25}C_{23}$ (b) ${}^{17}C_2$

(c) ${}^{23}C_2$ (d) None of these

37. The coefficient of x^{100} in the expansion of $\sum_{j=0}^{200}(1+x)^j$ is :

(a) $\binom{200}{100}$ (b) $\binom{201}{102}$

(c) $\binom{200}{101}$ (d) $\binom{201}{100}$

38. Derivative of $\left(\sqrt{x}+\frac{1}{\sqrt{x}}\right)^2$ is

(a) $\frac{1}{x^2}$ (b) $1-\frac{1}{x^2}$

(c) 1 (d) $1+\frac{1}{x^2}$

39. If f: R → R, g : R → R and h : R → R are such that $f(x) = x^2$, g(x) = tan x and h (x) = log x, then the value of [h o (gof)], if $x = \frac{\sqrt{\pi}}{2}$ will be :

(a) 0 (b) 1 (c) –1 (d) 10

40. If matrix $A = \begin{bmatrix} 3 & -2 & 4 \\ 1 & 2 & -1 \\ 0 & 1 & 1 \end{bmatrix}$ and

$A^{-1} = \frac{1}{k}\text{adj}(A)$, then *k* is

(a) 7 (b) – 7 (c) 15 (d) – 11

41. Let *f*(*x*) be a function defined as follows :

$f(x) = \sin(x^2 - 3x),\ x \le 0$; and $6x + 5x^2,\ x > 0$

Then at *x* = 0, *f*(*x*)

(a) has a local maximum
(b) has a local minimum
(c) is discontinuous
(d) None of these

42. $\int_{-\frac{3\pi}{2}}^{-\frac{\pi}{2}} [(x+\pi)^3 + \cos^2(x+3\pi)]dx$ is equal to

(a) $\frac{\pi^4}{32}$ (b) $\frac{\pi^4}{32}+\frac{\pi}{2}$

(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{4}-1$

43. For non zero, non collinear vectors $\vec{p}$ and $\vec{q}$, the value of $[\hat{i}\ \vec{p}\ \vec{q}]\hat{i} + [\hat{j}\ \vec{p}\ \vec{q}]\hat{j} + [\hat{k}\ \vec{p}\ \vec{q}]\hat{k}$ is

(a) $\vec{0}$ (b) $2(\vec{p}\times\vec{q})$

(c) $(\vec{q}\times\vec{p})$ (d) $(\vec{p}\times\vec{q})$

44. The area bounded by the x-axis, the curve y = f(x) and the lines x =1, x =b, is equal to $\sqrt{b^2+1}-\sqrt{2}$ for all b > 1, then f(x) is

(a) $\sqrt{x-1}$ (b) $\sqrt{x+1}$

(c) $\sqrt{x^2+1}$ (d) $\frac{x}{\sqrt{1+x^2}}$

45. The maximum value of P = x + 3y such that $2x + y \le 20,\ x + 2y \le 20,\ x \ge 0,\ y \ge 0$ is

(a) 10 (b) 60

(c) 30 (d) None of these

46. If $A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ then A^{100} :

(a) $2^{100}A$ (b) $2^{99}A$

(c) $2^{101}A$ (d) None of the above

47. Let f be the function defined by

$$f(x) = \begin{cases} \frac{x^2-1}{x^2-2|x-1|-1}, & x \ne 1 \\ 1/2, & x = 1 \end{cases}$$

(a) The function is continuous for all values of x
(b) The function is continuous only for x > 1
(c) The function is continuous at x = 1
(d) The function is not continuous at x = 1

48. The value of $\int e^{\tan^{-1}x}\frac{(1+x+x^2)}{1+x^2}dx$ is

(a) $x\, e^{\tan^{-1}x} + C$ (b) $\tan^{-1}x + C$

(c) $e^{\tan^{-1}x} + 2x + C$ (d) None of these

49. The angle between two lines

$\frac{x+1}{2} = \frac{y+3}{2} = \frac{z-4}{-1}$ and

$\frac{x-4}{1} = \frac{y+4}{2} = \frac{z+1}{2}$ is:

(a) $\cos^{-1}\left(\frac{1}{9}\right)$ (b) $\cos^{-1}\left(\frac{4}{9}\right)$

(c) $\cos^{-1}\left(\frac{2}{9}\right)$ (d) $\cos^{-1}\left(\frac{3}{9}\right)$

50. A fair die is thrown twenty times. The probability that on the tenth throw the fourth six appears is

(a) $\frac{^{20}C_{10}\times 5^6}{6^{20}}$ (b) $\frac{120\times 5^7}{6^{10}}$

(c) $\frac{84\times 5^6}{6^{10}}$ (d) None of these

Mock Test-6

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

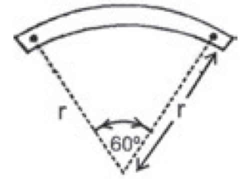
1. The fundamental frequency of a closed end organ pipe is n. Its length is doubled and radius is halved. Its frequency will become nearly
(a) n/2 (b) n/3 (c) n (d) 2 n

2. If the density of a small planet is the same as that of earth, while the radius of the planet is 0.2 times that of the earth, the gravitational acceleration on the surface of the planet is
(a) 0.2 g (b) 0.4 g (c) 2 g (d) 4 g

3. Which of the following statement is correct ?
(a) Gauss's law is valid only for symmetrical charge distributions.
(b) Gauss's law is valid only for charge placed in vacuum.
(c) The electric field calculated by Gauss's law is the field due to the charges inside the Gaussian surface.
(d) The flux of the electric field through a closed surface due to all the charges is equal to the flux due to the charges enclosed by the surface.

4. Wavefront is the locus of all points, where the particles of the medium vibrate with the same
(a) phase (b) amplitude
(c) frequency (d) period

5. A bar magnet of length 'ℓ' and magnetic dipole moment 'M' is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be



(a) $\frac{3}{\pi}M$
(b) $\frac{2}{\pi}M$
(c) $\frac{M}{2}$
(d) M

6. The transformer voltage induced in the secondary coil of a transformer is mainly due to
(a) a varying electric field
(b) a varying magnetic field
(c) the vibrations of the primary coil
(d) the iron core of the transformer

7. In the experiment of potentiometer, at balance point, there is no current in the
(a) main circuit
(b) galvanometer circuit
(c) potentiometer circuit
(d) both main and galvanometer circuits

8. Radiations of two photon's energy, twice and ten times the work function of metal are incident on the metal surface successsively. The ratio of maximum velocities of photoelectrons emitted in two cases is
(a) 1 : 2 (b) 1 : 3 (c) 1 : 4 (d) 1 : 1

9. If a vector $2\hat{i}+3\hat{j}+8\hat{k}$ is perpendicular to the vector $4\hat{j}-4\hat{i}+\alpha\hat{k}$, then the value of α is
(a) 1/2 (b) –1/2 (c) 1 (d) –1

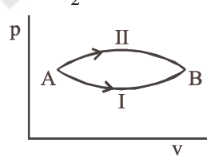
10. A wire has a mass 0.3 ± 0.003 g, radius 0.5 ± 0.005 mm and length 6 ± 0.06 cm. The maximum percentage error in the measurement of its density is
(a) 1 (b) 2 (c) 3 (d) 4

11. In a transistor, the change in base current from 100 μA to 125 μA causes a change in collector current from 5 mA to 7.5 mA, keeping collector-to-emitter voltage constant at 10 V. What is the current gain of the transistor?
(a) 200 (b) 100 (c) 50 (d) 25

12. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid
(a) 0.4 m/s (b) 0.133 m/s
(c) 0.1 m/s (d) 0.2 m/s

13. Two gases A and B having the same temperature T, same pressure P and same volume V are mixed. If the mixture is at the same temperature T and occupies a volume V, the pressure of the mixture is
(a) 2 P (b) P (c) P/2 (d) 4 P

14. A system goes from A to B via two processes I and II as shown in figure. If ΔU_1 and ΔU_2 are the changes in internal energies in the processes I and II respectively, then
(a) relation between ΔU_1 and ΔU_2 can not be determined
(b) $\Delta U_1 = \Delta U_2$
(c) $\Delta U_1 < \Delta U_2$
(d) $\Delta U_1 > \Delta U_2$



15. Two capacitors of capacitance C are connected in series. If one of them is filled with dielectric substance k, what is the effective capacitance ?
(a) $\frac{kC}{(1+k)}$ (b) $C(k+1)$
(c) $\frac{2kC}{1+k}$ (d) None of these

16. Two identical circular loops of metal wire are lying on a table without touching each other. Loop–A carries a curent which increases with time. In response, the loop–B
(a) remains stationary
(b) is attracted by the loop-A
(c) is repelled by the loop-A
(d) rotates about its CM, with CM fixed (CM is the centre of mass)

17. A proton moving with a velocity 3×10^5 m/s enters a magnetic field of 0.3 tesla at an angle of 30º with the field. The radius of curvature of its path will be (e/m for proton = 10^8 C/kg)
(a) 2 cm (b) 0.5 cm
(c) 0.02 cm (d) 1.25 cm

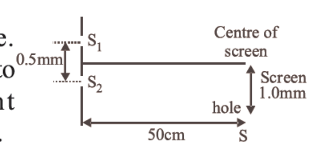
18. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200N to the lower end. The weight stretches the wire by 1 mm. Then the elastic energy stored in the wire is
(a) 0.2 J (b) 10 J (c) 20 J (d) 0.1 J

19. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A bob is suspended from the roof of the car by a light wire of length 1.0 m. The angle made by the wire with the vertical is
(a) 0° (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{6}$ (d) $\frac{\pi}{4}$

20. The least coefficient of friction for an inclined plane inclined at angle α with horizontal in order that a solid cylinder will roll down without slipping is
(a) $\frac{2}{3}\tan\alpha$ (b) $\frac{2}{7}\tan\alpha$
(c) $\tan\alpha$ (d) $\frac{5}{7}\tan\alpha$

21. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material are denoted by μ_d, μ_p and μ_f respectively, then
(a) $\mu_d = 0$ and $\mu_p \neq 0$ (b) $\mu_d \neq 0$ and $\mu_p = 0$
(c) $\mu_p = 0$ and $\mu_f \neq 0$ (d) $\mu_d \neq 0$ and $\mu_f \neq 0$

22. In Young's double slit experiment shown in figure S_1 and S_2 are coherent sources and S is the screen having a hole at a point 1.0mm away from the central line. White light (400 to 700nm) is sent through the slits.



Which wavelength passing through the hole has strong intensity?
(a) 400 nm (b) 700 nm
(c) 500 nm (d) 667 nm

23. The equation of plane progressive wave motion is $y = a\sin\frac{2\pi}{\lambda}(vt - x)$. Velocity of the particle is

(a) $y\frac{dv}{dx}$ (b) $v\frac{dy}{dx}$

(c) $-y\frac{dv}{dx}$ (d) $-v\frac{dy}{dx}$

24. If a body cools down from 80°C to 60°C in 10 min when the temperature of the surrounding is 30°C, then the temperature of the body after next 10 min will be

(a) 50°C (b) 48°C

(c) 30°C (d) None of these

25. In a fission reaction

$^{236}_{92}U \rightarrow {}^{117}X + {}^{117}Y + n + n$

the binding energy per nucleon of X and Y is 8.5 MeV whereas of ^{236}U is 7.6 MeV. The total energy liberated will be about

(a) 2000 MeV (b) 200 MeV

(c) 2 MeV (d) 200 keV

26. An audio signal represented as 25 sin 2π (2000 t) amplitude modulated by a carrier wave : 60 sin 2π(100, 000)t. The modulation index of the modulated signal is

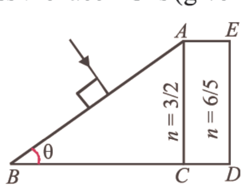
(a) 25% (b) 41.6 % (c) 50 % (d) 75 %

27. A ball of mass 10 g moving perpendicular to the plane of the wall strikes it and rebounds in the same line with the same velocity. If the impulse experienced by the wall is 0.54 Ns, the velocity of the ball is

(a) 27 ms^{-1} (b) 3.7 ms^{-1}

(c) 54 ms^{-1} (d) 37 ms^{-1}

28. In Fig. ABC is the cross section of a right - angled prism and ACDE is the cross section of a glass slab. The value of θ so that incident normally on the face AB does not cross the face AC is (given $\sin^{-1}(3/5) = 37°$).



(a) $\theta \le 37°$

(b) $\theta < 37°$

(c) $\theta \le 53°$

(d) $\theta < 53°$

29. Two bodies of masses 2 kg and 4 kg are moving with velocities 2 m/s and 10 m/s respectively along same direction. Then the velocity of their centre of mass will be

(a) 8.1 m/s (b) 7.3 m/s

(c) 6.4 m/s (d) 5.3 m/s

30. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\frac{\pi}{2}$ at point A and π at point B. Then the difference between the resulting intensities at A and B is

(a) 2 I (b) 4 I (c) 5 I (d) 7 I

31. A straight wire of diameter 0.5 mm carrying a current of 1 A is replaced by another wire of 1 mm diameter carrying same current. The strength of magnetic field far away is

(a) twice the earlier value

(b) same as the earlier value

(c) one-half of the earlier value

(d) one-quarter of the earlier value

32. An inductor, a resistor and a capacitor are joined in series with an AC source. As the frequency of the source is slightly increased from a very low value, the reactance of the

(a) inductor increases (b) resistor increases

(c) capacitor increases(d) circuit increases

33. A ring of mass m and radius r is melted and then moulded into a sphere. The moment of inertia of the sphere will be

(a) more than that of the ring

(b) less than than of the ring

(c) equal to that of the ring

(d) None of these

34. A drop of oil is placed on the surface of water. Which of the following statements is correct?

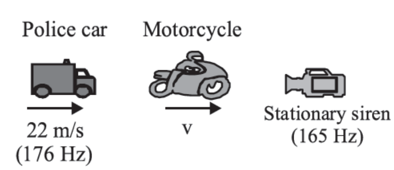
(a) It will remain on it as a sphere

(b) It will spread as a thin layer

(c) It will partly be a spherical droplet and partly a thin film

(d) It will float as a distorted drop on the water surface

35. A police car moving at 22 m/s, chases a motorcyclist. The policeman sounds his horn at 176 Hz, while both of them move towards a stationary siren of frequency 165 Hz. The speed of the motorcycle, if it is given that he does not observe any beats is



(a) 33 m/s (b) 22 m/s (c) zero (d) 11 m/s

36. The maximum velocity of a particle, executing simple harmonic motion with an amplitude 7 mm, is 4.4 m/s. The period of oscillation is

(a) 0.01 s (b) 10 s (c) 0.1 s (d) 100 s

37. The radii of circular orbits of two satellites A and B of the earth, are 4R and R, respectively. If the speed of satellite A is 3 V, then the speed of satellite B will be:

(a) 3 V/4 (b) 6V (c) 12 V (d) 3 V/2

38. Unpolarized light is incident on a plane sheet on water surface. The angle of incidence for which the reflected and refracted rays are perpendicular to each other is $\left(\mu \text{ of water} = \frac{4}{3}\right)$

(a) $\sin^{-1}\left(\frac{4}{3}\right)$ (b) $\tan^{-1}\left(\frac{3}{4}\right)$

(c) $\tan^{-1}\left(\frac{4}{3}\right)$ (d) $\sin^{-1}\left(\frac{1}{3}\right)$

39. The wavelength of radiation is λ_0 when an electron jumps from third to second orbit of hydrogen atom. For the electron to jump from the fourth to the second orbit of the hydrogen atom, the wavelength of radiation emitted will be

(a) $\frac{16}{25}\lambda_0$ (b) $\frac{20}{27}\lambda_0$

(c) $\frac{27}{20}\lambda_0$ (d) $\frac{25}{16}\lambda_0$

40. A body of mass (4m) is lying in x-y plane at rest. It suddenly explodes into three pieces. Two pieces, each of mass (m) move perpendicular to each other with equal speeds (v). The total kinetic energy generated due to explosion is

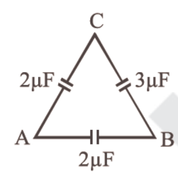
(a) mv^2 (b) $\frac{3}{2}mv^2$

(c) $2\,mv^2$ (d) $4\,mv^2$

41. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is (take $g = 10\ \text{m/s}^2$)

(a) 1.6 (b) 4.0 (c) 2.0 (d) 2.5

42. Three capacitors are connected in the arms of a triangle ABC as shown in figure 5 V is applied between A and B. The voltage between B and C is



(a) 2V

(b) 1V

(c) 3V

(d) 1.5V

43. A particle of mass 10 gm is describing S.H.M. along a straight line with period of 2 sec and amplitude of 10 cm. Its kinetic energy when it is at 5 cm from its equilibrium position is

(a) $37.5\pi^2$ *erg* (b) $3.75\pi^2$ *erg*

(c) $375\pi^2$ *erg* (d) $0.375\pi^2$ *erg*

44. Two waves having the intensities in the ratio of 9 : 1 produce interference. The ratio of maximum to the minimum intensity, is equal to

(a) 2 : 1 (b) 4 : 1 (c) 9 : 1 (d) 10 : 8

45. A particle is going parallel to x-axis with constant speed v at a distance a from the axis. Then its angular velocity about an axis passing through the origin O, at the instant when radial vector of the particle makes angle θ with the x-axis is

(a) $\frac{v}{a}\sin^2\theta$ (b) $\frac{v}{2a}\cos^2\theta$

(c) $\frac{a}{v}\sin\theta$ (d) $\frac{v^2}{a^2}\sin^2\theta$

46. Currents of a 10 ampere and 2 ampere are passed through two parallel thin wires A and B respectively in opposite directions. Wire A is infinitely long and the length of the wire B is 2 m. The force acting on the conductor B, which is situated at 10 cm distance from A will be

(a) 8×10^{-5} N (b) 5×10^{-5} N

(c) $8\pi \times 10^{-7}$ N (d) $4\pi \times 10^{-7}$ N

47. A force of 10^3 newton, stretches the length of a hanging wire by 1 millimetre. The force required to stretch a wire of same material and length but having four times the diameter by 1 millimetre is

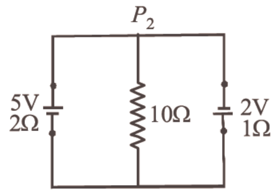
(a) 4×10^3 N (b) 16×10^3 N

(c) $\frac{1}{4}\times 10^3$ N (d) $\frac{1}{16}\times 10^3$ N

48. Two coils, one primary of 500 turns and one secondary of 25 turns, are wound on an iron ring of mean diameter 20 cm and cross-sectional area 12 cm^2. If the permeability of iron is 800, the mutual inductance is :

(a) 0.48 H (b) 2.4 H (c) 0.12 H (d) 0.24 H

49. A 5V battery with internal resistance 2Ω and a 2V battery with internal resistance 1Ω are connected to a 10Ω resistor as shown in the figure.



The current in the 10Ω resistor is

(a) 0.27 A P_2 to P_1 (b) 0.03 A P_1 to P_2
(c) 0.03 A P_2 to P_1 (d) 0.27 A P_1 to P_2

50. Water rises to a height of 10 cm in capillary tube and mercury falls to a depth of 3.1 cm in the same capillary tube. If the density of mercury is 13.6 and the angle of contact for mercury is 135°, the approximate ratio of surface tensions of water and mercury is

(a) 1 : 0.15 (b) 1 : 3 (c) 1 : 6 (d) 1.5 : 1

CHEMISTRY

51. Which of the following lanthanoid ions is diamagnetic ?
(At nos. Ce = 58, Sm = 62, Eu = 63, Yb = 70)

(a) Sm^{2+} (b) Eu^{2+} (c) Yb^{2+} (d) Ce^{2+}

52. For *fcc* if AB is just like the rock salt like structure then, A^+ and B^- are located at –

(a) A^+ - Tetrahedral voids ; B^- - Corner
(b) A^+ - Corner and faces ; B^- - Octahedral voids
(c) A^+ - Octahedral voids ; B^- - Corner and faces
(d) A^+ - Corner and faces ; B^- - Octahedral and tetrahedral voids

53. Second and successive electron affinity of an element

(a) is always successive (energy is released)
(b) is always positive (energy is absorbed)
(c) can be positive or negative
(d) is always zero

54. Hydrogenation of benzoyl chloride in the presence of Pd and $BaSO_4$ gives

(a) benzyl alcohol (b) benzaldehyde
(c) benzoic acid (d) phenol

55. XeO_4 molecule is tetrahedral having :

(a) Two $p\pi - d\pi$ bonds
(b) One $p\pi - d\pi$ bonds
(c) Four $p\pi - d\pi$ bonds
(d) Three $p\pi - d\pi$ bonds

56. When $CuSO_4$ is electrolysed using platinum electrodes,

(a) copper is liberated at cathode, sulphur at anode.
(b) copper is liberated at cathode, oxygen at anode.
(c) sulphur is liberated at cathode, oxygen at anode.
(d) oxygen is liberated at cathode, copper at anode.

57. Silver is monovalent and has atomic mass of 108. Copper is divalent and has an atomic mass of 63.6. The same electric current is passed for the same length of time through a silver coulometer and a copper coulometer. If 27.0 g of silver is deposited, then the corresponding amount of copper deposited is

(a) 63.60 g (b) 31.80 g
(c) 15.90 g (d) 7.95 g

58. XeF_6 dissolves in anhydrous HF to give a good conducting solution which contains:

(a) H^+ and XeF_7^- ion
(b) HF_2^- and XeF_5^+ ions
(c) $HXeF_6^+$ and F^- ions
(d) none of these

59. Primary and secondary amines can be distinguished by:

(a) Schiff's reagent
(b) Carbylamine reaction
(c) Hoffmann's bromamide reaction
(d) Biuret reaction

60. A mixture of benzaldehyde and formaldehyde on heating with aqueous NaOH solution gives.

(a) benzyl alcohol and sodium formate.
(b) sodium benzoate and methyl alcohol.
(c) sodium benzoate and sodium formate.
(d) benzyl alcohol and methyl alcohol

61. Which of the following modes of expressing concentration is independent of temperature ?

(a) Molarity (b) Molality
(c) Formality (d) Normality

62. The best method for the separation of naphthalene and benzoic acid from their mixture is:
(a) distillation (b) sublimation
(c) chromatography (d) crystallisation

63. The gaseous product formed when HOCl reacts with H_2O_2 in acidic medium is
(a) H_2 (b) Cl_2 (c) O_2 (d) $HClO_2$

64. The pH of 10^{-10} M NaOH solution is nearest to:
(a) 6 (b) -10 (c) 4 (d) 7

65. If $1\frac{1}{2}$ moles of oxygen combine with Al to form Al_2O_3 the weight of Al used in the reaction is (Al = 27)
(a) 27 g (b) 54 g (c) 49.5 g (d) 31 g

66. Which of the following statement is wrong?
(a) Polar stratospheric clouds (PSCs) are clouds formed over Antarctica.
(b) Acid rain dissolves heavy metals such as Cu, Pb, Hg and Al from soil, rocks and sediments.
(c) H_2SO_4 is major contributor to acid rain, HNO_3 ranks second and HCl third in this respect.
(d) Fishes grow in warm as well as in cold water.

67. If one strand of DNA has the sequence ATGCTTGA, the sequence in the complimentary strand would be
(a) TCCGAACT (b) TACGTAGT
(c) TACGAACT (d) TAGCTAGT

68. $\underset{\substack{|\\CH_3}}{CH_3CH}-CH=CH_2 \xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } B_2H_6} X \xrightarrow[140\,°C]{H_2SO_4} Y$

What is Y ?
(a) $CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_2-CH_2-O-CH_2-CH_2-\underset{\substack{|\\CH_3}}{CH}-CH_3$
(b) $CH_3-\underset{\substack{|\\CH_3}}{CH}-CH=CH_2$
(c) $CH_3-\underset{\substack{|\\CH_3}}{CH}-\underset{\substack{|\\CH_3}}{CH}-O-\underset{\substack{|\\CH_3}}{CH}-\underset{\substack{|\\CH_3}}{CH}-CH_3$
(d) $CH_3-\overset{\substack{CH_3\\|}}{\underset{\substack{|\\C_2H_5}}{C}}-O-\overset{\substack{CH_3\\|}}{\underset{\substack{|\\C_2H_5}}{C}}-CH_3$

69. The IUPAC name of the complex $[Co(NH_3)_2(H_2O)_4]Cl_3$ is
(a) Diamminetetraaquacobalt (III) trichloride
(b) Diamminetetraaquacobalt (II) chloride
(c) Diamminetetraaquacobalt (III) chloride
(d) Tetraaquadiamminecobalt (III) trichloride

70. During the charging of lead storage battery, the reaction at anode is represented by :
(a) $Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4$
(b) $PbSO_4 + 2H_2O \longrightarrow PbO_2 + SO_4^{2-} + 4H^+ + 2e^-$
(c) $Pb \longrightarrow Pb^{2+} + 2e^-$
(d) $Pb^{2+} + 2e^- \longrightarrow Pb$

71. The most reactive compound for electrophilic nitration is:
(a) Benzene (b) Nitrobenzene
(c) Benzoic acid (d) Toluene.

72. Which of the following polymer is an example of fibre
(a) silk (b) dacron
(c) nylon-6,6 (d) all of these

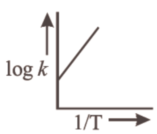
73. The organic compound with two asymmetric carbon atoms is
(a) 3,4-dimethylheptane
(b) 3-methyl-l-pentene
(c) 2-chloropentane
(d) 5-ethyl-2,3 -dimethylheptane

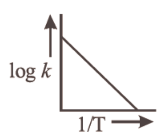
74. Zinc and mercury do not show variable valency like *d*-block elements because
(a) they are soft.
(b) their *d*-shells are complete.
(c) they have only two electrons in the outermost subshell.
(d) their *d*-shells are incomplete.

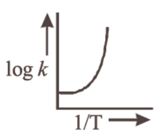
75. Select the correct statement
(a) The non-stoichiometric form of NaCl is yellow and that of KCl is blue lilac.
(b) Solids containing F-centres (Farbe) are paramagnetic
(c) Conduction by electrons is known as *n*-type super conduction
(d) All the above are correct

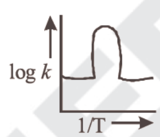
76. What is the decreasing order of strength of the bases ?
OH^-, NH_2^-, $HC \equiv C^-$ and $CH_3CH_2^-$?
(a) $CH_3CH_2^- > NH_2^- > HC \equiv C^- > OH^-$
(b) $HC \equiv C^- > CH_3CH_2^- > NH_2^- > OH^-$
(c) $OH^- > NH_2^- > HC \equiv C^- > CH_3CH_2^-$
(d) $NH_2^- > HC \equiv C^- > OH^- > CH_3CH_2^-$

77. A graph plotted between log *k* vs 1/T for calculating activation energy is shown by

(a) 

(b) 

(c) 

(d) 

78. The geometry of the compound $[Pt(NH_3)_2Cl_2]$ is
(a) square planar (b) pyramidal
(c) tetrahedral (d) octahedral

79. Which of the following statements is correct?
(a) RNA controls the synthesis of proteins.
(b) The sugar present in DNA is D-(–)-ribose.
(c) RNA has double stranded α-helix structure.
(d) DNA mainly occurs in the cytoplasm of the cell.

80. A colloidal solution is subjected to an electrical field. The particles move towards anode. The coagulation of same sol is studied using NaCl, $BaCl_2$ and $AlCl_3$ solutions. Their coagulating power should be
(a) $NaCl > BaCl_2 > AlCl_3$
(b) $BaCl_2 > AlCl_3 > NaCl$
(c) $AlCl_3 > BaCl_3 > NaCl$
(d) $BaCl_2 > NaCl > AlCl_3$

81. On electrolysis of dilute sulphuric acid using platinum electrodes, the product obtained at the anode will be
(a) hydrogen (b) oxygen
(c) hydrogen sulphide (d) Sulphur dioxide

82. How many EDTA (ethylenediaminetetraacetic acid) molecules are required to make an octahedral complex with a Ca^{2+} ion?
(a) One (b) Two
(c) Six (d) Three

83. The stablity of lyophillic colloids is due to which of the following?
(a) Charge on their particles
(b) Large size of their particles
(c) Small size of their particles
(d) A layer of dispersion medium

84. Which of the following is not correct regarding terylene ?
(a) Step-growth polymer
(b) Synthetic fibre
(c) Condensation polymer
(d) Thermosetting plastic

85. An ideal gas obeying kinetic theory of gases can be liquefied if
(a) its temperature is more than critical temperature T_C
(b) its pressure is more than critical pressure P_C
(c) its pressure is more than P_C at a temperature less than T_C
(d) it cannot be liquefied at any value of P and T

86. Doping of AgCl crystals with $CdCl_2$ results in
(a) Frenkel defect
(b) Schottky defect
(c) Substitutional cation vacancy
(d) Formation of F - centres

87. Benzene can be obtained in the reaction:
(a) Ethene + 1, 3-butadiene
(b) Trimerisation of ethyne
(c) Reduction of PhCHO
(d) All of these

88. In countries nearer to polar region, the roads are sprinkled with $CaCl_2$. This is
(a) to minimise the snow fall
(b) to minimise pollution
(c) to minimise the accumulation of dust on the road
(d) to minimise the wear and tear of the roads

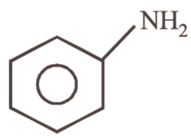
89. Acetanilide on nitration followed by alkaline hydrolysis mainly gives:
(a) *o*-Nitroaniline
(b) *p*-Nitroaniline
(c) *m*-Nitroaniline
(d) 2, 4, 6-Trinitroaniline

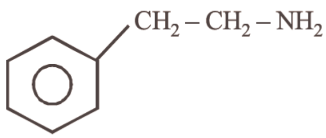
90. A substance initial concentration (a) reacts according to zero order kinetics. What will be the time for the reaction to go to completion

(a) $\frac{a}{k}$ (b) $\frac{k}{a}$ (c) $\frac{a}{2k}$ (d) $\frac{2k}{a}$

91. Arrange the following amines in the decreasing order of their basicity

(1) 

(2) 

(3) 

(a) $1 > 3 > 2$ (b) $3 > 2 > 1$
(c) $1 > 2 > 3$ (d) $2 > 1 > 3$

92. If $1\frac{1}{2}$ moles of oxygen combine with Al to form Al_2O_3 the weight of Al used in the reaction is (Al = 27)
(a) 27 g (b) 54 g (c) 49.5 g (d) 31 g

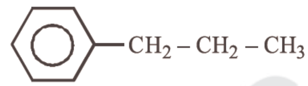
93. Which of the following terms indicates to the arrangement of different protein subunits in a multiprotein complex ?
(a) Primary structure
(b) Secondary structure
(c) Tertiary structure
(d) Quaternary structure

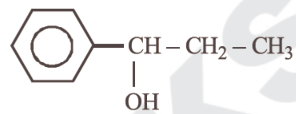
94. If chloroform is left open in air in the presence of sunlight, it gives
(a) carbon tetrachloride
(b) carbonyl chloride
(c) mustard gas
(d) lewisite

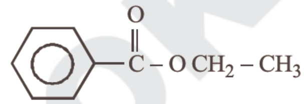
95. Which one of the following alcohols is least soluble in water?
(a) CH_3OH (b) C_3H_7OH
(c) C_4H_9OH (d) $C_{10}H_{21}OH$

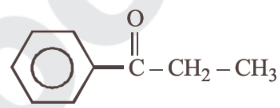
96. The final product (III) obtained in the reaction sequence –

$$CH_3 - CH_2 - COOH \xrightarrow{PCl_3} I$$
$$\xrightarrow{C_6H_6/AlCl_3} II \xrightarrow[\text{base/heat}]{NH_2-NH_2} III$$

(a) 

(b) 

(c) 

(d) 

97. Which of the following statements is not true about enzyme inhibitors?
(a) Inhibit the catalytic activity of the enzyme
(b) Prevent the binding of substrate
(c) Generally a strong covalent bond is formed between an inhibitor and an enzyme
(d) Inhibitors can be competitive or non – competitive

98. Identify the incorrect statement among the following.
(a) Br_2 reacts with hot and strong NaOH solution to give NaBr and H_2O.
(b) Ozone reacts with SO_2 to give SO_3.
(c) Silicon reacts with NaOH(aq) in the presence of air to give Na_2SiO_3 and H_2O.
(d) Cl_2 reacts with excess of NH_3 to give N_2 and HCl.

99. MnO_4^- has the strongest and weakest oxidising power in
(a) alkaline and acidic medium.
(b) alkaline and neutral medium.
(c) acidic and neutral medium.
(d) acidic and alkaline medium.

100. 3 moles of ethanol react with one mole of phosphorus tribromide to form 3 moles of bromoethane and one mole of X. Which of the following is X?
(a) H_3PO_4 (b) H_3PO_2
(c) HPO_3 (d) H_3PO_3

SECTION-B

MATHEMATICS

1. Given $n(U) = 20, n(A) = 12, n(B) = 9, n(A \cap B) = 4$, where U is the universal set, A and B are subsets of U, then $n((A \cup B)^c) =$

(a) 17 (b) 9 (c) 11 (d) 3

2. Which of the following functions are periodic?

(a) $f(x) = \log x, x > 0$
(b) $f(x) = e^x, x \in R$
(c) $f(x) = x - [x], x \in R$
(d) $f(x) = x + [x], x \in R$

3. The least difference between the roots, in the first quadrant $\left(0 \le x \le \frac{\pi}{2}\right)$, of the equation

$4\cos x(2 - 3\sin^2 x) + (\cos 2x + 1) = 0$ is

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

4. If S_n denotes the sum of n terms of an A.P., then

$S_{n+3} - 3S_{n+2} + 3S_{n+1} - S_n =$

(a) 0 (b) 1 (c) $\frac{1}{2}$ (d) 2

5. The values of k for which the line $(k-3)x - (4-k^2)y + k^2 - 7k + 6 = 0$ is parallel to the x-axis, is

(a) 3 (b) 2 (c) 1 (d) 4

6. If OA and OB are the tangents from the origin to the circle $x^2 + y^2 + 2gx + 2fy + c = 0$ and C is the centre of the circle, the area of the quadrilateral OACB is

(a) $\frac{1}{2}\sqrt{c(g^2 + f^2 - c)}$

(b) $\sqrt{c(g^2 + f^2 - c)}$

(c) $c\sqrt{g^2 + f^2 - c}$

(d) $\frac{\sqrt{g^2 + f^2 - c}}{c}$

7. Let $z = \log_2(1 + i)$, then $(z + \bar{z}) + i(z - \bar{z}) =$

(a) $\frac{\ln 4 + \pi}{\ln 4}$ (b) $\frac{\pi - \ln 4}{\ln 2}$

(c) $\frac{\ln 4 - \pi}{\ln 4}$ (d) $\frac{\pi + \ln 4}{\ln 2}$

8. Six dice are thrown. The probability that different numbers will turn up is :

(a) $\frac{129}{1296}$ (b) $\frac{1}{54}$ (c) $\frac{5}{324}$ (d) $\frac{5}{54}$

9. If $y = (1 + x^{1/4})(1 + x^{1/2})(1 - x^{1/4})$, then $\frac{dy}{dx}$ is equal to

(a) 1 (b) –1 (c) x (d) $\sqrt{x}$

10. Identify the false statements

(a) $\sim[p \vee (\sim q)] \equiv (\sim p) \vee q$
(b) $[p \vee q] \vee (\sim p)$ is a tautology
(c) $[p \wedge q) \wedge (\sim p)$ is a contradiction
(d) $\sim[p \vee q] \equiv (\sim p) \vee (\sim q)$

11. The mean of 13 observations is 14. If the mean of the first 7 observations is 12 and that of the last 7 observations is 16, what is the value of the 7th observation ?

(a) 12 (b) 13 (c) 14 (d) 15

12. In how many ways can 12 gentlemen sit around a round table so that three specified gentlemen are always together?

(a) 9! (b) 10! (c) 3! 10! (d) 3! 9!

13. If $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + 3\hat{j} + \hat{k}$, $\vec{c} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\alpha\vec{a} + \beta\vec{b} + \gamma\vec{c} = -3(\hat{i} - \hat{k})$, then the ordered triplet (α, β, γ) is

(a) (2, –1, –1) (b) (–2, 1, 1)
(c) (–2, –1, 1) (d) (2, 1, –1)

14. If $y = a \log x + bx^2 + x$ has its extreme value at $x = 1$ and $x = 2$, then (a, b) is :

(a) $\left(1, \frac{1}{2}\right)$ (b) $\left(\frac{1}{2}, 2\right)$

(c) $\left(2, \frac{-1}{2}\right)$ (d) $\left(\frac{-2}{3}, \frac{-1}{6}\right)$

15. Let R be the relation over the set of straight lines of a plane, such that $l_1 R l_2 \Leftrightarrow l_1 \perp l_2$. Then, R is
(a) symmetric
(b) reflexive
(c) transitive
(d) an equivalence relation

16. Evaluate integral $\int \frac{\sin(x+a)}{\sin(x+b)} dx$.
(a) $x\cos(a-b)+\sin(a-b)\log|\sin(x+b)|+C$
(b) $x\sin(a-b)+\cos(a-b)\log|\sin(x+b)|+C$
(c) $x\cos(a+b)+\sin(a+b)\log|\sin(x-b)|+C$
(d) $x\sin(a+b)+\cos(a+b)\log|\sin(x-b)|+C$

17. If A is idempotent and A + B = I, then which of the following is false?
(a) B is idempotent (b) AB = 0
(c) BA = 0 (d) None of these

18. If $(\sqrt{2})^x+(\sqrt{3})^x=(\sqrt{13})^{x/2}$, then the number of values of x is
(a) 2 (b) 4
(c) 1 (d) None of these

19. The value of a for which the function $f(x) = a \sin x + (1/3) \sin 3x$ has an extremum at $x = \pi/3$ is
(a) 1 (b) –1 (c) 0 (d) 2

20. Let L be the line of intersection of the planes $2x + 3y + z = 1$ and $x + 3y + 2z = 2$. If L makes an angle α with the positive x-axis, then cos α equals
(a) 1 (b) $\frac{1}{\sqrt{2}}$ (c) $\frac{1}{\sqrt{3}}$ (d) $\frac{1}{2}$

21. A boat is to be manned by eight men of whom 2 can only row on bow side and 3 can only row on stroke side, the number of ways in which the crew can be arranged is
(a) 4360 (b) 5760
(c) 5930 (d) None of these

22. A bag contains 4 red and 4 blue balls. Four balls are drawn one by one from the bag, then find the probability that the drawn balls are in alternate colour.
(a) $\frac{35}{6}$ (b) $\frac{2}{35}$ (c) $\frac{3}{35}$ (d) $\frac{6}{35}$

23. If the middle point of the sides of a triangle ABC are (0, 0); (1, 2) and (–3, 4), then the area of triangle is
(a) 40 (b) 20 (c) 10 (d) 60

24. $\lim_{n\to\infty} \frac{5^{n+1}+3^n-2^{2n}}{5^n+2^n+3^{2n+3}}$ is equal to
(a) 5 (b) 3 (c) 1 (d) 0

25. If p and q be the roots of the quadratic equation $x^2-(\alpha-2)x-\alpha-1=0$ then minimum value of p^2+q^2 is equal to
(a) 2 (b) 3 (c) 6 (d) 5

26. The area of the region lying between the line $x-y+2=0$ and the curve $x=\sqrt{y}$ is
(a) 9 (b) 9/2
(c) 10/3 (d) None of these

27. The function f(x) = $\frac{1-\sin x+\cos x}{1+\sin x+\cos x}$ is not defined at $x = \pi$. The value of $f(\pi)$, so that $f(x)$ is continuous at $x = \pi$, is
(a) $-\frac{1}{2}$ (b) $\frac{1}{2}$ (c) –1 (d) 1

28. If $(r+1)^{\text{th}}$ term is $\frac{3.5....(2r-1)}{r!}\left(\frac{1}{5}\right)^r$, then this is the term of binomial expansion
(a) $\left(1-\frac{2}{5}\right)^{1/2}$ (b) $\left(1-\frac{2}{5}\right)^{-1/2}$
(c) $\left(1+\frac{2}{5}\right)^{-1/2}$ (d) $\left(1+\frac{2}{5}\right)^{1/2}$

29. If A + B + C = π, then $\cos 2A + \cos 2B + \cos 2C + 4 \sin A \sin B \sin C$ is equal to :
(a) 0 (b) 1 (c) 2 (d) 3

30. $\left(x+\frac{1}{x}\right)^2+\left(x^2+\frac{1}{x^2}\right)^2+\left(x^3+\frac{1}{x^3}\right)^2$ ....upto n terms is
(a) $\frac{x^{2n}-1}{x^2-1}\times\frac{x^{2n+2}+1}{x^{2n}}+2n$
(b) $\frac{x^{2n}+1}{x^2+1}\times\frac{x^{2n+2}-1}{x^{2n}}-2n$
(c) $\frac{x^{2n}-1}{x^2-1}\times\frac{x^{2n}-1}{x^{2n}}-2n$
(d) None of these

31. Two pairs of straight lines have the equations $y^2+xy-12x^2=0$ and $ax^2+2hxy+by^2=0$. One line will be common among them if

(a) $a=-3(2h+3b)$ (b) $a=8(h-2b)$

(c) $a=2(b+h)$ (d) Both (a) and (b)

32. If the focal distance of an end of the minor axis of any ellipse (referred to its axis as the axes of x and y respectively) is k and the distance between the foci is 2h, then its equation is

(a) $\frac{x^2}{k^2}+\frac{y^2}{k^2+h^2}=1$ (b) $\frac{x^2}{k^2}+\frac{y^2}{h^2-k^2}=1$

(c) $\frac{x^2}{k^2}+\frac{y^2}{k^2-h^2}=1$ (d) $\frac{x^2}{k^2}+\frac{y^2}{h^2}=1$

33. The value of $(1+2\omega+\omega^2)^{3n}-(1+\omega+2\omega^2)^{3n}$ is :

(a) 0 (b) 1 (c) ω (d) ω^2

34. Let p is a non-singular matrix such that $1+p+p^2+...+p^n=O$ (O denotes the null matrix), then p^{-1} is

(a) p^n (b) $-p^n$

(c) $-(1+p+....+p^n)$ (d) None of these

35. The value of $\int\frac{x\sin^{-1}x}{\sqrt{1-x^2}}dx$ is equal to :

(a) $\sqrt{(1-x^2)}\sin^{-1}x+C$

(b) $x\sin^{-1}x+C$

(c) $x-\sqrt{(1-x^2)}\sin^{-1}x+C$

(d) $\sqrt{(\sin^{-1}x)}+C$

36. The constraints

$-x_1+x_2\le 1,\ -x_1+3x_2\le 9,\ x_1,x_2\ge 0$ define on

(a) Bounded feasible space

(b) Unbounded feasible space

(c) Both bounded and unbounded feasible space

(d) None of these

37. If $x\in(7\pi, 8\pi)$, then $\tan^{-1}\sqrt{\frac{1-\cos x}{1+\cos x}}=$

(a) $-\frac{x}{2}$ (b) $\frac{x}{2}$

(c) $4\pi-\frac{x}{2}$ (d) None of these

38. The equations $2x+3y+4=0$; $3x+4y+6=0$ and $4x+5y+8=0$ are

(a) consistent with unique solution

(b) inconsistent

(c) consistent with infinitely many solutions

(d) None of the above

39. The value of $\int_0^{\frac{\pi}{4}}\log_e(1+\tan x)dx$ is

(a) π (b) $\frac{\pi^2}{4}$

(c) $\pi\log_e 2$ (d) $\frac{\pi}{8}\log_e 2$

40. If $y=\log^n x$, where $\log^n$ means log log log... (repeated n time), then $x\log x\log x\log^2 x\log^3 x\ ...\log^{n-1}x\log^n x\frac{dy}{dx}$ is equal to

(a) $\log x$ (b) $\log^n x$ (c) $\frac{1}{\log x}$ (d) 1

41. Let f(x), g(x) be two continuously differentiable functions satisfying the relationships $f'(x)=g(x)$ and $f''(x)=-f(x)$.
Let $h(x)=[f(x)]^2+[g(x)]^2$. If $h(0)=5$, then $h(10)=$

(a) 10 (b) 5

(c) 15 (d) None of these

42. The line, $\frac{x-2}{3}=\frac{y+1}{2}=\frac{z-1}{-1}$ intersects the curve $xy=c^2$, $z=0$ if c is equal to

(a) ± 1 (b) $\pm\frac{1}{3}$

(c) $\pm\sqrt{5}$ (d) None of these

43. If $f(x)=\begin{cases}2x+a & ; x\ge -1\\ bx^2+3 & ; x<-1\end{cases}$ and

$g(x)=\begin{cases}x+4 & ; 0\le x\le 4\\ -3x-2 & ; -2<x<0\end{cases}$

If domain of $g(f(x))$ is $[-1, 4]$, then –

(a) $a=0, b>5$ (b) $a=2, b>7$
(c) $a=2, b>10$ (d) $a=0, b\in R$

44. If $f(x)=\begin{cases}x-1, & x<0\\ \frac{1}{4}, & x=0,\\ x^2, & x>0\end{cases}$ then

(a) $\lim_{x\to 0+} f(x)=1$

(b) $\lim_{x\to 0-} f(x)=1$

(c) $f(x)$ is discontinuous at $x=0$

(d) None of these

45. A force $F = 2i + j - k$ acts at a point A, whose position vector is $2i - j$. The moment of F about the origin is

(a) $i+2j-4k$ (b) $i-2j-4k$
(c) $i+2j+4k$ (d) $i-2j+4k$

46. The solution to the differential equation

$$\frac{dy}{dx}=\frac{yf'(x)-y^2}{f(x)}$$

where $f(x)$ is a given function is

(a) $f(x)=y(x+c)$ (b) $f(x)=cxy$
(c) $f(x)=c(x+y)$ (d) $yf(x)=cx$

47. If $a_n=2n+1$ and $C_r = {}^nC_r$ then

$a_0C_0^2 + a_1C_1^2 + a_2C_2^2 + \ldots\ldots\ldots\ldots a_nC_n^2 =$

(a) $(n-1)\,({}^{2n}C_n)$ (b) $n\,({}^{2n}C_n)$
(c) $(n+1)\,({}^{2n}C_n)$ (d) $(n+1)({}^nC_{n/2})$

48. The maximum value of $z = 6x + 8y$ subject to constraints $2x+y\le 30, x+2y\le 24$ and $x\ge 0, y\ge 0$ is

(a) 90 (b) 120 (c) 96 (d) 240

49. If $A=\begin{bmatrix}2 & 1\\ 0 & x\end{bmatrix}$ and $A^{-1}=\begin{bmatrix}\frac{1}{2} & \frac{1}{6}\\ 0 & \frac{1}{x}\end{bmatrix}$, then the value of x is equal to

(a) –3 (b) 3 (c) –2 (d) 6

50. If the mean of a binomial distribution is 25, then its standard deviation lies in the interval given below

(a) $[0, 5)$ (b) $(0, 5]$ (c) $[0, 25)$ (d) $(0, 25]$

Mock Test-7

<u>General Instructions</u>

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  Section-A: *Physics & Chemistry - 50 Questions each and*
  Section-B: *Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

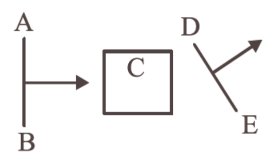
PHYSICS

1. Kepler's second law regarding constancy of areal velocity of a planet is a consequence of the law of conservation of
(a) energy
(b) angular momentum
(c) linear momentum
(d) None of these

2. Which of the following is not correct for elastic potential energy of a strained body.
(a) $U = \frac{1}{2}\frac{AY}{L}\ell^2$
(b) $U = \frac{1}{2}$ stress × strain
(c) $U = \frac{1}{2}$ stress × strain × volume
(b) $U = \frac{1}{2}$ × maximum stretching force × extension

3. A liquid does not wet the sides of a solid, if the angle of contact is
(a) Zero
(b) Obtuse (more than 90°)
(c) Acute (less than 90°)
(d) 90° (right angle)

4. A wavefront AB passing through a system C emerges as DE. The system C could be



(a) a slit (b) a biprism
(c) a prism (d) a glass slab

5. At the centre of a cubical box + Q charge is placed. The value of total flux that is coming out a wall is
(a) Q/ε_o (b) $Q/3\varepsilon_o$ (c) $Q/4\varepsilon_o$ (d) $Q/6\varepsilon_o$

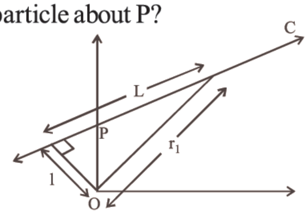
6. If we double the radius of a coil keeping the current through it unchanged, then the magnetic field at any point at a large distance from the centre becomes approximately
(a) double (b) three times
(c) four times (d) one-fourth

7. A steel wire of length ℓ has a magnetic moment M. It is then bent into a semicircular arc. The new magnetic moment is
(a) $\frac{M}{\pi}$ (b) $\frac{2M}{\pi}$ (c) $\frac{3M}{\pi}$ (d) $\frac{4M}{\pi}$

8. The energy of electron in the nth orbit of hydrogen atom is expressed as $E_n = \frac{-13.6}{n^2}$eV. The shortest wavelength of Lyman series will be
(a) 910 Å (b) 5463 Å
(c) 1315 Å (d) None of these

9. When a ferromagnetic material is heated to temperature above its Curie temperature, the material
(a) is permanently magnetized
(b) remains ferromagnetic
(c) behaves like a diamagnetic material
(d) behaves like a paramagnetic material

10. A particle of mass m moves along line PC with velocity v as shown. What is the angular momentum of the particle about P?



(a) mvL
(b) mvl
(c) mvr
(d) zero

11. Two drops of the same radius are falling through air with a steady velocity of 5 cm per sec. If the two drops coalesce, the terminal velocity would be
(a) 10 cm per sec (b) 2.5 cm per sec
(c) $5 \times (4)^{1/3}$ cm per sec (d) $5 \times \sqrt{3}$ cm per sec

12. Which one of the following is not measured in units of energy ?
(a) Couple × angle
(b) Moment of inertia × (angular velocity)^2
(c) Force × distance
(d) Impulse × time

13. Ground wave propagation is possible for
(a) low radio frequency over a short range
(b) high radio frequency over a short range
(c) high radio frequency over a long range
(d) low radio frequency over a short range.

14. Forces of 4 N and 5 N are applied at origin along X-axis and Y-axis respectively. The resultant force will be
(a) $\sqrt{41}\text{N}, \tan^{-1}\left(\frac{5}{4}\right)$ (b) $\sqrt{41}\text{N}, \tan^{-1}\left(\frac{4}{5}\right)$
(c) $-\sqrt{41}\text{N}, \tan^{-1}\left(\frac{5}{4}\right)$ (d) $-\sqrt{41}\text{N}, \tan^{-1}\left(\frac{4}{5}\right)$

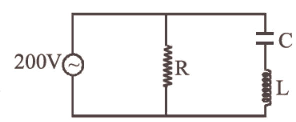
15. The expression corresponding to the truth table

A	B	Y
1	0	1
0	1	1
0	0	0
1	1	1

(a) $Y = \overline{\overline{A+B}}$ (b) $Y = \overline{\overline{A}.\overline{B}}$
(c) $Y = \overline{A-B}$ (d) $Y = \overline{A \times B}$

16. A wire is placed parallel to the lines of force in a magnetic field and a current flows in the wire. Then
(a) the wire will experience a force in the direction of the magnetic field
(b) the wire will not experience any force at all
(c) the wire will experience a force in a direction opposite to the field
(d) it experiences a force in a direction perpendicular to lines of force

17. In the circuit diagram shown, $X_C = 100\ \Omega$, $X_L = 200\ \Omega$ & $R = 100\ \Omega$. The effective current through the source is $2\sqrt{x}$ A then find value of x.



(a) 4 (b) 3
(c) 2 (d) 5

18. The threshold frequency for a photosensitive metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on this metal, the cut-off voltage for the photoelectric emission is nearly
(a) 2V (b) 3V (c) 5V (d) 1V

19. Assuming the radius of the earth as R, the change in gravitational potential energy of a body of mass m, when it is taken from the earth's surface to a height $3R$ above its surface, is
(a) $3\ mg\ R$ (b) $\frac{3}{4} mg\ R$
(c) $1\ mg\ R$ (d) $\frac{3}{2} mg\ R$

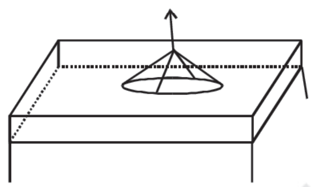
20. An electric fan has blades of length 30 cm measured from the axis of rotation. If the fan is rotating at 120 rpm, the acceleration of a point on the tip of the blade is
(a) 1600 ms^{-2} (b) 47.4 ms^{-2}
(c) 23.7 ms^{-2} (d) 50.55 ms^{-2}

21. We increase the charge on the plates of a capacitor, it means,
(a) increasing the capacitance
(b) increasing P.D. between plates
(c) decreasing P.D. between plates
(d) no change in field between plates

22. Two waves are represented by the equations $y_1 = a\sin(\omega t + kx + 0.57)\,m$ and $y_2 = a\cos(\omega t + kx)\,m$, where x is in meter and t in sec. The phase difference between them is
(a) 1.0 radian (b) 1.25 radian
(c) 1.57 radian (d) 0.57 radian

23. In a room where the temperature is 30°C, a body cools from 61°C to 59°C in 4 minutes. The time (in minutes) taken by the body to cool from 51°C to 49°C will be :
(a) 8 (b) 5 (c) 6 (d) 4

24. The surface tension of water is 75 dyne/cm. Find the minimum vertical force required to pull a thin wire ring up (refer figure) if it is initially resting on a horizontal water surface. The circumference of the ring is 20 cm and its weight is 0.1 N :



(a) 0.125 N
(b) 0.225 N
(c) 0.115 N
(d) 0.130 N

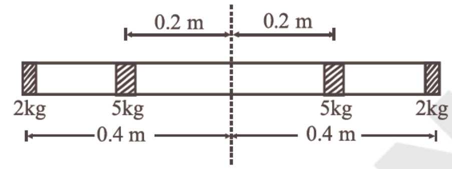
25. Resistance of 12 Ω and X Ω are connected in parallel in the left gap and resistances of 9 Ω and 7 Ω are connected in series in the right gap of the meter bridge. If the balancing length is 36 cm, then the value of resistance X is
(a) 72 Ω (b) 54 Ω (c) 36 Ω (d) 64 Ω

26. A coil of resistance 400Ω is placed in a magnetic field. If the magnetic flux ϕ (wb) linked with the coil varies with time t (sec) as $\phi = 50t^2 + 4$. The current in the coil at $t = 2$ sec is
(a) 0.5 A (b) 0.1 A (c) 2 A (d) 1 A

27. A particle of mass 10 kg is moving in a straight line. If its displacement, x with time t is given by $x = (t^3 - 2t - 10)$ m, then the force acting on it at the end of 4 seconds is
(a) 24 N (b) 240 N (c) 300 N (d) 1200N

28. At the magnetic north pole of the earth, the value of the horizontal component of earth's magnetic field and angle of dip are respectively
(a) zero, maximum
(b) maximum, minimum
(c) maximum, maximum
(d) minimum, minimum

29. Four masses are fixed on a massless rod as shown in the adjoining figure. The moment of inertia about the dotted axis is about



(a) 2 kg m^2 (b) 1 kg m^2
(c) 0.5 kg m^2 (d) 0.3 kg m^2

30. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time
(a) $1/10\lambda$ (b) $1/11\lambda$ (c) $11/10\lambda$ (d) $1/9\lambda$

31. If two vessels A and B contain the same gas but the volume of vessel A is twice that of B and temperature and pressure of gas A is twice that of gas in B, then the ratio of gas molecules in A and B is
(a) 1 : 2 (b) 1 : 4 (c) 4 : 1 (d) 2 : 1

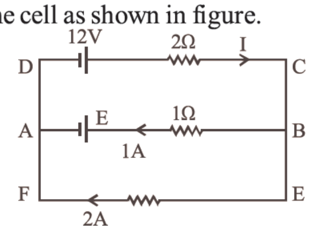
32. If the temperatures of source and sink of a Carnot engine having efficiency η are each decreased by 100 K, then the efficiency
(a) remains constant (b) becomes 1
(c) decreases (d) increases

33. In Young's experiment, two coherent sources are placed 0.90 mm apart and fringe are observed one metre away. If it produces second dark fringe at a distance of 1 mm from central fringe, the wavelength of monochromatic light used would be
(a) 60×10^{-4} cm (b) 10×10^{-4} cm
(c) 10×10^{-5} cm (d) 6×10^{-5} cm

34. The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of :
(a) 2 : 1 (b) 4 : 1 (c) 1 : 1 (d) 1 : 2

35. A simple pendulum oscillates in air with time period T and amplitude A. As the time passes
(a) T and A both decrease
(b) T increases and A is constant
(c) T remains same and A decreases
(d) T decreases and A is constant

36. Find emf E of the cell as shown in figure.

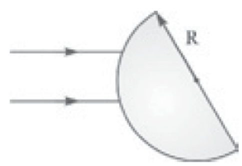


(a) 15V
(b) 10V
(c) 12V
(d) 5V

37. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10A$ and $\omega = 100 \pi$ radian/sec. The maximum value of e.m.f. in the second coil is

(a) 2π (b) 5π (c) π (d) 4π

38. A parallel beam of light is incident on the surface of a transparent hemisphere of radius R and refractive index 2.0 as shown in figure. The position of the image formed by refraction at the first surface is :



(a) $R/2$
(b) R
(c) $2R$
(d) $3R$

39. A single slit Fraunhoffer diffraction pattern is formed with white light. For what wavelength of light the third secondary maximum in the diffraction pattern coincides with the second secondary maximum in the pattern for red light of wavelength 6500 Å?

(a) 4400 Å (b) 4100 Å
(c) 4642.8 Å (d) 9100 Å

40. A train moving at a speed of 220 ms^{-1} towards a stationary object, emits a sound of frequency 1000 Hz. Some of the sound reaching the object gets reflected back to the train as echo. The frequency of the echo as detected by the driver of the train is (speed of sound in air is 330 ms^{-1})

(a) 3500 Hz (b) 4000 Hz
(c) 5000 Hz (d) 3000 Hz

41. The amplitude of a particle executing SHM is 4 cm. At the mean position the speed of the particle is 16 cm/sec. The distance of the particle from the mean position at which the speed of the particle becomes $8\sqrt{3}$ cm/s, will be

(a) $2\sqrt{3}\,cm$ (b) $\sqrt{3}\,cm$
(c) $1\,cm$ (d) $2\,cm$

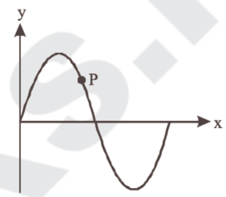
42. A body of mass 0.4 kg is whirled in a vertical circle making 2 rev/sec. If the radius of the circle is 1.2 m, then tension in the string when the body is at the top of the circle, is

(a) 41.56 N (b) 89.86 N
(c) 109.86 N (d) 115.86 N

43. The ratio of the accelerations for a solid sphere (mass 'm' and radius 'R') rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is :

(a) 5 : 7 (b) 2 : 3 (c) 2 : 5 (d) 7 : 5

44. A transverse sinusoidal wave moves along a string in the positive x-direction at a speed of 10 cm/s. The wavelength of the wave is 0.5 m and its amplitude is 10 cm. At a particular time t, the snap–shot of the wave is shown in figure. The velocity of point P when its displacement is 5 cm is



(a) $\frac{\sqrt{3}\pi}{50}\hat{j}\,m/s$ (b) $-\frac{\sqrt{3}\pi}{50}\hat{j}\,m/s$
(c) $\frac{\sqrt{3}\pi}{50}\hat{i}\,m/s$ (d) $-\frac{\sqrt{3}\pi}{50}\hat{i}\,m/s$

45. Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature t°C, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is

(a) $\frac{r^2\sigma(t+273)^4}{4\pi R^2}$ (b) $\frac{16\pi^2 r^2 \sigma t^4}{R^2}$
(c) $\frac{r^2\sigma(t+273)^4}{R^2}$ (d) $\frac{4\pi r^2 \sigma t^4}{R^2}$

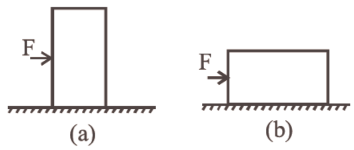
46. An electric charge $+q$ moves with velocity $\vec{v} = 3\hat{i} + 4\hat{j} + \hat{k}$ in an electromagnetic field given by $\vec{E} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = \hat{i} + \hat{j} - 3\hat{k}$ The y-component of the force experienced by $+q$ is :

(a) $11\,q$ (b) $5\,q$ (c) $3\,q$ (d) $2\,q$

47. A transistor-oscillator using a resonant circuit with an inductor L (of negligible resistance) and a capacitor C in series produce oscillations of frequency f. If L is doubled and C is changed to 4C, the frequency will be

(a) 8f (b) $f/2\sqrt{2}$
(c) f/2 (d) f/4

48. A rectangular block is placed on a rough horizontal surface in two different ways as shown, then



(a) friction will be more in case (a)
(b) friction will be more in case (b)
(c) friction will be equal in both the cases
(d) friction depends on the relations among its dimensions.

49. Three condensor each of capacitance 2F are put in series. The resultant capacitance is
(a) 6 F (b) 3/2 F (c) 2/3 F (d) 5 F

50. If a motorcyclist skids and stops after covering a distance of 15 m. The stopping force acting on the motorcycle by the road is 100 N, then the work done by the motorcycle on the road is
(a) 1500 J (b) –1500 J
(c) 750J (d) Zero

CHEMISTRY

51. In which of the following compounds, nitrogen exhibits highest oxidation state ?
(a) N_2H_4 (b) NH_3 (c) N_3H (d) NH_2OH

52. The nature of curve of E°_{cell} vs. log K_c is :
(a) straight line (b) parabola
(c) hyperbola (d) elliptical curve

53. Formation of alkanes by action of Zn on alkyl halides is called:
(a) Frankland's reaction
(b) Cannizaro's reaction
(c) Wurtz's reaction
(d) Kolbe's reaction

54. CdO has NaCl structures with density 8.27 g/cc. If the ionic radius of O^{2-} is 1.24 Å, determine ionic radius of Cd^{2+}:
(a) 1.5 Å (b) 1.1 Å (c) 1.9 Å (d) 1.5 Å

55. Indicate the nature of bonding in CCl_4 and CaH_2
(a) Covalent in CCl_4 and electrovalent in CaH_2
(b) Electrovalent in both CCl_4 and CaH_2
(c) Covalent in both CCl_4 and CaH_2
(d) Electrovalent in CCl_4 and covalent in CaH_2

56. What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene ?
(a) 2.8 kg (b) 6.4 kg (c) 9.6 kg (d) 96 kg

57. Nucleophilic addition reaction will be most favoured in
(a) $(CH_3)_2C=O$
(b) CH_3CH_2CHO
(c) CH_3CHO
(d) $CH_3-CH_2-CH_2-\overset{\overset{\large O}{\|}}{C}-CH_3$

58. Knowing that the chemistry of lanthanoids(Ln) is dominated by its + 3 oxidation state, which of the following statements is incorrect?
(a) The ionic size of Ln (III) decrease in general with increasing atomic number.
(b) Ln (III) compounds are generally colourless.
(c) Ln (III) hydroxide are mainly basic in character.
(d) Because of the large size of the Ln (III) ions the bonding in its compounds is predominantly ionic in character.

59. The rate constant of a reaction is 10.8×10^{-5} mol dm^{-3} s^{-1}. The order of the reaction is
(a) zero (b) 1 (c) 2 (d) 3

60. The most durable metal plating on iron to protect against corrosion is
(a) nickel plating (b) copper plating
(c) tin plating (d) zinc plating

61. One Faraday of electricity is passed through molten Al_2O_3, aqueous solution of $CuSO_4$ and molten NaCl taken in three different electrolytic cells connected in series. The mole ratio of Al, Cu and Na deposited at the respective cathode is
(a) 2 : 3 : 6 (b) 6 : 2 : 3
(c) 6 : 3 : 2 (d) 1 : 2 : 3

62. Producer gas is the mixture of :
(a) $CO + N_2$
(b) $CO + H_2$
(c) CO + water vapours
(d) $N_2 + CH_4$

63. Hydrogen can be fused to form helium at
(a) high temperature and high pressure
(b) high temperature and low pressure
(c) low temperature and high pressure
(d) low temperature and low pressure

64. Steam reacts with iron at high temperature to give hydrogen gas and Fe_3O_4 (s). The correct expression for the equilibrium constant is

(a) $\frac{P_{H_2}^2}{P_{H_2O}^2}$ (b) $\frac{[P_{H_2}]^4}{[P_{H_2O}]^4}$

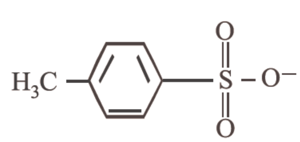
(c) $\frac{[P_{H_2}]^4[Fe_3O_4]}{[P_{H_2O}]^4[Fe]}$ (d) $\frac{[Fe_3O_4]}{[Fe]}$

65. The reaction $A \rightarrow B$ follows first order kinetics. The time taken for 0.8 mole of A to produce 0.6 mole of B is 1 hour. What is the time taken for conversion of 0.9 mole of A to produce 0.675 mole of B?
(a) 0.5 hour (b) 0.25 hour
(c) 2 hours (d) 1 hour

66. The pyrimidine bases present in DNA are
(a) cytosine and thymine
(b) cytosine and uracil
(c) cytosine and adenine
(d) cytosine and guanine

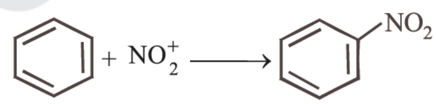
67. The most basic compound among the following is:
(a) Acetanilide (b) Benzylamine
(c) p-Nitroaniline (d) Aniline

68. Which of the following has minimum flocculation value for positively charged sol?
(a) Cl^- (b) SO_4^{2-}
(c) PO_4^{3-} (d) $[Fe(CN)_6]^{4-}$

69. The decreasing order of nucleophilicity among the nucleophiles
(I) $CH_3C(=O)-O^-$
(II) CH_3O^-
(III) CN^-
(IV)  is
(a) (III) > (II) > (I) > (IV)
(b) (II) > (III) > (I) > (IV)
(c) (IV) > (III) > (II) > (I)
(d) (I) > (II) > (III) > (IV)

70. In which of the following compound does hydrogen exhibit a negative oxidation state :
(a) LiH (b) H_2O
(c) HCl (d) none of these

71. Adiabatic expansions of an ideal gas is accompanied by
(a) decrease in ΔE
(b) increase in temperature
(c) decrease in ΔS
(d) no change in any one of the above properties

72. Which of the following is disproportionation reaction?
(a) $2HCHO \xrightarrow{NaOH} CH_3OH + HCOONa$
(b) $2CH_3CHO \xrightarrow{NaOH} CH_3CH(OH)CH_2CHO$
(c) 
(d) Both (a) & (b)

73. The number of unpaired electrons in the complex $[Cr(NH_3)_6]Br_3$ is (Atomic number of Cr = 24)
(a) 4 (b) 1 (c) 2 (d) 3

74. For orthorhombic system axial ratios are $a \neq b \neq c$ and the axial angles are
(a) $\alpha = \beta = \gamma \neq 90°$
(b) $\alpha = \beta = \gamma = 90°$
(c) $\alpha = \beta = \gamma = 90°, \beta \neq 90°$
(d) $\alpha \neq \beta \neq \gamma = 90°$

75. $\Delta_f G^-$ vs T plot in the Ellingham diagram slopes downward for the reaction
(a) $Mg + \frac{1}{2}O_2 \rightarrow MgO$
(b) $2Ag + \frac{1}{2}O_2 \rightarrow Ag_2O$
(c) $C + \frac{1}{2}O_2 \rightarrow CO$
(d) $CO + \frac{1}{2}O_2 \rightarrow CO_2$

76. The values of heat of formation of SO_2 and SO_3 are –298.2 kJ and –98.2 kJ respectively. The heat of formation of the reaction

$SO_2 + (1/2)O_2 \rightarrow SO_3$ will be

(a) –200 kJ (b) –356.2 kJ
(c) +200 kJ (d) – 396.2 kJ

77. Amphoteric oxides are

(a) ZnO, K_2O, SO_3
(b) ZnO, P_2O_5, Cl_2O_7
(c) SnO_2, Al_2O_3, ZnO
(d) PbO_2, SnO_2, SO_3

78. Before introducing FeO in blast furnace, it converted to Fe_2O_3 by roasting so that

(a) it may not be removed as slag with silica
(b) it may not evaporate in the furnace
(c) presence of it may increase the m.pt. of charge
(d) None of these

79. The formation of $O_2^+[PtF_6]^-$ is the basis for the formation of xenon fluorides. This is because

(a) O_2 and Xe have comparable sizes
(b) both O_2 and Xe are gases
(c) O_2 and Xe have comparable ionisation energies
(d) Both (a) and (c)

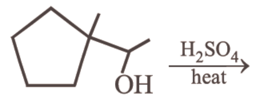
80. A similarity between optical and geometrical isomerism is that

(a) each gives equal number of isomers for a given compound
(b) if in a compound one is present then so is the other
(c) both are included in stereoisomerism
(d) they have no similarity

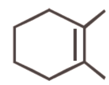
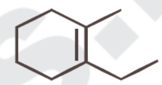
81. The electronic configuration of gadolinium (At. No. 64) is

(a) $[Xe]4f^8 5d^1 6s^2$
(b) $[Xe]4f^7 5d^1 6s^2$
(c) $[Xe]4f^3 5d^5 6s^2$
(d) $[Xe]4f^6 5d^2 6s^2$

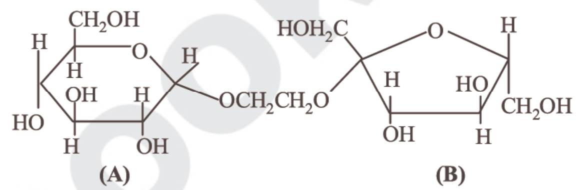
82. The most probable product in the reacion given below is



(a)  (b) 

(c)  (d) 

83. The correct statement about the following disaccharide is



(a) Ring (A) is pyranose with α - glycosidic link
(b) Ring (A) is furanose with α - glycosidic link
(c) Ring (B) is furanose with α - glycosidic link
(d) Ring (B) is pyranose with β - glycosidic link

84. Which of the following compound will undergo electrophilic substitution more readily than benzene ?

(a) Nitrobenzene (b) Benzoic acid
(c) Benzaldehyde (d) Phenol

85. Equal volumes of 0.1 M HCl and 0.1M NaOH are mixed. The concentration of the resulting solution will be

(a) 0.1 M (b) 0.05 M (c) 0.2 M (d) 0.0 M

86. Acidified $K_2Cr_2O_7$ solution turns green when Na_2SO_3 is added to it. This is due to the formation of :

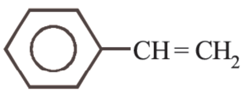
(a) $Cr_2(SO_4)_3$ (b) CrO_4^{2-}
(c) $Cr_2(SO_3)_3$ (d) $CrSO_4$

87. Which of the following is not used in Friedel-Crafts reaction?

(a) N–Phenyl acetanilide
(b) Bromobenzene
(c) Benzene
(d) Chlorobenzene

88. Polyvinylalcohol can be prepared by
(a) polymerization of vinyl alcohol.
(b) alkaline hydrolysis of polyvinyl acetate.
(c) polymerization of acetylene.
(d) reaction of acetylene with H_2SO_4 in presence of $HgSO_4$.

89. Which one of the following sets forms the biodegradable polymer?
(a) $CH_2=CH-CN$ and $CH_2=CH-CH=CH_2$
(b) H_2N-CH_2-COOH and $H_2N-(CH_2)_5-COOH$
(c) $HO-CH_2-CH_2-OH$ and

(d)  and $CH_2=CH-CH=CH_2$

90. When 2-methoxypropane is heated with HI, in the mole ratio 1 : 1, the major products formed are
(a) methanol and 2-iodopropane
(b) methyl iodide and 2-propanol
(c) methyl iodide and 2-iodopropane
(d) methanol and 2-propanol

91. When mango is placed in dilute aqueous solution of hydrochloric acid, it
(a) shrinks (b) swells
(c) bursts (d) Nothing happens

92. The geometry of $[Ni(CN)_4]^{2-}$ and $[Ni(PPh_3)_2Cl_2]$ are
(a) both square planar
(b) tetrahedral and square planar
(c) both tetrahedral
(d) square planar and tetrahedral

93. Which of the following is not true ?
(a) Some disinfectants can be used as antiseptics.
(b) Sulphadiazine is a synthetic antibacterial.
(c) Aspirin is analgesic as well as antipyretic.
(d) Polystyrene is used to make non-stick cookware.

94. Which of the following is true in respect of chemical adsorption?
(a) $\Delta H<0, \Delta S>0, \Delta G>0$
(b) $\Delta H<0, \Delta S<0, \Delta G<0$
(c) $\Delta H>0, \Delta S>0, \Delta G<0$
(d) $\Delta H>0, \Delta S<0, \Delta G>0$

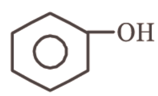
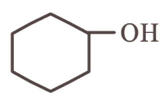
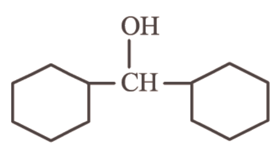
95. $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{Ni/H_2} Y \xrightarrow{\text{acetic anhydride}} Z$

Z in the above reacting sequence is
(a) $CH_3CH_2CH_2NHCOCH_3$
(b) $CH_3CH_2CH_2NH_2$
(c) $CH_3CH_2CH_2CONHCH_3$
(d) $CH_3CH_2CH_2CONHCOCH_3$

96. The appearance of colour in solid alkali metal halides is generally due to
(a) Schottky defect
(b) Frenkel defect
(c) Interstitial positions
(d) F-centre

97. Given below, catalyst and corresponding process/reaction are matched. The one with mismatch is:
(a) $[RhCl(PPh_3)_2]$: Hydrogenation
(b) $TiCl_4 + Al(C_2H_5)_3$: Polymerization
(c) V_2O_5 : Haber-Bosch process
(d) Nickel : Hydrogenation

98. Identify the incorrect statement, regarding the molecule XeO_4:
(a) XeO_4 molecule is tetrahedral
(b) XeO_4 molecule is square planar
(c) There are four $p\pi-d\pi$ bonds
(d) There are four sp^3-p, σ bonds

99. Which one of the following compounds has the most acidic nature?
(a) 
(b) 
(c) 
(d) 

100. Which is correct statement?
(a) Starch is a polymer of α-glucose
(b) In cyclic structure of fructose, there are four carbons and one oxygen atom
(c) Amylose is a component of cellulose
(d) Proteins are composed of only one type of amino acids

SECTION-B

MATHEMATICS

1. A set A has 3 elements and another set B has 6 elements. Then

(a) $3 \le n(A \cup B) \le 6$ (b) $3 \le n(A \cup B) \le 9$
(c) $6 \le n(A \cup B) \le 9$ (d) $0 \le n(A \cup B) \le 9$

2. A real valued function $f(x)$ satisfies the functional equation
$f(x-y) = f(x)f(y) - f(a-x)f(a+y)$
where a is a given constant and $f(0) = 1, f(2a-x)$ is equal to

(a) $-f(x)$ (b) $f(x)$
(c) $f(a)+f(a-x)$ (d) $f(-x)$

3. General solution of the equation
$(\sqrt{3}-1)\sin\theta + (\sqrt{3}+1)\cos\theta = 2$ is

(a) $2n\pi \pm \frac{\pi}{4} + \frac{\pi}{12}$ (b) $n\pi + (-1)^n \frac{\pi}{2}$

(c) $2n\pi \pm \frac{\pi}{4} - \frac{\pi}{12}$ (d) None

4. If $a_n = \sqrt{7+\sqrt{7+\sqrt{7+\ldots\ldots}}}$ having n radical signs then by methods of mathematical induction which is true

(a) $a_n > 7 \;\forall\; n \ge 1$ (b) $a_n < 7 \;\forall\; n \ge 1$
(c) $a_n < 4 \;\forall\; n \ge 1$ (d) $a_n < 3 \;\forall\; n \ge 1$

5. Let x_1 and y_1 be real numbers. If z_1 and z_2 are complex numbers such that $|z_1| = |z_2| = 4$, then $|x_1z_1 - y_1z_2|^2 + |y_1z_1 + x_1z_2|^2 =$

(a) $32(x_1^2 + y_1^2)$
(b) $16(x_1^2 + y_1^2)$
(c) $4(x_1^2 + y_1^2)$
(d) $32(x_1^2 + y_1^2)\,|z_1 + z_2|^2$

6. If $f(x) = x \sin x$, then $f'\left(\frac{\pi}{2}\right)$ is equal to

(a) 0 (b) 1 (c) -1 (d) $\frac{1}{2}$

7. Which of the function defined below is one–one?

(a) $f:(0,\infty) \to R,\ f(x) = x^2 - 4x + 3$
(b) $f:[0,\infty) \to R,\ f(x) = x^2 + 4x - 5$
(c) $f: R \to R,\ f(x) = e^x + \frac{1}{e^x}$
(d) $f: R \to R,\ f(x) = \ell n(x^2 + x + 1)$

8. Given the system of straight lines: $a(2x + y - 3) + b(3x + 2y - 5) = 0$, the line of the system situated farthest from the point (4, –3) has the equation

(a) $4x + 11y - 15 = 0$ (b) $7x + y - 8 = 0$
(c) $4x + 3y - 7 = 0$ (d) $3x - 4y + 1 = 0$

9. If $f(x) = \begin{cases} \left(x^2/a\right) - a, & \text{when } x < a \\ 0, & \text{when } x = a, \text{then} \\ a - \left(x^2/a\right), & \text{when } x > a \end{cases}$

(a) $\lim_{x \to a} f(x) = a$
(b) $f(x)$ is continuous at x = a
(c) $f(x)$ is discontinuous at x = a
(d) None of these

10. The probability of getting sum more than 7 when a pair of dice are thrown is

(a) $\frac{7}{36}$ (b) $\frac{5}{12}$
(c) $\frac{7}{12}$ (d) None of these

11. Evaluate $\int \frac{x^2+1}{x^4+x^2+1}\,dx$

(a) $\tan^{-1}\left(\frac{(x^2-1)}{\sqrt{3}x}\right) + c$

(b) $\frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{(x^2-1)}{\sqrt{3}x}\right) + c$

(c) $\cos^{-1}\left(\frac{(x^2-1)}{\sqrt{3}x}\right) + c$

(d) $\sec^{-1}\left(\frac{(x^2-1)}{\sqrt{3}x}\right) + c$

12. Find the minimum value of $e^{(2x^2-2x-1)\sin^2 x}$.
(a) 1 (b) 2
(c) 0 (d) None of these

13. The number of real roots of the equation $|2-|1-|x||| = 1$ is
(a) 1 (b) 3 (c) 5 (d) 6

14. In the expression $(x+1)(x+4)(x+9)(x+16)$....... $(x+400)$, the coefficeient of x^{19} is
(a) 2870 (b) 2100 (c) 4001 (d) 1900

15. The area enclosed between the curves $y=\log_e(x+e),\ \ x=\log_e\frac{1}{y}$ and the x-axis, is
(a) 2 sq unit (b) 1 sq unit
(c) 4 sq unit (d) None of these

16. The letters of the word MODESTY are written in all possible orders and these words are written out as in a dictionary then the rank of the word MODESTY is
(a) 5040 (b) 720 (c) 1681 (d) 2520

17. The solution of the differential equation $y'\left(y^2-x\right)=y$ is
(a) $y^3-3xy=C$ (b) $y^3+3xy=C$
(c) $x^3-3xy=C$ (d) $y^3-xy=C$

18. Equation of the circle concentric with the circle $x^2+y^2-3x+4y-c=0$ and passing through the point $(-1,-2)$, is
(a) $x^2+y^2-3x-4y=0$
(b) $x^2+y^2-3x+4y=0$
(c) $x^2+y^2+3x+4y=0$
(d) $x^2+y^2-7x+7y=0$

19. The value of $\lim\limits_{x\to 0}\dfrac{(4^x-1)^3}{\sin\dfrac{x^2}{4}\log(1+3x)}$, is
(a) $\frac{4}{3}(\ln 4)^2$ (b) $\frac{4}{3}(\ln 4)^3$
(c) $\frac{3}{2}(\ln 4)^2$ (d) $\frac{3}{2}(\ln 4)^3$

20. Vectors $\vec{a}$ and $\vec{b}$ are inclined at an angle θ = 120°. If $|\vec{a}|=|\vec{b}|=2$, then $\left[(\vec{a}+3\vec{b})\times(3\vec{a}+\vec{b})\right]^2$ is equal to
(a) 190 (b) 275 (c) 300 (d) 192

21. If $\begin{vmatrix} p & q-y & r-z \\ p-x & q & r-z \\ p-x & q-y & r \end{vmatrix}=0$, then the value of $\frac{p}{x}+\frac{q}{y}+\frac{r}{z}$ is
(a) 0 (b) 1 (c) 2 (d) 4pqr

22. If $\cos x = b$. For what b do the roots of the equation form an A.P. ?
(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{1}{2}$
(c) –1 (d) None of these

23. If the perpendicular distance of the point (6, 5, 8) from the Y-axis is 5λ unit, then λ is equal to
(a) 5 (b) 3 (c) 4 (d) 2

24. The three planes $x+y=0$, $y+z=0$ and $x+z=0$
(a) meet in a unique point
(b) meet in a line
(c) meet taken two at a time in parallel lines
(d) None of these

25. *If* $\sin^{-1}x+\sin^{-1}y+\sin^{-1}z=\frac{3\pi}{2}$ then the value of
$x^{100}+y^{100}+z^{100}-\dfrac{3}{x^{101}+y^{101}+z^{101}}$ is
(a) 0 (b) 1 (c) 2 (d) 3

26. Two dice are thrown n times in succession. The probability of obtaining a double-six atleast once is
(a) $\left(\frac{1}{36}\right)^n$ (b) $1-\left(\frac{35}{36}\right)^n$
(c) $\left(\frac{1}{12}\right)^n$ (d) None of these

27. What is $\int\left(e^x+1\right)^{-1}dx$ equal to?

(a) $\ln\left(e^x+1\right)+c$ (b) $\ln\left(e^{-x}+1\right)+c$

(c) $-\ln\left(e^{-x}+1\right)+c$ (d) $-\left(e^x+1\right)+c$

28. If $f(x)=\begin{cases}x+\lambda, & x<3\\ 4, & x=3\\ 3x-5, & x>3\end{cases}$ is continuous at x = 3, then $\lambda=$

(a) 4 (b) 3 (c) 2 (d) 1

29. The base of a cliff is circular. From the extremities of a diameter of the base the angles of elevation of the top of the cliff are 30° and 60°. If the height of the cliff be 500 metres, then the diameter of the base of the cliff is

(a) $1000\sqrt{3}$m (b) $2000/\sqrt{3}$m

(c) $1000/\sqrt{3}$m (d) $2000\sqrt{2}$m

30. If the amplitude of $z-2-3i$ is $\pi/4$, then the locus of $z=x+iy$ is

(a) $x+y-1=0$ (b) $x-y-1=0$

(c) $x+y+1=0$ (d) $x-y+1=0$

31. If α and β are roots of the equation $x^2+px+\frac{3p}{4}=0$, such that $|\alpha-\beta|=\sqrt{10}$, then p belongs to the set :

(a) $\{2,-5\}$ (b) $\{-3,2\}$

(c) $\{-2,5\}$ (d) $\{3,-5\}$

32. If the circle $x^2+y^2+2gx+2fy+c=0$ bisects the circumference of the circle $x^2+y^2+2g'x+2f'y+c'=0$ then the length of the common chord of these two circles is

(a) $2\sqrt{g^2+f^2-c}$ (b) $2\sqrt{g'^2+f'^2-c'}$

(c) $2\sqrt{g^2+f^2+c}$ (d) $2\sqrt{g'^2+f'^2+c'}$

33. There are four letters and four envelopes, the letters are placed into the envelopes at random, the probability that all letters are placed in the wrong envelopes is

(a) $\frac{1}{8}$ (b) $\frac{3}{8}$ (c) $\frac{5}{8}$ (d) 1

34. If A is 3×2 matrix and B is a matrix such that A′ B and B A′ are both defined. Then , order of matrix B is–

(a) 3×4 (b) 3×2 (c) 4×4 (d) 4×3

35. The statement "If $2^2=5$ then I get first class" is logically equivalent to

(a) $2^2=5$ and I do not get first class

(b) $2^2=5$ or I do not get first class

(c) $2^2\neq5$ or I get first class

(d) None of these

36. Let $f:R\to R$ be such that $f(1)=3$ and $f'(1)=6$. Then $\lim_{x\to0}\left(\frac{f(1+x)}{f(1)}\right)^{1/x}$ equals

(a) 1 (b) $e^{1/2}$ (c) e^2 (d) e^3

37. Suppose $f(x)=(x+1)^2$ for $x\geq-1$. If g(x) is the function whose graph is the reflection of the graph of f(x) with respect to the line y = x, then g(x) equals

(a) $-\sqrt{x}-1, x\geq0$ (b) $\frac{1}{(x+1)^2}, x>-1$

(c) $\sqrt{x+1}, x\geq-1$ (d) $\sqrt{x}-1, x\geq0$

38. If $\vec{p},\vec{q}$ and $\vec{r}$ are perpendicular to $\vec{q}+\vec{r},\vec{r}+\vec{p}$ and $\vec{p}+\vec{q}$ respectively and if $|\vec{p}+\vec{q}|=6, |\vec{q}+\vec{r}|=4\sqrt{3}$ and $|\vec{r}+\vec{p}|=4$ then $|\vec{p}+\vec{q}+\vec{r}|$ is

(a) $5\sqrt{2}$ (b) 10 (c) 15 (d) 5

39. If 7 points out of 12 are in the same straight line, then the number of triangles formed is

(a) 19 (b) 185

(c) 201 (d) None of these

40. If the ratio of the 7th term from the beginning to the 7th term from the end in $\left(\sqrt[3]{2}+\frac{1}{\sqrt[3]{3}}\right)^n$ is $\frac{1}{6}$ them n equals to

(a) 10 (b) 9 (c) 8 (d) 12

41. The area between the parabola $y = x^2$ and the line $y = x$ is:

(a) $\frac{1}{6}$ sq.units (b) $\frac{1}{3}$ sq.units

(c) $\frac{1}{2}$ sq.units (d) None of these

42. If $\begin{vmatrix} 1+a^2+a^4 & 1+ab+a^2b^2 & 1+ac+a^2c^2 \\ 1+ab+a^2b^2 & 1+b^2+b^4 & 1+bc+b^2c^2 \\ 1+ac+a^2c^2 & 1+bc+b^2c^2 & 1+c^2+c^4 \end{vmatrix}$

$= (a-b)^k (b-c)^k (c-a)^k$, then k is

(a) –1 (b) 1 (c) 2 (d) –2

43. Let S_1, S_2 be the foci of the ellipse $\frac{x^2}{16} + \frac{y^2}{8} = 1$. If $A(x+y)$ is any point on the ellipse, then the maximum area of the triangle AS_1S_2 (in square units) is

(a) $2\sqrt{2}$ (b) $2\sqrt{3}$ (c) 8 (d) 4

44. If $|r| > 1$ and $x = a + \frac{a}{r} + \frac{a}{r^2} + ...\text{to } \infty$,

$y = b - \frac{b}{r} + \frac{b}{r^2} - ....\text{to } \infty$

and $z = c + \frac{c}{r^2} + \frac{c}{r^4} + ...\text{to } \infty$, then $\frac{xy}{z} =$

(a) $\frac{ab}{c}$ (b) $\frac{ac}{b}$ (c) $\frac{bc}{a}$ (d) 1

45. $\int_0^{\pi/2} x \sin^2 x \cos^2 x \, dx$ is equal to

(a) $\frac{\pi^2}{32}$ (b) $\frac{\pi^2}{16}$

(c) $\frac{\pi}{32}$ (d) None of these

46. Find the minimum value of $e^{(2x^2-2x-1)\sin^2 x}$.

(a) 1 (b) 2
(c) 0 (d) None of these

47. The image of the pair of lines represented by: $ax^2 + 2hxy + by^2 = 0$ by the line mirror $y = 0$ is

(a) $ax^2 - 2hxy - by^2 = 0$
(b) $bx^2 - 2hxy + ay^2 = 0$
(c) $bx^2 + 2hxy + ay^2 = 0$
(d) $ax^2 - 2hxy + by^2 = 0$

48. The mean mark in statistics of 100 students in a class was 72. The mean mark of boys was 75, while their number was 70. The mean mark of girls in the class was

(a) 65 (b) 60 (c) 66 (d) 62

49. If $f(x) = \begin{cases} x, & x \le 1 \\ x^2 + bx + c, & x > 1 \end{cases}$, then find the values of b and c if $f(x)$ is differentiable at $x = 1$.

(a) $b = c = 1$ (b) $b = -1, c = 1$

(c) $b = 0, c = 1$ (d) $b = -1, c = 0$

50. Maximum value of $12x + 3y$ subject to constraints $x \ge 0, y \ge 0, x + y \le 5$ and $3x + y \le 9$ is

(a) 15 (b) 36 (c) 60 (d) 40

ANSWER KEYS & SOLUTIONS

(Mock Test-1)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(d)	**11**	(a)	**16**	(d)	**21**	(a)	**26**	(c)	**31**	(d)	**36**	(b)	**41**	(c)	**46**	(a)
2	(d)	**7**	(b)	**12**	(d)	**17**	(b)	**22**	(b)	**27**	(a)	**32**	(b)	**37**	(d)	**42**	(d)	**47**	(a)
3	(d)	**8**	(b)	**13**	(a)	**18**	(c)	**23**	(c)	**28**	(a)	**33**	(d)	**38**	(d)	**43**	(d)	**48**	(b)
4	(c)	**9**	(d)	**14**	(b)	**19**	(c)	**24**	(b)	**29**	(b)	**34**	(d)	**39**	(c)	**44**	(a)	**49**	(b)
5	(d)	**10**	(c)	**15**	(d)	**20**	(a)	**25**	(d)	**30**	(b)	**35**	(b)	**40**	(c)	**45**	(a)	**50**	(b)
CHEMISTRY																			
51	(a)	**56**	(d)	**61**	(c)	**66**	(b)	**71**	(b)	**76**	(c)	**81**	(c)	**86**	(c)	**91**	(a)	**96**	(a)
52	(c)	**57**	(d)	**62**	(d)	**67**	(d)	**72**	(c)	**77**	(b)	**82**	(d)	**87**	(a)	**92**	(d)	**97**	(b)
53	(a)	**58**	(b)	**63**	(b)	**68**	(c)	**73**	(b)	**78**	(b)	**83**	(b)	**88**	(b)	**93**	(b)	**98**	(d)
54	(b)	**59**	(d)	**64**	(b)	**69**	(c)	**74**	(a)	**79**	(b)	**84**	(d)	**89**	(a)	**94**	(d)	**99**	(c)
55	(b)	**60**	(c)	**65**	(d)	**70**	(a)	**75**	(c)	**80**	(b)	**85**	(a)	**90**	(b)	**95**	(b)	**100**	(b)
SECTION-B																			
MATHEMATICS																			
1	(c)	**6**	(a)	**11**	(b)	**16**	(b)	**21**	(c)	**26**	(d)	**31**	(c)	**36**	(b)	**41**	(d)	**46**	(a)
2	(a)	**7**	(b)	**12**	(d)	**17**	(c)	**22**	(c)	**27**	(a)	**32**	(a)	**37**	(b)	**42**	(b)	**47**	(b)
3	(d)	**8**	(c)	**13**	(d)	**18**	(d)	**23**	(a)	**28**	(d)	**33**	(c)	**38**	(a)	**43**	(c)	**48**	(a)
4	(c)	**9**	(a)	**14**	(a)	**19**	(a)	**24**	(a)	**29**	(b)	**34**	(c)	**39**	(a)	**44**	(a)	**49**	(b)
5	(c)	**10**	(c)	**15**	(b)	**20**	(a)	**25**	(b)	**30**	(c)	**35**	(b)	**40**	(c)	**45**	(a)	**50**	(b)

SECTION-A

PHYSICS

1. (a) Distance covered in one circular loop $= 2\pi r$
$= 2 \times 3.14 \times 100 = 628$ m

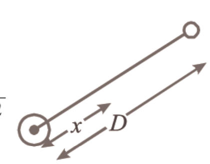
Speed $= \dfrac{628}{62.8} = 10$ m / s

Displacement in one circular loop = 0

Velocity $= \dfrac{0}{\text{time}} = 0$

2. (d) $\dfrac{Gm_e}{x^2} = \dfrac{Gm_m}{(D-x)^2}$

or $\dfrac{G(81m)}{x^2} = \dfrac{Gm}{(D-x)^2}$



$\therefore \quad x = \dfrac{9D}{10}$.

3. (d)

4. (c)

5. (d) Work done in storing a charge Q in a capacitor is stored in capacitor as its energy U

$$U = W = \frac{1}{2}QV = \frac{Q^2}{2C} = \frac{1}{2}CV^2.$$

6. (d) $W_1 = \frac{1}{2}kx^2$ and $W_2 = \frac{1}{2}k(x+y)^2$

$$\therefore\ W = W_2 - W_1 = \frac{1}{2}k(x+y)^2 - \frac{1}{2}kx^2$$

$$= \frac{1}{2}ky(2x+y)$$

7. (b) $v = \omega[A^2 - x^2]^{1/2} \Rightarrow x = \left[A^2 - \frac{v^2}{\omega^2}\right]^{1/2}$

Given that $v = \frac{v_{max}}{2} = \frac{A\omega}{2}$.

so, $\left[A^2 - \frac{A^2\omega^2}{4\omega^2}\right]^{1/2} = \frac{\sqrt{3}}{2}A$

8. (b) $m = \frac{\text{actual frequency deviation}}{\text{max. allowed frequency deviation}} \times 100\%$

$$= \frac{(\Delta f)\text{actual}}{(\Delta f)\text{max}} \times 100\%$$

if (Δf) actual $= (\Delta f)$ max

m = 100%

9. (d)

10. (c) $m \times 10 = 2 \times 3 \times 10^{-2} \times \frac{10}{100}$

or $m = 6 \times 10^{-4}$ kg $= 6 \times 10^{-4} \times 10^3$ g $= 0.6$ g

11. (a)

12. (d) Density of nuclear material = mass/volume

$$= \frac{10^{-27}}{\frac{4}{3}\pi r^3} = \frac{3 \times 10^{-27}}{4\pi(2 \times 10^{-15})^3} = 10^{17}\ \text{kg/m}^3$$

13. (a) $\because \lambda_0 = \frac{hc}{\phi}$

$$\therefore\ (\lambda_0)_{sodium} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2 \times 1.6 \times 10^{-19}} = 6188\ \text{Å}$$

$$\because \lambda_0 \propto \frac{1}{\phi} \Rightarrow \frac{(\lambda_0)_{sodium}}{(\lambda_0)_{copper}} = \frac{(\phi)_{copper}}{(\phi)_{sodium}}$$

$$\Rightarrow (\lambda_0)_{copper} = \frac{2}{4} \times 6188 = 3094\ \text{Å}$$

To eject photo-electrons from sodium the longest wavelength is 6188 Å and that for copper is 3094 Å.
Hence for light of wavelength 4000 Å, sodium is suitable.

14. (b) The coordinates of C.M of three particle are

$$x = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

$$\&\ y = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$

here $m_1 = m_2 = m_3 = m$

so $x = \frac{(x_1 + x_2 + x_3)m}{m+m+m} = 2$,

$$y = \frac{(y_1 + y_2 + y_3)m}{m+m+m} = 2$$

So coordinates of C.M. of three particle are (2,2)

15. (d)

16. (d) Angle of banking is $\tan\theta$

$$= \frac{v^2}{rg} = \frac{20^2}{40\sqrt{3} \times 10}$$

$\tan\theta = \frac{1}{\sqrt{3}}$ $\therefore\ \theta = 30°$

17. (b) Let ℓ_0 be the unstretched length and ℓ_3 be the length under a tension of 9N. Then

$$Y = \frac{4\ell_0}{A(\ell_1 - \ell_0)} = \frac{5\ell_0}{A(\ell_2 - \ell_0)} = \frac{9\ell_0}{A(\ell_3 - \ell_0)}$$

These give

$$\frac{4}{\ell_1 - \ell_0} = \frac{5}{\ell_2 - \ell_0} \Rightarrow \ell_0 = 5\ell_1 - 4\ell_2$$

Further, $\frac{4}{\ell_1 - \ell_0} = \frac{9}{\ell_2 - \ell_0}$

Substituting the value of ℓ_0 and solving, we get $\ell_3 = 5\ell_2 - 4\ell_1$

18. (c) $R = \frac{V}{I_g} - G = \frac{10}{0.01} - 10 = 990\ \Omega$ in series.

19. **(c)** Flux going in pyramid $= \dfrac{Q}{2\varepsilon_0}$.

which is divided equally among all 4 faces.

$\therefore$ Flux through one face $= \dfrac{Q}{8\varepsilon_0}$

20. **(a)** Impulse = force × time
$= MLT^{-2} \times T = [M\ LT^{-1}]$.

21. **(a)**

22. **(b)** Escape velocity

$$v_e = \sqrt{\frac{2GM_e}{R_e}},\ v'_e = \sqrt{\frac{2GM'_e}{R'_e}}$$

$$\therefore \quad \frac{v'_e}{v_e} = \sqrt{\frac{M'_e}{M_e} \times \frac{R_e}{R'_e}}$$

Given $M'_e = 2M_e$ and $R'_e = \dfrac{R_e}{2}$

$$\therefore \quad \frac{v'_e}{v_e} = \sqrt{\frac{2M_e}{M_e} \times \frac{R_e}{R_e/2}} = \sqrt{4} = 2$$

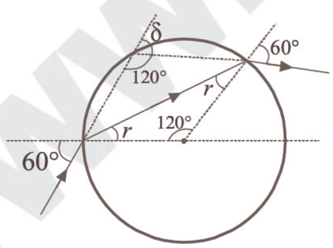
$$v'_e = 2v_e = 2 \times 11.2 = 22.4 \text{ km/s}$$

23. **(c)**

24. **(b)** $E = h\nu = h\dfrac{c}{\lambda} \therefore \dfrac{E_1}{E_2} = \dfrac{\lambda_2}{\lambda_1} = \dfrac{5000}{1}$

25. **(d)** From Snell's law,

$$\frac{\sin 60°}{\sin r} = \sqrt{3} \text{ or}$$



$$\sin r = \frac{\sqrt{3}}{2 \times \sqrt{3}} = \frac{1}{2}$$

$\therefore \quad r = 30°$

Thus, $\delta = 60°$

26. **(c)** Ratio of number of half life taken is given as:
After 16 days

$$T_{A1/2} = \frac{16}{4} = 4, \qquad T_{B1/2} = \frac{16}{8} = 2$$

$$N = N_0\left(\frac{1}{2}\right)^n$$

$$\frac{N_A}{N_B} = \frac{1}{2^4} : \frac{1}{2^2} = 2^2 : 2^4$$

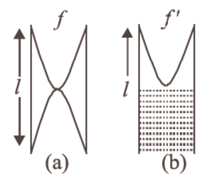
$= 4 : 16, = 1 : 4$

27. **(a)** As we know, |impulse| = |change in momentum|
$= |p_2 - p_1| = |0 - mv_1| = |0 - 3 \times 2| = 6$ Ns

28. **(a)**

29. **(b)** The fundamental frequency in case (a) is

$$f = \frac{v}{2\ell}$$



The fundamental frequency in case (b) is

$$f' = \frac{v}{4(\ell/2)} = \frac{v}{2\ell} = f$$

30. **(b)**

31. **(d)**

32. **(b)**

33. **(d)** Limiting friction $= 0.5 \times 2 \times 10 = 10$N
The applied force is less than force of friction, therefore the force of friction is equal to the applied force.

34. **(d)** $\dfrac{1}{2}mv^2 = \dfrac{hc}{\lambda} - \phi$

$$\frac{1}{2}mv'^2 = \frac{hc}{(5\lambda/4)} - \phi = \frac{4hc}{5\lambda} - \phi$$

Clearly, $v' > \sqrt{\dfrac{5}{3}}v$

35. **(b)**

36. **(b)** This is a balanced wheatstone bridge condition,

$$\frac{5}{R} = \frac{\ell_1}{100 - \ell_1} \text{ and } \frac{5}{R/2} = \frac{1.6\ell_1}{100 - 1.6\ell_1}$$

$\Rightarrow \quad R = 15\,\Omega$

37. **(d)** $m = -\frac{v}{u} = -\left(\frac{f}{u-f}\right)$

Now $m_1 = -\left(\frac{f}{25-f}\right)$ ...(i)

and $m_2 = -\left(\frac{f}{40-f}\right)$ ...(ii)

$\therefore \frac{m_1}{m_2} = \frac{40-f}{25-f}$ or $4 = \frac{40-f}{25-f}$ or $f = 20$ cm.

38. **(d)** There is no current inside the pipe. Therefore

$\oint \vec{B}.\vec{d\ell} = \mu_o I \Rightarrow I = 0$

$B = 0$

39. **(c)** $W = F s \cos\theta, \ \cos\theta = \frac{W}{Fs} = \frac{25}{5\times 10} = \frac{1}{2}$,

$\theta = 60^o$.

40. **(c)** $W = \frac{\pi r_1 r_2}{2} = \frac{\pi\times 1\times 1}{2} = \pi/2$ J

41. **(c)** From Bernoulli's theorem,

$P_0 + \frac{1}{2}\rho v_1^2 + \rho gh = P_0 + \frac{1}{2}\rho v_2^2 + 0$

$v_2 = \sqrt{v_1^2 + 2gh} = \sqrt{0.16 + 2\times 10\times 0.2} = 2.03$ m/s

From equation of continuity, $A_2 v_2 = A_1 v_1$

$\pi\frac{D_2^2}{4}\times v_2 = \pi\frac{D_1^2}{4}v_1 \Rightarrow D_2 = D_1\sqrt{\frac{v_1}{v_2}} = 3.55\times 10^{-3}$ m

42. **(d)** According to Lenz's law, when switch is closed, the flux in the loop increases out of plane of paper, so induced current will be clockwise.

43. **(d)**

44. **(a)** Moment of inertia is given by

$I = \sum_{i=1}^{n} m_i r_i^2$

Thus, it does not depend on angular velocity.

45. **(a)** Frequency heard by observer directly coming from source $= \frac{355-5}{355+5}\times 180 = 175$ Hz.

$f_2 \rightarrow$ frequency heard by observer after reflection

$= \left[\frac{355}{355-5}\times\right]\left[\frac{355-5}{355}\right]\times 180 = 180$ Hz

$f_2 - f_1 = 5$ Hz

46. **(a)**

47. **(a)** For Brackett series

$\frac{1}{\lambda_{max}} = R\left[\frac{1}{4^2} - \frac{1}{5^2}\right] = \frac{9}{25\times 16}R$

and $\frac{1}{\lambda_{min}} = R\left[\frac{1}{4^2} - \frac{1}{\infty^2}\right] = \frac{R}{16}$

$\Rightarrow \frac{\lambda_{max}}{\lambda_{min}} = \frac{25}{9}$

48. **(b)**

49. **(b)** Distance covered by lift is given by $y = t^2$

$\therefore$ Acceleration of lift upwards

$= \frac{d^2y}{dt^2} = \frac{d}{dt}(2t) = 2\ m/s^2 = \frac{g}{5}$

$T' = 2\pi\sqrt{\frac{\ell}{g + \frac{g}{5}}} = 2\pi\sqrt{\frac{\ell}{\frac{6}{5}g}} = \sqrt{\frac{5}{6}}T.$

50. **(b)** $\frac{2T}{r} = \frac{2\times 0.07}{0.14\times 10^{-3}} = 10^3$ N/m^2

Pressure applied, $= P_a - \frac{2T}{r} = 10^5 - 10^3 = 99 \times 10^3$ N/m^2

CHEMISTRY

51. **(a)** Joule is the unit of work and Pascal is unit of pressure.

$JPa^{-1} = \frac{J}{Pa} = \frac{Work}{Pressure} = \frac{Nm}{Nm^{-2}} = m^3$

52. **(c)** $\underset{(X)}{C_3H_8O} \xrightarrow{[O]} C_3H_6O$ (Ketone)

$$\underset{2^\circ \text{ Alcohol}}{CH_3 - \overset{\overset{OH}{|}}{CH} - CH_3} \xrightarrow{[O]} \underset{\text{Ketone}}{CH_3 - \overset{\overset{O}{\|}}{C} - CH_3}$$

Ketones are oxidation products of 2° alcohols.

53. (a) The element with outer electron configuration $3d^5 4s^2$ is Mn which exhibits oxidation states from + 2 to + 7.

54. (b) Al_2O_3 cannot be reduced by carbon.

55. (b) According to Arrhenius equation,

$k = A.e^{-E_a/RT}$

where k = rate constant

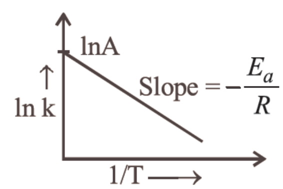
or $\ln k = \ln A - \dfrac{E_a}{RT}$

A = frequency factor or pre-exponential factor

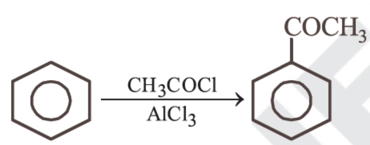
E_a = Energy of activation.

In Arrhenius plot, ln k vs 1/T

Slop is $-\dfrac{E_a}{R}$ and intercept in lnA.



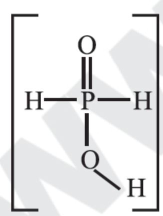
56. (d)



Acetophene

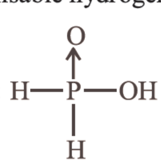
57. (d)

58. (b)



Hypophosphorous acid

(H_3PO_2) is a monobasic acid. i.e., it has only one ionisable hydrogen atom or one OH is present



59. (d) 4-nitrobenzyl chloride is most likely to react by the S_N2 mechanism as the strongly electron-withdrawing nitro group would destabilize the carbocation intermediate of the S_N1 mechanism, a benzylic chloride that disfavours the S_N1 mechanism.

60. (c) Acc. to Kohlrausch law,

$\Lambda_{eq}(NaF) + \Lambda_{eq}(HCl) - \Lambda_{eq}(NaCl)$

$= \Lambda_{eq}(HF)$

61. (c) $\underset{\text{Thiol}}{2R-S-H} \rightleftharpoons \underset{\text{Disulphide}}{R-S-S-R}$

62. (d) $\underset{\text{alkyl isocyanide}}{R-N \equiv C} \xrightarrow{4[H]} \underset{\text{secondary amine}}{RNH-CH_3}$

63. (b) Ni shows sp^3, sp^3 and dsp^2-hybridisation in $Ni(CO)_4$, $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ respectively.

CN^- being a strong field ligand pairs up unpaired electron in Ni^{2+}.

64. (b) Specific conductance of the solution (κ) = 0.012 ohm^{-1} cm^{-1} and resistance (R) = 55 ohm.

Cell constant = Specific conductance × Observed resistance = 0.012 × 55 = 0.66 cm^{-1}.

65. (d) Rate = $k\,[N_2O_5]$;

$2.4 \times 10^{-5} = 3.0 \times 10^{-5}[N_2O_5]$

$\therefore [N_2O_5] = 0.8$

66. (b) Na_3AlF_6 is cryolite and used in the electrolysis of alumina to lower the melting point and increase electrical conductivity.

67. (d) Linseed oil, lanolin and glycogen attract water hence contain a hydrophilic structure, but rubber does not attract water and thus does not contain a hydrophilic structure.

68. (c) For an ideal solution, $\Delta H = 0$, $\Delta V = 0$

Hence, option (c) is incorrect.

69. (c) In compounds

I II

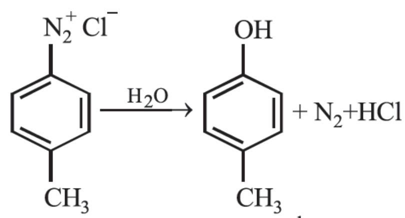
I has more dipole moment than II, hence its boiling point will be higher. Melting point depends on symmetry, therefore I has higher melting point than II. Steric crowding in II is more than in I therefore I is more stable than II.

70. **(a)** Baking powder has starch, $NaHCO_3$ and $Ca(H_2PO_2)_2$.

71. **(b)** $2KBr + I_2 \longrightarrow 2KI + Br_2$ (not possible)
Because Br^- ion is not oxidised to Br_2 with I_2 due to higher electrode (oxidation) potential of I_2 than that of bromine.

72. **(c)**

73. **(b)**



p- cresol

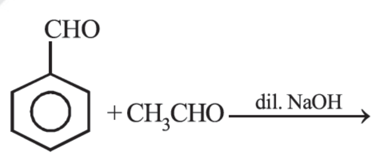
74. **(a)** IUPAC name of sodium nitroprusside $Na_2[Fe(CN)_5NO]$ is sodium pentacyano-nitrosylferrate (III)
$2 \times$ O.N. of Na + O.N. of Fe + $5 \times$ O.N. of CN + $1 \times$ O.N. of NO = 0
$2 \times (+1)$ + O.N. of Fe + $5 \times (-1) + 1 = 0$
O.N. of Fe $= 5 - 3 = +2$, hence ferrate (II)

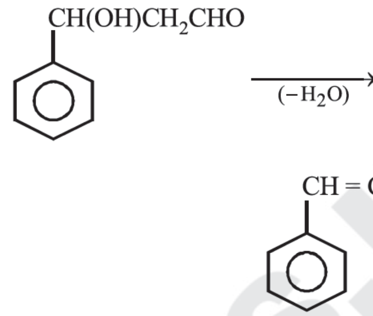
75. **(c)** $Ca_3P_2 + 6H_2O \rightarrow 3Ca(OH)_2 + 2PH_3$; i.e 2 moles of phosphine are produced from one mole of calcium phosphide.

76. **(c)** As we know that, units of rate constant.
= (unit of conc.)$^{1-n}$ (unit of time)$^{-1}$
= (mol L^{-1})$^{1-n}$ (sec)$^{-1}$
On comparing these units with the given units of rate constant, we get
(mol L^{-1})$^{1-n}$ (sec)$^{-1}$ = L mol^{-1} sec^{-1}
$\Rightarrow$ L^{n-1} mol^{1-n} sec^{-1} = L mol^{-1} sec^{-1}
On comparing the powers, we get
$n - 1 = 1 \Rightarrow n = 2$
So, reaction is of second order.

77. **(b)**

78. **(b)** Aldol formed in aromatic aldehydes itself loses water molecule without heating because double bond formed is more stable due to conjugation with benzene ring.





Cinnamaldehyde

79. **(b)** $2CuSO_4 + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Chocolate ppt.}}{Cu_2[Fe(CN)_6]} + 2K_2SO_4$

80. **(b)**

81. **(c)** Number of moles of AgCl

$$= \frac{4.305}{143.5} = 0.03 \text{ mol}$$

0.01 mol. of complex $\rightarrow$ 0.03 mol of AgCl
1 mol. of complex $\rightarrow$ 3 moles of AgCl
Hence, the compound has three ionisable Cl atoms. Thus formula of the complex must be $[Co(NH_3)_6]Cl_3$.

82. **(d)**

83. **(b)** Methyl vinyl ether under anhydrous condition at room temperature undergoes addition reaction.

$$CH_2 = CH - OCH_3 \xrightarrow{HBr} CH_3-\underset{\underset{Br}{|}}{CH}-O-CH_3$$

84. **(d)** $C_6H_5COOAg + Br_2 \xrightarrow{\text{Hunsdiecker reaction}} C_6H_5Br + CO_2 + AgBr$

85. **(a)** (a) and (d) are L– sugar but (a) gives an optically active dibasic acid.

86. **(c)** These two components A and B follows the condition of Raoult's law, if the force of attraction between A and B is equal to the force of attraction between A and A or B and B.

87. **(a)** Charge = 0.2×1 Faraday
= 0.2×96500 coulombs
= $19300 = 1.93 \times 10^4$ coulombs

88. **(b)** Dehydration of CH_3OH gives carbene (methylene), an unstable intermediate.

$$CH_3OH \xrightarrow{H_2SO_4} \underset{\text{Carbene}}{[:CH_2]} + H_2O$$

89. **(a)** Tyndall effect is the simplest way to check colloidal system since path of light beam becomes visible due to scattering of light.

90. **(b)**

91. **(a)** Isopropyl chloride $CH_3-\underset{\underset{Cl}{|}}{\overset{2^\circ}{CH}}-CH_3$

92. **(d)** For reaction, $A + 2B \rightleftharpoons 2C$

$$K = \frac{[C]^2}{[A][B]^2} = 40 \qquad \text{...(i)}$$

For reaction,

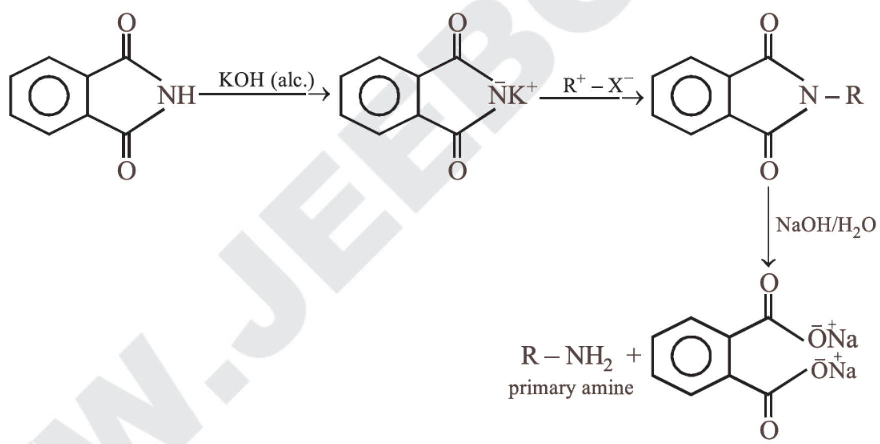
$$C \rightleftharpoons B + \frac{1}{2}A$$

$$K' = \frac{[B][A]^{1/2}}{[C]} \qquad \text{...(ii)}$$

Dividing (ii) by (i)

$$K' = \left[\frac{1}{K}\right]^{1/2} = \left[\frac{1}{40}\right]^{1/2}$$

93. **(b)** Gabriel phthalimide synthesis is the best method of preparing primary amines from alkyl halides without changing the number of carbon atoms in the chain.



94. **(d)** Sulpha drugs (antibacterials and antibiotics) are group of drugs which are derivatives of sulphanilamide.

95. **(b)** Petroleum ether has lower boiling point than all the other three products.

96. **(a)** $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$

97. **(b)** $CH_3OH \xrightarrow{\text{Oxidation}}$

$$\underset{(A)}{HCOOH} \xrightarrow{NH_3} \underset{(B)}{HCOONH_4}$$

98. **(d)** Due to diagonal relationship.

99. **(c)**

100. **(b)** In binary copolymerization, there are two different chain radicals which can add both the monomers, though not necessarily with same ease, the system characterizes four simultaneous propagation reactions.

SECTION-B

MATHEMATICS

1. **(c)** $n(A' \cap B') = n(A \cup B)' = n(U) - n(A \cup B)$
$= n(U) - [n(A) + n(B) - n(A \cap B)]$
$= 700 - [200 + 300 - 100] = 300$

2. **(a)** When x = 1, y = 7 $\in$ N, so (1, 7) $\in$ R
When x = 2, y = 2 + 3 = 5 $\in$ N, so (2, 5) $\in$ R
Again for x = 3, y = 3 + 2 = 5 $\in$ N, (3, 5) $\in$ R
Similarly for x = 4, y = 4 + $\frac{6}{4} \notin$ N and for x = 5, y = 5 + $\frac{6}{5} \notin$ N. Thus, R = {(1, 7), (2, 5), (3, 5)}
$\therefore$ Domain of R = {1, 2, 3} and Range of R = {7, 5}.

3. **(d)** $3f(x) - f\left(\frac{1}{x}\right) = \log x^4$; $x \equiv \frac{1}{x}$
$3f\left(\frac{1}{x}\right) - f(x) = \log\left(\frac{1}{x}\right)^4$
After solving we get $f(x) = \log x$
$f(e^{-x}) = \log_e e^{-x} = -x$

4. **(c)** $f(x)$ is defined if $3x^2 - 4x + 5 \geq 0$

$$\Rightarrow 3\left[x^2 - \frac{4}{3}x + \frac{5}{3}\right] \geq 0 \Rightarrow 3\left[\left(x - \frac{2}{3}\right)^2 + \frac{11}{9}\right] \geq 0$$

Which is true for all real x
$\therefore$ Domain of $f(x) = (-\infty, \infty)$
Let $y = \sqrt{3x^2 - 4x + 5}$
$\Rightarrow y^2 = 3x^2 - 4x + 5$ i.e. $3x^2 - 4x + (5 - y^2) = 0$
For x to be real , $16 - 12(5 - y^2) \geq 0 \Rightarrow y \geq \sqrt{\frac{11}{3}}$
$\therefore$ Range of $y = \left[\sqrt{\frac{11}{3}}, \infty\right)$

5. **(c)** The given expression

$$= \tan A + \left[\frac{\sqrt{3} + \tan A}{1 - \sqrt{3}\tan A}\right] - \left[\frac{\sqrt{3} - \tan A}{1 + \sqrt{3}\tan A}\right]$$

$$= \tan A + \left[\frac{8\tan A}{1 - 3\tan^2 A}\right] = \frac{9\tan A - 3\tan^3 3}{1 - 3\tan^2 A}$$

$$= 3.\frac{(3\tan A - \tan^3 A)}{1 - 3\tan^2 A} = 3\tan 3A$$

6. **(a)** Given equation, $\sec^2\theta = \frac{4xy}{(x+y)^2}$
Since range of sec θ is $(-\infty, -1] \cup [1, \infty)$.
$\therefore \sec^2\theta \geq 1 \quad \Rightarrow \frac{4xy}{(x+y)^2} \geq 1$
$\Rightarrow (x+y)^2 - 4xy \leq 0 \quad \Rightarrow x^2 + y^2 + 2xy - 4xy \leq 0$
$\Rightarrow (x-y)^2 \leq 0$ But $(x-y)^2 \not< 0$ for any $x, y \in R$
$\therefore (x-y)^2 = 0 \Rightarrow x = y$

7. **(b)**

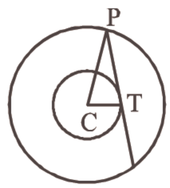
$$\frac{S_{nx}}{S_x} = \frac{\frac{nx}{2}[2a + (nx-1)d]}{\frac{x}{2}[2a + (x-1)d]}$$

$$= \frac{n[(2a-d) + nxd]}{(2a-d) + xd}$$

For $\frac{S_{nx}}{S_x}$ to be independent of x
$2a - d = 0 \Rightarrow 2a = d$
now, $S_p = \frac{p}{2}[2a + (P-1)d] = P^2 a$

8. **(c)** Let $(e^t + e^{-t}, e^t - e^{-t}) \equiv (h, k)$
or $h = e^t + e^{-t}$ and $k = e^t - e^{-t}$
Squaring and subtracting, we get
$h^2 - k^2 = (e^t + e^{-t})^2 - (e^t - e^{-t})^2 = 4$
Therefore, the locus is $x^2 - y^2 = 4$.

9. **(a)** Let the radius of the first circle be CT = r_1. Also, let the radius of the second circle be CP = r_2.



In the triangle PCT, T is a right angle

So, $PT = \sqrt{PC^2 - CT^2} = \sqrt{r_1^2 - r_2^2}$

$= \sqrt{(f^2 - \lambda) - (f^2 - \mu)} = \sqrt{\mu - \lambda}$

10. **(c)** $4y = 3x - 48 \Rightarrow m = 3/4, c = -12$

$y^2 = 64x \Rightarrow a = 16$

Length of intercept $= \frac{4}{m^2}\sqrt{a(1+m^2)(a-mc)}$

$= \frac{4}{9} \times 16\sqrt{16(1+\frac{9}{16})(16+12\times\frac{3}{4})} = \frac{1600}{9}$

11. **(b)** Let total no. of numbers divisible by 4 between 1 to 80 is n ;

$\Rightarrow 80 = 4 + (n-1)4 \Rightarrow 80 = 4n \Rightarrow n = 20$

$\therefore$ Required probability $= \frac{^{20}C_2}{^{80}C_2} = \frac{19}{316}$

12. **(d)** $z + |z| = 8 + 12i$

$\Rightarrow x + iy + \sqrt{x^2 + y^2} = 8 + 12i$

$\Rightarrow x + \sqrt{x^2 + y^2} = 8$ ...(i) & $y = 12$ ...(ii)

$(x = -5)$ So, $z = -5 + 12i$

$\Rightarrow |z| = \sqrt{25 + 144} = 13 \Rightarrow |z^2| = |z|^2 = 169$

13. **(d)** Given inequality is $5x + 1 > -24$

$\Rightarrow 5x > -25 \Rightarrow x > -5$

Also, $5x - 1 < 24$

$\Rightarrow 5x < 25 \Rightarrow x < 5$

Hence, $-5 < x < 5$

$\Rightarrow x \in (-5, 5)$

14. **(a)** We know that $1! + 2! + 3! + 4! = 33$

Also, $5! = 120, 6! = 720, 7! = 5040, 8! = 40320$ and $9! = 362880$. Thus, tens digit of $1! + 2! + ... + 9!$ is 1.

Also, note that n! is divisible by 100 for all $n \geq 10$.

Therefore, the tens digit of $1! + 2! + ... + 49!$ is 1.

15. **(b)** Given expansion is $(a + bx)^{-3}$ which can be written as

$$\left[a\left(1+\frac{b}{a}x\right)\right]^{-3} = a^{-3}\left(1+\frac{b}{a}x\right)^{-3}$$

$$= a^{-3}\left(1 - \frac{3b}{a}x + 6\left(\frac{b}{a}x\right)^2 - ....\right)$$

(By using $(1 + x)^{-3} = 1 - 3x + 6x^2 - ....$)

But given that: $(a + bx)^{-3} = \frac{1}{8} + \frac{9}{8}x + ...$

$$\therefore\ a^{-3}\left[1 - \frac{3b}{a}x + 6\frac{b^2}{a^2}.x^2 - ....\right] = \frac{1}{8} + \frac{9}{8}x + ...$$

$$\Rightarrow a^{-3} = \frac{1}{8} = 2^{-3} \Rightarrow a = 2$$

and $-3ba^{-4} = 9 \,.\, 2^{-3} \Rightarrow b = -6$

16. **(b)** We have,

$$\frac{d}{dx}\left[\frac{(1+x^2+x^4)(1-x^2+x^4)}{(1+x^2+x^4)}\right] = ax^3 + bx$$

$$\Rightarrow \frac{d}{dx}(1 - x^2 + x^4) = ax^3 + bx$$

$\Rightarrow -2x + 4x^3 = ax^3 + bx$

$\Rightarrow a = 4$ and $b = -2$.

17. **(c)** The total weight of seven students is $55 \times 7 = 385$ kg

The sum of the weights of six students is $52 + 58 + 55 + 53 + 56 + 54 = 328$ kg

Hence, the weight of the seventh student is $385 - 328 = 57$ kg.

18. **(d)** $f(x) = [x]^2 + [x + 1] - 3 = \{[x] + 2\}\{[x] - 1\}$

So, $x = 1, 1.1, 1.2, ... \Rightarrow f(x) = 0$

$\therefore$ f(x) is many one.

only integral values will be attained.

$\therefore$ f(x) is into.

19. **(a)** $A^2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$A^2 = A^4 = A^6 = I_3 \Rightarrow A^2 + 2A^4 + 4A^6$

$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix} + \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$

$= \begin{bmatrix} 7 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 7 \end{bmatrix} = 7I_3 = 7A^8$

20. **(a)** $f(x) = \begin{cases} \dfrac{3\sin \pi x}{5x}, x \neq 0 \\ 2k, \ x = 0 \end{cases}$ is continuous at $x = 0$

$\Rightarrow \lim_{x \to 0} f(x) = \lim_{x \to 0} \dfrac{3\sin \pi x}{5x} = f(0)$

Now, $\lim_{x \to 0} \dfrac{3\sin \pi x}{5x} = \lim_{x \to 0} \dfrac{3\pi \cos \pi x}{5} = 3\pi / 5$

$\Rightarrow \dfrac{3\pi}{5} = 2k \Rightarrow k = \dfrac{3\pi}{10}$ (using L.' Hospital Rule)

21. **(c)** Given that $4y - x^2 - 8 = 0 \Rightarrow y = \dfrac{x^2 + 8}{4}$

Differentiating w.r.t. x $\dfrac{dy}{dx} = \dfrac{2x}{4}$

For increasing function $\dfrac{dy}{dx} > 0$

So, $\dfrac{2x}{4} > 0 \Rightarrow x > 0$

Thus, the curve is increasing in $(0, 4)$.

22. **(c)** Let $\int_2^e \left\{\dfrac{1}{\log_e x} - \dfrac{1}{(\log_e x)^2}\right\} dx$

Put $\log_e x = t \Rightarrow x = e^t \Rightarrow dx = e^t \, dt$

Also if $x = 2$ then $t = \log_e 2$ and if $x = e$ then $t = 1$

$\therefore I = \int_{\log_e 2}^{1} \left(\dfrac{1}{t} - \dfrac{1}{t^2}\right) e^t \, dt = \int_{\log_e 2}^{1} \left(\dfrac{1}{t} + \dfrac{-1}{t^2}\right) e^t \, dt$

$= \left[\dfrac{e^t}{t}\right]_{\log_e 2}^{1} = e - \dfrac{e^{\log_e 2}}{\log_e 2} = e - 2\log_2 e$

23. **(a)** $\dfrac{dy}{dx} = |x| \Rightarrow \dfrac{dy}{dx} = x$ for $x \geq 0$ & $\dfrac{dy}{dx} = -x$ for $x < 0$

$\int dy = \int x \, dx \Rightarrow y = \dfrac{x^2}{2} + c_1$ ...(i);

$\int dy = -1 \, x \, dx \Rightarrow y = -\dfrac{x^2}{2} + c_1$ ...(ii)

From (i) and (ii) $y = \dfrac{x|x|}{2} + c$

24. **(a)** Let A, B, C are the vertices of a Δ whose position vectors are $\vec{a}, \vec{b}$ and $\vec{c}$ respectivety. Let G be the centroid of ΔABC. $\therefore$ Centroid of triangle $(G) = \dfrac{\vec{a} + \vec{b} + \vec{c}}{3}$

Consider, $\overrightarrow{GA} + \overrightarrow{GB} + \overrightarrow{GC}$

$= \left(\vec{a} - \dfrac{\vec{a} + \vec{b} + \vec{c}}{3}\right) + \left(\vec{b} - \dfrac{\vec{a} + \vec{b} + \vec{c}}{3}\right) + \left(\vec{c} - \dfrac{\vec{a} + \vec{b} + \vec{c}}{3}\right)$

$= \dfrac{1}{3}[2\vec{a} - \vec{b} - \vec{c} + 2\vec{b} - \vec{a} - \vec{c} + 2\vec{c} - \vec{a} - \vec{b}] = 0.$

25. **(b)** $\begin{vmatrix} x & \sin\theta & \cos\theta \\ -\sin\theta & -x & 1 \\ \cos\theta & 1 & x \end{vmatrix}$

$= x(x^2 - 1) - \sin\theta(-x\sin\theta - \cos\theta)$

$+ \cos\theta(-\sin\theta + x\cos\theta)$

$= -x^3 - x + x\sin^2\theta + \sin\theta\cos\theta - \cos\theta\sin\theta + x\cos^2\theta)$

$= x^3 - x + x = x^3$

26. **(d)** $\frac{dx}{d\theta} = -a\sin\theta$ and $\frac{dy}{d\theta} = a\cos\theta$

$\therefore \frac{dy}{dx} = -\cot\theta.$

$\therefore$ The slope of the normal at $\theta = \tan\theta$

$\therefore$ The equation of the normal at θ is

$y - a\sin\theta = \tan\theta(x - a - a\cos\theta)$

$\Rightarrow y\cos\theta - a\sin\theta\cos\theta$

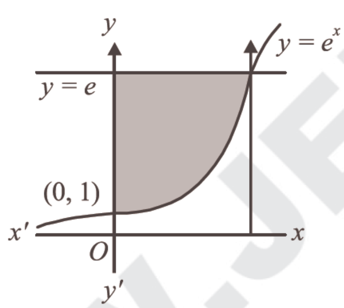
$= x\sin\theta - a\sin\theta - a\sin\theta\cos\theta$

$\Rightarrow x\sin\theta - y\cos\theta = a\sin\theta \Rightarrow y = (x-a)\tan\theta$

which always passes through (a, 0)

27. **(a)** Required area $= \int_1^e \ln y \, dy$

$= (y\ln y - y)_1^e = (e-e) - [-1] = 1$



Also, $\int_1^e \ln y dy = \int_1^e \ln(e+1-y)dy$

Further, required area $= e \times 1 - \int_0^1 e^x \, dx$

28. **(d)** $P\left(\frac{B}{A\cup\overline{B}}\right) = \frac{P[B\cap(A\cup\overline{B})]}{P(A\cup\overline{B})}$

$= \frac{P[B\cap A)\cup(B\cap\overline{B})]}{P(A)+P(\overline{B})-P(A\cap\overline{B})}$

$\Rightarrow P(A\cap\overline{B}) = 0.5 \Rightarrow P(A) - P(A\cap B) = 0.5$

$\Rightarrow P(A\cap B) = P(A) - P(A\cap\overline{B}) = 0.7 - 0.5 = 0.2$

$P\left(\frac{B}{A\cup\overline{B}}\right) = \frac{P(A\cap B)}{P(A)+P(\overline{B})-P(A\cap\overline{B})}$

$= \frac{0.2}{0.7+0.6-0.5} = 0.25$

29. **(b)** $(1+\omega^2)^n = (1+\omega^4)^n$

$\Rightarrow (-\omega)^n = (1+\omega)^n = (-\omega^2)^n \Rightarrow \omega^n = 1 \Rightarrow n = 3$

30. **(c)** ${}^nC_{r+1} + {}^nC_{r-1} + 2\,{}^nC_r = {}^nC_{r-1} + {}^nC_r$

$+ {}^nC_r + {}^nC_{r+1}$

$= {}^{n+1}C_r + {}^{n+1}C_{r+1} = {}^{n+2}C_{r+1}$

31. **(c)** General Term $T_{r+1} = {}^{500}C_r \, 3^{\frac{500-r}{2}} \, 2^{\frac{r}{2}}$

The above term is integral if r is even. Also

$0 \le r \le 500$

So $r = 0, 2, 4, 6, \ldots\ldots, 500$

32. **(a)** Let the points are A, B, C and D respectively

Mid point of AC is

$\left(\frac{4-1}{2}, \frac{7-2}{2}, \frac{8+1}{2}\right)$ or $\left(\frac{3}{2}, \frac{5}{2}, \frac{9}{2}\right)$.

Mid point of BD is

$\left(\frac{2+1}{2}, \frac{3+2}{2}, \frac{4+5}{2}\right)$ or $\left(\frac{3}{2}, \frac{5}{2}, \frac{9}{2}\right)$.

Thus AC and BD bisect each other. Further,

$AC = \sqrt{(4+1)^2+(7+2)^2+(8-1)^2} = \sqrt{25+81+49} = \sqrt{155}$

$BD = \sqrt{(2-1)^2+(3-2)^2+(4-5)^2} = \sqrt{1+1+1} = \sqrt{3}$

$\therefore AC \neq BD$. Hence, ABCD represents a parallelogram.

33. **(c)** Let $\lim_{n\to\infty} b_n = b$ Now,

$b_{n+1} = \frac{1}{3}\left(2b_n + \frac{125}{b_n^2}\right)$

or $\lim_{n\to\infty} b_{n+1} = \frac{1}{3}\left(2\lim_{n\to\infty} b_n + \frac{125}{\lim_{n\to\infty} b_n^2}\right)$

or $b = \frac{1}{3}\left(2b + \frac{125}{b^2}\right)$

$\Rightarrow \frac{b}{3} = \frac{125}{3b^2} \Rightarrow b^3 = 125$ or $b = 5$.

34. **(c)** $p \to (\sim p \vee q)$ has truth value F.
It means $p \to (\sim p \vee q)$ is false.
It means p is true and $\sim p \vee q$ is false.
$\Rightarrow$ p is true and both $\sim p$ and q are false.
$\Rightarrow$ p is true and q is false.

35. **(b)** If $y = \frac{2}{3}\frac{10^x - 10^{-x}}{10^x + 10^{-x}}$, $10^{2x} = \frac{3y+2}{2-3y}$

or $x = \frac{1}{2}\log_{10}\frac{2+3y}{2-3y}$

$\therefore f^{-1}(x) = \frac{1}{2}\log_{10}\frac{2+3x}{2-3x}$.

36. **(b)** We have,

$\tan^{-1}\frac{x}{\pi} < \frac{\pi}{3} \Rightarrow \tan\left(\tan^{-1}\frac{x}{\pi}\right) < \tan\frac{\pi}{3}$

$\Rightarrow \frac{x}{\pi} < \sqrt{3} \Rightarrow x < \sqrt{3}\pi = 5.5$ (approx.)

$\therefore$ The maximum value of x is 5.

37. **(b)** We have ,

$$I = AA^{-1} = \frac{1}{2}\begin{bmatrix} 0 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & a & 1 \end{bmatrix}\begin{bmatrix} 1 & -1 & 1 \\ -8 & 6 & 2c \\ 5 & -3 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & c+1 \\ 0 & 1 & 2(c+1) \\ 4(1-a) & 3(a-1) & 2+ac \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Comparing the elements we get $c + 1 = 0 \Rightarrow c = -1$
and $a - 1 = 0 \quad \Rightarrow a = 1$

38. **(a)** We have $y = x^3 - 8x + 7 \therefore \frac{dy}{dx} = 3x^2 - 8$

It is given that when $t = 0, x = 3$. Therefore, when $t = 0$,

$\frac{dy}{dx} = 3 \times 3^2 - 8 = 19$. Also, $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$ ...(1)

Since when $t = 0$, $\frac{dy}{dx} = 19$ and $\frac{dy}{dt} = 2$, from (1)

$19 = \frac{2}{dx/dt}$ or $\frac{dx}{dt} = \frac{2}{19}$

39. **(a)** The projection of $\vec{a}$ on $\vec{b}$ is $\frac{\vec{a}.\vec{b}}{|\vec{b}|}$.

Here, $\vec{a} = \hat{i} - 2\hat{j} + \hat{k}$, $\vec{b} = 4\hat{i} - 4\hat{j} + 7\hat{k}$

$\therefore$ Required projection

$= \frac{(\hat{i} - 2\hat{j} + \hat{k}).(4\hat{i} - 4\hat{j} + 7\hat{k})}{\sqrt{(4)^2 + (-4)^2 + (7)^2}}$

$= \frac{4+8+7}{\sqrt{16+16+49}} = \frac{19}{\sqrt{81}} = \frac{19}{9}$ units

40. **(c)** Let us take a triangle ABC and their vertices A (a, 0, 0), B (0, b, 0) and C (0, 0, c)
Therefore the equation of plane is

$\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$ .... (i)

Now, given centroid of ΔABC is (α, β, γ)
As we know, centroid of ΔABC with vertices (x_1, y_1, z_1), (x_2, y_2, z_2) and (x_3, y_3, z_3) is given by

$\left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3}, \frac{z_1 + z_2 + z_3}{3},\right)$

$\therefore$ By using this formula, we have

$\frac{a+0+0}{3} = \alpha \Rightarrow a = 3\alpha$, ; $\frac{0+b+0}{3} = \beta$

$\Rightarrow b = 3\beta$

and $\frac{0+0+c}{3} = \gamma \Rightarrow c = 3\gamma$

Now, put the values of a, b, c in equation (i), which gives

$$\frac{x}{3\alpha}+\frac{y}{3\beta}+\frac{z}{3\gamma}=1 \quad \therefore \quad \frac{x}{\alpha}+\frac{y}{\beta}+\frac{z}{\gamma}=3$$

41. **(d)** Let the vertices of a triangle be

$$\left(\frac{x_1}{a},\frac{y_1}{a}\right),\left(\frac{x_2}{b},\frac{y_2}{b}\right) and \left(\frac{x_3}{x},\frac{y_3}{c}\right)$$

$$\text{Area of the triangle} = \frac{1}{2}\begin{vmatrix} \frac{x_1}{a} & \frac{y_1}{a} & 1 \\ \frac{x_2}{b} & \frac{y_2}{b} & 1 \\ \frac{x_3}{c} & \frac{y_3}{c} & 1 \end{vmatrix}$$

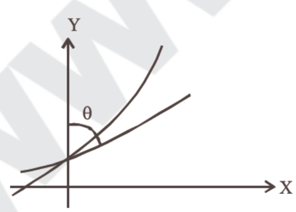
$$= \frac{1}{2abc}\begin{vmatrix} x_1 & y_1 & a \\ x_2 & y_2 & b \\ x_3 & y_3 & c \end{vmatrix}$$

$$= \frac{1}{4}\frac{1}{abc}\begin{vmatrix} x_1 & y_1 & 2a \\ x_2 & y_2 & 2b \\ x_3 & y_3 & 2c \end{vmatrix} C_3 \to 2C_3$$

$$= \frac{1}{4}\times\frac{1}{abc}\times\frac{abc}{2}=\frac{1}{8}.$$

42. **(b)** Given $y = ke^{kx}$. The curve intersects the y-axis at (0, k)

So, $\left(\frac{dy}{dx}\right)_{(0,k)} = k^2$



If θ is the angle at which 1 the given curve intersects the y-axis, then

$$\tan\left(\frac{\pi}{2}-\theta\right)=\frac{k^2-0}{1+0.k^2}=k^2 \Rightarrow \theta=\cot^{-1}(k^2)$$

43. **(c)** Let $I=\int_0^{\pi} x(\sin^4 x\cos^4 x)\,dx$

$$=\int_0^{\pi}(\pi-x)\sin^4(\pi-x)\cos^4(\pi-x)dx$$

$$=\pi\int_0^{\pi}\sin^4 x\cos^4 x\,dx - I$$

$$\therefore I=\frac{\pi}{2}\int_0^{\pi}\sin^4 x\cos^4 x\,dx = 2.\frac{\pi}{2}\int_0^{\pi/2}\sin^4 x\cos^4 x\,dx$$

$$=\pi.\frac{3\cdot1\cdot3\cdot1}{8\cdot6\cdot4\cdot2}.\frac{\pi}{2}=\frac{3\pi^2}{256}$$

44. **(a)** Let Shamali invest ₹ x in saving certificate and ₹ y in PPF.

$\therefore$ $x+y\le 50000$, $x\ge 15000$ and $y\ge 20000$

Total income $=\frac{8}{100}x+\frac{9}{100}y$

$\therefore$ Given problem can be formulated as

Maximize $Z=0.08x+0.09y$

Subject to, $x+y\le 50000$, $x\ge 15000$, $y\ge 20000$.

45. **(a)** $\frac{P(X=r)}{P(X=n-r)}=\frac{{}^nC_r p^r(1-p)^{n-r}}{{}^nC_{n-r}p^{n-r}(1-p)^r}=\frac{(1-p)^{n-2r}}{p^{n-2r}}$

$$=\left(\frac{1-p}{p}\right)^{n-2r}=\left(\frac{1}{p}-1\right)^{n-2r} \quad \text{and} \quad \left(\frac{1}{p}\right)-1>0$$

$\therefore$ ratio will be independent of n and r if $(1/p)-1=1$

$\Rightarrow p=1/2$

46. **(a)** Put $x=z^6 \Rightarrow dx=6z^5\,dz$

$$\therefore \quad \int\frac{x+\sqrt[3]{x^2}+\sqrt[6]{x}}{x(1+\sqrt[3]{x})}dx=\int\frac{(z^6+z^4+z)6z^5dz}{z^6(1+z^2)}$$

$$=6\int\frac{z^5+z^3+1}{z^2+1}dz=6\int\left(z^3+\frac{1}{z^2+1}\right)dz$$

$$=\frac{3}{2}z^4+6\tan^{-1}z+C=\frac{3}{2}x^{2/3}+6\tan^{-1}x^{1/6}+C$$

47. **(b)** Equation of plane through (1, 0, 0) is

$a(x-1)+by+cz=0$ ...(i)

(i) passes through (0, 1, 0). $-a+b=0$

$\Rightarrow b=a$; Also,

$\cos 45° = \dfrac{a+a}{\sqrt{2(2a^2+c^2)}} \Rightarrow 2a = \sqrt{2a^2+c^2}$

$\Rightarrow 2a^2 = c^2 \Rightarrow c = \sqrt{2}a$.

So d.r of normal are a, a $\sqrt{2}a$ i.e. 1, 1, $\sqrt{2}$.

48. **(a)** The equation of such a parabola is $y^2 = l(x+h)$, where l and h are arbitrary constants. Differentiating (i) we get

$$2y\frac{dy}{dx} = l \qquad \ldots(2)$$

Differentiating again,

$$2y\frac{d^2y}{dx^2} + 2\left(\frac{dy}{dx}\right)^2 = 0 \Rightarrow y\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0$$

49. **(b)** We have,

$$\int_0^a f(x)\,dx = \frac{a^2}{2} + \frac{a}{2}\sin a + \frac{\pi}{2}\cos a$$

Differentiating w.r.t. a, we get

$$f(a) = a + \frac{1}{2}(\sin a + a\cos a) - \frac{\pi}{2}\sin a$$

Put $a = \dfrac{\pi}{2}$; $f\left(\dfrac{\pi}{2}\right) = \dfrac{\pi}{2} + \dfrac{1}{2} - \dfrac{\pi}{2} = \dfrac{1}{2}$

50. **(b)** By definition of mode, the required value of X is the mode. Here $(n+1)P = (9+1)\dfrac{1}{5} = 2$ = integer $\Rightarrow$ bimodal, modes being 2 and $2-1$.

(Mock Test-2)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(b)	**6**	(d)	**11**	(a)	**16**	(c)	**21**	(d)	**26**	(b)	**31**	(b)	**36**	(c)	**41**	(a)	**46**	(b)
2	(b)	**7**	(b)	**12**	(d)	**17**	(c)	**22**	(a)	**27**	(c)	**32**	(b)	**37**	(d)	**42**	(b)	**47**	(b)
3	(b)	**8**	(c)	**13**	(c)	**18**	(d)	**23**	(d)	**28**	(b)	**33**	(b)	**38**	(a)	**43**	(a)	**48**	(c)
4	(b)	**9**	(d)	**14**	(b)	**19**	(a)	**24**	(a)	**29**	(d)	**34**	(c)	**39**	(a)	**44**	(c)	**49**	(a)
5	(b)	**10**	(d)	**15**	(c)	**20**	(b)	**25**	(c)	**30**	(d)	**35**	(b)	**40**	(a)	**45**	(d)	**50**	(b)
CHEMISTRY																			
51	(c)	**56**	(d)	**61**	(c)	**66**	(a)	**71**	(b)	**76**	(b)	**81**	(b)	**86**	(a)	**91**	(b)	**96**	(d)
52	(c)	**57**	(b)	**62**	(b)	**67**	(b)	**72**	(b)	**77**	(c)	**82**	(c)	**87**	(a)	**92**	(b)	**97**	(c)
53	(c)	**58**	(a)	**63**	(d)	**68**	(c)	**73**	(a)	**78**	(a)	**83**	(a)	**88**	(c)	**93**	(c)	**98**	(b)
54	(c)	**59**	(d)	**64**	(c)	**69**	(a)	**74**	(d)	**79**	(b)	**84**	(d)	**89**	(d)	**94**	(d)	**99**	(a)
55	(a)	**60**	(d)	**65**	(d)	**70**	(d)	**75**	(a)	**80**	(b)	**85**	(d)	**90**	(a)	**95**	(b)	**100**	(b)
SECTION-B																			
MATHEMATICS																			
1	(d)	**6**	(a)	**11**	(b)	**16**	(d)	**21**	(d)	**26**	(c)	**31**	(d)	**36**	(b)	**41**	(b)	**46**	(a)
2	(c)	**7**	(a)	**12**	(c)	**17**	(b)	**22**	(c)	**27**	(d)	**32**	(c)	**37**	(d)	**42**	(b)	**47**	(b)
3	(d)	**8**	(c)	**13**	(c)	**18**	(b)	**23**	(a)	**28**	(d)	**33**	(a)	**38**	(c)	**43**	(b)	**48**	(d)
4	(b)	**9**	(a)	**14**	(b)	**19**	(a)	**24**	(d)	**29**	(a)	**34**	(a)	**39**	(c)	**44**	(d)	**49**	(a)
5	(c)	**10**	(c)	**15**	(c)	**20**	(a)	**25**	(d)	**30**	(a)	**35**	(d)	**40**	(b)	**45**	(a)	**50**	(d)

SECTION-A

PHYSICS

1. **(b)** For negotiating a circular curve on a levelled road, the maximum velocity of the car is

$v_{max} = \sqrt{\mu rg}$

Here $\mu = 0.6$, $r = 150$ m, $g = 9.8$

$\therefore\ v_{max} = \sqrt{0.6 \times 150 \times 9.8} \simeq 30 \text{m/s}$

2. **(b)** Because radius of the sphere will be very less in comparison to ring (although mass is equal).

3. **(b)** Young's modulus of wire does not vary with dimensions of wire.

4. **(b)** When the light is incident at the polarising angle on the transparent medium, the reflected light is completely polarised.

5. **(b)** When some mercury is drained off, the centre of gravity of the bob moves down and so length of the pendulum increases, which result increase in time period.

6. **(d)** Relative magnetic permeability

$$\mu_r = \frac{\text{magnetic permeability of material}\,(\mu)}{\text{permeability of free space}\,(\mu_0)}$$

It is a dimensionless pure ratio and for paramagnetic materials $\mu_r > 1$.

7. **(b)**

8. **(c)** $y = A \sin(\omega t - kx)$

Particle velocity, $v_p = \frac{dy}{dt} = A\,\omega \cos(\omega t - kx)$

$\therefore\ v_{p\,max} = A\,\omega$

wave velocity $= \frac{\omega}{k}$ $\quad \therefore\ A\omega = \frac{\omega}{k}$

i.e., $\quad A = \frac{1}{k}$ But $k = \frac{2\pi}{\lambda}$

$\therefore\ \lambda = 2\pi A$

9. **(d)** $\Delta I = 6A,\ \Delta t = 0.3s,\ E = 30\,V$

$$E = L\frac{dI}{dt}$$

$$\therefore\ L = \frac{30 \times 0.3}{6} = 1.5\,H.$$

10. **(d)** Energy $= \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{0.5\times10^{-10}}\,J$

$$= \frac{6.6\times10^{-34}\times3\times10^{8}}{5\times10^{-11}\times1.6\times10^{-19}}\,eV = 24.82\text{ keV}$$

11. **(a)** The centre of mass of two particles lies always on the line joining the two particles.

12. **(d)**

13. **(c)**

14. **(b)** When hot water temperature (T) and surrounding temparature (T_0) readings are noted, and $\log(T - T_0)$ is plotted versus time, we get a straight line having a negative slope; as a proof of Newton's law of cooling.

15. **(c)** $\frac{R_s}{R_{He}} = \left(\frac{A_s}{A_{He}}\right)^{1/3} = \left(\frac{32}{4}\right)^{1/3} = 2$

16. **(c)** $\beta = \beta'$

or $\quad \frac{D\lambda}{d} = \frac{D'\lambda}{(2d)}$

$\therefore\quad D' = 2D$

17. **(c)** Length of pipe = 85 cm = 0.85m

Frequency of oscillations of air column in closed organ pipe is given by,

$$f = \frac{(2n-1)\upsilon}{4L} \le 1250$$

$$\Rightarrow \frac{(2n-1)\times340}{0.85\times4} \le 1250$$

$$\Rightarrow 2n - 1 \le 12.5 \approx 6$$

18. **(d)** Joule-second is the unit of angular momentum.

19. **(a)**

20. **(b)** We know that efficiency of Carnot Engine

$$= \frac{T_1 - T_2}{T_1}$$

where, T_1 is temp. of source & T_2 is temp. of sink

$$\therefore\ 0.40 = \frac{T_1 - 300}{T_1} \Rightarrow T_1 - 300 = 0.40T_1$$

$$0.6T_1 = 300 \Rightarrow T_1 = \frac{300}{.6} = \frac{3000}{6} = 500K$$

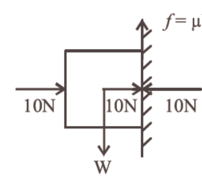
Now efficiency to be increased by 50%

$$\therefore\ 0.60 = \frac{T_1 - 300}{T_1} \Rightarrow T_1 - 300 = 0.6T_1$$

$$0.4T_1 = 300 \Rightarrow T_1 = \frac{300}{.4} = \frac{300\times10}{4} = 750$$

Increase in temp = 750 – 500 = 250 K

21. **(d)** For the block to remain stationary with the wall



$f = W$

$\mu N = W$

$0.2 \times 10 = W \Rightarrow W = 2N$

22. **(a)** Time period,

$$T = 2\pi\sqrt{LC} = 2\pi\sqrt{(50\times10^{-3})\times4\times10^{-6}} = 28\times10^{-4}\text{ s}$$

Time taken by capacitor to charge fully,

$$t = \frac{T}{4} = 7\times10^{-4}s.$$

23. **(d)** Pre-emphasis of higher frequency component is required in FM-system because high frequency terms of modulating signal have small amplitude and therefore small power relative to those of low frequency term.

In the reproduced program at the o/p, these high frequency terms have poor S/N ratio and at time noise may completely mask the signal at these high frequencies, so it is necessary to provide pre-emphasis of high frequencies.

24. **(a)** Applying law of conservation of momentum,

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

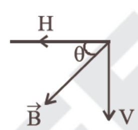
or, $m_1u_1 = (m_1 + m_2)v \qquad (\because u_2 = 0)$

$\Rightarrow \quad m\dfrac{(3\times 1000)}{3600} = 3m(v)$

$\Rightarrow \quad v = \dfrac{1000}{3600}\text{ m/s} = 1\text{ km/h}$

25. **(c)** Horizontal component of earth's field, $H = B\cos\theta$, since, $\theta = 60°$

$3.6\times 10^{-5} = B\times\dfrac{1}{2}$



$\Rightarrow B = 7.2\times 10^{-5}$ Tesla

26. **(b)** $\overline{A}\times\overline{B} = \begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 4 & 6 & 0\\ 2 & 3 & 0\end{vmatrix}$

$= \hat{i}(0-0) - \hat{j}(0-0) + \hat{k}(12-12) = 0$

27. **(c)** As α-particles are doubly ionised helium He^{++} i.e. Positively charged and nucleus is also positively charged and we know that like charges repel each other.

28. **(b)** $v_1 = \dfrac{dy_1}{dt} = 0.1\times 100\pi\cos\left(100\pi t + \dfrac{\pi}{3}\right)$

$v_2 = \dfrac{dy_2}{dt} = -0.1\pi\sin\pi t = 0.1\pi\cos\left(\pi t + \dfrac{\pi}{2}\right)$

$\therefore$ Phase diff. $= \phi_1 - \phi_2 = \dfrac{\pi}{3} - \dfrac{\pi}{2} = \dfrac{2\pi - 3\pi}{6}$

$= -\dfrac{\pi}{6}$

29. **(d)**

30. **(d)** $\phi = nBA\cos\theta = 10\,Ba^2\cos\omega t$

$e = -\dfrac{d\phi}{dt} = -\dfrac{d}{dt}\left(10\,Ba^2\cos\omega t\right) = 10\,Ba^2\sin\omega t\,(\omega).$

31. **(b)** $i = \dfrac{A+\delta_m}{2} = \dfrac{60^0 + 30^0}{2} = 45°$

32. **(b)** Here $u = 10\text{ ms}^{-1}$, $v = -2\text{ ms}^{-1}$, $t = 4$ s, $a = ?$

Using $a = \dfrac{v-u}{t} = \dfrac{-2-10}{4} = -3\text{ m/s}^2$

$\therefore$ Force, $F = ma = 10\times(-3) = -30$ N

33. **(b)**

34. **(c)**

35. **(b)** A raw egg behaves like a spherical shell and a half boiled egg behaves like a solid sphere

$\therefore \quad \dfrac{I_r}{I_s} = \dfrac{2/3\,mr^2}{2/5\,mr^2} = \dfrac{5}{3} > 1$

36. **(c)**

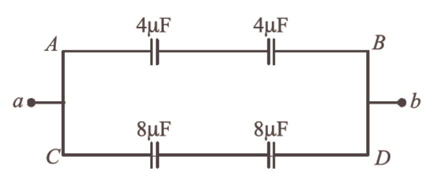
37. **(d)** $eV_0 = \dfrac{hc}{\lambda_0} - W_0$ and $eV' = \dfrac{hc}{2\lambda_0} - W_0$

Subtracting them we have

$e(V_0 - V') = \dfrac{hc}{\lambda_0}\left[1 - \dfrac{1}{2}\right] = \dfrac{hc}{2\lambda_0}$ or

$V' = V_0 - \dfrac{hc}{2e\lambda_0}$

38. **(a)** Rearranging the circuits, we get the following circuit.



$\therefore$ equivalent capacitance between A and B,

$C_{AB} = \dfrac{4\times 4}{4+4} = 2\mu F$

and equivalent capacitance between C and D,

$C_{CD} = \dfrac{8\times 8}{8+8} = 4\mu F$

$\therefore \quad C_{ab} = 2\mu F + 4\mu F = 6\mu F$

39. **(a)**

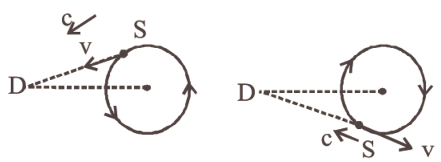
40. **(a)** We know

$$\frac{I}{I_S} = 1 + \frac{G}{S}$$

$$\frac{750}{100} = 1 + \frac{13}{S}$$

$S \Rightarrow 2\Omega$

41. **(a)**



Largest frequency (f_1) Lowest frequency (f_2)

Largest frequency will be detected when the source approaches detector along the line joining and the smallest frequency will be detected when the source recedes the detector along the line joining them

$$\frac{f_1}{f_2} = \frac{\left(\frac{c}{c-v}\right)f}{\left(\frac{c}{c+v}\right)f} = \frac{c+v}{c-v}$$

42. **(b)** Terminal velocity, $v_0 = \frac{2\,r^2(\rho - \rho_0)g}{9\eta}$

$$= \frac{2 \times (2 \times 10^{-3})^2 \times (8 - 1.3) \times 10^3 \times 9.8}{9 \times 0.83}$$

$= 0.07\ ms^{-1}$

43. **(a)** EMF, $E = Kl$ where $K = \frac{V}{L}$ potential gradient

$$K = \frac{V}{L} = \frac{iR}{L} = \left(\frac{E_0 r}{r + r_1}\right)\frac{l}{L}$$

So, $E = Kl = \frac{E_0 r l}{(r + r_1)L}$

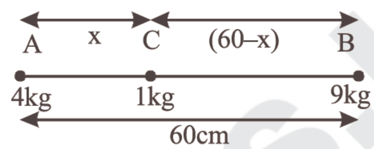
44. **(c)** $\omega_1 = 600\pi, \omega_2 = 604\pi$,

$f_1 = 300\ Hz,\ f_2 = 302\ Hz$

Beat frequency, $f_2 - f_1 = 2\ Hz$

$\Rightarrow$ Number of beats in three seconds = 6

45. **(d)**



$$\therefore\ G\frac{4 \times 1}{x^2} = G\frac{9 \times 1}{(60 - x)^2}$$

or $\frac{2}{3} = \frac{x}{(60 - x)} \Rightarrow x = 24\ cm$

46. **(b)** By using Kirchhoff's first law

$I_1 + I_5 = I_6$ ... (i)

$I_2 = I_4 + I_5$ ... (ii)

Adding (i) and (ii), we get

$I_1 + I_2 = I_6 + I_4$

47. **(b)**

48. **(c)** Gravitational P.E. = m × gravitational potential $U = mV$, so the graph of U will be same as that of V for a spherical shell.

49. **(a)**

50. **(b)** Increment in area of soap film $= A_2 - A_1$

$= 2 \times [(10 \times 0.6) - (10 \times 0.5)] \times 10^{-4} = 2 \times 10^{-4}\ m^2$

Work done $= T \times \Delta A$

$= 7.2 \times 10^{-2} \times 2 \times 10^{-4} = 1.44 \times 10^{-5} J$

CHEMISTRY

51. **(c)**

$$HC \equiv CH \xrightarrow[20\%H_2SO_4]{1\%HgSO_4} \underset{[A]}{CH_3CHO} \xrightarrow[H_2O]{CH_3MgX}$$

$$\underset{[B]}{CH_3CH(OH)CH_3} \xrightarrow{[O]} \underset{\text{Acetone [C]}}{CH_3COCH_3}$$

52. **(c)** Cr(III) has three 3*d* unpaired electrons with two vacant orbitals available for bonding. The outer orbital bonding is not required.

53. **(c)** Applicable to bimolecular reactions.

54. **(c)** In arenes, π electrons are delocalised, hence arenes do not undergo addition reactions easily. Aromatic compounds (arenes) are highly stable and show resonance, e.g. benzene.

55. **(a)** ZnS has cubic close packed (ccp) structure. The S^{2-} ions are present at the corners of the cube and at the centre of each face. Zinc ions occupy half of the tetrahedral sites. Each zinc ion is surrounded by four sulphide ions which are disposed towards the corners of a regular tetrahedron. Similarly, S^{2-} ion is surrounded by four Zn^{2+} ions.

56. **(d)** The larger the size of anion the more is its polarizability

57. **(b)** For a first order reaction

$$k = \frac{2.0303}{t}\log\frac{a}{a-x} = \frac{2.303}{40}\log\frac{0.1}{0.025}$$

$$= \frac{2.303}{40}\log 4 = \frac{2.303 \times 0.6020}{40} = 3.47 \times 10^{-2}$$

$R = k[A]^1 = 3.47 \times 10^{-2} \times 0.01$
$= 3.47 \times 10^{-4}\,\text{mol L}^{-1}\,\text{min}^{-1}$

58. **(a)** 22.4 L of O_2 at STP = 32 g

$\therefore$ 1 L of O_2 at STP $= \frac{32}{22.4} \times 1 = 1.428$ g = 1.43 g

59. **(d)**

60. **(d)** $C_6H_5CH_2OH$ does not give iodoform test because it has neither CH_3CO— group nor $\underset{\underset{R}{|}}{CH_3CHOH}$ group.

61. **(c)** $2NO + O_2 \rightarrow 2NO_2$ brown

62. **(b)** Moles of glucose $= \frac{18}{180} = 0.1$

Moles of water $= \frac{178.2}{18} = 9.9$

Total moles = 0.1 + 9.9 = 10

p_{H_2O} = Mole fraction × Total pressure

$= \frac{9.9}{10} \times 760 = 752.4$ Torr

63. **(d)** n of $O_2 = \frac{16}{32} = \frac{1}{2}$

n of $H_2 = \frac{3}{2}$

$\therefore$ Total number of moles $= \frac{3}{2} + \frac{1}{2} = 2$

$$V = \frac{nRT}{P} = \frac{2 \times 0.082 \times 273}{1} = 44.8\,\text{L}$$

= 44800 mL

64. **(c)** Since the organic amino compound on reaction with nitrous acid at low temperature produces an oily nitrosoamine so the organic amino compound is a secondary aliphatic amine.

Note : This reaction is used as a test for aliphatic amines since no other class of amines liberates N_2 gas on treatment with HNO_2.

65. **(d)** Chemical formula of iron (III) hexacynaoferrate (II) is $Fe_4[Fe(CN)_6]_3$.

66. **(a)** In $HC \equiv CH$ hydrogens are acidic since carbon is sp hybridised.

67. **(b)** Ionic molar conductivity of H^+ is very high and NH_4OH is a weak electrolyte.

68. **(c)** Zinc oxide is mixed with powdered coke and heated to 1673 K in a fire clay resort when it is reduced to Zinc metal.

$$ZnO + C \xrightarrow{1673\,K} Zn + CO$$

At 1673 K, Zinc being volatile, distills over and is condensed.

69. **(a)**

70. **(d)** Rate constant does not change with concentration.

71. **(b)** Cl^- is oxidised to Cl_2 at anode.

72. **(b)** Correct order of decreasing priority is – COOH, – SO_3H, – COOR, – OH.

73. **(a)**

74. **(d)** Arabinose is an aldopentose $HOCH_2$–$(CHOH)_3$–CHO

75. **(a)** $\underset{\text{1-Chlorobutane}}{CH_3—CH_2—CH_2—CH_2—Cl} + KOH\ (Alc)$

$$\downarrow$$

$$\underset{\text{1-Butene}}{CH_3—CH_2—CH{=}CH_2} + KCl + H_2O$$

76. **(b)** $Cu^{2+}[Ar]3d^9; Ti^{4+}[Ar]3d^0;$

$$Co^{2+}[Ar]3d^7; Fe^{2+}[Ar]3d^6$$

1,3,4 are coloured ions.

77. **(c)** Frenkel defect is due to dislocation of ion from its usual lattice site to interstitial position.

78. **(a)**

79. **(b)** Red P does not react with NaOH to give PH_3.

80. **(b)**

81. **(b)** The colour exhibited by transition metal ions is due to the presence of unpaired electrons in *d*-orbitals which permits the *d* - *d* excitation of electrons.

In TiF_6^{2-} – Ti is in + 4 O.S. ; $3d^0$ – colourless

In CoF_6^{3-} – Co is in + 3 O.S ; $3d^6$ – coloured

In Cu_2Cl_2 – Cu is in +1 O.S. ; $3d^{10}$ – colourless

In $NiCl_4^{2-}$ – Ni is in + 2 O.S ; $3d^8$ – coloured

82. **(c)** If $H_2O = x$ mole

Mass of x mole of $H_2O = 18x$ g

Then urea = x mole

Mass of x mole of $NH_2-\overset{\overset{\displaystyle O}{||}}{C}-NH_2 = 60x$ g

Total mass of the solution = $18x + 60x = 78x$ g

Mass % of urea = $\dfrac{60x}{78x} \times 100 = 76.92\%$

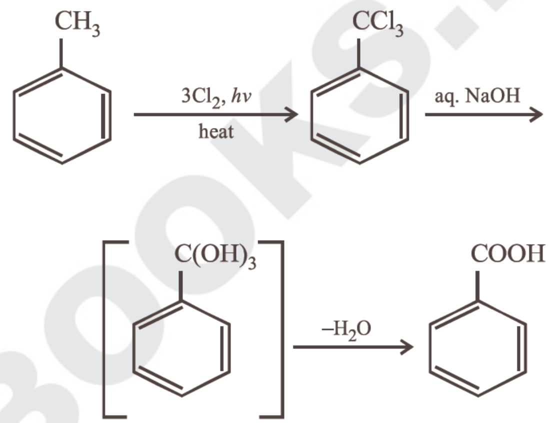
83. **(a)** Surface tension of lyophilic sols is lower than water (dispersion medium).

84. **(d)** $2\overset{+7}{KMnO_4} + 16HCl \rightarrow$

$$2\overset{+2}{MnCl_2} + 2KCl + 8H_2O + 5Cl_2$$

O.S of Mn changes from +7 to +2 hence reduction occurs and Cl_2 is formed.

85. **(d)**



86. **(a)** $[Co(NH_3)_5CO_3]ClO_4$. Six monodentate ligands are attached to Co hence C. N. of Co = 6;

O. N. = x + 5 × (0) + 1 × (–2) + 1 × (–1) = 0 ∴ x = + 3 ; electronic configuration of Co^{3+}[Ar] $3d^64s^0$ hence number of *d* electrons is 6. All d electrons are paired due to strong ligand hence unpaired electron is zero.

87. **(a)** Excess of HCl is used to convert free aniline to aniline hydrochloride otherwise free aniline would undergo coupling reaction with benzenediazonium chloride.

88. **(c)** Cuprite : Cu_2O; Chalcocite : Cu_2S; Chalcopyrite : $CuFeS_2$; Malachite: $Cu(OH)_2.CuCO_3$.

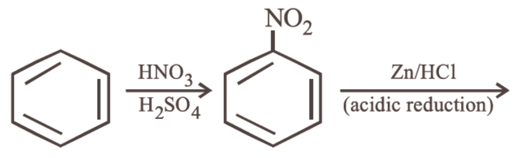
89. **(d)** Solid $\rightleftharpoons$ Liquid

It is an endothermic process. So when temperature is raised, more liquid is formed. Hence adding heat will shift the equilbrium in the forward direction.

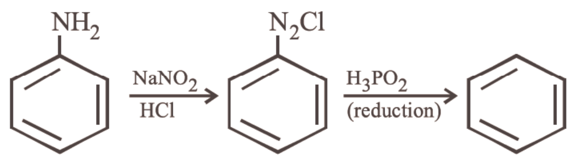
90. **(a)** III is not true because in some reactions, there is no elimination of any molecule. Besides, monofuntional monomers fail to complete the reaction. At each step of reaction, two functional groups, one of each kind, are lost.

91. **(b)** Tollen's reagent is ammonical $AgNO_3$. Aldehydes form silver mirror with it and ketones do not show any change. So Tollen's reagent is used to distinguish between aldehydes and ketones.

92. **(b)**



(W)



(X) (Y) (Z)

93. **(c)** Alum coagulates mud particles and helps in purifying water.

94. **(d)** Before removing face centered atoms:
The number of 'A' atoms

$$= \left(8\times\frac{1}{8}\right)+\left(6\times\frac{1}{2}\right)=4$$

[There are 8 'A' atoms at the corners and 6 'A' atoms at the face centers]
The number of 'B' atoms

$$= \left(12\times\frac{1}{4}\right)+(1\times1)=4$$

[There are 12 B atoms at the edges and 1 'B' atom at the centre of the unit cell]
After removing two face centered 'A' atoms along one of the axes.
The number of 'A' atoms

$$= \left(8\times\frac{1}{8}\right)+\left(4\times\frac{1}{2}\right)=3$$

[There are now only 4 atoms]

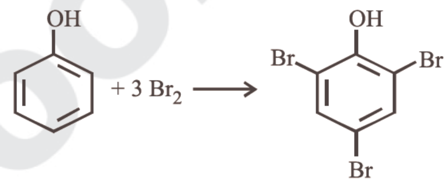
95. **(b)** Neptunium (Np) and plutonium (Pu) show highest oxidation state of + 7.

96. **(d)** Reduction occurs at cathode.

97. **(c)**

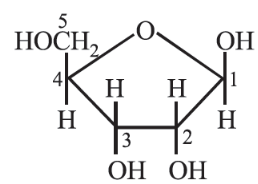
98. **(b)** Proline contains imino (secondary amino), $>$NH group.

99. **(a)** Phenol has activating (electron releasing) –OH group and bromine water supplies Br^+ ion easily, hence under such conditions reaction does not stop at monobromo or dibromo stage but a fully brominated (2,4,6,-tribromophenol) compound is the final product.

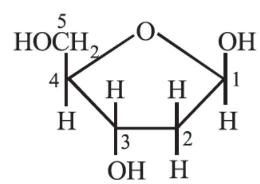


2, 4, 6-Tribromophenol

100. **(b)** RNA has D (–) – Ribose and the DNA has 2–Deoxy D (–) – ribose as the carbohydrate unit.



Ribose



2-Deoxy ribose

From the structures it is clear that 2[nd] carbon in DNA does not have OH group.

SECTION-B

MATHEMATICS

1. **(d)** Here $n(\text{M}) = 55$, $n(\text{P}) = 67$, $n(\text{M} \cup \text{P}) = 100$
since $n(\text{M} \cup \text{P}) = n(\text{M}) + n(\text{P}) - n(\text{M} \cap \text{P})$
$100 = 55 + 67 - n(\text{M} \cap \text{P})$
$n(\text{M} \cap \text{P}) = 122 - 100 = 22$
$\therefore n(\text{Physics only}) = n(\text{P}) - n(\text{M} \cap \text{P}) = 67 - 22 = 45$

2. **(c)** Given functions are : $f(x) = x$ and $g(x) = |x|$
$\therefore \ (f + g)(x) = f(x) + g(x) = x + |x|$
According to definition of modulus function,

$$(f+g)(x) = \begin{cases} x + x, & x \ge 0 \\ x - x, & x < 0 \end{cases} = \begin{cases} 2x, & x \ge 0 \\ 0, & x < 0 \end{cases}$$

3. **(d)** In option (d), $a \notin A$ $\therefore$ It is not a relation.

4. **(b)** $\sin^2 A + \sin^2 B + \sin^2 C$

$= 1 - \cos^2 A + 1 - \cos^2 B + \sin^2 C$

$= 2 - \cos^2 A - \cos(B + C)\cos(B - C)$

$= 2 - \cos A[\cos A - \cos(B - C)]$

$= 2 - \cos A[-\cos(B + C) - \cos(B - C)]$

$= 2 + \cos A . 2\cos B \cos C$
$\therefore \sin^2 A + \sin^2 B + \sin^2 C - 2\cos A \cos B \cos C = 2$

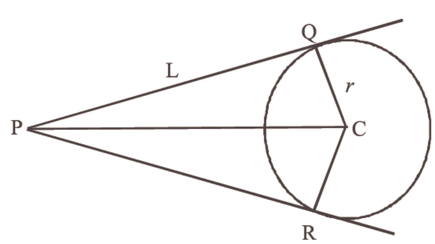
5. **(c)** Given ${}^mC_{r-1}$, ${}^mC_r$, ${}^mC_{r+1}$ are in A.P.

$2\,{}^mC_r = {}^mC_{r-1} + {}^mC_{r+1}$

$$\Rightarrow \ 2 = \frac{{}^mC_{r-1}}{{}^mC_r} + \frac{{}^mC_{r+1}}{{}^mC_r} = \frac{r}{m-r+1} + \frac{m-r}{r+1}$$

$\Rightarrow \ m^2 - m(4r + 1) + 4r^2 - 2 = 0$.

6. **(a)** Area PQCR $= 2\Delta$ PQC $= 2 \times \dfrac{1}{2} L \times r$



where L = length of tangent and r = radius of circle.

$L = \sqrt{S_1} = 15$ and $r = \sqrt{1 + 4 + 20} = 5$

Hence the required area = 75 sq. units.

7. **(a)** Event = {(1, 1), (1, 2), (1, 4), (1, 6), (2, 1), (2, 3), (2, 5), (3, 2),
(3, 4), (4, 1), (4, 3), (5, 2), (5, 6), (6, 1), (6, 5),}

$$\text{Probability} = \frac{15}{36} = \frac{5}{12}$$

8. **(c)** Consider $|\bar{z}\omega| = |\bar{z}||\omega| = |z||\omega| = |z\omega| = 1$
Consider

$\text{Arg}(\bar{z}\omega) = \arg(\bar{z}) + \arg(\omega) = -\arg(z) + \arg\omega$

$= -\dfrac{\pi}{2} \quad \therefore \bar{z}\omega = -1$

9. **(a)** $\dfrac{2}{9!} + \dfrac{2}{3!7!} + \dfrac{1}{5!5!}$

$$= \frac{1}{1!9!} + \frac{1}{3!7!} + \frac{1}{5!5!} + \frac{1}{3!7!} + \frac{1}{9!1!}$$

$$= \frac{1}{10!}\{{}^{10}C_1 + {}^{10}C_3 + {}^{10}C_5 + {}^{10}C_7 + {}^{10}C_9\}$$

$$= \frac{1}{10!}(2^{10-1}) = \frac{2^9}{10!} = \frac{2^a}{b!} \quad \text{(given)}$$

$\Rightarrow \ a = 9, b = 10$

10. **(c)** Put $\log_{10} x = y$, the given expression becomes $(x + x^y)^5$.

$T_3 = {}^5C_2 \, . x^3 (x^y)^2 = 10x^{3+2y} = 10^6 \text{(given)}$

$\Rightarrow (3 + 2y) \log_{10} x = 5\log_{10} 10 = 5$

$\Rightarrow (3 + 2y)y = 5$

$\Rightarrow y = 1, -\dfrac{5}{2} \Rightarrow \log_{10} x = 1 \ \ or \ \log_{10} x = -\dfrac{5}{2}$

$\therefore \ x = 10$ or $x = (10)^{-5/2}$

11. **(b)** Let the coordinates of point P be (x, y, z).
Here, $PA^2 = (x - 3)^2 + (y - 4)^2 + (z - 5)^2$
$PB^2 = (x + 1)^2 + (y - 3)^2 + (z + 7)^2$

By the given condition $PA^2 + PB^2 = 2K^2$

We have

$$(x-3)^2+(y-4)^2+(z-5)^2+(x+1)^2 + (y-3)^2+(z+7)^2 = 2K^2$$

i.e. $2x^2+2y^2+2z^2-4x-14y+4z = 2K^2-109$

12. (c) Let $y = \lim\limits_{x\to 0}(\operatorname{cosec} x)^{1/\log x}$

Taking log on both sides, we get

$$\log y = \lim_{x\to 0}\frac{\log \operatorname{cosec} x}{\log x}\left[\frac{\infty}{\infty}\text{ form}\right]$$

$$= \lim_{x\to 0}\frac{-\cot x}{1/x} \qquad \text{(By L' Hopital rule)}$$

$$= -\lim_{x\to 0}\frac{x}{\tan x}$$

$$\Rightarrow \quad \log y = -1 \quad \Rightarrow y = e^{-1} = \frac{1}{e}$$

Hence, required limit $= \frac{1}{e}$

13. (c) We know that $p \leftrightarrow q$ is true if p and q both are true or false.

so $p \leftrightarrow \sim q$ is true when if p and $\sim q$ is true.

i.e., p is true and q is false.

or p and $\sim q$ is false, i.e. p is false and q is true.

14. (b) Let

$$y = 5^{x(x-4)} \Rightarrow x(x-4) = \log_5 y$$

$$\Rightarrow x^2 - 4x - \log_5 y = 0$$

$$\Rightarrow x = \frac{4 \pm \sqrt{16+4\log_5 y}}{2} = (2 \pm \sqrt{4+\log_5 y})$$

But $x \ge 4$, so $x = (2+\sqrt{4+\log_5 y})$

$$\therefore \quad f^{-1}(x) = 2+\sqrt{4+\log_5 x}$$

15. (c) Let $S_\infty = \cot^{-1}2 + \cot^{-1} 8 + \cot^{-1} 18 + \cot^{-1} 32 + ...$

$$\therefore T_n = \cot^{-1} 2n^2 = \tan^{-1}\frac{1}{2n^2}$$

$$= \tan^{-1}\left(\frac{2}{4n^2}\right) = \tan^{-1}\left(\frac{(2n+1)-(2n-1)}{1+(2n+1)(2n-1)}\right)$$

$$= \tan^{-1}(2n+1) - \tan^{-1}(2n-1)$$

$$\therefore \quad S_n = \sum_{n=1}^{\infty}\{\tan^{-1}(2n+1)-\tan^{-1}(2n-1)\}$$

$$= \tan^{-1}\infty - \tan^{-1} 1 = \frac{\pi}{2}-\frac{\pi}{4} = \frac{\pi}{4}$$

16. (d) $A^2 = \begin{pmatrix}1 & 0\\ 1/2 & 1\end{pmatrix}\begin{pmatrix}1 & 0\\ 1/2 & 1\end{pmatrix} = \begin{pmatrix}1 & 0\\ 2\left(\frac{1}{2}\right) & 1\end{pmatrix}$

$$A^3 = A^2 A = \begin{pmatrix}1 & 0\\ 1/2 & 1\end{pmatrix}\begin{pmatrix}1 & 0\\ 2\left(\frac{1}{2}\right) & 1\end{pmatrix} = \begin{pmatrix}1 & 0\\ 3\left(\frac{1}{2}\right) & 1\end{pmatrix}$$

Continuing in this way, we get

$$A^{400} = \begin{pmatrix}1 & 0\\ 400\left(\frac{1}{2}\right) & 1\end{pmatrix} = \begin{pmatrix}1 & 0\\ 200 & 1\end{pmatrix}$$

In fact $A^{2n} = \begin{pmatrix}1 & 0\\ n & 1\end{pmatrix} \forall\ n \in N$

17. (b) We have determinant

$$\Delta = \begin{vmatrix} a & b & \frac{ax+b}{x} \\ b & c & bx+c \\ ax+b & bx+c & 0 \end{vmatrix} = 0$$

If $x = 1$ then $\Delta = \begin{vmatrix} a & b & a+b \\ b & c & b+c \\ a+b & b+c & 0 \end{vmatrix} = 0$

$$\Delta = \begin{vmatrix} a & b & 0 \\ b & c & 0 \\ a+b & b+c & -(c+a+2b) \end{vmatrix} = 0$$

$[C_3 \to C_3 - (C_1 + C_2)]$

$\Rightarrow (a+c+2b)(ac-b^2)=0$ [by expanding]

$\Rightarrow b^2 = ac$ and $a+c=-2b$

$\therefore$ a, b, c are in G.P.

18. **(b)** We have, $f(x)=\dfrac{1}{1-x}$.

As at x = 1, f(x) is not defined, x = 1 is a point of discontinuity of f(x).

If $x \neq 1, f[f(x)] = f\left(\dfrac{1}{1-x}\right) = \dfrac{1}{1-1/(1-x)} = \dfrac{x-1}{x}$

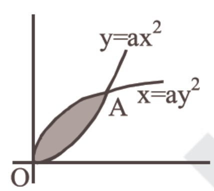
$\therefore x = 0, 1$ are points of discontinuity of $f[f(x)]$.

If $x \neq 0, x \neq 1$

$f[f\{f(x)\}] = f\left(\dfrac{x-1}{x}\right) = \dfrac{1}{1-\dfrac{(x-1)}{x}} = x$.

19. **(a)** $y = ax^2$ & $x = ay^2$

Points of intersection are O (0, 0) & $A\left(\dfrac{1}{a}, \dfrac{1}{a}\right)$



$\therefore$ Area $= \int_0^{1/a}\left(\sqrt{\dfrac{x}{a}} - ax^2\right)dx$

$= \dfrac{2}{3a^2} - \dfrac{1}{3a^2} = \dfrac{1}{3a^2} = 1 \Rightarrow a = \dfrac{1}{\sqrt{3}}$

20. **(a)** $\int \dfrac{dx}{\cos x - \sin x} = \int \dfrac{dx}{\sqrt{2}\cos\left(x+\dfrac{\pi}{4}\right)}$

$= \dfrac{1}{\sqrt{2}}\int \sec\left(x+\dfrac{\pi}{4}\right)dx$

$= \dfrac{1}{\sqrt{2}}\log\left|\tan\left(\dfrac{\pi}{4}+\dfrac{x}{2}+\dfrac{\pi}{8}\right)\right| + C$

$= \dfrac{1}{\sqrt{2}}\log\left|\tan\left(\dfrac{x}{2}+\dfrac{3\pi}{8}\right)\right| + C$

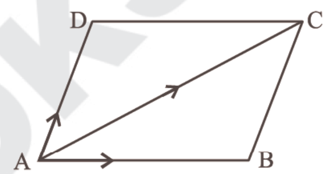
21. **(d)** Let $y = \log x$

$\Rightarrow y_1 = \dfrac{1}{x}, y_2 = \dfrac{-1}{x^2}, y_3 = \dfrac{2}{x^3}, \ldots, y_n = \dfrac{(-1)^{n-1}(n-1)!}{x^n}$

22. **(c)** Let $\overrightarrow{AB} = \hat{i}+3\hat{j}+7\hat{k}$ and $\overrightarrow{AD} = 2\hat{i}+3\hat{j}-5\hat{k}$

$\overrightarrow{AC} = \overrightarrow{AB}+\overrightarrow{AD} = (\hat{i}+3\hat{j}+7\hat{k})+(2\hat{i}+3\hat{j}-5\hat{k})$

$= 3\hat{i}+6\hat{j}+2\hat{k}$



Since $\vec{p}$ is a unit vector parallel to $\overrightarrow{AC}$ therefore

$P = \dfrac{\overrightarrow{AC}}{|\overrightarrow{AC}|} = \dfrac{3\hat{i}+6\hat{j}+2\hat{k}}{\sqrt{(3)^2+(6)^2+(2)^2}}$

$= \dfrac{1}{7}(3\hat{i}+6\hat{j}+2\hat{k})$

23. **(a)** $\dfrac{x-b}{a} = \dfrac{y}{1} = \dfrac{z-d}{c}; \dfrac{x-b'}{a'} = \dfrac{y}{1} = \dfrac{z-d'}{c'}$.

For perpendicularity of lines $aa'+1+cc'=0$

24. **(d)** We have equation of tangent to any curve f(x) at (x_1, y_1) is $(y-y_1) = \left.\dfrac{dy}{dx}\right|_{(x_1,y_1)}(x-x_1)$

Given curve is $y = e^{-|x|}$

Point of intersection is $\left(1, \dfrac{1}{e}\right)$ at $x = 1, |x| = x$

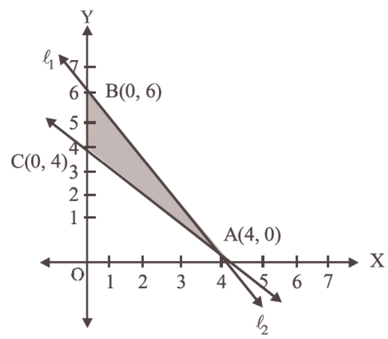
So, $y = e^{-x} \Rightarrow \dfrac{dy}{dx} = -e^{-x}$ $\therefore$

$\left(\dfrac{dy}{dx}\right)_{x=1} = -e^{-1}$

Therefore, equation of tangent is

$$y-\frac{1}{e}=\frac{-1}{e}(x-1)\Rightarrow x+ey=2$$

25. **(d)** We have, minimized $Z=4x+6y$
Subject to $3x+2y\le 12$, $x+y\ge 4$, $x, y\ge 0$
Let $\ell_1: 3x+2y=12$
$\ell_2: x+y=4$
$\ell_3: x=0$ and $\ell_4: y=0$
Shaded portion ABC is the feasible region, where A(4, 0), C(0, 4), B(0, 6).



Now maximize $Z=4x+6y$
Z at A(4, 0) = 4(4) + 6(0) = 16
Z at B (0, 6) = 4(0) + 6(6) = 36
Z at C (0, 4) = 4(0) + 6(4) = 24
Thus, Z is maximized at B(0, 6) and its maximum value is 36.

26. **(c)** The differential equation is

$$\frac{dy}{dx}-\frac{y}{x}=-\frac{5x}{(x+2)(x-3)}$$

$$\text{I. F}=e^{\int\left(-\frac{1}{x}\right)dx}=e^{-\ln x}=\frac{1}{x}$$

Solution is

$$y\left(\frac{1}{x}\right)=\int\left(\frac{1}{x}\right)\times\frac{5x}{(x+2)(x-3)}dx=\ln\left(\frac{x+2}{x-3}\right)+C$$

It passes through (4, 0), so $C=-\ln 6$

$$\therefore\ y=x\ln\left\{\frac{(x+2)}{6(x-3)}\right\}$$

Putting (5, a), we get $a=5\ln\left(\frac{7}{12}\right)$

27. **(d)** Let E : 'face 1 comes up' and F: 'face 1 or 2 comes up'

$$\Rightarrow E\cap F=E \qquad (\because E\subset F)$$

$\therefore P(E)=0.10$ and $P(F)=P(1)+P(2)=0.10+0.32=0.42$

Hence, required probability

$$=P(E/F)=\frac{P(E\cap F)}{P(F)}=\frac{P(E)}{P(F)}=\frac{0.10}{0.42}=\frac{5}{21}$$

28. **(d)** $$\int_0^2[x^2]dx=\int_0^1[x^2]dx+\int_1^{\sqrt{2}}[x^2]dx+\int_{\sqrt{2}}^{\sqrt{3}}[x^2]+\int_{\sqrt{3}}^{2}[x^2]dx$$

$$=\int_0^1 0dx+\int_1^{\sqrt{2}}1dx+\int_{\sqrt{2}}^{\sqrt{3}}2dx+\int_{\sqrt{3}}^{2}3dx$$

$$=[x]_1^{\sqrt{2}}+[2x]_{\sqrt{2}}^{\sqrt{3}}+[3x]_{\sqrt{3}}^{2}$$

$$=\sqrt{2}-1+2\sqrt{3}-2\sqrt{2}+6-3\sqrt{3}=5-\sqrt{3}-\sqrt{2}$$

29. **(a)** We have, $81^{\sin^2 x}+81^{\cos^2 x}=30$

Now check by options, put $x=\frac{\pi}{6}$

then $(81)^{\sin^2\pi/6}+(81)^{\cos^2\pi/6}=30$

$$\Rightarrow\ (81)^{1/4}+(81)^{3/4}=30\Rightarrow 30=30$$

30. **(a)** If a, ar, ar^2, ar^3 .... are in G.P., then

sum of infinite G.P. $=a+ar+.....+\infty=\frac{a}{1-r}$

where 'a' is the first term and 'r' is the common ratio of G.P.

Given $x=1+a+a^2+.....\infty$
This is a GP, with common ratio 'a'.

$$\Rightarrow x = \frac{1}{1-a} \Rightarrow x - ax = 1 \Rightarrow a = \frac{x-1}{x}$$

Again, $y = 1 + b + b^2 + ...\infty$ This is also a G.P., with common ratio 'b'.

$$\Rightarrow \; y = \frac{1}{1-b} \Rightarrow b = \frac{y-1}{y}$$

Now, consider $1 + ab + a^2b^2 + ...\infty$
which is again *a* GP with common ratio '*ab*'.

$$\therefore \; \text{Sum} = \frac{1}{1-ab} = \frac{1}{1 - \frac{x-1}{x} . \frac{y-1}{y}}$$

$$= \frac{xy}{xy - xy + x + y - 1} = \frac{xy}{x + y - 1}$$

31. **(d)** $\tan\frac{\pi}{4} = \left|\frac{3 - m_2}{1 + 3m_2}\right| \Rightarrow 1 + 3m_2 = 3 - m_2$

or $1 + 3m_2$
$= -(3 - m_2) - 2 = -4m_2$ or $m_2 = -2$

$\therefore \; m_2 = -2, \frac{1}{2}$

32. **(c)** The ellipse can be written as, $\frac{x^2}{25} + \frac{y^2}{16} = 1$

Here $a^2 = 25$, $b^2 = 16$, but $b^2 = a^2(1 - e^2) \Rightarrow 16/25 = 1 - e^2$

$\Rightarrow \; e^2 = 1 - 16/25 = 9/25 \Rightarrow e = 3/5$

Foci of the ellipse are $(\pm ae, 0) = (\pm 3, 0)$, i.e., F_1 and F_2

$\therefore$ We have $PF_1 + PF_2 = 2a = 10$ for every point P on the ellipse.

33. **(a)** Consider eqn $t^2x^2 + |x| + 9 = 0$
Product of real roots

$= \frac{9}{t^2} > 0, \; \forall \; t \in R$

$\therefore$ Product of real roots is always positive.

34. **(a)** $z = 1 + 2i \Rightarrow |z| = \sqrt{1+4} = \sqrt{5}$

$$\therefore \; f(z) = \frac{7 - z}{1 - z^2} = \frac{7 - 1 - 2i}{1 - (1 + 2i)^2}$$

$$= \frac{6 - 2i}{1 - (1 - 4 + 4i)} = \frac{6 - 2i}{4 - 4i} = \frac{3 - i}{2 - 2i}$$

$$\Rightarrow |f(z)| = \left|\frac{3 - i}{2 - 2i}\right| = \frac{|3 - i|}{|2 - 2i|}$$

$$= \frac{\sqrt{9+1}}{\sqrt{4+4}} = \frac{\sqrt{5}}{2} = \frac{|z|}{2}$$

35. **(d)** We have

$$5^{x+2} > \left(\frac{1}{25}\right)^{\frac{1}{x}} \Rightarrow 5^{x+2} > 5^{-\frac{2}{x}} \Rightarrow x + 2 > -\frac{2}{x}$$

$[\because \text{base } 5 > 1]$

$$\Rightarrow x + 2 + \frac{2}{x} > 0 \Rightarrow \frac{x^2 + 2x + 2}{x} > 0 \Rightarrow \frac{1}{x} > 0$$

$[\because x^2 + 2x + 2 > 0 \; \forall \; x \in R]$

$\Rightarrow x > 0$ or $x \in (0, \infty)$

36. **(b)** First prize can be given in 5 ways. Then second prize can be given in 4 ways and the third prize in 3 ways (Since a competitior cannot get two prizes) and hence the no. of ways. $= 5 \times 4 \times 3 = 60$ ways

37. **(d)** $(a + b + c)^{12} = [(a + b) + c]^{12}$

$= {}^{12}C_0(a + b)^{12} + {}^{12}C_1(a + b)^{11}c + ... + {}^{12}C_{12}c^{12}$

The R.H.S. contains, $13 + 12 + 11 + ... + 1$ terms

$= \frac{13(13+1)}{2} = 91$ terms

Also no. of term in the expansion of $(a + b + c)^n$ is given by ${}^{n+2}C_2$.

Thus for $n = 12$; ${}^{n+2}C_2 = {}^{14}C_2 = \frac{14 \times 13}{2} = 91$.

38. **(c)** $y=\left(1+\frac{1}{x}\right)\left(1+\frac{2}{x}\right)\left(1+\frac{3}{x}\right)...\left(1+\frac{n}{x}\right)$

$$\frac{dy}{dx}=\left(-\frac{1}{x^2}\right)\left(1+\frac{2}{x}\right)\left(1+\frac{3}{x}\right)...\left(1+\frac{n}{x}\right)$$

$$+\left(1+\frac{1}{x}\right)\left(-\frac{2}{x^2}\right)\left(1+\frac{3}{x}\right)...\left(1+\frac{n}{x}\right)$$

$$+...+\left(1+\frac{1}{x}\right)\left(1+\frac{2}{x}\right)\left(1+\frac{3}{x}\right)...\left(-\frac{n}{x^2}\right)$$

$$\because \left.\frac{dy}{dx}\right|_{x=-1}=(-1)(-1)(-2)(-3)....(1-n)$$

$=(-1)^n(1)(2)(3)....(n-1)=(-1)^n(n-1)\,!$

39. **(c)** Sum of 100 items $=49\times 100=4900$
Sum of items added $=60+70+80=210$
Sum of items replaced $=40+20+50=110$
New sum $=4900+210-110=5000$

$\therefore$ Correct mean $=\frac{5000}{100}=50$

40. **(b)** $f(x)=\sin x+\cos x,\ g(x)=x^2-1$
$\Rightarrow g(f(x))=(\sin x+\cos x)^2-1=\sin 2x$

Clearly $g(f(x))$ is invertible in $-\frac{\pi}{2}\le 2x\le\frac{\pi}{2}$

$\Rightarrow -\frac{\pi}{4}\le x\le\frac{\pi}{4}$

41. **(b)** $A^2=\begin{bmatrix}-5 & -8 & 0\\ 3 & 5 & 0\\ 1 & 2 & -1\end{bmatrix}\begin{bmatrix}-5 & -8 & 0\\ 3 & 5 & 0\\ 1 & 2 & -1\end{bmatrix}$

$$=\begin{bmatrix}25-24+0 & 40-40+0 & 0+0+0\\ -15+15+0 & -24+25+0 & 0+0+0\\ -5+6-1 & -8+10-2 & 0+0+1\end{bmatrix}$$

$$=\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}=I$$

Hence, the matrix A is involutory.

42. **(b)** Given system of equations is homogeneous which is
$x+ay=0;\ \ y+az=0;\ \ \ z+ax=0$
It can be written in matrix form as

$$A=\begin{pmatrix}1 & a & 0\\ 0 & 1 & a\\ a & 0 & 1\end{pmatrix}$$

Now, $|A|=[1-a(-a^2)]=1+a^3\neq 0$
So, system has only trivial solution.
Now, $|A|=0$ only when $a=-1$
So, system of equations has infinitely many solutions
which is not possible because it is given that system has a unique solution.
Hence set of all real values of 'a' is $R-\{-1\}$.

43. **(b)** $y=\frac{(a-x)^{3/2}+(x-b)^{3/2}}{\sqrt{a-x}+\sqrt{x-b}}$

$$=\frac{(\sqrt{a-x}+\sqrt{x-b})(a-x-\sqrt{a-x}\sqrt{x-b}+x-b)}{\sqrt{a-x}+\sqrt{x-b}}$$

$$=a-b-\sqrt{a-x}\sqrt{x-b}$$

or $\frac{dy}{dx}=\frac{1}{2\sqrt{a-x}}\sqrt{x-b}-\frac{1}{2\sqrt{x-b}}\sqrt{a-x}$

$$=\frac{2x-a-b}{2\sqrt{a-x}\sqrt{x-b}}$$

44. **(d)** Let $I=\int\frac{(1+x)e^x}{\cot(xe^x)}dx$

Put $xe^x=t \Rightarrow (xe^x+e^x)\,dx=dt\Rightarrow e^x(x+1)\,dx=dt$

$\therefore I=\int\frac{dt}{\cot(t)}=\log|\sec t|+C=\log|\sec(xe^x)|+C$

45. **(a)** $(\vec{a}\times\vec{b})^2+(\vec{a}\cdot\vec{b})^2=676$

$(|\vec{a}|.|\vec{b}|\sin\theta\hat{n})^2+(|\vec{a}|\cdot|\vec{b}|\cos\theta)^2=676$

$\Rightarrow a^2b^2\sin^2\theta+a^2b^2\cos^2\theta=676\ \ [(\hat{n})^2=1]$

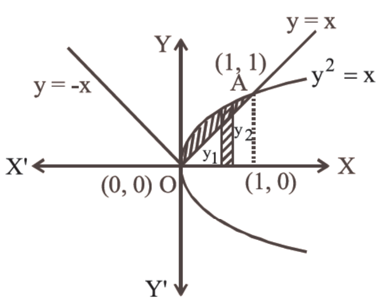
$\Rightarrow\ \ a^2b^2(\sin^2\theta+\cos^2\theta)=676$

$\Rightarrow a^2 = \frac{676}{b^2} = \frac{676}{4}$

$|\vec{a}| = \sqrt{\frac{676}{4}} \Rightarrow |\vec{a}| = \frac{26}{2} \Rightarrow |\vec{a}| = 13$

46. **(a)** The area enclosed between the curves $y^2 = x$ and $y = |x|$

From the figure, area lies between $y^2 = x$ and $y = x$



$\therefore$ Required area $= \int_0^1 (y_2 - y_1)dx$

$= \int_0^1 (\sqrt{x} - x)dx = \left[\frac{x^{3/2}}{3/2} - \frac{x^2}{2}\right]_0^1$

$\therefore$ Required area $= \frac{2}{3}\left[x^{3/2}\right]_0^1 - \frac{1}{2}\left[x^2\right]_0^1$

$= \frac{2}{3} - \frac{1}{2} = \frac{1}{6}$

47. **(b)** We have a result that if a coin is tossed $(m+n)$ times $(m > n)$. The probability of at least m consecutive heads is $\frac{n+2}{2^{m+1}}$. Here $m = 4$, $n = 3$

$\therefore$ Required prob $= \frac{3+2}{2^{4+1}} = \frac{5}{32}$

48. **(d)** Let $t = \sin^2 x;\ t \in [0, 1]$; $f(x) = g(t) = te^{-2t}$

$g'(t) = (1-2t)e^{-2t}$; $g'(t) = 0$ at $t = 1/2$;

$g\left(\frac{1}{2}\right) = \frac{1}{2e}$

$g(0) = 0$ and $g(1) = e^{-2}$ $\therefore g_{max.} = 1/2e$ and $g_{min.} = 0$

$\therefore \max. f(x) - \min. f(x) = \frac{1}{2e}$.

49. **(a)** $\frac{dy}{dx} = \frac{e^x(\sin^2 x + \sin 2x)}{y\,(2\log y + 1)}$

$\Rightarrow \int (2y\log y + y)dy = \int e^x(\sin^2 x + \sin 2x)dx$

On integrating by parts, we get $y^2(\log y) = e^x \sin^2 x + c$.

50. **(d)** $I = \int_0^\pi x f(\sin x)dx = \int_0^\pi (\pi - x) f(\sin x)dx$

$= \pi\int_0^\pi f(\sin x)dx - I \Rightarrow 2I = \pi\int_0^\pi f(\sin x)dx$

$I = \frac{\pi}{2}\int_0^\pi f(\sin x)dx = \pi\int_0^{\pi/2} f(\sin x)dx$

$= \pi\int_0^{\pi/2} f(\cos x)dx$

(Mock Test-3)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(c)	**6**	(d)	**11**	(d)	**16**	(d)	**21**	(a)	**26**	(a)	**31**	(b)	**36**	(a)	**41**	(a)	**46**	(b)
2	(a)	**7**	(a)	**12**	(c)	**17**	(a)	**22**	(a)	**27**	(b)	**32**	(d)	**37**	(c)	**42**	(a)	**47**	(b)
3	(d)	**8**	(b)	**13**	(b)	**18**	(a)	**23**	(c)	**28**	(d)	**33**	(c)	**38**	(d)	**43**	(c)	**48**	(c)
4	(b)	**9**	(a)	**14**	(c)	**19**	(a)	**24**	(c)	**29**	(a)	**34**	(c)	**39**	(d)	**44**	(b)	**49**	(d)
5	(d)	**10**	(d)	**15**	(b)	**20**	(b)	**25**	(a)	**30**	(a)	**35**	(b)	**40**	(a)	**45**	(b)	**50**	(c)
CHEMISTRY																			
51	(c)	**56**	(c)	**61**	(b)	**66**	(a)	**71**	(d)	**76**	(c)	**81**	(d)	**86**	(c)	**91**	(a)	**96**	(c)
52	(b)	**57**	(c)	**62**	(a)	**67**	(d)	**72**	(b)	**77**	(a)	**82**	(b)	**87**	(b)	**92**	(a)	**97**	(b)
53	(a)	**58**	(c)	**63**	(b)	**68**	(d)	**73**	(b)	**78**	(b)	**83**	(b)	**88**	(b)	**93**	(a)	**98**	(a)
54	(d)	**59**	(a)	**64**	(b)	**69**	(a)	**74**	(d)	**79**	(c)	**84**	(b)	**89**	(b)	**94**	(a)	**99**	(c)
55	(d)	**60**	(b)	**65**	(c)	**70**	(b)	**75**	(b)	**80**	(c)	**85**	(d)	**90**	(a)	**95**	(c)	**100**	(c)
SECTION-B																			
MATHEMATICS																			
1	(c)	**6**	(a)	**11**	(a)	**16**	(a)	**21**	(c)	**26**	(b)	**31**	(a)	**36**	(a)	**41**	(b)	**46**	(a)
2	(a)	**7**	(c)	**12**	(c)	**17**	(a)	**22**	(b)	**27**	(d)	**32**	(d)	**37**	(c)	**42**	(d)	**47**	(b)
3	(b)	**8**	(b)	**13**	(b)	**18**	(d)	**23**	(a)	**28**	(d)	**33**	(a)	**38**	(a)	**43**	(d)	**48**	(d)
4	(d)	**9**	(c)	**14**	(a)	**19**	(c)	**24**	(d)	**29**	(a)	**34**	(a)	**39**	(b)	**44**	(d)	**49**	(a)
5	(d)	**10**	(b)	**15**	(a)	**20**	(c)	**25**	(c)	**30**	(b)	**35**	(a)	**40**	(a)	**45**	(a)	**50**	(c)

SECTION-A

PHYSICS

1. **(c)** Acceleration should be like, $a = -kx$.

2. **(a)** $r = 30\,m$ and $\mu = 0.4$.

$$v_{\max} = \sqrt{\mu r g} = \sqrt{0.4 \times 30 \times 9.8} = 10.84 \text{m/s}$$

3. **(d)**

4. **(b)** $I = I_0 \cos^2 \theta$

Intensity of polarized light $= \dfrac{I_0}{2}$

$\Rightarrow$ Intensity of untransmitted light

$$= I_0 - \frac{I_0}{2} = \frac{I_0}{2}$$

5. **(d)** By Gauss law, we know that

$\phi = \dfrac{q}{\varepsilon_0}$ Here, Net electric flux, $\phi = \phi_2 - \phi_1$

$$= 9 \times 10^6 - 6 \times 10^6 = \frac{q}{\varepsilon_0} \Rightarrow q = 3 \times 10^6 \times \varepsilon_0.$$

6. **(d)**

7. **(a)** For conversion of a Galvanometer to a voltmeter, we connect a large resistance R in series with the Galvanometer.

8. **(b)** As momentum is conserved, therefore,

$$\frac{m_1}{m_2} = \frac{A_1}{A_2} = \frac{v_2}{v_1} = \frac{1}{5}$$

$$\therefore \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{1}{5}\right)^{1/3} = 1 : 5^{1/3}$$

9. **(a)** In stream line flow velocity of flow at any point in the liquid does not vary with time.

10. **(d)**

11. **(d)** $\left|\vec{A} \times \vec{B}\right| = \sqrt{3}(\vec{A}.\vec{B})$

$$\Rightarrow AB\sin\theta = \sqrt{3}AB\cos\theta$$

$$\Rightarrow \tan\theta = \sqrt{3} \Rightarrow \theta = 60°$$

12. **(c)**

13. **(b)** $m_a = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{10-4}{10+4} = \frac{6}{14} = 0.43$

14. **(c)** Kirchhoff's junction rule states that the algebraic sum of all currents into and out of any branch point is zero : $\Sigma I = 0$. By convention, the sign of current entering a junction is positive and current leaving a junction is negative.
$4A + 5A - 6A + I_{AB} = 0$, therefore $I_{AB} = -3A$.
The wire between points A and B carries a current of 3A away from the junction.

15. **(b)** $\vec{r} = \frac{m_1\vec{r_1} + m_2\vec{r_2}}{m_1 + m_2} = \frac{m(\vec{x} + \vec{y})}{2m} = \frac{\vec{x} + \vec{y}}{2}$

16. **(d)** $M = \frac{\mu_0 N_1 N_2 A}{\ell} = \frac{4\pi \times 10^{-7} \times 300 \times 400 \times 100 \times 10^{-4}}{0.2}$

$$= 2.4\pi \times 10^{-4}\,H$$

17. **(a)**

18. **(a)** $g' = g - \omega^2 R\cos^2\lambda \Rightarrow 0 = g - \omega^2 R\cos^2 60°$

$$0 = g - \frac{\omega^2 R}{4} \Rightarrow \omega = 2\sqrt{\frac{g}{R}} = \frac{1}{400}\frac{rad}{s}$$

$$= 2.5 \times 10^{-3}\frac{rad}{s}$$

19. **(a)** Path difference, $S_1B = \Delta x = n\lambda$.
As P is the position of 11^{th} fringe from Q, so from O it will be 10.
$\therefore\ \Delta x = n\lambda = 10\lambda$
$= 10 \times 6000 \times 10^{-10} = 6 \times 10^{-6}$ m

20. **(b)**

A	B	$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$	C
0	0	1	1	1	0
0	1	1	0	1	0
1	0	0	1	1	0
1	1	0	0	0	1

$\equiv$ AND gate

21. **(a)** W = F s cos 90° = zero

22. **(a)**

23. **(c)** Given, $\omega = 2$ rad s^{-1}, r = 2 m, t = $\frac{\pi}{2}$s

Angular displacement, θ

$$= \omega t = 2 \times \frac{\pi}{2} = \pi \text{ rad}$$

Linear velocity, $v = r \times \omega = 2 \times 2 = 4$ m s^{-1}

$\therefore$ change in velocity, $\Delta v = 2v\sin\frac{\theta}{2}$

$$= 2 \times 4 \times \sin\left(\frac{\pi}{2}\right) = 8\ ms^{-1}$$

24. **(c)** Initial magnetic flux linked with the coil is
ϕ_i = BA cos θ = 0.1 × 200 × 10^{-4} × cos0°
= 2 × 10^{-3} Wb
Final magnetic flux linked with the coil is $\phi_f = 0$

$\therefore$ By Faraday's law, $\varepsilon = -\frac{N\Delta\phi}{\Delta t}$

$= \frac{-N(\phi_f - \phi_i)}{\Delta t}$

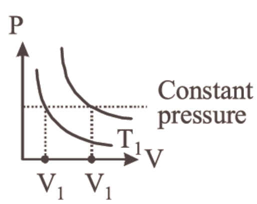
$= \frac{-100(0 - 2\times10^{-3})}{1} = 2\times10^{-1}V = 0.2V$

Induced current

$I = \frac{\varepsilon}{R} = \frac{0.2V}{2\Omega} = 0.1A$

Induced charge $q = It = 0.1 \times 1 = 0.1$ C

25. **(a)** For a given pressure, volume will be more if temperature is more (Charle's law)



From the graph it is clear that $V_2 > V_1 \Rightarrow T_1 > T_2$

26. **(a)** Force required $= \frac{\text{change in momentum}}{\text{time taken}}$

$= \frac{(50\times10^{-3}\times30)\times400-(5\times0)}{60} = 10$ N

27. **(b)** In case of internal resistance measurement by potentiometer,

$\frac{V_1}{V_2} = \frac{\ell_1}{\ell_2} = \frac{\{ER_1/(R_1+r)\}}{\{ER_2/(R_2+r)\}} = \frac{R_1(R_2+r)}{R_2(R_1+r)}$

Here $\ell_1 = 2m$, $\ell_2 = 3m$, $R_1 = 5\Omega$ and $R_2 = 10\Omega$

$\therefore \frac{2}{3} = \frac{5(10+r)}{10(5+r)}$ or $20+4r = 30+3r$ or $r = 10\,\Omega$

28. **(d)** Since radio frequency waves can travel long distances because these waves are of wave length of the order of 100 m and their energy content is quite large therefore e.m.wave of audible frequency are superimposed with radio frequency waves.

29. **(a)** ${}_1D^2 \longrightarrow {}_2He^4$

Energy released $= 28 - 2\times2.2 = 23.6$ MeV

(Binding energy is energy released on formation of Nucleus)

30. **(a)** Given that ${}_w\mu_g = \frac{5}{4}$ and ${}_a\mu_w = \frac{4}{3}$

$\therefore {}_a\mu_g = {}_w\mu_g \times {}_a\mu_w = \frac{5}{4}\times\frac{4}{3} = \frac{5}{3}$

31. **(b)** Gravitational force will be due to M_1 only.

32. **(d)** $E = E_4 - E_3$

$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{3^2}\right) = -0.85 + 1.51$

$= 0.66$ eV

33. **(c)** $a = \frac{F-\mu R}{m} = \frac{100-0.5\times(10\times10)}{10} = 5\,ms^{-2}$

34. **(c)** $V^2 = V_R^2 + (V_L - V_C)^2$

Since $V_L = V_C$ hence $V = V_R = 200$ V

35. **(b)**

36. **(a)** $v = \omega\sqrt{a^2 - y^2}$

At $x = 0$, $v = \omega\sqrt{a^2 - o^2} = \omega a$.

At $x = \frac{a}{2}$, $v' = \omega\sqrt{a^2 - \left(\frac{a}{2}\right)^2} = \omega\sqrt{\frac{3a^2}{4}}$

$\therefore \frac{v'}{v} = \frac{\sqrt{3}}{2}$

or $v' = \frac{\sqrt{3}}{2}\omega a$

$= \frac{\sqrt{3}\pi a}{2}\omega a = \frac{\sqrt{3}\pi a}{T}\left(\because \omega = \frac{2\pi}{T}\right)$

37. **(c)**

38. **(d)**

39. **(d)** Beyond Curie temperature, ferromagnetic substances behaves like a paramagnetic substance.

40. **(a)** Initially at $t = 0$

Rate of cooling (R) $\propto$ Fall in temperature of body $(\theta - \theta_0)$

$$\Rightarrow \frac{R_1}{R_2} = \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0} = \frac{100-40}{80-40} = \frac{3}{2}$$

41. **(a)** For strong reflection, the least optical path difference introduced by the film should by $\lambda/2$. The optical path difference between the waves reflected from the two surfaces of the film is $2\mu d$.

Thus, for strong reflection, $2\mu d = \lambda/2$.

$$d = \frac{\lambda}{4\mu} = \frac{589}{4 \times 1.25} = 118 \text{ nm.}$$

42. **(a)** Weight of the liquid column $= T\cos\theta \times 2\pi r$. For water $\theta = 0°$. Here weight of liquid column $W = 7.5 \times 10^{-4}$N and $T = 6 \times 10^{-2}$N/m. Then circumference, $2\pi r = W/T = 1.25 \times 10^{-2}$m

43. **(c)** Time period, $T_1 = 2\pi\sqrt{LC}$, $T_2 = 2\pi\sqrt{\frac{LC}{2}}$,

$T_3 = 2\pi\sqrt{2LC}$.

Clearly $t_2 < t_1 < t_3$.

44. **(b)** $\frac{\Delta f}{f} = \frac{v}{C}$ $\Rightarrow \frac{(\text{Beats})/2}{f} = \frac{v}{C}$ $\Rightarrow$ Beats $=$

$\frac{2fv}{C} = 4.$

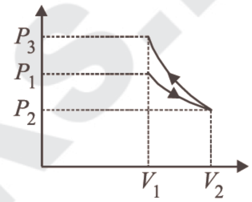
45. **(b)**

46. **(b)** Let T be the tension in the ring, then

$$Y = \frac{T.2\pi r}{A.2\pi(R-r)} = \frac{Tr}{A(R-r)}$$

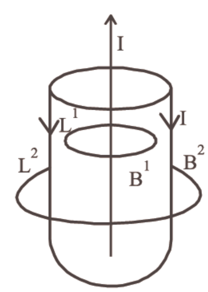
$$\therefore T = \frac{YA(R-r)}{r}$$

47. **(b)** In the first process W is + ve as ΔV is positive, in the second process W is – ve as ΔV is – ve and area under the curve of second process is more



$\therefore$ Net Work < 0 and also $P_3 > P_1$.

48. **(c)** Apply Ampere's circular law to the coaxial circular loops L_1 and L_2. The magnetic field is B_1 at all points on L_1 and B_2 at all points of L_2. $\Sigma I \neq 0$ for L_1 and 0 for L_2.



Hence, $B_1 \neq 0$ but $B_2 = 0$

$$\left[\text{As} \oint \vec{B}.d\vec{i} = \mu_0 \sum I\right]$$

49. **(d)** $\frac{1}{f} = (\mu_w - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$= \left(\frac{4}{3} - 1\right)\left(\frac{1}{-20} - \frac{1}{\infty}\right)$$

$\therefore f = -60$ cm.

50. **(c)** Since, stopping potential is independent of distance hence new stopping potential will remain unchanged i.e., new stopping potential $= V_0$.

CHEMISTRY

51. (c) The absorption of visible light and hence coloured nature of the transition metal cation is due to the promotion of one or more unpaired - *d* - electron from a lower to higher level withing same *d*-subshell. Hence higher will be the number of unpaired electron higher will be the absorpion in visible light.

The electronic configuration of the given elements is

Sc^{3+} (18) = $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^0\,4s^0$ - no unpaired e^-.

Ti^{4+} (18) = $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^0\,4s^0$ - no unpaired e^-.

V^{3+} (20) = $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^2\,4s^0$ - Two unpaired e^-.

Zn^{2+} (28) = $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^0$ - no unpaired e^-.

52. (b) Calcination decomposes carbonates into their respective oxides and used for removal of volatile impurities like H_2O and CO_2.

$$\underset{\text{Bauxite}}{Al_2O_3\,.\,2H_2O} \xrightarrow{\Delta} \underset{\text{Alumina}}{Al_2O_3} + 2H_2O$$

$$\underset{\text{Limestone}}{CaCO_3} \xrightarrow{\Delta} \underset{\text{Calcium oxide}}{CaO} + CO_2$$

53. (a) rate $\propto [p_{reactant}]^0$

i.e., rate $= k$

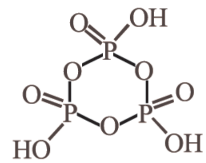
So, the order of reaction will be zero.

54. (d) All are chiral.

55. (d) 1-Phenylethanol ($CH_3\overset{\overset{\displaystyle C_6H_5}{|}}{C}HOH$) is a 2° alcohol and can be prepared by the reaction of benzaldehyde with Grignard reagent CH_3MgI.

56. (c) Mn_2O_7 is acidic, V_2O_5 is amphoteric acid and CrO is basic.

57. (c) In cyclic metaphosporic acid number of P–O–P bonds is three.



58. (c) Nernst equation E_{cell} =

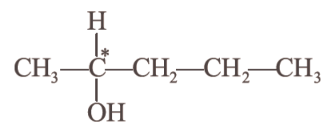
$$E^o_{cell} - \frac{RT}{nF}\frac{\ln[Fe^{2+}]^2}{[Fe^{3+}]^2}\left[Zn^{2+}\right]$$ increasing

$[Fe^{2+}]$ will decrease the E_{cell}.

59. (a) $C_nH_{2n}O_2$ is general formula for carboxylic acids.

60. (b) $A:B:C = \frac{1}{8}\times 8 : \frac{1}{2}\times 2 : \frac{1}{2}\times 4 = 1:1:2$

61. (b) Those compound which have asymmetric Carbon or chiral carbon atom (*) show optical isomerism,



2-Pentanol

62. (a) Friedel Craft reactions are examples of aromatic electrophilic substitution. In this, a Lewis acid (like $AlCl_3, FeBr_3$ etc.) is used as catalyst.

$$C_6H_6 + CH_3Cl \xrightarrow{AlCl_3} C_6H_5CH_3 + HCl$$

63. (b) $PtCl_4.5NH_3 : [Pt(NH_3)_5Cl]Cl_3 \rightarrow [Pt(NH_3)_5Cl]^{3+} + 3Cl^-$ (4 ions)

$PtCl_4.4NH_3 : [Pt(NH_3)_4Cl_2]Cl_2 \rightarrow [Pt(NH_3)_4Cl_2]^{2+} + 2Cl^-$ (3 ions)

$PtCl_4.3NH_3 : [Pt(NH_3)_3Cl_3]Cl \rightarrow [Pt(NH_3)_3Cl_3]^+ + Cl^-$ (2 ions)

$PtCl_4.2NH_3 : [Pt(NH_3)_2Cl_4]$ (no ion)
Non ionic

64. **(b)**

65. **(c)** $\underset{\text{Calcium carbide}}{CaC_2} + 2H_2O \longrightarrow \underset{\text{Acetylene}}{HC \equiv CH} + Ca(OH)_2$

66. **(a)** Since oxidation potential of Zn is highest hence strongest reducing agent.

67. **(d)**

68. **(d)** $R - NH_2 + CHCl_3 \xrightarrow{\text{alc. KOH}} R - \overset{\oplus}{N} \equiv \overset{\ominus}{C}$
(Where, R = Alkyl or Aryl Group)

69. **(a)** Enthalpy change during adsorption is negative. As in adsorption, there is decrease in residual forces of the surface which result in decrease in surface energy in form of heat.

70. **(b)** When $E_a = 0$, rate constant is independent of temperature.

71. **(d)** Amongst all tropolone is a non-benzenoid aromatic compound.

72. **(b)** The key step in the manufacture of H_2SO_4 is catalystic oxidation of SO_2 with O_2 to give SO_3 in presence of V_2O_5.

73. **(b)** Mn^{2+} (d^5) is more stable than Mn^{3+} (d^4), thus $E^{-}_{Mn^{3+}/Mn^{2+}} = +ve$

74. **(d)** $k = \frac{2.303}{t} \log \frac{a}{a-x}$

$$= \frac{2.303}{24} \log \frac{1}{\frac{1}{8}} = \frac{2.303}{24} \log 8 \text{ min}^{-1}$$

75. **(b)** $\underbrace{CO + H_2}_{\text{water gas}} + H_2O \xrightarrow{\text{catalyst}} CO_2 + 2H_2$

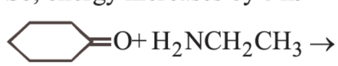
76. **(c)**

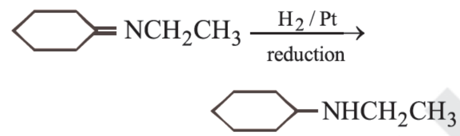
77. **(a)** q = + 10 kJ, w = – 4 kJ

$\because \quad \Delta E = q + w$

$\quad = 10 - 4 = 6$ kJ

So, energy increases by 6 kJ

78. **(b)** 



79. **(c)** The ions present in the ionisation sphere are precipitated.
Hence $[CrCl_2(H_2O)_4]Cl.2H_2O$ contains 1/3 Cl in ionisation sphere to be precipitated by $AgNO_3$ as AgCl.

80. **(c)** $N_2 + O_2 \rightleftharpoons 2NO; \Delta n = 0$

81. **(d)** As the size increases, the basic nature of oxides changes to acidic nature i.e., acidic nature increases.

$$\underset{\text{Acidic}}{SO_2 > P_2O_3} > \underset{\text{Weak acidic}}{SiO_2} > \underset{\text{Amphoteric}}{Al_2O_3}$$

SO_2 and P_2O_3 are acidic as their corresponding acids H_2SO_3 and H_3PO_3 are strong acids.

82. **(b)** Amorphous solids are isotropic, because these substances show same properties in all directions.

83. **(b)** Cloud and fog are colloidal system having dispersed phase liquid and dispersion medium gas

84. **(b)** $La^{3+} : 54\, e^- = [Xe]$

$Ti^{3+} : 19\, e^- = [Ar]\, 3d^1$ (Colour)

$Lu^{3+} : 68\, e^- = [Xe]\, 4f^{14}$

$Sc^{3+} : 18\, e^- = [Ar]$

85. **(d)** The two components should be $(CH_3)_3CONa + (CH_3)_3CBr$. However, tert-alkyl halides tend to undergo elimination reaction rather than substitution leading to the formation of an alkene, $Me_2C = CH_2$

86. **(c)** From molarity equation

$M_1V_1 + M_2V_2 = M_3(V_1 + V_2)$

$1 \times 2.5 + 0.5 \times 3 = M_3 \times 5.5$

$$M_3 = \frac{4}{5.5} = 0.73M$$

87. (b) Bromide in the mother liquor is oxidised to Br_2 by Cl_2 which is a stronger oxidising agent. $2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$

88. (b) A is more reactive than B, because it has high oxidation potential. Therefore, A will replace B.

89. (b) Adenosine is a nucleoside which contains a fine carbon ribose sugar and a base (adenine).

90. (a) MnO

91. (a) Carboxylic acids are acidic in nature because of stabilisation (i.e., dispersal of negative charge) of carboxylate ion. So any factor which can enhance the dispersal of negative charge of the carboxylate ion will increase the acidity and vice versa. Thus electron-withdrawing substituents (like halogens, —NO_2, —C_6H_5 etc.) would disperse the negative charge and hence stabilise the carboxylate ion and thus increase acidity of the parent acid. On the other hand, electron-releasing substituents would intensify the negative charge, destabilise the carboxylate ion and thus decrease acidity of the parent acid.

Now, since alkyl groups are electron-releasing, their presence in the molecule will decrease the acidity. In general, greater the length of the alkyl chain, lower shall be the acidity of the acid. Thus formic acid (HCOOH), having no alkyl group, is about 10 times stronger than acetic acid (CH_3COOH). Thus correct order of acidic strength is

$CF_3COOH > CHCl_2COOH > HCOOH > C_6H_5CH_2COOH > CH_3COOH$

92. (a) Given structures are representing *cis-trans* isomerism (geometrical) hence differ only in configuration.

93. (a) In acidic medium Zwitter ion convert into

$$\overset{+}{N}H_3—\underset{\underset{R}{|}}{CH}—COO^- + H^+$$

$$\overset{+}{N}H_3—\underset{\underset{R}{|}}{CH}—COOH$$

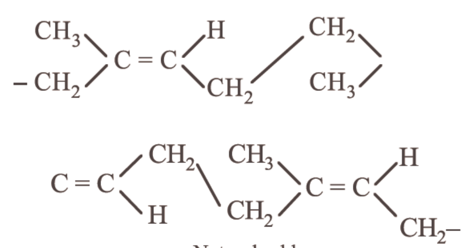
94. (a) Micelle formation is shown by surfactants detergents (Dodecyl trimethyl ammonium chloride) in their aqueous solutions.

95. (c) Dissociation energy of any molecule depends upon its bond order. Bond order in N_2 molecule is 3 while bond order in N_2^+ is 2.5. Further we know that more the Bond order, more is the stability and more is the bond dissociation energy.

96. (c)

	No. of molecules
Moles of $CO_2 = \frac{44}{44} = 1$	N_A
Moles of $O_3 = \frac{48}{48} = 1$	N_A
Moles of $H_2 = \frac{8}{2} = 4$	$4N_A$
Moles of $SO_2 = \frac{64}{64} = 1$	N_A

97. (b)



Natural rubber
(All cis configuration)

98. (a)

$$\text{Rate of } S_N2 \propto \frac{1}{\text{Steric crowding near reaction centre}}.$$

99. (c) Narrow spectrum antibiotics are effective against Gram–positive or Gram-negative bacteria. Limited spectrum antibiotics are effective against a single organism or disease.

100. (c) At a bridge head position S_N1 and S_N2 do not takes place.

SECTION-B

MATHEMATICS

1. (c) Given $y=\cos^2 x+\sec^2 x$

$\Rightarrow\quad y=\cos^2 x+\dfrac{1}{\cos^2 x}\left(\because \cos x=\dfrac{1}{\sec x}\right)$

$\Rightarrow\quad y=\cos^2 x+\dfrac{1}{\cos^2 x}+2-2$

$\Rightarrow\quad y=\left(\cos x-\dfrac{1}{\cos x}\right)^2+2$

$\Rightarrow\quad y=(\cos x-\sec x)^2+2$

As $(\cos x-\sec x)^2=0$ or positive

$\therefore\quad y=2$ or $y\geq 2$

2. (a) $A=\{2,4,6\}, B=\{2,3,5\}$

Number of relations from A to B $=2^{3\times 3}=2^9$

3. (b) Let $n(P)$ = Number of teachers in Physics

$n(M)$ = Number of teachers in Maths

$n(P\cup M)=n(P)+n(M)-n(P\cap M)$

$20=n(P)+12-4\Rightarrow n(P)=12$

Only Physic's teacher = 8

4. (d) Given $t_n=t_{n+1}+t_{n+2}$

$\Rightarrow ar^{n-1}=ar^n+ar^{n+1}$

$\Rightarrow\quad 1=r+r^2\Rightarrow r^2+r-1=0$

$\Rightarrow r=\dfrac{-1\pm\sqrt{1+4}}{2}$

$\therefore\quad r=\dfrac{-1+\sqrt{5}}{2}$, since $r>0$

Therefore $r=2\sin 18°$

5. (d) Let the vertex C be (h,k), then the centroid of

ΔABC is $\left(\dfrac{2-2+h}{3},\dfrac{-3+1+k}{3}\right)$ or

$\left(\dfrac{h}{3},\dfrac{-2+k}{3}\right)$.

It lies on $2x+3y=1\Rightarrow\dfrac{2h}{3}-2+k=1$

$\Rightarrow 2h+3k=9\quad\therefore$ Locus of C is $2x+3y=9$

6. (a) The equation of parabola parallel to y-axis is

$y=ax^2+bx+c$ ...(1)

Since it passes through the points (0, 4), (1, 9) and (4, 5),

$\therefore\quad 4=0+0+c\Rightarrow c=4$ ...(2)

$9=a+b+c\Rightarrow a+b=5$ ...(3)

$(\because c=4)$

and $5=16a+4b+c\Rightarrow 16a+4b=1$ ...(4)

$(\because c=4)$

Solving (3) and (4), we get

$a=-\dfrac{19}{12}$ and $b=\dfrac{79}{12}$ ... (5)

Substituting the values of a, b and c from (2) and (5) in (1), we obtain the equation of parabola as

$y=-\dfrac{19}{12}x^2+\dfrac{79}{12}x+4$

7. (c) Let $\dfrac{-1+i\sqrt{3}}{2}=\omega$ then $\dfrac{-1-\sqrt{3}i}{2}=\omega^2$

where ω = cube root of unity

Consider $\left(\dfrac{-1+\sqrt{-3}}{2}\right)^{100}+\left(\dfrac{-1-\sqrt{-3}}{2}\right)^{100}$

$=\left(\dfrac{-1+\sqrt{3}i}{2}\right)^{100}+\left(\dfrac{-1-\sqrt{3}i}{2}\right)^{100}$

$=\omega^{100}+\omega^{200}=\omega+\omega^2=-1$

$(\because \omega^3=1$ and $1+\omega+\omega^2=0)$

8. (b) The equation are $3^x\cdot 5^y=75$ ...(1)

and $3^y\cdot 5^x=45$ ...(2)

Dividing the two equations, we get

$\left(\dfrac{3}{5}\right)^{x-y}=\dfrac{75}{45}=\dfrac{5}{3}\Rightarrow x-y=-1$ ...(3)

Multiplying equations (1) and (2), we get

$(15)^{x+y}=45\times 75=(15)^3\Rightarrow x+y=3$ ...(4)

solving (3) and (4) we get x = 1, y = 2
Hence, only one ordered pair that satisfying given equations

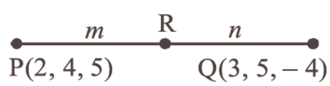
9. **(c)** 30 marks to be alloted to 8 questions. Each question has to be given ≥ 2 marks
Let questions be a, b, c, d, e, f, g, h
and $a+b+c+d+e+f+g+h=30$
Let $a = a_1 + 2$ so, $a_1 \geq 0$
$b = a_2 + 2$ so, $a_2 \geq 0, \ldots\ldots, a_8 \geq 0$

$$\text{So, } \left.\begin{matrix} a_1 + a_2 + \ldots\ldots + a_8 \\ +2+2+\ldots\ldots+2 \end{matrix}\right\} = 30$$

$\Rightarrow a_1 + a_2 + \ldots\ldots + a_8 = 30 - 16 = 14$
So, this is a problem of distributing 14 articles in 8 groups.
Number of ways $= {}^{14+8-1}C_{8-1} = {}^{21}C_7$

10. **(b)** No. of terms in the expansion $= {}^{n+3-1}C_{3-1}$
$\therefore {}^{n+2}C_2 = 45 \Rightarrow n = 8$

11. **(a)** Let the point R divides the line joining the points P (2, 4, 5) and Q (3, 5, –4) in the ratio $m : n$.



$\therefore$ The coordinate of R is

$$\left(\frac{3m-2n}{m+n}, \frac{5m-4n}{m+n}, \frac{-4m+5n}{m+n}\right)$$

Since, the point R is on yz-plane, therefore x-coordinate will be zero.

$$\therefore \frac{3m-2n}{m+n} = 0 \Rightarrow 3m - 2n = 0 \Rightarrow 3m = 2n$$

$$\Rightarrow \frac{m}{n} = \frac{2}{3}$$

12. **(c)** $\lim\limits_{x \to 0} \dfrac{(\cos x - 1)(\cos x - e^x)}{x^n}$

$$= \lim_{x \to 0} \frac{\left(-\frac{x^2}{2!} + \frac{x^4}{4!} + \ldots\ldots\right)\left(-x - x^2 + \ldots\ldots\right)}{x^n}$$

is non-zero $\Rightarrow$ n = 3.

13. **(b)** p : A number is a prime
q : It is odd.
We have $p \Rightarrow q$
The inverse of $p \Rightarrow q$ is $\sim p \Rightarrow \sim q$
i.e., if a number is not a prime then it is not odd.

14. **(a)** Given, $\sigma = 9$.
Let a student obtains x out of 75. Then his marks out of 100 are $\frac{4x}{3}$. Each observation is multiplied by $\frac{4}{3}$

New $\sigma = \frac{4}{3} \times 9 = 12$, Variance $= \sigma^2 = 144$.

15. **(a)** $\because f(x) = \dfrac{x}{x-1}$ $\therefore$ (f o f) (x) = f {f (x)} = f $\left(\dfrac{x}{x-1}\right)$

$$= \frac{\frac{x}{x-1}}{\frac{x}{x-1} - 1} = \frac{\frac{x}{x-1}}{\frac{x-x+1}{x-1}} = \frac{\frac{x}{x-1}}{\frac{1}{x-1}} = x.$$

$$\Rightarrow (f \circ f \circ f)(x) = f(f \circ f)(x) = f(x) = \frac{x}{x-1}$$

$$\Rightarrow \underbrace{(f \circ f \circ f \ldots\ldots \circ f)}_{19 \text{ times}}(x) = f(f \circ f)(x) = f(x) = \frac{x}{x-1}$$

16. **(a)** As $A^2 = 0, A^k = 0 \ \forall \ k \geq 2$.
Thus, $(A+I)^{50} = I + 50A \Rightarrow (A+I)^{50} - 50A = I$
$\therefore$ a = 1, b = 0, c = 0, d = 1
abc + abd + bcd + acd = 0

17. **(a)** $\begin{vmatrix} 1 & \sin A & \sin^2 A \\ 1 & \sin B & \sin^2 B \\ 1 & \sin C & \sin^2 C \end{vmatrix} = 0$

$\Rightarrow (\sin A - \sin B)(\sin B - \sin C)(\sin C - \sin A) = 0$

$\Rightarrow \sin A = \sin B$ or $\sin B = \sin C$ or $\sin C = \sin A$

$\therefore$ atleast two of A, B, C are equal.
Hence the triangle is isosceles or equilateral.

18. **(d)** For $f(x)$ to be continuous at $x = 0$, we should have

$$\lim_{\infty \to 0} f(x) = f(0) = 12(\log 4)^3$$

$\lim\limits_{\infty\to 0} f(x)$

$$= \lim_{x\to 0}\left(\frac{4^x-1}{x}\right)^3 \times \frac{\left(\frac{x}{p}\right)}{\left(\sin\frac{x}{p}\right)} \cdot \frac{px^2}{\log\left(1+\frac{1}{3}x^2\right)}$$

$$= (\log 4)^3 \cdot 1 \cdot p \cdot \lim_{x\to 0}\left(\frac{x^2}{\frac{1}{3}x^2 - \frac{1}{18}x^4 + \dots}\right)$$

$= 3p\,(\log 4)^3 \cdot$ Hence $p = 4$.

19. **(c)** $((\vec{a}\times\vec{b})\times(\vec{c}\times\vec{d})).(\vec{a}\times\vec{d}) = 0$

$\Rightarrow ([\vec{a}\,\vec{c}\,\vec{d}]\vec{b} - [\vec{b}\,\vec{c}\,\vec{d}]\vec{a}).(\vec{a}\times\vec{d}) = 0$

$\Rightarrow \quad [\vec{a}\,\vec{c}\,\vec{d}][\vec{b}\,\vec{a}\,\vec{d}] = 0$

Either $\vec{c}$ or $\vec{b}$ must lie in the plane of $\vec{a}$ and $\vec{d}$.

20. **(c)** $I = \int \frac{dx}{\cos x + \sqrt{3}\sin x}$

$$\Rightarrow I = \int \frac{dx}{2\left[\frac{1}{2}\cos x + \frac{\sqrt{3}}{2}\sin x\right]}$$

$$= \frac{1}{2}\int \frac{dx}{\left[\sin\frac{\pi}{6}\cos x + \cos\frac{\pi}{6}\sin x\right]}$$

$$= \frac{1}{2}.\int \frac{dx}{\sin\left(x+\frac{\pi}{6}\right)}$$

$$\Rightarrow \quad I = \frac{1}{2}.\int \operatorname{cosec}\left(x+\frac{\pi}{6}\right)dx$$

$\int \operatorname{cosec} x\,dx = \log|(\tan x/2)| + C$

$$\therefore \quad I = \frac{1}{2}.\log\tan\left(\frac{x}{2}+\frac{\pi}{12}\right) + C$$

21. **(c)** For $\left(\frac{1}{\sqrt{2}}, \frac{1}{2}, k\right)$ to represent direction cosines, we should have

$$\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{2}\right)^2 + k^2 = 1$$

or, $\frac{1}{2} + \frac{1}{4} + k^2 = 1 \Rightarrow \quad k = \pm\frac{1}{2}$

22. **(b)** Let $f(x) = \sin x - kx - c$ where k and c are constants

$f'(x) = \cos x - k \quad \therefore f$ decreases *if* $\cos x \le k$

Thus, $f(x) = \sin x - kx - c$ decrease always when $k \ge 1$.

23. **(a)** Put $1 + x = t^2 \Rightarrow dx = 2tdt$

Then integral is

$$I = \int_2^3 \frac{2-3(t^2-1)}{(t^2-1)t}2tdt = 2\int_2^3\left[\frac{2}{t^2-1} - 3\right]dt$$

$$= \left[2\ln\frac{t-1}{t+1}\right]_2^3 - 6 = 2\log_e\frac{3}{2} - 6 = 2\log_e\frac{3}{2e^3}$$

24. **(d)** Construct the following table of objective function

Corner Point	Value of F = 4x + 6y	
(0, 2)	$4\times 0 + 6\times 2 = 12$	} ← minimum
(3, 0)	$4\times 3 + 6\times 0 = 12$	
(6, 0)	$4\times 6 + 6\times 0 = 24$	
(6, 8)	$4\times 6 + 6\times 8 = 72$	← maximum
(0, 5)	$4\times 0 + 6\times 5 = 30$	

Since the minimum value (F) = 12 occurs at two distinct corner points, it occurs at every points of the segment joining these two points.

25. **(c)**

$$y = \tan^{-1}\left(\frac{\log_e(e/x^2)}{\log_e(ex^2)}\right) + \tan^{-1}\left(\frac{3+2\log_e x}{1-6\log_e x}\right)$$

$$= \tan^{-1}\left(\frac{1-2\log_e x}{1+2\log_e x}\right) + \tan^{-1}\left(\frac{3+2\log_e x}{1-3.2\log_e x}\right)$$

$= \tan^{-1}(1) - \tan^{-1}(2\log_e x) + \tan^{-1}(3) + \tan^{-1}$ $(2\log_e x)$

$= \tan^{-1}(1) + \tan^{-1}(3)$

$\therefore \quad \frac{dy}{dx} = 0 \quad$ So, $\quad \frac{d^2y}{dx^2} = 0$

26. (b) Required probability

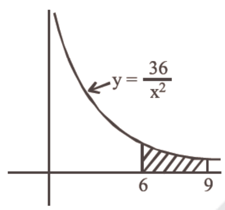
$P(A' \cap B \cap C) + P(A \cap B' \cap C) + P(A \cap B \cap C')$

$= [(1 - P(A)]P(B)P(C) + P(A)[(1 - P(B)]P(C) + P(A)P(B)[(1 - P(C)]$

$= (1-0.4)(0.3)(0.2) + (0.4)(1-0.3)(0.2) + (0.4)(0.3)(1-0.2)$

$= 0.036 + 0.056 + 0.096 = 0.188$

27. (d) $y = \frac{36}{x^2}, x = 6, x = 9$



Desired area $= \int_6^9 \frac{36}{x^2} dx$

$= -36\left[\frac{1}{9} - \frac{1}{6}\right] = 2$

28. (d) $P(X < 1) = \sum_{n=1}^{\infty} p\left(X = \frac{n}{n+1}\right)$

$= \sum_{n=1}^{\infty}\left(\frac{1}{2}\right)^{n+1} = \frac{1}{2}$

Similarly, $P(X > 1) = \frac{1}{2}$

Also, $P\left(\frac{1}{2} < X < 1\right) = \sum_{n=2}^{\infty}\left(\frac{1}{2}\right)^{n+1}$

$= \frac{1}{4} < P(X > 1)$

Note that $P(X > 3/2) = 0 < P(X < 1)$

29. (a) $n(S) = 100$; E = square of terms lies between 1 to 100.

$= 1, 4, 9, 16, 25, 36, 49, 64, 81, 100$; $n(E) = 10$

$\therefore$ Required probability $= \frac{n(E)}{n(S)} = \frac{10}{100} = \frac{1}{10}$

30. (b) Middle term = 6th term = 30

$\Rightarrow a + 5d = 30 \; S_{11}$

$= \frac{11}{2}[2a + 10d] = \frac{11}{2} \times 2[a + 5d] = 11 \times 30 = 330$

31. (a) Let the line make intercept 'a' on x-axis. Then, it makes intercept '$2a$' on y-axis. Therefore, the equation of the line is given by $\frac{x}{a} + \frac{y}{2a} = 1$

It passes through (1, 2), so, we have

$\frac{1}{a} + \frac{2}{2a} = 1$ or $a = 2$

Therefore, the required equation of the line is given by

$\frac{x}{2} + \frac{y}{4} = 1$ or $2x + y = 4$

32. (d) Given equation of circle :

$x^2 + y^2 + 10x - 6y + 9 = 0$ ....(i)

and we know the general equation of the circle is

$x^2 + y^2 + 2gx + 2fy + c = 0$ ....(ii)

On comparing equation (i) and (ii), we get

$g = 5, f = -3$ and $c = 9$

Now, the length of intercept on x-axis

$= 2\sqrt{g^2 - c} = 2\sqrt{(5)^2 - 9} = 2\sqrt{16} = 8$ units

33. (a) Since $(7 + 4\sqrt{3})(7 - 4\sqrt{3}) = 1$,

$\therefore$ The given equation becomes

$y + \frac{1}{y} = 14$ where $y = (7 - 4\sqrt{3})^{x^2 - 4x + 3}$

$\Rightarrow y^2 - 14y + 1 = 0 \Rightarrow y = 7 \pm 4\sqrt{3}$

Now $y = 7 + 4\sqrt{3} \Rightarrow x^2 - 4x + 3 = -1 \Rightarrow x = 2, 2$

Also $y = 7 - 4\sqrt{3} \Rightarrow x^2 - 4x + 3 = 1 \Rightarrow x = 2 \pm \sqrt{2}$

34. (a) $\log_{\sin x} 2^{\tan x} > 0$; $\sin x > 0, \sin x \neq 1$

$0 < \sin x < 1$ in $\left(0, \frac{\pi}{2}\right)$; $\quad 2^{\tan x} < 1$ (not possible)

Thus, the equation has no solution.

35. **(a)** There must be 5 at hundred place, now 2 numbers to be chosen from 5 numbers i.e., ${}^5P_2 = 5 \times 4 = 20$.

36. **(a)** General term of the given binomial series is given by:

$$T_{r+1} = {}^{10}C_r \left\{\frac{x^{1/2}}{3}\right\}^{10-r} . \{x^{-1/4}\}^r$$

Put r = 4, we get $T_5 = {}^{10}C_4 . \frac{1}{3^6} x^3 . x^{-1}$

$$= \frac{10\times 9\times 8\times 7}{4\times 3\times 2\times 1} . \frac{1}{3^6} x^2 = \frac{70}{243} x^2$$

Thus coefficient of $x^2 = \frac{70}{243}$.

37. **(c)** Given,

$$f(x) = \frac{x^{100}}{100} + \frac{x^{99}}{99} + ... + \frac{x^2}{2} + x + 1$$

$$\Rightarrow f'(x) = \frac{100x^{99}}{100} + \frac{99x^{98}}{99} + ... + \frac{2x}{2} + 1 + 0$$

$[\because f(x) = x^n \Rightarrow f'(x) = nx^{n-1}]$

$\Rightarrow f'(x) = x^{99} + x^{98} + ... + x + 1$ ...(i)

Putting x = 1, we get

$$f'(1) = \underbrace{(1)^{99} + 1^{98} + ... + 1 + 1}_{100 \text{ times}}$$

$$= \underbrace{1 + 1 + 1 ... + 1 + 1}_{100 \text{ times}}$$

$\Rightarrow f'(1) = 100$ ...(ii)

Again, putting x = 0, we get

$f'(0) = 0 + 0 + ... + 0 + 1 \Rightarrow f'(0) = 1$ ...(iii)

From eqs. (ii) and (iii), we get; $f'(1) = 100f'(0)$

Hence, m = 100

38. **(a)** The domain of f(x) is all real numbers.

Since $f: R \to A$ is surjective, A must be the range of f(x).

Let f(x) = y, i.e., $y = \frac{x^2}{x^2+1}$

$$\begin{array}{ccccc} - & | & + & | & - \\ & 0 & & 1 & \end{array}$$

or $x^2y + y = x^2$ or $x = \sqrt{\frac{y}{1-y}}$

exists if $\frac{y}{1-y} \geq 0$ or $0 \leq y < 1$ Hence, $A \in [0, 1)$.

39. **(b)** $\tan^{-1}\frac{xy}{zr} + \tan^{-1}\frac{yz}{xr} + \tan^{-1}\frac{xz}{yr}$

$$= \tan^{-1}\left[\frac{\frac{xy}{zr} + \frac{yz}{xr} + \frac{xz}{yr} - \frac{xyz}{r^3}}{1 - \left(\frac{x^2 + y^2 + z^2}{r^2}\right)}\right] = \tan^{-1}\infty = \frac{\pi}{2}$$

40. **(a)** $A^n = \begin{bmatrix} \cos n\theta & \sin n\theta \\ -\sin n\theta & \cos n\theta \end{bmatrix}$

$$\Rightarrow \frac{1}{n}A^n = \begin{bmatrix} \frac{\cos n\theta}{n} & \frac{\sin n\theta}{n} \\ -\frac{\sin n\theta}{n} & \frac{\cos n\theta}{n} \end{bmatrix}$$

But $-1 \leq \cos n\theta \leq 1$ and $-1 \leq \sin n\theta \leq 1$

$$\lim_{n\to\infty} \frac{\sin n\theta}{n} = 0, \lim_{n\to\infty} \frac{\cos n\theta}{n} = 0$$

$$\Rightarrow \lim_{n\to\infty} \frac{1}{n} A^n = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

41. **(b)** $\Delta = \begin{vmatrix} -a & 1 & 1 \\ 1 & -b & 1 \\ 1 & 1 & -c \end{vmatrix} = 0$

for non-zero solution

$\Rightarrow abc - a - b - c - 2 = 0 \Rightarrow abc = a + b + c + 2$

Now, $\frac{1}{1+a} + \frac{1}{1+b} + \frac{1}{1+c}$

$$= \frac{3+2(a+b+c)+(ab+bc+ac)}{1+(a+b+c)+(ab+bc+ac)+abc}$$

$$= \frac{3+2(a+b+c)+(ab+bc+ac)}{1+2(a+b+c)+2+ab+bc+ac} = 1$$

42. **(d)** $f(x)=[x]^2-[x^2]=(-1)^2-(0)^2=0, -1<x<0$

$\Rightarrow 0 < x^2 < 1$

$f(x)=0-0=0,\ 0 \le x < 1$ and $f(x)=1-1=0,$

$1 \le x < \sqrt{3}$ and $f(x)=1-3=-2,\ \sqrt{3} \le x < \sqrt{4}$

$\therefore$ From above it is clear that the function is discontinuous at $\sqrt{n}\ \ \forall\ n \in \mathbf{I}$ except at $x = 1$.

43. **(d)** Let $y = \frac{\ln x}{x}$;

$$\frac{dy}{dx} = \frac{x.\frac{1}{x} - \ln x.1}{x^2} = \frac{1-\log x}{x^2}$$

For maxima, put $\frac{dy}{dx} = 0$

$$\Rightarrow \quad \frac{1-\ln x}{x^2} = 0 \Rightarrow x = e$$

Now, $$\frac{d^2y}{dx^2} = \frac{x^2\left(-\frac{1}{x}\right)-(1-\ln x)2x}{\left(x^2\right)^2}$$

At $x = e$ we have $\frac{d^2y}{dx^2} < 0$

$\therefore$ The maximum value at $x = e$ is $y = \frac{1}{e}$

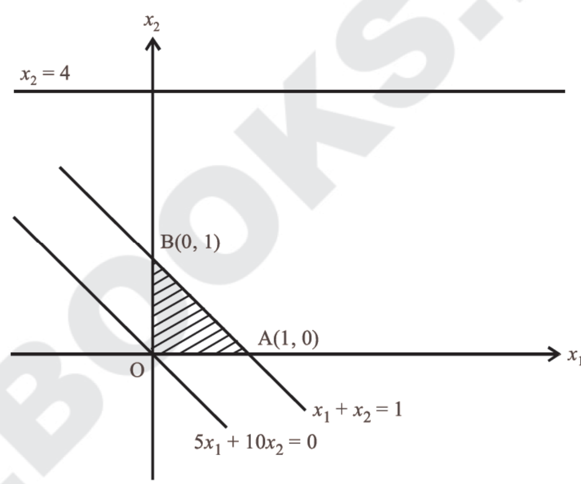
44. **(d)** We have $\int_0^2 f(x)dx = \frac{3}{4}$; Now,

$$\int_0^2 xf'(x)dx = x\int_0^2 f'(x)dx - \int_0^2 f(x)dx$$

$$=[x\ f(x)]_0^2 - \frac{3}{4} = 2f(2) - \frac{3}{4}$$

$$= 0 - \frac{3}{4}\ (\because f(2)=0) = -\frac{3}{4}.$$

45. **(a)** It is clear from the graph that it is bounded solution.



46. **(a)**

$$\int \frac{(x^2-1)}{x\sqrt{x^4+3x^2+1}}dx = \int \frac{(x^2-1)}{x^2\sqrt{x^2+3+\frac{1}{x^2}}}dx$$

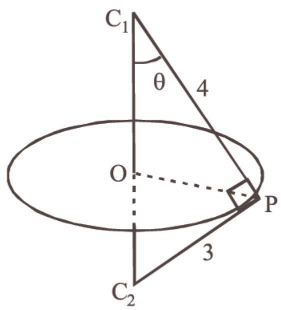
$$= \int \frac{\left(1-\frac{1}{x^2}\right)}{\sqrt{\left(x+\frac{1}{x}\right)^2+1}}dx = \int \frac{dz}{\sqrt{z^2+1}}$$

$$\left[\text{Putting } x+\frac{1}{x} = z \Rightarrow \left(1-\frac{1}{x^2}\right)dx = dz\right]$$

$$= \log\left|z+\sqrt{z^2+1}\right| + C$$

$$= \log\left|x+\frac{1}{x}+\sqrt{x^2+\frac{1}{x^2}+3}\right| + C$$

47. **(b)** For the orthogonal section C_1P and C_2P are pendicular where C_1 and C_2 are centres of sphere of radii 4 and 3 respectively



Now $C_1P = 4$ and $C_2P = 3$, so $\tan\theta = \frac{3}{4}$

$\therefore$ Radius of circle of intersection

$OP = C_1P\sin\theta = 4 \times \frac{3}{5} = \frac{12}{5}$

48. **(d)** Differentiate $xy(x) = x^2y'(x) + 2xy(x)$

or $\quad xy(x) + x^2y'(x) = 0$ or $\quad x\frac{dy}{dx} + y = 0$

or $\quad \ln y + \ln x = \ln c \quad$ or $\quad xy = c$

49. **(a)** $I = \int_1^{e^{37}} \frac{\pi\sin(\pi\log_e x)}{x}dx$

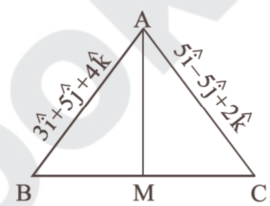
Put $\pi\log_e x = t \Rightarrow \frac{\pi}{x}dx = dt$

$$\therefore \quad I = \int_0^{37\pi}\sin t\,dt = \int_0^{\pi}\sin t\,dt + \int_{\pi}^{\pi+18.2\pi}\sin t\,dt$$

$$= \int_0^{\pi}\sin t\,dt + 18\int_0^{2\pi}\sin t\,dt = 2 + 0 = 2$$

50. **(c)** Let the given vectors be $\overrightarrow{AB} = 3\hat{i} + 5\hat{j} + 4\hat{k}$

and $\overrightarrow{AC} = 5\hat{i} - 5\hat{j} + 2\hat{k}$



Let AM be the median through A

$$\therefore \quad \overrightarrow{AM} = \frac{1}{2}(\overrightarrow{AB} + \overrightarrow{AC})$$

$$= \frac{1}{2}[(3\hat{i} + 5\hat{j} + 4\hat{k}) + (5\hat{i} - 5\hat{j} + 2\hat{k})]$$

$$= \frac{1}{2}(8\hat{i} + 6\hat{k}) = (4\hat{i} + 3\hat{k})$$

$\therefore$ Length of the median AM $= \sqrt{4^2 + 3^2} = 5$ units

(Mock Test-4)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(d)	**6**	(d)	**11**	(b)	**16**	(a)	**21**	(c)	**26**	(a)	**31**	(c)	**36**	(c)	**41**	(b)	**46**	(a)
2	(c)	**7**	(d)	**12**	(d)	**17**	(a)	**22**	(a)	**27**	(a)	**32**	(c)	**37**	(d)	**42**	(a)	**47**	(b)
3	(d)	**8**	(d)	**13**	(d)	**18**	(a)	**23**	(b)	**28**	(a)	**33**	(c)	**38**	(b)	**43**	(a)	**48**	(a)
4	(d)	**9**	(b)	**14**	(d)	**19**	(c)	**24**	(c)	**29**	(d)	**34**	(a)	**39**	(a)	**44**	(c)	**49**	(c)
5	(c)	**10**	(a)	**15**	(a)	**20**	(a)	**25**	(b)	**30**	(a)	**35**	(c)	**40**	(d)	**45**	(b)	**50**	(c)
CHEMISTRY																			
51	(b)	**56**	(b)	**61**	(d)	**66**	(d)	**71**	(d)	**76**	(d)	**81**	(c)	**86**	(c)	**91**	(b)	**96**	(d)
52	(a)	**57**	(d)	**62**	(d)	**67**	(d)	**72**	(a)	**77**	(a)	**82**	(d)	**87**	(c)	**92**	(d)	**97**	(b)
53	(c)	**58**	(b)	**63**	(c)	**68**	(c)	**73**	(c)	**78**	(b)	**83**	(a)	**88**	(a)	**93**	(a)	**98**	(d)
54	(c)	**59**	(c)	**64**	(d)	**69**	(d)	**74**	(d)	**79**	(a)	**84**	(b)	**89**	(b)	**94**	(c)	**99**	(c)
55	(d)	**60**	(d)	**65**	(a)	**70**	(b)	**75**	(d)	**80**	(a)	**85**	(b)	**90**	(b)	**95**	(b)	**100**	(c)
SECTION-B																			
MATHEMATICS																			
1	(a)	**6**	(c)	**11**	(d)	**16**	(a)	**21**	(d)	**26**	(a)	**31**	(a)	**36**	(c)	**41**	(a)	**46**	(b)
2	(d)	**7**	(a)	**12**	(c)	**17**	(b)	**22**	(b)	**27**	(a)	**32**	(c)	**37**	(c)	**42**	(b)	**47**	(a)
3	(a)	**8**	(c)	**13**	(d)	**18**	(a)	**23**	(a)	**28**	(b)	**33**	(a)	**38**	(c)	**43**	(b)	**48**	(a)
4	(b)	**9**	(d)	**14**	(d)	**19**	(b)	**24**	(b)	**29**	(c)	**34**	(b)	**39**	(c)	**44**	(a)	**49**	(c)
5	(c)	**10**	(d)	**15**	(c)	**20**	(b)	**25**	(c)	**30**	(c)	**35**	(a)	**40**	(c)	**45**	(c)	**50**	(c)

SECTION-A

PHYSICS

1. **(d)** Angular velocity $\omega = \frac{\theta}{t} = [M^0L^0T^{-1}]$

2. **(c)** Mass $= 150 \text{ gm} = \frac{150}{1000}\text{kg}$

Force = Mass × acceleration

$= \frac{150}{1000} \times 20\text{N} = 3\text{ N}$

Impulsive force $= F.\Delta t = 3 \times 0.1 = 0.3\ N$

3. **(d)** We know that β

$= \frac{\Delta i_c}{\Delta i_B} = \frac{(3.5-1.0)\times 10^{-3}}{(80-30)\times 10^{-6}} = 50$

4. **(d)**

5. **(c)** modulutaion index (m)

$= \frac{A_m}{A_c} = \frac{M_1 - M_2}{M_1 + M_2} = \frac{20-4}{20+4} = \frac{16}{24} = \frac{2}{3}$

6. **(d)**

7. **(d)**

8. **(d)** $\frac{\Delta r / r}{\Delta l / l} = 0.5 = \frac{1}{2}, \frac{\Delta r}{r} = \frac{1}{2}\frac{\Delta l}{l}$

9. **(b)** As $R^2 = a^2 + b^2 + 2ab\cos\phi$

$\therefore\ a^2 = a^2 + a^2 + 2a^2\cos\varphi$,

$\cos\phi = -\frac{1}{2}$, $\phi = \frac{2\pi}{3}$

10. **(a)** Total energy of rolling body
= translational K.E. + Rotational K.E

$= \frac{1}{2}Mv_{c.m}^2 + \frac{1}{2}I_{c.m}\omega^2$

Where I is the moment of inertia about an axis passing through its C.M. & perpendicular to the plane of body.

For hoop $I_{cm} = MR^2$, $v_{c.m.} = R\omega$

So $\dfrac{\text{Rotational K.E}}{\text{Total energy}} = \dfrac{\frac{1}{2}I_{c.m}\omega^2}{\frac{1}{2}Mv_{c.m.}^2 + \frac{1}{2}I_{c.m.}\omega^2}$

$= \dfrac{\frac{1}{2}MR^2\omega^2}{\frac{1}{2}MR^2\omega^2 + \frac{1}{2}MR^2\omega^2} = 1 : 2$

11. **(b)** Intensity of light transmitted by polariser is half of intensity of unpolarised light.

12. **(d)**

13. **(d)** Kirchhoff's first law is based on conservation of charge and Kirchhoff's second law is based on conservation of energy.

14. **(d)** Let the mass of the gas be m.
At a fixed temperature and pressure, volume is fixed.

Density of the gas, $\rho = \dfrac{m}{V}$

Now $\dfrac{\rho}{P} = \dfrac{m}{PV} = \dfrac{m}{nRT}$

$\Rightarrow \dfrac{m}{nRT} = x$ (By question)

$\Rightarrow xT = \text{constant} \Rightarrow x_1T_1 = x_2T_2$

$\Rightarrow x_2 \Rightarrow \dfrac{x_1T_1}{T_2} = \dfrac{283}{383}x \quad \begin{bmatrix} \therefore & & \\ T_1 & = & 283K \\ T_2 & = & 383K \end{bmatrix}$

15. **(a)**

16. **(a)** Current (I) = 12 A and magnetic field (B) = 3×10^{-5} Wb/m^2. Consider magnetic field $\vec{B}$ at distance r.

Magnetic field, $B = \dfrac{\mu_0 I}{2\pi r}$

$\Rightarrow \quad r = \dfrac{\mu_0 I}{2\pi B} = \dfrac{(4\pi \times 10^{-7}) \times 12}{2 \times \pi \times (3 \times 10^{-5})} = 8 \times 10^{-2}$ m

17. **(a)** After every half-life, the mass of the substance reduces to half its initial value.

$N_0 \xrightarrow{5\text{ years}} \dfrac{N_0}{2} \xrightarrow{5\text{ years}} \dfrac{N_0/2}{2}$

$= \dfrac{N_0}{4} \xrightarrow{5\text{years}} \dfrac{N_0/4}{2} = \dfrac{N_0}{8}$

18. **(a)** $e = \dfrac{d\phi}{dt} = \dfrac{d}{dt}(NBA) = NA\dfrac{dB}{dt}$

$= 100 \times 0.1 \times 0.05 \times \left(\dfrac{0.1 - 0.05}{0.05}\right) = 0.5$ V

19. **(c)**

20. **(a)**

21. **(c)** $v = \dfrac{m_1 v_1 + m_2 v_2}{m_1 + m_2} = \dfrac{a \times b + 0}{a + c} = \dfrac{a\,(b)}{a + c}$.

22. **(a)** $F = 6\pi\eta r v = 6 \times 3.14 \times (8 \times 10^{-5}) \times 0.03 \times 100$
$= 4.52 \times 10^{-3}$ dyne

23. **(b)** According to Wien's law $\lambda_m \propto \dfrac{1}{T}$ and from the figure $(\lambda_m)_1 < (\lambda_m)_3 < (\lambda_m)_2$ therefore $T_1 > T_3 > T_2$.

24. **(c)** $\dfrac{I_1}{I_2} = \dfrac{a_1^2}{a_2^2} = \dfrac{9}{1}$ or $\dfrac{a_1}{a_2} = \dfrac{3}{1}$

$\therefore \quad \dfrac{I_{max}}{I_{min}} = \dfrac{(3+1)^2}{(3-1)^2} = \dfrac{16}{4} = \dfrac{4}{1}$

25. **(b)** As we know, escape velocity,

$V_e = \sqrt{\dfrac{2GM}{R}} = \sqrt{\dfrac{2G}{R} \cdot \left(\dfrac{4}{3}\pi R^3 \rho\right)} \propto R\sqrt{\rho}$

$\therefore \quad \dfrac{V_e}{V_p} = \dfrac{R_e}{R_p}\sqrt{\dfrac{\rho_e}{\rho_p}} \Rightarrow \dfrac{V_e}{V_p} = \dfrac{R_e}{2R_e}\sqrt{\dfrac{\rho_e}{2\rho_e}}$

$\therefore$ Ratio $\dfrac{V_e}{V_p} = 1 : 2\sqrt{2}$

26. **(a)** For an SHM, the acceleration $a = -\omega^2 x$ where ω^2 is a constant. Therefore, $\dfrac{a}{x}$ is a constant. The time period T is also constant. Therefore, $\dfrac{aT}{x}$ is a constant.

27. (a) In coil A, $B = \frac{\mu_0}{4\pi}\frac{2\pi I}{R}$. $\therefore B \propto \frac{I}{R}$;

Hence, $\frac{B_1}{B_2} = \frac{I_1}{R_1}\cdot\frac{R_2}{I_2} = \frac{2}{2} = 1$

28. (a) $Y = 2\times 10^{10}\,Nm^{-2}$; $\frac{\Delta l}{l} = 0.01$

Work done per unit volume

$= \frac{1}{2}\times$ stress $\times$ strain $= \frac{1}{2}\times Y\times$ strain^2

$= \frac{1}{2}Y\left(\frac{\Delta l}{l}\right)^2$

$\therefore\ U = \frac{1}{2}\times 2\times 10^{10}\times\left(\frac{1}{100}\right)^2 = U = 10^6\ Jm^{-3}$

29. (d) Unit positive charge at O will be repelled equally by three charges at the three corners of triangle.

By symmetry, resultant $\vec{E}$ at O would be zero.

30. (a) $W_1 = \frac{1}{2}\times 5\times 10^3\times(0.05)^2$

$\Rightarrow W_2 = \frac{1}{2}\times 5\times 10^3\times(0.10)^2$

$\therefore\ \Delta W = \frac{1}{2}\times 5\times 10^3\times 0.15\times 0.05 = 18.75 J.$

31. (c) As refracted ray emerges normally from opposite surface, $r_2 = 0$

As $A = r_1 + r_2 \therefore r_1 = A$

Now, $\mu = \frac{\sin i_1}{\sin r_1} = \frac{i_1}{r_1} = \frac{i}{A}; i = \mu A$

32. (c) The centre of mass remains at rest because force of attraction is mutual. No external force is acting.

33. (c)

34. (a) According to Faraday's law of electro-magnetic inductions,

$e = \left|L\frac{dI}{dt}\right| \Rightarrow 2 = L\,\frac{(8-2)}{3\times 10^{-2}} \Rightarrow L = 10\ mH$

35. (c) $\tan\delta = \frac{V}{H} = \frac{V}{\sqrt{3}V} = \frac{1}{\sqrt{3}}$

$\therefore\ \delta = 30^\circ = \pi/6$ radian

36. (c) Curve A, B shows expansion. For expansion of a gas,

$W_{isothermal} > W_{adiabatic}$

$P_{isothermal} > P_{adiabatic}$

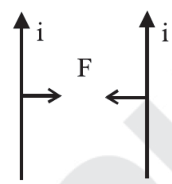
$T_{isothermal} > T_{adiabatic}$

$\Rightarrow$ Slope of curve for isothermal change < slope of curve for adiabatic change.

So, curve B shows isothermal change and curve A shows adiabatic change.

37. (d) $\beta = \frac{D\lambda}{d}$ and $\beta' = \frac{(2D)\lambda}{(d/2)} = 4\beta$

38. (b)



$\frac{F}{\ell} = \frac{\mu_0 i_1 i_2}{2\pi d} = \frac{\mu_0 i^2}{2\pi d}$

(attractive as current is in the same direction)

39. (a) Potential gradient = Potential fall per unit length. In this case resistance of unit length.

$R = \frac{\rho l}{A} = \frac{10^{-7}\times 1}{10^{-6}} = 10^{-1}\Omega$

Potential fall across R is

$V = I.R = 0.1\times 10^{-1} = 0.01$ volt/m.

$= 10^{-2}$ volt / m

40. (d) At equilibrium, weight of the given block is balanced by force due to surface tension, i.e., 2L. S = W

or $S = \frac{W}{2L} = \frac{1.5\times 10^{-2}\,N}{2\times 0.3\,m} = 0.025\,Nm^{-1}$

41. (b) On a banked road,

$\frac{V_{max}^2}{Rg} = \left(\frac{\mu_s + \tan\theta}{1-\mu_s\tan\theta}\right)$

Maximum safe velocity of a car on the banked road

$V_{max} = \sqrt{Rg\left[\frac{\mu_s + \tan\theta}{1-\mu_s\tan\theta}\right]}$

42. (a) Fluid resistance is given by $R = \frac{8\eta L}{\pi r^4}$

When two capillary tubes are joined in series, then equivalent fluid resistance is

$R_S = R_1 + R_2 = \frac{8\eta L}{\pi R^4} + \frac{8\eta\times 2L}{\pi(2R)^4}$

$$= \left(\frac{8\eta L}{\pi R^4}\right) \times \frac{9}{8}$$

Rate of flow $= \frac{P}{R_S} = \frac{\pi P R^4}{8\eta L} \times \frac{8}{9} = \frac{8}{9} X$

$\left[\text{as } X = \frac{\pi P R^4}{8\eta L}\right]$

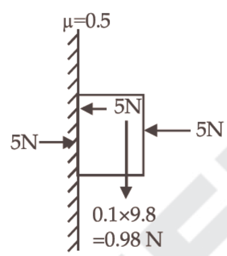
43. **(a)** From $v = n\lambda$, we find $\lambda \propto v$ because freq. n is constant. Therefore, new wavelength $= 4\lambda$.

44. **(c)** The time period of LC oscillations, $T = 2\pi\sqrt{LC}$.

The time at which charge on the capacitor will be zero is $\frac{T}{4}$.

So $t = \frac{\pi}{2}\sqrt{LC}$.

45. **(b)** The magnitude of the frictional force f has to balance the weight 0.98 N acting downwards. Therefore the frictional force = 0.98 N



46. **(a)** $E_k = E - \phi_0 = 6.2 - 4.2 = 2.0$ eV,
$E_k = 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ J

47. **(b)** Object distance u = – 40 cm
Focal length f = – 20 cm
According to mirror formula

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f} \text{ or } \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\text{or } \frac{1}{v} + \frac{1}{-20} - \frac{1}{(-40)} = \frac{1}{-20} + \frac{1}{40}$$

$$\frac{1}{v} = \frac{-2+1}{40} = -\frac{1}{40} \quad \text{or } v = -40 \text{ cm}.$$

Negative sign shows that image is infront of concave mirror. The image is real.

Magnification, $m = \frac{-v}{u} = -\frac{(-40)}{(-40)} = -1$

The image is of the same size and inverted.

48. **(a)** Let T_1 and T_2 be the time period of the two pendulums $T_1 = 2\pi\sqrt{\frac{1}{g}}$ and $T_2 = 2\pi\sqrt{\frac{4}{g}}$

As $\ell_1 < \ell_2$ therefore $T_1 < T_2$

Let longer length pendulum complete n oscillation and shorter length pendulum complete (n + 1) oscillation. For unison swinging

$$(n+1)T_1 = nT_2$$

$$(n+1) \times 2\pi\sqrt{\frac{1}{g}} = (n) \times 2\pi\sqrt{\frac{4}{g}} \Rightarrow n = 1$$

$\therefore n + 1 = 1 + 1 = 2$

49. **(c)** $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$\Rightarrow \frac{1}{970.6 \times 10^{-10}} = 1.097 \times 10^7 \left[\frac{1}{1^2} - \frac{1}{n_2^2}\right] \Rightarrow n_2 = 4$$

$\therefore$ Number of emission line $N = \frac{n(n-1)}{2} = \frac{4 \times 3}{2} = 6$

50. **(c)** Given : r = 30 cm 0.3 m and v = 2t
Radial acceleration at t = 3 sec

$$a_r = \frac{v^2}{r} = \frac{4t^2}{0.3} = \frac{4 \times (3)^2}{0.3} = 120 \text{ m/sec}^2$$

and tangential acceleration

$$a_t = \frac{dv}{dt} = 2 \text{ m/sec}^2$$

CHEMISTRY

51. **(b)** The $\overset{+5}{H N}O_3$ is stronger than $\overset{+3}{H N}O_2$. The more the oxidation state of N, the more is the acid character.

52. **(a)** Since in NaCl type of structure 4 formula units form a cell.
58.5 gm. of NaCl = 6.023×10^{23} atoms

1 gm of NaCl = $\frac{6.023 \times 10^{23}}{58.5}$ atoms

4 atoms constitute 1 unit cell

$\therefore \frac{6.023 \times 10^{23}}{58.5}$ atoms constitute

$$= \frac{6.023 \times 10^{23}}{58.5 \times 4}$$

$= 2.57 \times 10^{21}$ unit cells.

53. **(c)**
$$\overset{1^\circ}{CH_3}-\overset{2^\circ}{CH_2}-\overset{3^\circ}{CH}(\underset{1^\circ}{CH_3})-\overset{4^\circ}{C}(\overset{1^\circ}{CH_3})(\underset{1^\circ}{CH_3})-\overset{2^\circ}{CH_2}-\overset{2^\circ}{CH_2}-\overset{1^\circ}{CH_3};$$

Thus there are five 1° carbon atoms.

54. **(c)** $CH_3CHO \xrightarrow{NaOH} CH_3-CH=CH-CHO$

$\xrightarrow{H_2/Ni} CH_3-CH_2-CH_2-CH_2-OH$

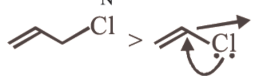
55. **(d)** D-penicillamine is used in treatment of Wilson's disease which is a rare genetic disorder of Cu metablism, penicill amine treatment relies on its binding to accumulated Cu and elimination through urine.

56. **(b)** $3A \longrightarrow 2B$

Rate of appearance of B is equal to rate of disappearance of A.

$$\frac{1}{2}\frac{d[B]}{dt}=-\frac{1}{3}\frac{d[A]}{dt} \Rightarrow \frac{d[B]}{dt}=-\frac{2}{3}\frac{d[A]}{dt}$$

57. **(d)** Rate of S_N2



due to partial D.B. character rate of S_N2 decreases

58. **(b)** Sphere Tetrahedral void Octahedral void

O^{2-}	X^{2+}	Y^{3+}
1	$\frac{2\times 20}{100}$	$\frac{50}{100}$
1	0.4	0.5
10	4	5

Hence formula $X_4Y_5O_{10}$

59. **(c)** $2F_2(g)+2H_2O(l) \rightarrow 4H^+(aq) + 4F^-(aq)+O_2(g)$

$Cl_2(g)+2H_2O(l) \rightarrow HCl(aq)+HOCl$

60. **(d)** Proline contains an imino group i.e., secondary amine.

61. **(d)** $CHCl_3$ on exposure to air forms phosgene which is poisonous gas and removed by converting it into diethyl carbonate (which is non-poisonous substance).

$$CHCl_3 \xrightarrow{O_2/light} \underset{\substack{\text{Phosgene}\\\text{(Poisonous)}}}{COCl_2} + HCl$$

$$COCl_2+2C_2H_5OH \longrightarrow \underset{\substack{\text{Diethyl carbonate}\\\text{(non-poisonous)}}}{(C_2H_5)_2CO_3} + 2HCl$$

62. **(d)** Magnetic moment $\mu=\sqrt{n(n+2)}$ where n = number of unpaired electrons

$\sqrt{15}=\sqrt{n(n+2)}$ $\therefore$ n = 3

63. **(c)** Molar conductance of solution is related to specific conductance as follows :

$$\Lambda_m=\kappa\times\frac{1000}{C} \quad ....(a)$$

where C is molar concentration.

Putting $\kappa=6.3\times10^{-2}$ ohm^{-1} cm^{-1} and $C=0.1$M

$$\Lambda_m=(6.3\times10^{-2}\,ohm^{-1}\,cm^{-1})\times\frac{1000}{(0.1\,mol/cm^3)}$$

$=6.3\times10^{-2}\times10^4$ ohm^{-1}cm^2 mol^{-1}

$=630$ ohm^{-1} cm^2 mol^{-1}

64. **(d)** We know that carbon having

(i) 4 σ bonds correspond to sp^3

(ii) 3 σ and 1 π bond correspond to sp^2

(iii) 2 σ and 2 π bonds correspond to sp

$$\overset{(1)}{H_3C}-\overset{(2)}{C}\equiv\overset{(3)}{C}-\overset{(4)}{CH_3}$$

	(1)	(2)	(3)	(4)
No. of bonds :	4σ	2σ	2σ	4σ
	–	2π	2π	–
Hybridisation :	sp^3	sp	sp	sp^3

Thus, 2-butyne has sp and sp^3 hybridised carbon atoms.

65. **(a)** The stability of +2 O.S. follows the order: $Pb^{2+}>Sn^{2+}>Ge^{2+}$

Hence order of reducing power is: Ge > Sn > Pb

66. **(d)** Given $\Delta H=41$ kJ mol^{-1} = 41000 J mol^{-1}

T = 100°C = 273 + 100 = 373 K

n = 1

$\Delta U=\Delta H-\Delta nRT=41000-(1\times8.314\times373)$

$=37898.88$ J mol^{-1} $\simeq 37.9$ kJmol^{-1}

67. **(d)** Bond angle decreases progressively from $H_2O \rightarrow H_2S \rightarrow H_2Se \rightarrow H_2Te$ due to decreasing *bp-bp* repulsions as the electronegativity of the central atom decreases down the group. H_2O has smaller bond angle in comparison to NH_3 due to presence of two lone pair of electrons. Hence smallest bond angle is in H_2Te.

68. **(c)** For given cell;

$$E_{cell} = \frac{RT}{F}\log\frac{[H^+]_{RHS}}{[H^+]_{LHS}}$$

for max. emf $[H^+]_{LHS}$ should be min. and that is for NH_4OH (aq).

69. **(d)** Vapour phase refining method is used for the purification of titanium, zirconium etc. and is called Van Arkel method.

70. **(b)** Buna – N is a copolymer of butadiene. $(CH_2 = CH - CH = CH_2)$ and acrylonitrile $(CH_2 = CHCN)$.

71. **(d)** Stephen's reaction is used to prepare aldehydes only.

72. **(a)**

$$[Cr(NH_3)_4Cl_2]ClO_3 \rightarrow \underbrace{[Cr(NH_3)_4Cl_2]^- + ClO_2^-}_{\text{2 ions}}$$

73. **(c)** Fire due to action of water on saline hydrides cannot be extinguished with water or CO_2. These hydrides can reduce CO_2 at high temperature to produce O_2.

74. **(d)** Disproportionation involves simultaneous oxidation and reduction of the same atom in a molecule.

75. **(d)**

76. **(d)** $\underset{}{CH_3CH_2OH} \xrightarrow{P+I_2} \underset{(A)}{CH_3CH_2I} \xrightarrow[\text{Ether}]{Mg}$

$$\underset{(B)}{CH_3CH_2MgI} \xrightarrow{HCHO} \underset{(C)}{H-\overset{\displaystyle CH_2CH_3}{\overset{|}{\underset{\displaystyle H}{\underset{|}{C}}}}-OMgI}$$

$$\xrightarrow{H_2O} \underset{\text{(D)}\ \text{n–propyl alcohol}}{H-\overset{\displaystyle CH_2CH_3}{\overset{|}{\underset{\displaystyle H}{\underset{|}{C}}}}-OH}$$

77. **(a)**

78. **(b)** $A \rightarrow B$, For a first order reaction

Given $a = 0.8$ mol, $(a-x) = 0.8 - 0.6 = 0.2$ mol

$$k = \frac{2.303}{1}\log\frac{0.8}{0.2} \text{ or } k = 2.303 \log 4$$

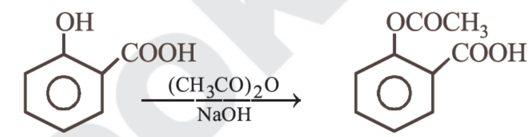
again $a = 0.9$ mol, $a - x = 0.9 - 0.675 = 0.225$ mol

$$k = \frac{2.303}{t}\log\frac{0.9}{0.225}$$

$$2.303 \log 4 = \frac{2.303}{t}\log 4$$

Hence, $t = 1$ hour

79. **(a)**



Salicylic acid → Acetyl salicylic acid (Aspirin)

80. **(a)** Cu_2O is yellow in colour.

81. **(c)**

82. **(d)** Match box is orthorhombic.

83. **(a)** The π bond is formed by the sideways overlapping of two *p*-orbitals of the two carbon atoms.

The molecular plane does not have any π electron density as the *p*-orbitals are perpendicular to the plane containing the ethene molecule. The nodal plane in the π-bond of ethene is located in the molecular plane.

84. **(b)** Given $k_b = x$ K kg mol^{-1}

$\Delta T_b = k_b \times m$

$\therefore\ y = x \times m$

$$m = \frac{y}{x}$$

We know

$\Delta T_f = k_f \times m$

On substituting value of m,

$$\Delta T_f = \frac{yz}{x}$$

85. **(b)** $2MgSO_4 + 2Na_2CO_3 + H_2O \longrightarrow$

$MgCO_3.Mg(OH)_2 + 2Na_2SO_4 + CO_2$

Basic magnesium carbonate

86. (c) PMw = dRT

$$\frac{P_A}{P_B} = \frac{d_A}{d_B} \times \frac{M_B}{M_A} = \frac{4}{1}$$

87. (c)

88. (a) In lanthanides there is a regular decrease in the atomic radii as well as ionic radii of trivalent ions as the atomic number increases from Ce to Lu. This decrease in size of atoms and ions is known as **lanthanide contraction**. Although the atomic radii do show some irregualrities but ionic radii decreases from La to Lu. Thus the correct order is.

$Yb^{+3} < Pm^{+3} < Ce^{+3} < La^{+3}$

86pm 98pm 103pm 106pm

89. (b) Arene diazonium salts are most stable among the given options because of the dispersal of +ve charge on the benzene ring due to resonance.

90. (b) $K = 10^{\frac{6 \times FE^\circ}{2.303\,RT}}$

$$\log 10^{30} = \frac{6 \times E^\circ}{0.0591} \Rightarrow E^\circ = 0.2955\text{ V}$$

91. (b) Flux is used during metallurgy to remove silica and undesirable metal oxides.

92. (d) Rate = $K[A]^2[B]^n$

93. (a)

94. (c)

$[Fe(CN)_6]^{4-} \rightarrow$ 

– no. of unpaired electrons = 0

$[MnCl_4]^{2-} \rightarrow$ 

– no. of unpaired electrons = 5

$[CoCl_4]^{2-} \rightarrow$ 

– no. of unpaired electrons = 3

The greater the number of unpaired electrons, greater the magnitude of magnetic moment. Hence the correct order will be

$$[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$$

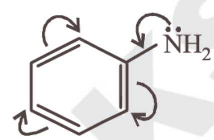
95. (b) Prostaglandin is a non-steroidal hormone.

96. (d) C_2H_5I and C_2H_5OH form non-ideal solution.

97. (b) Due to greater electronegativity of sp^2-hybridized carbon atoms of the benzene ring, diaryl ethers are not attacked by nucleophiles like I^-.

98. (d) Carbon belongs to 2nd period, while iodine belongs to 5th period, hence the C-I bond in $CH_3CH_2CH_2I$ must be formed by the overlapping of $2sp^3$ orbital of C with the $5p_z$ orbital of iodine.

99. (c) (I)



+ R effect

the lone pair of electron is less easily available for protonation.

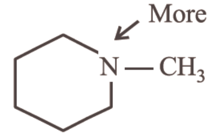
(II)

+ R effect

the lone pair of electron is not available for protonation.

(III)

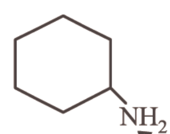
More +I, less H-bonding



+ I, H-bonding

+I more preferred than H-bonding, is due to steric hindrance to H-bonding in 1° amine.

(IV)



+ I, H-bonding

More H-bonding, less +I effect

Unstable Thus, the correct order is (II) < (I) < (IV) < (III)

100. (c) $MF + XeF_4 \longrightarrow M^+\left[XeF_5^-\right]$

sp^3d^3, Pentagonal planar

SECTION-B

MATHEMATICS

1. **(a)** Minimum value of $n = 100 - (30 + 20 + 25 + 15)$
$= 100 - 90 = 10$

2. **(d)** Here $R = \{(x, y) : |x^2 - y^2| < 16\}$
and given $A = \{1, 2, 3, 4, 5\}$
$\therefore$ $R = \{(1, 2)(1, 3)(1, 4); (2, 1)(2, 2)(2,3)(2, 4); (3, 1); (3, 2)(3,3)(3, 4); (4, 1)(4,2)(4, 3); (4, 4), (4, 5), (5, 4)(5, 5)\}$

3. **(a)** $f(x + y) = f(x) + 2y^2 + kxy$
$f(1 + y) = 2 + 2y^2 + ky$, putting $x = 1$
putting $y = 1$, $f(2) = 8 = 2 + 2 + k \Rightarrow k = 4$
$\therefore f(1 + y) = 2 + 2y^2 + 4y = 2(y + 1)^2 \ \therefore f(x) = 2x^2$

4. **(b)** For checking equal function

(a) Domain of $f(x) = R$ but range $= [0, \infty)$
Domain of $g(x) = R$, range $= R$
Domain same but range is different so it is not an equal function.

(b) Domain of $f(x) = R$
Domain of $g(x) = R$
Domain and range both same so it is an equal function.

(c) Domain of $f(x) = R - \{0\}$
Domain of $g(x) = R$
Not equal function as domain is different.

5. **(c)**

$$A = \frac{1}{1 - r^a} \Rightarrow 1 - r^a = \frac{1}{A} \Rightarrow r^a = 1 - \frac{1}{A} = \frac{A - 1}{A}$$

$$B = \frac{1}{1 - r^b} \Rightarrow 1 - r^b = \frac{1}{B} \Rightarrow r^b = 1 - \frac{1}{B} = \frac{B - 1}{B}$$

$$\therefore \ a \log r = \log\left(\frac{A - 1}{A}\right) \text{ and } b \log r = \log\left(\frac{B-1}{B}\right)$$

$$\therefore \frac{a}{b} = \frac{\log\left(\frac{A - 1}{A}\right)}{\log\left(\frac{B - 1}{B}\right)} = \log_{\frac{B-1}{B}}\left(\frac{A - 1}{A}\right)$$

6. **(c)** If a point is equidistant from the two intersecting lines, then the locus of this point is the angle bisector of those lines.

Now, let (h, k) be the point which is equidistant from the lines $4x - 3y + 7 = 0$ and $3x - 4y + 14 = 0$

$$\text{Then } \frac{4h - 3k + 7}{\sqrt{4^2 + (-3)^2}} = \pm \frac{3h - 4k + 14}{\sqrt{3^2 + (-4)^2}}$$

$\Rightarrow 4h - 3k + 7 = \pm(3h - 4k + 14)$
$\Rightarrow$ $h + k - 7 = 0$ and $7h - 7k + 21 = 0$
Hence locus of (h, k) is $x + y - 7 = 0$ and $x - y + 3 = 0$

7. **(a)** The circles $x^2 + y^2 + 2gx + 2fy + c = 0$ and $x^2 + y^2 + 2g_1 x + 2f_1 y + c_1 = 0$
are orthogonal, if $2gg_1 + 2ff_1 = c + c_1$
Thus, in the given question, the condition will be
$2g_1 g_2 + 2f_1 f_2 = c_1 + c_2$.

8. **(c)** $n(S)$ = the area of the circle of radius r

$n(E)$ = the area of the circle of radius $\dfrac{r}{2}$

$$\therefore \text{ The probability } = \frac{n(E)}{n(S)} = \frac{\pi\left(\frac{r}{2}\right)^2}{\pi r^2} = \frac{1}{4}.$$

9. **(d)** Suppose xy-plane divides the line joining the given points in the ratio $\lambda : 1$. The coordinate of the point of division are

$$\left(\frac{2\lambda - 1}{\lambda + 1}, \frac{-5\lambda + 3}{\lambda + 1}, \frac{6\lambda + 4}{\lambda + 1}\right).$$

This point lies on xy-plane.

$$\frac{6\lambda + 4}{\lambda + 1} = 0 \Rightarrow \lambda = -\frac{3}{2}$$

Hence, xy-plane divides externally in the ratio 3 : 2.

10. **(d)** Consider $\displaystyle\lim_{x \to 0}\left(\frac{a^x + b^x + c^x}{3}\right)^{\lambda/x}$

$$= e^{\lim_{x\to 0}\left(\frac{a^x + b^x + c^x}{3} - 1\right)\times\frac{\lambda}{x}}$$

$$= e^{\frac{\lambda}{3}\lim_{x\to 0}\left(\frac{a^x - 1}{x} + \frac{b^x - 1}{x} + \frac{c^x - 1}{x}\right)}$$

$= e^{\lambda\backslash 3}(\log a + \log b + \log c)$

$$= e^{\lambda/3(\log abc)} = (abc)^{\lambda/3}$$

11. **(d)** $2^x + 2^{|x|} \geq 2\sqrt{2}$ ...(i)

Case I. $x \geq 0$, then Eq. (i) becomes

$2^x + 2^x \geq 2\sqrt{2} \Rightarrow 2^x \geq \sqrt{2} \Rightarrow x \geq \frac{1}{2}$

Case II. $x < 0$, then eq. (i) becomes

$2^x + 2^{-x} \geq 2\sqrt{2}$

$\Rightarrow t + \frac{1}{t} \geq 2\sqrt{2}$, where $2^x = t$

$\Rightarrow t^2 - 2\sqrt{2}t + 1 \geq 0$

$\Rightarrow x \leq \log_2(\sqrt{2}-1)$

Also, $0 < \sqrt{2} - 1 < 1$, $\log_2(\sqrt{2}-1) < 0$.

$\therefore$ The solution is

$(-\infty, \log_2(\sqrt{2}-1))] \cup \left[\frac{1}{2}, \infty\right).$

12. **(c)** We have to form 7 digit numbers, using the digits 1, 2 and 3 only, such that the sum of the digits in a number = 10.

This can be done by taking 2, 2, 2, 1, 1, 1, 1, or by taking 2, 3, 1, 1, 1, 1, 1.

$\therefore$ Number of ways $= \frac{7!}{3!4!} + \frac{7!}{5!} = 77.$

13. **(d)** Replace $\log_b a$ by $\frac{\log a}{\log b}$

$$\therefore \Delta = \frac{1}{\log x \log y \log z} \times \begin{vmatrix} \log x & \log y & \log z \\ \log x & 3\log y & \log z \\ \log x & \log y & 5\log z \end{vmatrix}$$

Take log x, log y, log z common from C_1, C_2, C_3 respectively.

$$\Delta = \begin{vmatrix} 1 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 5 \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 \\ 1 & 2 & 0 \\ 1 & 0 & 4 \end{vmatrix} = 1 \times 2 \times 4 = 8$$

14. **(d)** We know that $\sim(p \to q) \equiv p \wedge \sim q$

$\therefore \sim((p \wedge r) \to (r \vee q)) \equiv (p \wedge r) \wedge [\sim(r \vee q)]$

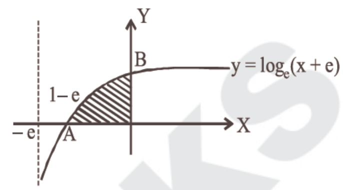
$\equiv (p \wedge r) \wedge (\sim r \wedge \sim q)$

15. **(c)** L.H.L. $= \lim_{x \to 0^-} \frac{\sqrt{1+kx} - \sqrt{1-kx}}{x} = k$

R.H.L $= \lim_{x \to 0^+} \left(2x^2 + 3x - 2\right) = -2$

Since it is continuous, L.H.L = R. H. L $\Rightarrow$ k = –2

16. **(a)** Required area (OAB)



$$= \int_{1-c}^{0} \ln(x+e)dx$$

$$= \left[x\ln(x+e) - \int \frac{1}{x+e} x dx\right]_0^1 = 1.$$

17. **(b)** Since length of the normal $= y\sqrt{1+\left(\frac{dy}{dx}\right)^2}$

According to the question $y\sqrt{1+\left(\frac{dy}{dx}\right)^2} = k$

Squaring on both side, we get

$$y^2\left(1+\left(\frac{dy}{dx}\right)^2\right) = k^2 \Rightarrow y^2 + y^2\left(\frac{dy}{dx}\right)^2 = k^2$$

$$y^2\left(\frac{dy}{dx}\right)^2 = k^2 - y^2$$

$$\therefore \left(y\frac{dy}{dx}\right)^2 = k^2 - y^2$$

18. **(a)** Let $I = \int \frac{x^{n-1}\,dx}{x^{2n} + a^2}$

Let $x^n = t \Rightarrow n \,.\, x^{n-1}\,dx = dt$

$$\therefore \quad I = \int \frac{1}{n} \cdot \frac{dt}{t^2 + a^2} = \frac{1}{n} \cdot \frac{1}{a} \tan^{-1}\left(\frac{t}{a}\right) + C$$

$$= \frac{1}{na} \tan^{-1}\left[\frac{x^n}{a}\right] + C$$

19. **(b)** Here $T_{r+1} = {}^{10}C_r (\sqrt{2})^{10-r}(3^{1/5})^r$, where $r = 0, 1, 2, ...,10$.

We observe that in general term T_{r+1} powers of 2 and 3 are

$\frac{1}{2}(10-r)$ and $\frac{1}{5}r$ respectively and $0 \le r \le 10$.

So both these powers will be integers together only when r

$= 0$ or 10

$\therefore$ Sum of required terms $= T_1 + T_{11}$

$= {}^{10}C_0(\sqrt{2})^{10} + {}^{10}C_{10}(3^{1/5})^{10} = 32 + 9 = 41$

20. **(b)** Let R be a relation defined by aRb, $a \ge b$, where a and b are real number

Reflexivity : If a is real number (given) then $a \ge a$ is true $\Rightarrow$ R is reflexive.

Symmetry : If a and b are two real numbers such that $a \ge b$ then $b \ge a$ is not true

$\Rightarrow$ R is not symmetric.

Transitivity : If a, b and c are the real numbers then $a \ge b, b \ge c \Rightarrow a \ge c \Rightarrow$ R is transitive

Hence, R is reflexive, transitive but not symmetric.

21. **(d)** Let $y = m\log x + nx^2 + x$

$\frac{dy}{dx} = \frac{m}{x} + 2nx + 1$; At $x = 2$, $\frac{dy}{dx} = 0$

$\therefore \frac{m}{2} + 2n\ (2) + 1 = 0$; At $x = 1$, $\frac{dy}{dx} = 0$

$m + 2n + 1 = 0$. Thus, we have $m + 8n + 2 = 0$

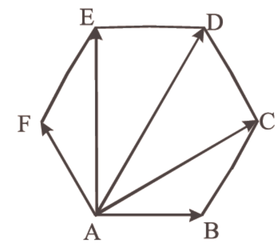
$\therefore 6n + 1 = 0 \therefore \left.\begin{matrix} 6n+1=0 \\ 3m+2=0 \end{matrix}\right\} \Rightarrow n = -\frac{1}{6}$

$m = -\frac{2}{3}$ Hence, $2m + 10n = \frac{-4}{3} - \frac{5}{3} = -3$

22. **(b)** $\because \overline{AB} = \overline{ED}$ and $\overline{AF} = \overline{CD}$, So

$\overrightarrow{AB} + \overrightarrow{AC} + \overrightarrow{AD} + \overrightarrow{AE} + \overrightarrow{AF}$

$= \overrightarrow{ED} + \overrightarrow{AC} + \overrightarrow{AD} + \overrightarrow{AE} + \overrightarrow{CD}$



$= (\overrightarrow{AC} + \overrightarrow{CD}) + (\overrightarrow{AE} + \overrightarrow{ED}) + \overrightarrow{AD}$

$= \overrightarrow{AD} + \overrightarrow{AD} + \overrightarrow{AD} = 3\overrightarrow{AD} \quad \therefore \quad k = 3$

23. **(a)** Let $A = (3, 4, 5)$, $P = (-1, 2, 4)$; $B = (4, 6, 3)$ and $Q = (1, 0, 5)$

$\therefore$ Dr's of line AB are $(4-3), (6-4), (3-5) = 1, 2, -2$

and Dr's of line PQ are $(1+1), (0-2), (5-4) = 2, -2, 1$

$\therefore$ Dc's of line PQ $= \frac{2}{\sqrt{2^2 + (-2)^2 + 1}}, \frac{-2}{3}, \frac{1}{3}$

$= \frac{2}{3}, \frac{-2}{3}, \frac{1}{3}$

$\therefore$ Projection of line segment AB on the line PQ is

$\left|\frac{2}{3}(1) + \left(\frac{-2}{3}\right)(2) + \left(\frac{1}{3}\right)(-2)\right| = \frac{4}{3}$

24. **(b)** $x + iy = \frac{3}{\cos\theta + i\sin\theta + 2}$

$\Rightarrow \frac{1}{x+iy} = \frac{\cos\theta + i\sin\theta + 2}{3}$

$\Rightarrow \frac{x - iy}{(x+iy)(x-iy)} = \frac{1}{3}[(\cos\theta + 2) + i\sin\theta]$

$\Rightarrow \frac{x}{x^2 + y^2} = \frac{1}{3}(\cos\theta + 2)$

$\Rightarrow \frac{x}{x^2+y^2} - \frac{2}{3} = \frac{1}{3}\cos\theta$

and $-\frac{y}{x^2+y^2} = \frac{1}{3}\sin\theta$

Squaring and adding, we get

$$\left(\frac{x}{x^2+y^2}-\frac{2}{3}\right)^2+\left(\frac{-y}{x^2+y^2}\right)^2=\frac{1}{9}$$

$$\Rightarrow \frac{1}{x^2+y^2}(3-4x)+1=0$$

$$\Rightarrow 3-4x=-x^2-y^2$$

$$\Rightarrow 4x-x^2-y^2=3$$

25. **(c)** $A^2=A\cdot A=\begin{bmatrix}1 & 1 & 3\\ 5 & 2 & 6\\ -2 & -1 & -3\end{bmatrix}\begin{bmatrix}1 & 1 & 3\\ 5 & 2 & 6\\ -2 & -1 & -3\end{bmatrix}$

$$=\begin{bmatrix}0 & 0 & 0\\ 3 & 3 & 9\\ -1 & -1 & -3\end{bmatrix}$$

Again, $A^3=A\cdot A^2$

$$=\begin{bmatrix}1 & 1 & 3\\ 5 & 2 & 6\\ -2 & -1 & -3\end{bmatrix}\begin{bmatrix}0 & 0 & 0\\ 3 & 3 & 9\\ -1 & -1 & -3\end{bmatrix}$$

$$=\begin{bmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0 & 0\end{bmatrix}=O$$

Thus, 3 is the least positive integer such that $A^3=O$. So, A is nilpotent with index 3.

26. **(a)** Given that, $x=\exp\left\{\tan^{-1}\left(\frac{y-x^2}{x^2}\right)\right\}$

Taking log on both sides, we get

$$\log x=\tan^{-1}\left(\frac{y-x^2}{x^2}\right)$$

$$\Rightarrow \frac{y-x^2}{x^2}=\tan(\log x)$$

$$\Rightarrow y=x^2\tan(\log x)+x^2$$

On differentiating w.r.t. x, we get

$$\frac{dy}{dx}=2x\tan(\log x)+x^2\frac{\sec^2(\log x)}{x}+2x$$

$$\Rightarrow \frac{dy}{dx}=2x\,[1+\tan(\log x)]+x\sec^2(\log x)$$

27. **(a)** $\int_{1/e}^{e}\frac{dt}{t(1+t)}=\int_{1/e}^{e}\left(\frac{1}{t}-\frac{1}{1+t}\right)dt$

$$=\left[\log t-\log(t+1)\right]_{1/e}^{e}$$

$$=\log\frac{e}{1+e}-\log\frac{1/e}{1+1/e}$$

$$=\log\frac{e}{1+e}-\log\frac{e}{1+e}=0$$

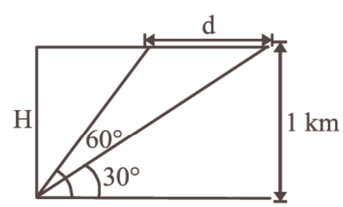
28. **(b)** S = { HHH, HHT, HTH, HTT, THH, THT, TTH, TTT }

E = {HHH, HHT, HTH, THH}; F = {HHH, HHT, HTH, HTT}

$E\cap F$ = {HHH, HHT, HTH}; $n(E\cap F)=3$, $n(F)=4$

$$\therefore \text{Reqd prob.}=P\left(\frac{E}{F}\right)=\frac{n(E\cap F)}{n(F)}=\frac{3}{4}$$

29. **(c)**



$d=H\cot 30°-H\cot 60°$

Time taken = 10 second

$\therefore$ speed

$$=\frac{\cot 30°-\cot 60°}{10}\times 60\times 60$$

$$=240\sqrt{3}$$

30. **(c)** As given, n^{th} term is : $T_n=3n+7$

Sum of n term, $S_n=\sum T_n$

$$=\sum(3n+7)=3\sum n+7\sum 1$$

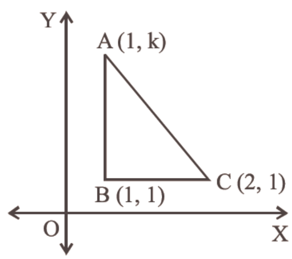
$= \frac{3n(n+1)}{2} + 7n = n\left[\frac{3n+3+14}{2}\right]$

$= n\left[\frac{3n+17}{2}\right]$

Sum of 50 terms $= S_{50} = 50\left[\frac{3\times 50+17}{2}\right]$

$= 50\left[\frac{167}{2}\right] = 25\times 167 = 4175$

31. **(a)** The vertices of a right angled triangle A(l, k), B(1, 1) and C(2, 1) and Area of $\Delta ABC = 1$ square unit



We know that, area of right angled triangle

$= \frac{1}{2}\times BC\times AB = 1 \Rightarrow \frac{1}{2}(1)|(k-1)| = 1$

$\Rightarrow \pm(k-1) = 2 \Rightarrow k = -1, 3$

32. **(c)** Given $a = b^2 - 10b + 25$
Now, $a > 1 \Rightarrow b^2 - 10b + 25 > 1$
$\Rightarrow b^2 - 10b + 24 > 0 \Rightarrow (b-6)(b-4) > 0$

33. **(a)** $f(x) = \sqrt{x-1} + \sqrt{25+(x-1)-10\sqrt{x-1}}$

$= \sqrt{x-1} + \sqrt{(5-\sqrt{x-1})^2}$

$= \sqrt{x-1} + |5-\sqrt{x-1}| = 5$

$[\because \sqrt{x-1} < 5 \text{ for } 1 < x < 26]$

$\therefore \quad f'(x) = 0$

34. **(b)** Let a student gets x marks out of 40. He gets $\frac{5x}{4}$ marks out of 50. Thus, each obseration will be multiplied by $\frac{5}{4}$. Hence, mean is also multiplied by $\frac{5}{4}$ giving mean

$= 38\times\frac{5}{4} = 47.5.$

35. **(a)** Let $a^{\cos x} = y$. The equation converts to

$y + \frac{1}{y} = 6 \Rightarrow y^2 - 6y + 1 = 0$

$\therefore y = \frac{6\pm\sqrt{32}}{2} = 3\pm 2\sqrt{2}$

$\Rightarrow a^{\cos x} = 3\pm 2\sqrt{2} \Rightarrow \cos x = \log_a(3\pm 2\sqrt{2})$

Since $a > 1$ and $-1 \le \cos x \le 1$

$\therefore$ for all real roots we must have

$-1 \le \log_a(3\pm 2\sqrt{2}) \le 1$

$\therefore \log_a(3-2\sqrt{2}) \ge -1$ and $\log_a(3+2\sqrt{2}) \le 1$

$\Rightarrow 3-2\sqrt{2} \ge a^{-1}$ and $3+2\sqrt{2} \le a$

$\Rightarrow \frac{1}{3+2\sqrt{2}} \ge \frac{1}{a}$ and $3+2\sqrt{2} \le a$

$\Rightarrow a \ge 3+2\sqrt{2}$ and $a \ge 3+2\sqrt{2}$

$\therefore a \in [3+2\sqrt{2}, +\infty)$

36. **(c)** The number of committees of 4 gentlemen $= {}^4C_4 = 1$
The number of committees of 3 gentlemen, 1 wife $= {}^4C_3 \times {}^1C_1$
($\because$ after selecting 3 gentlemen only 1 wife is left who can be included)
The number of committees of 2 gentlemen, 2 wives $= {}^4C_2 \times {}^2C_2$
The number of committees of 1 gentleman, 3 wives $= {}^4C_1 \times {}^3C_3$
The number of committees of 4 wives = 1
$\therefore$ The required number of committees
$= 1+4+6+4+1 = 16$

37. **(c)** Since $f:(4, 6) \rightarrow (6, 8) \Rightarrow f(x) = x + 2$

$\therefore \quad f^{-1}(x) = x - 2$

38. **(c)** $f(0) = 0;\ f(x) = xe^{-\left(\frac{1}{|x|}+\frac{1}{x}\right)}$

R.H.L. $\lim\limits_{h\to 0}(0+h)e^{-2/h} = \lim\limits_{h\to 0}\dfrac{h}{e^{2/h}} = 0$

L.H.L. $\lim\limits_{h\to 0}(0-h)e^{-\left(\frac{1}{h}-\frac{1}{h}\right)} = 0$

therefore, $f(x)$ is continuous.

R.H.D $= \lim\limits_{h\to 0}\dfrac{(0+h)e^{-\left(\frac{1}{h}+\frac{1}{h}\right)} - 0}{h} = 0$

L.H.D. $= \lim\limits_{h\to 0}\dfrac{(0-h)e^{-\left(\frac{1}{h}-\frac{1}{h}\right)} - 0}{-h} = 1$

therefore, L.H.D. $\neq$ R.H.D.
$f(x)$ is not differentiable at $x = 0$.

39. **(c)** $I_1 = \int\limits_{1-k}^{k} xf\{x(1-x)\}dx$

$= \int\limits_{1-k}^{k}(k+1-k-x)f[(k+1-k-x)$

$\{1-(k+1-k-x)\}]dx$

$= \int\limits_{1-k}^{k}(1-x)\, f\{(1-x)x\}dx = \int\limits_{1-k}^{k} f\{x(1-x)\}\, dx - \int\limits_{1-k}^{k} xf\{x(1-x)\}\, dx$

$\Rightarrow I_1 = I_2 - I_1 \Rightarrow 2I_1 = I_2 \Rightarrow \dfrac{I_1}{I_2} = \dfrac{1}{2}$

40. **(c)** Let $\vec{a} = x\vec{i} + y\vec{j} + z\vec{k}$

$\vec{a}\times\vec{i} = z\vec{j} - y\vec{k} \Rightarrow (\vec{a}\times\vec{i})^2 = y^2 + z^2$

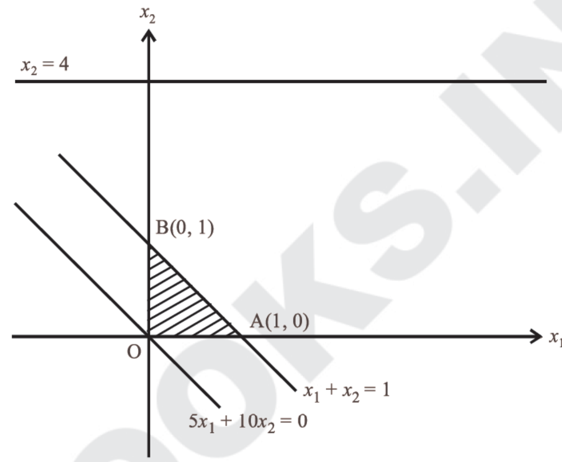
Similarly, $(\vec{a}\times\vec{j})^2 = x^2 + z^2$ and

$(\vec{a}\times\vec{k})^2 = x^2 + y^2$

$\Rightarrow (\vec{a}\times\vec{i})^2 + (\vec{a}\times\vec{j})^2 + (\vec{a}\times\vec{k})^2$

$= 2(x^2 + y^2 + z^2) = 2\vec{a}^2$

41. **(a)** It is clear from the graph that it is bounded solution.



42. **(b)** Probability of all the letters kept in the right envelope is

$\dfrac{1}{n!}$ ($\because$ Total letters $= n$) i.e., $P = \dfrac{1}{n!}$

We know, if q is the term used for the probability of the letters which are not kept in the right envelope.

Then $p + q = 1 \Rightarrow q = 1 - p = 1 - \dfrac{1}{n!}$.

43. **(b)** $I = \int\dfrac{dx}{x\sqrt{1-x^3}} = \int\dfrac{x^2dx}{x^3\sqrt{1-x^3}}$

Put $1 - x^3 = t^2 \Rightarrow -3x^2dx = 2t\,dt$

$I = -\dfrac{2}{3}\int\dfrac{t\ dt}{\left(1-t^2\right).t} = \dfrac{2}{3}\int\dfrac{dt}{t^2-1}$

$= \dfrac{2}{3}.\dfrac{1}{2}\ln\left|\dfrac{t-1}{t+1}\right| + C$

$= \dfrac{1}{3}\ln\left[\dfrac{\sqrt{1-x^3}-1}{\sqrt{1-x^3}+1}\right] + C \quad \therefore a = \dfrac{1}{3},\ b = -1$

44. **(a)** $y^2 = 18x \Rightarrow 2y\frac{dy}{dx} = 18 \Rightarrow \frac{dy}{dx} = \frac{9}{y}$

Given $\frac{dy}{dx} = 2 \Rightarrow \frac{9}{y} = 2 \Rightarrow y = \frac{9}{2}$

Putting in $y^2 = 18x \Rightarrow x = \frac{9}{8}$

$\therefore$ Required point is $\left(\frac{9}{8}, \frac{9}{2}\right)$

45. **(c)** We know that ${}^nC_0{}^2 + {}^nC_1{}^2 + \ldots + {}^nC_n{}^2 = {}^{2n}C_n$

and ${}^nC_0{}^2 - {}^nC_1{}^2 + \ldots + {}^nC_n{}^2$

$$= \begin{cases} 0, \text{if } n \text{ is odd} \\ {}^nC_{n/2}(-1)^{n/2}, \text{if } n \text{ is even} \end{cases}$$

From this ${}^{31}C_0{}^2 - {}^{31}C_0{}^2 + {}^{31}C_2{}^2 - \ldots - {}^{31}C_{31}{}^2 = 0$

${}^{32}C_0{}^2 - {}^{32}C_1{}^2 + {}^{32}C_2{}^2 - \ldots + {}^{32}C_{32}{}^2 = -{}^{32}C_{16}$

${}^{34}C_0{}^2 - {}^{34}C_1{}^2 + {}^{34}C_2{}^2 - \ldots + {}^{34}C_{32}{}^2 = -{}^{34}C_{17}$

${}^{32}C_0{}^2 + {}^{32}C_1{}^2 + {}^{32}C_2{}^2 - \ldots + {}^{32}C_{32}{}^2 = {}^{64}C_{32}$

Obviously ${}^{64}C_{32}$ is greatest.

46. **(b)** We have,

$\tan^{-1}\frac{x}{\pi} < \frac{\pi}{3} \Rightarrow \tan\left(\tan^{-1}\frac{x}{\pi}\right) < \tan\frac{\pi}{3}$

$\Rightarrow \frac{x}{\pi} < \sqrt{3} \Rightarrow x < \sqrt{3}\pi = 5.5$ (approx.)

$\therefore$ the maximum value of x is 5.

47. **(a)** $(A-2I)(A+I) = 0 \quad \Rightarrow AA - A - 2I = 0$

$\Rightarrow A\left(\frac{A-I}{2}\right) = I \qquad \therefore \frac{A-I}{2} = A^{-1}$

48. **(a)** We have

$(x^2+1)\frac{dy}{dx} + 2xy = x^2 - 1$

$\Rightarrow \frac{dy}{dx} + \frac{2xy}{x^2+1} = \frac{x^2-1}{x^2+1}$

Here, $P = \frac{2x}{x^2+1}$ and $Q = \frac{x^2-1}{x^2+1}$

Integrating factor $= e^{\int P dx} = e^{\int \frac{2x}{x^2+1}dx}$

Let $x^2 + 1 = t \Rightarrow 2xdx = dt$

$\therefore$ I.F $= e^{\int \frac{1}{t}dt} = e^{\log t} = e^{\log(x^2+1)} = x^2 + 1$

49. **(c)** Given curves are $y = e^x$ and $y = e^{-x}$

Now, $e^x = e^{-x} \Rightarrow x = 0$

$\therefore$ Area $= A = \int_0^1 (e^x - e^{-x})dx = (e^x + e^{-x})_0^1$

$= \left[(e + e^{-1}) - (e^0 + e^{-0})\right] = e + \frac{1}{e} - 2.$

50. **(c)** Any point on the line is $(r+3, 2r+4, 2r+5)$.

It lies on the plane $x + y + z = 17$,

$\therefore \quad (r+3) + (2r+4) + (2r+5) = 17$ i.e $r = 1$

Thus the point of intersection of the plane and the line is (4, 6, 7)

Required distance = distance between (3, 4, 5) and (4, 6, 7)

$= \sqrt{\{(4-3)^2 + (6-4)^2 + (7-5)^2\}} = 3$

(Mock Test-5)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(c)	**6**	(b)	**11**	(c)	**16**	(d)	**21**	(a)	**26**	(a)	**31**	(a)	**36**	(c)	**41**	(a)	**46**	(c)
2	(d)	**7**	(c)	**12**	(a)	**17**	(b)	**22**	(c)	**27**	(c)	**32**	(a)	**37**	(a)	**42**	(c)	**47**	(a)
3	(d)	**8**	(c)	**13**	(d)	**18**	(d)	**23**	(a)	**28**	(a)	**33**	(b)	**38**	(b)	**43**	(d)	**48**	(d)
4	(a)	**9**	(d)	**14**	(c)	**19**	(b)	**24**	(b)	**29**	(b)	**34**	(c)	**39**	(a)	**44**	(b)	**49**	(b)
5	(d)	**10**	(b)	**15**	(d)	**20**	(b)	**25**	(b)	**30**	(a)	**35**	(b)	**40**	(b)	**45**	(b)	**50**	(c)
CHEMISTRY																			
51	(c)	**56**	(d)	**61**	(c)	**66**	(c)	**71**	(d)	**76**	(b)	**81**	(a)	**86**	(d)	**91**	(b)	**96**	(c)
52	(a)	**57**	(b)	**62**	(a)	**67**	(a)	**72**	(a)	**77**	(b)	**82**	(d)	**87**	(a)	**92**	(d)	**97**	(d)
53	(b)	**58**	(b)	**63**	(b)	**68**	(b)	**73**	(c)	**78**	(b)	**83**	(b)	**88**	(d)	**93**	(c)	**98**	(a)
54	(c)	**59**	(d)	**64**	(b)	**69**	(b)	**74**	(a)	**79**	(d)	**84**	(b)	**89**	(a)	**94**	(c)	**99**	(b)
55	(d)	**60**	(d)	**65**	(d)	**70**	(a)	**75**	(c)	**80**	(b)	**85**	(d)	**90**	(c)	**95**	(a)	**100**	(d)
SECTION-B																			
MATHEMATICS																			
1	(d)	**6**	(b)	**11**	(b)	**16**	(b)	**21**	(a)	**26**	(d)	**31**	(d)	**36**	(a)	**41**	(b)	**46**	(b)
2	(d)	**7**	(a)	**12**	(a)	**17**	(a)	**22**	(c)	**27**	(c)	**32**	(d)	**37**	(a)	**42**	(c)	**47**	(d)
3	(c)	**8**	(d)	**13**	(d)	**18**	(a)	**23**	(b)	**28**	(b)	**33**	(c)	**38**	(b)	**43**	(d)	**48**	(a)
4	(d)	**9**	(b)	**14**	(b)	**19**	(c)	**24**	(b)	**29**	(c)	**34**	(c)	**39**	(a)	**44**	(d)	**49**	(b)
5	(b)	**10**	(a)	**15**	(a)	**20**	(b)	**25**	(c)	**30**	(c)	**35**	(a)	**40**	(c)	**45**	(c)	**50**	(c)

SECTION-A

PHYSICS

1. **(c)** The magnetic field at a point due to a current carying conductor is directly proportional to the current flowing through the conductor.

2. **(d)** The work done is stored as the potential energy. The potential energy stored in a capacitor is given by

$$U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2} \times \frac{\left(8 \times 10^{-18}\right)^2}{100 \times 10^{-6}}$$

$$= 32 \times 10^{-32}\,\text{J}$$

3. **(d)** Wave length, $\lambda = 6000$ Å

$= 6000 \times 10^{-10}$m

Slit width a = 0.1 mm = 0.1×10^{-3} m

In case of diffraction at single slit, the position of second minima is given by

$$\theta_2 = \frac{2\lambda}{a}$$

Substituting the values, we get,

$$\theta_2 = \frac{2 \times 6000 \times 10^{-10}}{0.1 \times 10^{-3}} = 0.012 \text{ radian.}$$

4. **(a)** Velocity in SHM is given by

$$v = \omega\sqrt{a^2 - y^2}$$

At $y = 4\text{ cm} = 0.04\text{ m}, v = 3\text{ m/s}$

$$\therefore\ 3 = \omega\sqrt{a^2 - (0.04)^2} \quad ....(1)$$

At $y = 3\text{ cm} = 0.03\text{ m}, v = 4\text{ m/s}$

$$\therefore\ 4 = \omega\sqrt{a^2 - (0.03)^2} \quad ....(2)$$

Dividing (2) by (1), we get $a = 0.05 = 5$ cm

5. **(d)** Since gravitational acceleration on earth is defined as $g_e = \dfrac{GM_e}{R_e{}^2}$ ....(i)

mass of planet is $M_P = \dfrac{M_e}{80}$ & radius

$R_P = \dfrac{R_e}{4}$

So $g_P = \dfrac{GM_P}{R_P^2}$ ……(ii)

From (i) & (ii), we get

$$g_P = g_e \frac{M_P}{R_P^2} \times \frac{R_e{}^2}{M_e} = \frac{g_e}{5} = 2\text{m/s}^2$$

(as $g = 10\text{m/s}^2$)

6. **(b)** Magnetic moment, $M = m\ell \Rightarrow \dfrac{M}{\ell} = m$, where m is the polestrength.

Therefore distance between poles

$= \sqrt{(\ell/2)^2 + (\ell/2)^2} = \dfrac{\ell}{\sqrt{2}}$ So,

$$M' = \frac{m\ell}{\sqrt{2}} = \frac{M}{\sqrt{2}}$$

7. **(c)** $B = \dfrac{H}{\cos\theta} = \dfrac{0.50}{\cos 30^\circ} = \dfrac{0.50 \times 2}{\sqrt{3}} = 1/\sqrt{3}$

8. **(c)** $P = E_{rms} i_{rms} \cos\phi = \dfrac{E_0}{\sqrt{2}} \times \dfrac{I_0}{\sqrt{2}} \times \dfrac{R}{Z}$

$$\Rightarrow \frac{E_0}{\sqrt{2}} \times \frac{E_0}{Z\sqrt{2}} \times \frac{R}{Z} \Rightarrow P = \frac{E_0^2 R}{2Z^2}$$

Given $X_L = R$ so $Z = \sqrt{2}R \Rightarrow P = \dfrac{E_0^2 R}{4R^2} = \dfrac{E_0^2}{4R}$

9. **(d)**

10. **(b)** In an amplitude modulated wave side band frequency gap is twice that of the message signal.

11. **(c)** $n_1 u_1 = n_2 u_2$

$$\therefore\ n_2 = n_1 \frac{u_1}{u_2} = 8\left[\frac{1}{20}\right]\left[\frac{5}{1}\right]^3 = 50.$$

12. **(a)** Excitation energy $\Delta E = E_2 - E_1 = 13.6\, Z^2 \left[\dfrac{1}{1^2} - \dfrac{1}{2^2}\right]$

$$\Rightarrow 40.8 = 13.6 \times \frac{3}{4} \times Z^2 \Rightarrow Z = 2.$$

Now required energy to remove the electron from ground state

$$= \frac{+13.6Z^2}{(1)^2} = 13.6(Z)^2 = 54.4\text{ eV}.$$

13. **(d)** Friction is the retarding force for the block

$F = ma = \mu R = \mu mg$

Therefore, from the first equation of motion

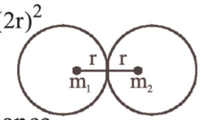
$v = u - at$

$$0 = V - \mu g \times t \Rightarrow \frac{V}{\mu g} = t$$

14. **(c)** The gravitational force of attraction between two identical spheres of radius r is

$$F = \frac{Gm_1m_2}{r^2} = \frac{G\frac{4}{3}\pi r^3\rho \times \frac{4}{3}\pi r^3\rho}{(2r)^2}$$

$= \dfrac{4}{9}\pi^2 p^2 r^4$ ie. $F \propto r^4$



15. **(d)** Coefficient of performance,

$$Cop = \frac{T_2}{T_1 - T_2}$$

$$5 = \frac{273 - 20}{T_1 - (273 - 20)} = \frac{253}{T_1 - 253}$$

$5T_1 - (5 \times 253) = 253$

$5T_1 = 253 + (5 \times 253) = 1518$

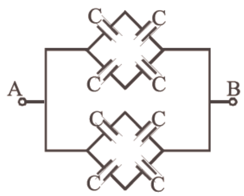
$$\therefore\ T_1 = \frac{1518}{5} = 303.6$$

or, $T_1 = 303.6 - 273 = 30.6 \cong 31°\text{C}$

16. **(d)** $\beta = \dfrac{\lambda D}{d} = \dfrac{5000 \times 10^{-10} \times 0.9}{3 \times 10^{-3}}\text{ m}$

$= 1.5 \times 10^{-4}\text{ m} = 0.15\text{ mm}$

17. (b)



The figure shows two independent balanced wheatstone Bridges connected in parallel each having a capacitance C. So, $C_{net} = C_{AB} = 2C$

18. (d) $eV_s = \frac{hc}{\lambda} - W_0$. If λ decreases, V_s increases

19. (b) $\varepsilon = M\frac{di}{dt}$ or $8 = M\left[\frac{(4-2)}{0.05}\right]$

$\therefore \quad M = \frac{8 \times 0.05}{2} = 0.2$ henry

20. (b)

21. (a) $\vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 2 \\ 0 & 4 & -3 \end{vmatrix}$

$\vec{v} = \hat{i}[6-8] + \hat{j}[0+3] + \hat{k}[4-0]$

$\vec{v} = -2\hat{i} + 3\hat{j} + 4\hat{k} \Rightarrow |\vec{v}| = \sqrt{29}$ units.

22. (c) $F = ma \Rightarrow$

$a = \frac{F}{m} = \frac{5 \times 10^4}{3 \times 10^7} = \frac{5}{3} \times 10^{-3} \text{ms}^{-2}$

Also, $v^2 - u^2 = 2as$

$\Rightarrow \quad v^2 - 0^2 = 2 \times \frac{5}{3} \times 10^{-3} \times 3 = 10^{-2}$

$\Rightarrow v = 0.1 \text{ ms}^{-1}$

23. (a) Angular momentum $L = m(v \times r)$

$2\,\text{kg}\left(\frac{dr}{dt} \times r\right) = 2\,\text{kg}(4t\,j \times 5i - 2t^2 \hat{j})$

$= 2\,\text{kg}(-20\,t\,\hat{k}) = 2\,\text{kg} \times -20 \times 2\,\text{m}^{-2}\,\text{s}^{-1}\,\hat{k} = -80\,\hat{k}$

24. (b)

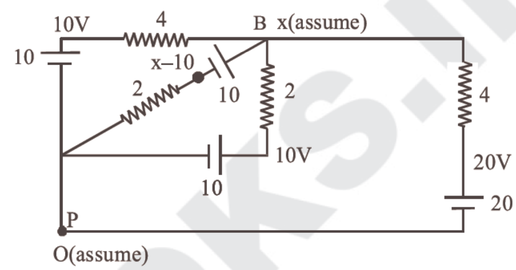
25. (b) Under isothermal conditions, there is no change in internal energy.

26. (a) $E_k = \frac{1}{2}mv^2$ or $mv = \sqrt{2E_k m}$ and

$r = \frac{mv}{Bq} = \frac{\sqrt{2E_k m}}{Bq}$

27. (c) $Y = \frac{F/A}{\Delta\ell/\ell} = \frac{\frac{250 \times 9.8}{50 \times 10^{-6}}}{\frac{0.5 \times 10^{-3}}{2}} \Rightarrow 19.6 \times 10^{10}\,\text{N/m}^2$

28. (a) The simplified circuit is



We have to find I.

Let potential of point P be 0. Potential at other points are shown in the figure apply Kirchoff's current law at B where potential is assume to be x volt.

$$\frac{x-10}{4} + \frac{x-10}{2} + \frac{x-20}{4} + \frac{(x-10)-0}{2} = 0$$

$\Rightarrow x - 10 + 2x - 20 + x - 20 + 2x - 20 = 0$

$\Rightarrow 6x = 70 \Rightarrow x = \frac{35}{3}$ volt

$\therefore \quad I = \frac{20 - \frac{35}{3}}{4} = \frac{25}{12}\,\text{A}$

29. (b) $m_1v_1 + m_2v_2 = (m_1 + m_2)v_{sys.}$

$20 \times 10 + 5 \times 0 = (20+5)v_{sys} \Rightarrow v_{sys} = 8m/s$

K. E. of composite mass

$= \frac{1}{2}(20+5) \times (8)^2 = 800J$

30. (a)

31. (a) Frequency (n) = 4.2 MHz = 4.2×10^6 Hz and speed of sound (v) = 1.7 km/s = 1.7×10^3 m/s. Wave length of sound in tissue

$(\lambda) = \frac{v}{n} = \frac{1.7 \times 10^3}{4.2 \times 10^6} = 4 \times 10^{-4}\,\text{m}$.

32. (a)

33. **(b)** By theorem of parallel axes,
$I = I_{cm} + Md^2$
$I = I_0 + M(L/2)^2 = I_0 + ML^2/4$

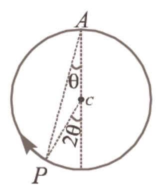
34. **(c)** We can assume that three particles of equal mass m are placed at the corners of triangle

$\vec{r}_1 = 0\hat{i} + 0\hat{j}, \vec{r}_2 = b\hat{i} + 0\hat{j}$ and $\vec{r}_3 = 0\hat{i} + h\hat{j}$

$$\therefore \overrightarrow{r_{cm}} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3} = \frac{b}{3}\hat{i} + \frac{h}{3}\hat{j}$$

i.e. coordinates of centre of mass is $\left(\frac{b}{3}, \frac{h}{3}\right)$

35. **(b)** From the geometry of the figure, the angle traverses about A and C are θ and 2θ respectively. So



$$\omega_A = \frac{\theta}{t} \text{ and } \omega_C = \frac{2\theta}{t} = 2\omega_A.$$

36. **(c)**

37. **(a)**

38. **(b)** If q is the required charge, then

$$\frac{q^2}{2C} = \frac{1}{2}\frac{Q^2}{2C}$$

$$\therefore \ q = \frac{Q}{\sqrt{2}}.$$

39. **(a)** When a body falls through a viscous liquid, its velocity increases due to gravity but after some time its velocity becomes uniform because of viscous force becoming equal to the gravitational force. Viscous force itself is a variable force which increases as velocity increases, so curve (a) represents the correct alternative.

40. **(b)** $e = \frac{d\phi}{dt} = \frac{d}{dt}(NBA) = NA\frac{dB}{dt} = 500 \times 10^{-2} \times 1 = 5.0\,V$

41. **(a)** Since VP^2 = constant,

$$VP^2 = 2VP'^2$$

$$\therefore P' = \frac{P}{\sqrt{2}}$$

As $\frac{P}{T}$ = constant or $T \propto P$, thus T becomes $T/\sqrt{2}$

42. **(c)** A tuning fork of frequency 256 Hz makes 5 beats/second with the vibrating string of a piano. Therefore, the frequency of the vibrating string of piano is (256 ± 5) Hz. i.e., either 261Hz or 251 Hz. When the tension in the piano string increases, its frequency will increases. Now since the beat frequency decreases, we can conclude that the frequency of piano string is 251Hz

43. **(d)** $$Q' = \frac{\pi(2P)\left(\frac{a}{2}\right)^4}{8\eta\ell} = \frac{Q}{8}$$

$$\left[\because Q = \frac{\pi P a^4}{8\eta\ell}\right]$$

44. **(b)** Here, $\vec{F}_{AB} + \vec{F}_{BCDA} = \vec{0}$

$\Rightarrow \vec{F}_{BCDA} = -\vec{F}_{AB} = -\vec{F}$

$(\because F_{AB} = \vec{F})$

45. **(b)** given : ${}^a\mu_g = \frac{1}{2}, {}^a\mu_w = \frac{1}{\sqrt{3}}$

$$\because \ {}^a\mu_w \times {}^w\mu_g = {}^a\mu_g$$

$$\therefore \ {}^w\mu_g = \frac{{}^a\mu_g}{{}^a\mu_w} = \frac{1/2}{1/\sqrt{3}} = \frac{\sqrt{3}}{2}$$

46. **(c)** As surface area decreases so energy is released.
Energy released $= 4\pi R^2 T[n^{1/3} - 1]$
where $R = n^{1/3} r$

$$= 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right] = 3VT\left[\frac{1}{r} - \frac{1}{R}\right]$$

47. **(a)** $$\frac{E_1}{E_2} = \frac{\sigma(T_1^4 - T_0^4)}{\sigma(T_2^4 - T_0^4)} = \frac{(600)^4 - (300)^4}{(500)^4 - (300)^4} = 2:1$$

48. **(d)**

49. (b) The incident angle is 45°.
Incident angle > critical angle, $i > i_c$

$\therefore \sin i > \sin i_c$ *or* $\sin 45 > \sin i_c$

$$\sin i_c = \frac{1}{n}$$

$$\therefore \sin 45° > \frac{1}{n} \ or \ \frac{1}{\sqrt{2}} > \frac{1}{n} \Rightarrow n > \sqrt{2}$$

50. (c) Velocity of source

$$v_s = r\omega = 0.50 \times 20 = 10 \text{ ms}^{-1}$$

$$n' = \frac{v}{v+v_s} n = \frac{340 \times 385}{340+10} = 374 \ Hz$$

CHEMISTRY

51. (c) In a *fcc* lattice, the distance between the cation and anion is equal to the sum of their radii, which is equal to half of the edge length of unit cell,

i.e. $r^+ + r^- = \frac{a}{2}$ (where a = edge length)

$r^+ = 95$ pm, $r^- = 181$ pm

Edge length

$= 2r^+ + 2r^- = (2 \times 95 + 2 \times 181)$ pm

$= (190 + 362)$ pm $= 552$ pm.

52. (a) 27 g of Al is obtained by charge of 3×96500 C.

$\therefore$ 1 gm of Al is obtained by charge of

$$3 \times \frac{96500}{27} \text{C.}$$

$\therefore 5.12 \times 10^3$ g of Al is obtained by charge of

$$= 3 \times \frac{96500}{27} \times 5.12 \times 1000$$

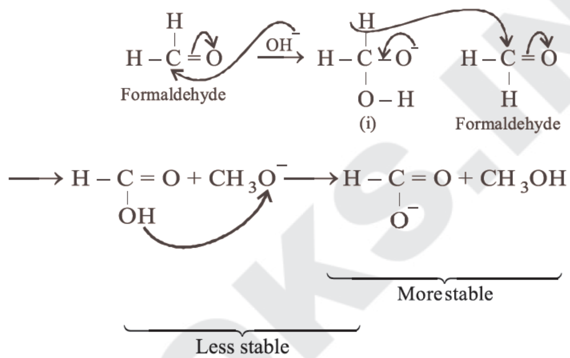
$$= 5.49 \times 10^7 \text{C.}$$

53. (b) SBR is styrene-butadiene rubber, is a synthetic rubber.

54. (c) In the Cannizzaro reaction, two moles of carbonyl compounds having no α-hydrogen atom when treated with strong alkali undergo, redox or disproportionation reaction.

$$2\text{H}-\overset{\overset{\text{H}}{|}}{\text{C}}=\text{O} \xrightarrow{\text{NaOH}} \text{H}-\overset{\overset{\text{O}}{||}}{\text{C}}-\text{ONa} + \text{CH}_3\text{OH}$$

Mechanism : First of all, base OH^- acts as a nucleophile and attacks one of carbonyl compounds to generate a hydroxy alkoxide ion which acts as a hydride ion donor to the other molecule of carbonyl compound. In the final step there is a exchange of proton from acid to alkoxide ion to get stable product.



55. (d) d^5 — strong ligand field

t_{2g}: $[\uparrow\downarrow][\uparrow\downarrow][\uparrow]$ e_g: $[\ ][\ ]$

$\mu = \sqrt{n(n+2)} = \sqrt{3} = 1.73$ B.M.

d^3 — in weak as well as in strong field

t_{2g}: $[\uparrow][\uparrow][\uparrow]$ e_g: $[\ ][\ ]$

$\mu = \sqrt{3(5)} = \sqrt{15} = 3.87$ B.M.

d^4 – in weak ligand field

t_{2g}: $[\uparrow][\uparrow][\uparrow]$ e_g: $[\uparrow][\ ]$

$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.89$ B.M.

d^4 – in strong ligand field

t_{2g}: $[\uparrow\downarrow][\uparrow][\uparrow]$ e_g: $[\ ][\ ]$

$\mu = \sqrt{2(4)} = \sqrt{8} = 2.82$ B.M.

56. (d) Molecularity of the reaction does not influence the rate of reaction.

57. (b) Reduction of alkynes with Na/liq. NH_3 gives trans-alkenes.

58. (b) The face centered cubic unit cell contains 4 atom

$\therefore$ Total volume of atoms

$$= 4 \times \frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$$

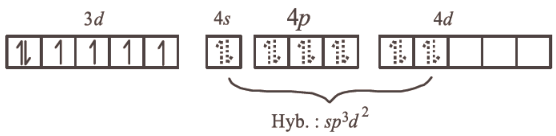
59. **(d)** BF_4^- hybridisation sp^3, tetrahedral structure.

NH_4^+ hybridisation sp^3, tetrahedral structure.

60. **(d)** $CH_3CN \xrightarrow{\text{Reduction}} CH_3-CH_2-NH_2$

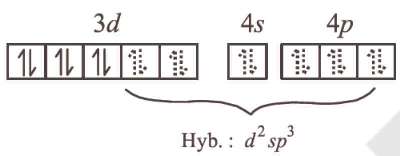
$\xrightarrow{\text{HONO}} CH_3-CH_2-OH + N_2 + H_2O$

61. **(c)** Fe^{2+} in $[Fe(H_2O)_6]^{2+}$



Colour : Pale green $\mu = 4.9$ B.M.; octahedral

Fe^{2+} in $[Fe(CN_6)]^{4-}$



Colour : Yellow; $\mu = 0$; octahedral

62. **(a)** Chalcopyrite : $CuFeS_2$

Fool's gold : FeS_2

Carnalite : $KMgCl_3.6H_2O$

Bauxite : $Al_2O_3.2H_2O$

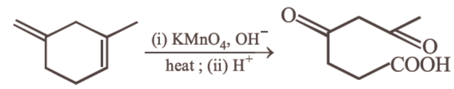
63. **(b)** Specific resistance = x

$\therefore$ Specific conductance (or conductivity)

$$= \kappa = \frac{1}{x}.$$

$$\therefore \Lambda_{eq} = \frac{\kappa \times 1000}{N} = \frac{1000}{xN}$$

64. **(b)** Alkenes are oxidatively cleaved by hot alk. $KMnO_4$ in the following way. The terminal CH_2 group ($=CH_2$) is completely oxidised to CO_2 and H_2O ; a monosubstituted atom of a double bond is converted to aldehyde which is further oxidised to carboxylic acid, and the disubstituted atom of a double bond is oxidised to ketone.



$+ CO_2$

65. **(d)** It forms calcium and magnesium complex with Ca^{2+} and Mg^{2+} ions present in hard water.

66. **(c)**

67. **(a)** $E° = \frac{0.0591}{2} \log K_{eq} ; \log K_{eq} = \frac{2 \times 0.22}{0.0591}$

$\Rightarrow$ 7.44 or $K_{eq} \approx 2.8 \times 10^7$

68. **(b)** $\underset{\text{(glass)}}{2XeF_6 + SiO_2} \longrightarrow \underset{\text{(explosive nature)}}{2XeOF_4} + SiF_4$

$2XeOF_4 + SiO_2 \longrightarrow 2XeO_2F_2 + SiF_4$

$2XeO_2F_2 + SiO_2 \longrightarrow \underset{\text{(explosive)}}{2XeO_3} + SiF_4$

69. **(b)** For a first order reaction, A $\rightarrow$ products

$r = k[A]$ or $k = \frac{r}{[A]}$

$\Rightarrow k = \frac{1.5 \times 10^{-2}}{0.5} = 3 \times 10^{-2}$

Further, $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{3 \times 10^{-2}} = 23.1$ min

70. **(a)** In bauxite ore, only Al_2O_3 reacts with conc. NaOH and forms sodium meta aluminate. This further dissolves in water.

$$Al_2O_3 + 2H_2O + 2NaOH \xrightarrow[\text{35 bar}]{\text{500K}} 2NaAlO_2 + 3H_2O$$

$NaAlO_2 + 2H_2O \rightarrow NaAl(OH)_4$

71. **(d)** Equanil is an important medicine used in depression and hypertension.

72. **(a)** 1° amines (aliphatic and aromatic) react with $CHCl_3$/KOH to yield isocyanide (foul smelling) This is known as carbylamine test which is not given by 2° and 3° amines.

73. (c) Strong base has higher tendency to accept the proton. Increasing order of base and hence the order of accepting tendency of proton is

$I^- < HS^- < NH_3 < RNH_2$

74. (a) $Mg^{2+} + Na_2CO_3 \longrightarrow MgCO_3 + 2Na^+$

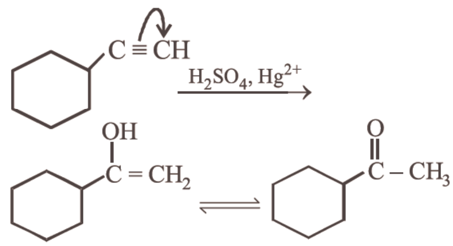
1 g eq. 1g eq.

1 g eq. of Mg^{2+} = 12 g of Mg^{2+} = 12000 mg

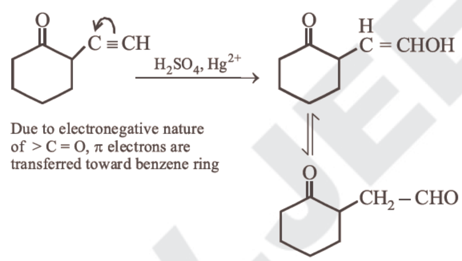
= 1000 milli eq. of Na_2CO_3

$\therefore$ 12 mg Mg^{2+} = 1 milli eq. Na_2CO_3

75. (c)



[A]



[B]

76. (b) $\underset{(A)}{PCl_5} + H_2O \longrightarrow \underset{(B)}{POCl_3} + 2HCl$

$\underset{(B)}{POCl_3} + 3H_2O \longrightarrow \underset{(C)}{H_3PO_4} + 3HCl$

77. (b) Solvent having high cryoscopic constant (camphor) can be used in determination of molecular masses of organic compounds like naphthalene, anthracene etc., by cryoscopic method.

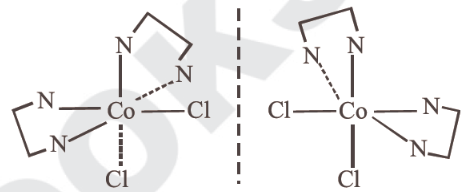
78. (b) $E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\ V$;

$E^\circ_{CrO_4^{2-}/Cr^{3+}} = -0.11\ V$

79. (d) All the given species contains 10 e^- each i.e. isoelectronic.

For isoelectronic species anion having high negative charge is largest in size and the cation having high positive charge is smallest.

80. (b) Non superimposable mirror images are called optical isomers and may be described as 'chiral'. They are also called enantiomers and rotate plane polarised light in opposite directions.



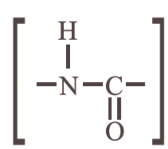
81. (a) $C_2H_5OC_2H_5 \xrightarrow[\text{Cleavage of ethers}]{\text{Red P / HI}} 2C_2H_5I$

$\xrightarrow[\text{Reduction}]{\text{Red P / HI}} \underset{\text{Ethane}}{2C_2H_6}$

82. (d) Solution X is unsaturated so v.p. will be more, solution Y and Z are saturated so v.p. of Y = v.p. of Z and 2 gm of solute would be present in form of solid in system Z.

83. (b) The more readily soluble and easily liquefiable gases such as NH_3, HCl and SO_2 are adsorbed more than the so called permanent gases like O_2. This is due to the van der Waals or intermolecular forces which are involved in adsorption.

84. (b) Peptide bonds are present in enzymes.



85. (d) Lucas reagent is anhydrous $ZnCl_2$ and conc. HCl. It is used to distinguish between 1°, 2° and 3° alcohols.

3° alcohols $\rightarrow$ Immediate turbidity

2° alcohols $\rightarrow$ Turbidity after 5 minutes

1° alcohols $\rightarrow$ No turbidity at room temp.

$$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-OH$$ is a tertiary alcohol, hence it will give fastest reaction with Lucas reagent.

86. **(d)** Amalgams are alloys having Hg as one of the constituents.

87. **(a)** Same as above, in Ph_3C^+, +ve charge can delocalise over three benzene rings.

88. **(d)** $\Delta H = \Delta U + \Delta n_g RT$; $\Delta n_g = 1$ in (d); $\Delta n_g = 0$ In other cases.

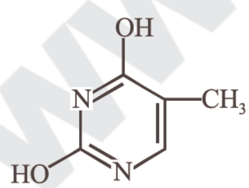
89. **(a)** Given drug is histamine which is used as Antacid.

90. **(c)** Methyl amine is a stronger base than ammonia due to +I effect. The alkyl groups which are electron releasing groups increase the electron density around the nitrogen thereby increasing the availability of the lone pair of electrons to proton or lewis acid and making the amine more basic

	NH_3	CH_3NH_2
$K_b =$	1.8×10^{-5}	44×10^{-5}

91. **(b)** This method is not applicable for the preparation of aryl halides because the C–O bond in phenol has a partial double bond character and is difficult to break being stronger than a single bond.

92. **(d)** The correct structure of thymine is



Thymine (T)

93. **(c)** Equivalent conductance of an electrolyte at infinite dilution is given by the sum of equivalent conductances of the respective ions at infinite dilution.

94. **(c)** Potassium ethoxide is a strong base, and 2-bromopentane is a 2° bromide, so elimination reaction predominates

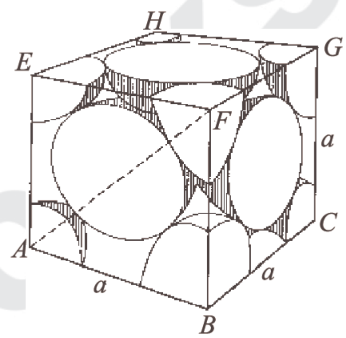
$$CH_3CH(Br)CH_2CH_2CH_3 \xrightarrow{^-OC_2H_5} \underset{\text{2-Pentene (major) } trans}{CH_3CH=CHCH_2CH_3}$$

$$+\underset{\text{1–Pentene (minor) } cis}{CH_2=CHCH_2CH_2CH_3}$$

Since *trans*- alkene is more stable than *cis,* thus *trans*-2-pentene is the main product.

95. **(a)**

96. **(c)**



An isolated *fcc* cell is shown here. Each face of the cell is common to two adjacent cells. Therefore, each face centre atom contributes only half of its volume and mass to one cell. Arranging six cells each sharing the remaining half of the face centred atoms, constitutes *fcc* cubic lattice. e.g., Cu and Al.

97. **(d)** The products of the concerned reaction react each other forming back the reactants.
$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$.

98. **(a)** Only 1° alkyl halides (i.e. CH_3Br) undergo S_N2 reaction.

99. **(b)** Since the compound is formed by hydration of an alkene, to get the structure of alkene remove a molecule of water from the alcohol.

$$\underset{\text{Isopropyl alcohol}}{CH_3\underset{\underset{OH}{|}}{C}HCH_3} \xrightarrow{-H_2O} \underset{\text{Propylene}}{CH_2=CHCH_3}$$

100. **(d)**

SECTION-B

MATHEMATICS

1. **(d)** $n(A) = 1000, n(B) = 500, n(A \cap B) \geq 1,$
$n(A \cup B) = p; n(A \cup B) = n(A) + n(B) - n(A \cap B)$
$p = 1000 + 500 - n(A \cap B)$
$1 \leq n(A \cap B) \leq 500$
Hence $p \leq 1499$ and $p \geq 1000$
$1000 \leq p \leq 1499$

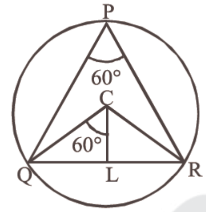
2. **(d)** $D(f) = R, D(g) = R - \{0\}$
$\therefore \quad D(h) = R - \{0\}$ and $h(x) = f(x)\, g(x) = x \times \frac{1}{x} = 1$
$\therefore \quad h(x) = 1$ if and only if $x \in R - \{0\}$

3. **(c)** Given $\frac{\tan 3x - \tan 2x}{1 + \tan 3x \tan 2x} = 1$
$\Rightarrow \tan(3x - 2x) = \tan \frac{\pi}{4}$
$\Rightarrow \quad \tan x = \tan \frac{\pi}{4} \Rightarrow x = (n\pi + \frac{\pi}{4},$
$n = 1, 2, 3, ...)$

4. **(d)** Let $a = \alpha - 3\beta,$, $b = \alpha - \beta$, $c = \alpha + \beta$ and $d = \alpha + 3\beta$ then
$(\alpha + 3\beta)^2 = (\alpha - 3\beta)^2 + (\alpha - \beta)^2 + (\alpha + \beta)^2$
$\Rightarrow \alpha^2 - 6\alpha\beta + \beta^2 = 0 \Rightarrow \frac{\alpha}{\beta} = 3 \pm 2\sqrt{2}$
$\because$ α, β must be rational number
$\therefore$ $\frac{\alpha}{\beta}$ cannot be irrational.

5. **(b)** Lines II and III are at right angles
$\left[\because \left(\frac{2}{3}\right)\left(-\frac{3}{2}\right) = -1\right]$
Lines I and II intersect at the point (1, 2) and (1, 2) does not belong to III. Hence, the lines are not concurrent, i.e., they form a right angled triangle.

6. **(b)** Given circle is $x^2 + y^2 + 2gx + 2fy + c = 0$ ...(1)
Let C be its centre and PQR be an equilateral triangle inscribed in the circle, then $C \equiv (-g, -f)$ and radius of the circle $CQ = \sqrt{g^2 + f^2 - c}$



From
ΔQLC, $QL = CQ \sin 60° = \frac{\sqrt{3}}{2}\sqrt{g^2 + f^2 - c}$
$\therefore$ $QR = 2QL = \sqrt{3}.\sqrt{g^2 + f^2 - c}$
Now, area of ΔPQR
$= \frac{\sqrt{3}}{4}.\, QR^2 = \frac{\sqrt{3}}{4} \cdot 3(g^2 + f^2 - c)$
$= \frac{3\sqrt{3}}{4}(g^2 + f^2 - c)$

7. **(a)** $z_1 = \sqrt{2}\left[\cos\frac{\pi}{4} + i \sin\frac{\pi}{4}\right]$
$= \sqrt{2}\left[\frac{1}{\sqrt{2}} + i\frac{1}{\sqrt{2}}\right] = 1 + i$
$|z_1| = \sqrt{2}$ and $z_2 = \sqrt{3}\left[\cos\frac{\pi}{3} + i \sin\frac{\pi}{3}\right]$
$= \sqrt{3}\left[\frac{1}{2} + i\frac{\sqrt{3}}{2}\right]$; $|z_2| = \sqrt{\frac{3}{4} + \frac{9}{4}} = \sqrt{3}$
$|z_1 z_2| = |z_1|\,|z_2| = \sqrt{2} \cdot \sqrt{3} = \sqrt{6}$

8. **(d)** The 7th term from the end = 5th term from beginning
$T_5 = {}^{10}C_4 x^6 \left(-\frac{2}{x^2}\right)^4 = {}^{10}C_4 \cdot 2^4\left(\frac{1}{x^2}\right)$

9. **(b)** The equation is
$abc^2x^2 + (3a^2c + b^2c)x - 6a^2 - ab + 2b^2 = 0$
Discriminant
$D = (3a^2 + b^2)^2c^2 - 4abc^2(-6a^2 - ab + 2b^2)$
$= 9a^4c^2 + b^4c^2 + 6a^2b^2c^2 + 24a^3bc^2$
$+ 4a^2b^2c^2 - 8ab^3c^2$
$= 9a^4c^2 + 16a^2b^2c^2 + b^4c^2 + 24a^3bc^2$
$-8ab^3c^2 - 6a^2b^2c^2$

$= (3a^2c + 4abc - b^2c)^2$

Since the discriminant is a prefect square, therefore the roots are rational provided a, b, c, are rational.

10. **(a)** Let $T_r = \frac{r}{1+r^2+r^4}$

$T_r = \frac{1}{2}\frac{2r}{(r^2+1)^2 - r^2} = \frac{1}{2}\left\{\frac{1}{r^2-r+1} + \frac{1}{r^2+r+1}\right\}$

$= \frac{1}{2}(a_r - a_{r+1})$

where $a_r = \frac{1}{(r-1)r+1}$

$\therefore \sum_{r=1}^{n} T_r = \frac{1}{2}\{(a_1 - a_2) + (a_2 - a_3) + ... + (a_n - a_{n+1})\}$

$= \frac{1}{2}(a_1 - a_{n+1}) = \frac{1}{2}\left\{1 - \frac{1}{(n+1)n+1}\right\}$

$\therefore \lim_{n\to\infty} \sum_{r=1}^{n} T_r = \lim_{n\to\infty} \frac{1}{2}\left\{1 - \frac{1}{(n+1)n+1}\right\} = \frac{1}{2}$

11. **(b)** Given, $n = 100$, $M = 50$, Median $= 52$

$M = \frac{\Sigma x}{n} = 50 \quad \therefore \Sigma x = 5000$

$\therefore$ Corrected mean $= \frac{5000 - 100 + 110}{100} = 50.10$

Median remains same.

12. **(a)** Total no. of arrangements of the letters of the word UNIVERSITY is $\frac{10!}{2!}$.

No. of arrangements when both I's are together = 9!

So. the no. of ways in which 2 I's do not together

$= \frac{10!}{2!} - 9!$

$\therefore$ Required probability $= \frac{\frac{10!}{2!} - 9!}{\frac{10!}{2!}} = \frac{10! - 9!\,2!}{10!}$

$= \frac{10 \times 9! - 9!.2!}{10!} = \frac{9![10-2]}{10 \times 9!} = \frac{8}{10} = \frac{4}{5}$

13. **(d)** Let $\Delta =$

$\begin{vmatrix} a^2+2a & 2a+1 & 1 \\ 2a+1 & a+2 & 1 \\ 3 & 3 & 1 \end{vmatrix} = \begin{vmatrix} a^2+2a-3 & 2a-2 & 0 \\ 2a-2 & a-1 & 0 \\ 3 & 3 & 1 \end{vmatrix}$

[Applying $R_1 \to R_1 - R_3$ and $R_2 \to R_2 - R_3$]

$= \begin{vmatrix} a^2+2a-3 & 2a-2 \\ 2a-2 & a-1 \end{vmatrix}$ [Expanding along C_3]

$= \begin{vmatrix} (a+3)(a-1) & 2(a-1) \\ 2(a-1) & a-1 \end{vmatrix} = (a-1)^2 \begin{vmatrix} a+3 & 2 \\ 2 & 1 \end{vmatrix}$

$= (a-1)^2 . (a+3-4) = (a-1)^3$

Clearly, $\Delta > 0$ if $a > 1$; $\Delta = 0$ if $a = 1$ and $\Delta < 0$ if $a < 1$.

14. **(b)** The function can be continuous only at those points for which

$\sin x = \cos x \Rightarrow x = n\pi + \frac{\pi}{4}$

15. **(a)** As A is an orthogonal matrix, $AA^T = I$

$\Rightarrow \frac{1}{3}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ a & 2 & b \end{bmatrix} \cdot \frac{1}{3}\begin{bmatrix} 1 & 2 & a \\ 2 & 1 & 2 \\ 2 & -2 & b \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$\Rightarrow \frac{1}{9}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ a & 2 & b \end{bmatrix}\begin{bmatrix} 1 & 2 & a \\ 2 & 1 & 2 \\ 2 & -2 & b \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$\Rightarrow \begin{bmatrix} 9 & 0 & a+4+2b \\ 0 & 9 & 2a+2-2b \\ a+4+2b & 2a+2-2b & a^2+4+b^2 \end{bmatrix}$

$= \begin{bmatrix} 9 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 9 \end{bmatrix}$

$\Rightarrow a + 4 + 2b = 0, 2a + 2 - 2b = 0$ and $a^2 + 4 + b^2 = 9$

$\Rightarrow a + 2b + 4 = 0, a - b + 1 = 0$ and $a^2 + b^2 = 5$

$\Rightarrow a = -2, b = -1$

16. **(b)** We have, $y^2 = 2ax$ ..(i)

Put $x = \frac{a}{2}$; $y^2 = 2a\left(\frac{a}{2}\right) \Rightarrow y = \pm a$

$\therefore$ The points are $\left(\frac{a}{2}, a\right)$ and $\left(\frac{a}{2}, -a\right)$

Differentiating (i) with respect to x, we get

$$2y\frac{dy}{dx} = 2a \Rightarrow \frac{dy}{dx} = \frac{a}{y}$$

At $\left(\frac{a}{2}, a\right)$; $\frac{dy}{dx} = \frac{a}{y} = \frac{a}{a} = 1 = m_1$ (say)

At $\left(\frac{a}{2}, -a\right)$; $\frac{dy}{dx} = \frac{a}{y} = \frac{a}{-a} = -1 = m_2$ (say)

Since $m_1 m_2 = -1$, the two tangents are at right angles.

17. **(a)** $y = \int_0^{4/a} (a \cdot x - \sqrt{4a \cdot x})\, dx$

$$\frac{1}{3} = \int_0^{4/a} ax\, dx - \int_0^{4/a} \sqrt{4ax}\, dx$$

$$\frac{1}{3} = \left[\frac{ax^2}{2}\right]_0^{4/a} - 2\left[\frac{(4ax)^{3/2}}{3}\right]_0^{4/a}$$

$$\frac{1}{3} = \frac{\frac{16a}{a^2}}{2} - \frac{2}{3}\left[4a\left(\frac{4}{a}\right)^{3/2}\right],\ a = 8.$$

Putting the value of a in $x^2 + 2x - a = 0$, we get its roots i.e., -4 and 2.

18. **(a)** We have, $1 \le \sin^{-1} \cos^{-1} \sin^{-1} \tan^{-1} x \le \frac{\pi}{2}$

$\Rightarrow \sin 1 \le \cos^{-1} \sin^{-1} \tan^{-1} x \le 1$

$\Rightarrow$ $\cos \sin 1 \ge \sin^{-1} \tan^{-1} x \ge \cos 1$

$\Rightarrow$ $\sin \cos \sin 1 \ge \tan^{-1} x \ge \sin \cos 1$

$\Rightarrow$ $\tan \sin \cos \sin 1 \ge x \ge \tan \sin \cos 1$

$\therefore$ $x \in [\tan \sin \cos 1, \tan \sin \cos \sin 1]$

19. **(c)** The given equation is

$$\frac{dy}{dx} - \frac{y}{x+1} = e^{3x}(x+1)$$

$$\text{I.F.} = e^{\int -\frac{1}{x+1}dx} = e^{-\log(x+1)} = \frac{1}{x+1}$$

The solution is

$$y\left(\frac{1}{x+1}\right) = \int e^{3x}(x+1).\frac{1}{x+1}dx + a$$

$$\Rightarrow \frac{y}{x+1} = \int e^{3x}dx + a = \frac{e^{3x}}{3} + a$$

$$\Rightarrow \frac{3y}{x+1} = e^{3x} + c,\ c = 3a$$

20. **(b)** Consider the following events :

A : Father has at least one boy

B : Father has 2 boys and one girl

Then, A = one boy and 2 girls, 2 boys and one girl, 3 boys and no girl $A \cap B = 2$ boys and one girl.

Now, the required probability is

$$P(A/B) = \frac{P(A \cap B)}{P(A)} = \frac{1}{3}.$$

21. **(a)** $\int \frac{x^6}{x + x^7} dx = \int \frac{x^6}{x(1+x^6)} dx$

$$= \int \frac{(1+x^6) - 1}{x(1+x^6)} dx$$

$$= \int \frac{1}{x} dx - \int \frac{1}{x + x^7} dx = \ln|x| - p(x) + c$$

22. **(c)** Given planes are $x + 2y - 2z + 1 = 0$

and $2x + 4y - 4z + 5 = 0$

These plane are parallel Put $x = 0, y = 0$ in

$$x + 2y - 2z + 1 = 0 \Rightarrow z = \frac{1}{2}$$

so, co-ordinate of a point on the plane

$x + 2y - 2z + 1 = 0$ are $\left(0, 0, \frac{1}{2}\right)$

$\therefore$ Required distance = Length of the perpendicular for $\left(0, 0, \frac{1}{2}\right)$ on the plane

$(2x + 4y - 4z + 5 = 0)$

$$= \left|\frac{0 + 0 - 4 \times \frac{1}{2} + 5}{\sqrt{4 + 16 + 16}}\right| = \frac{3}{\sqrt{36}} = \frac{3}{6} = \frac{1}{2}$$

23. **(b)** If $\vec{a} = 2\hat{i} - 2\hat{j} + \hat{k}$ and $\vec{c} = -\hat{i} + 2\hat{k}$

$|\vec{c}| = \sqrt{(-1)^2 + 2^2} = \sqrt{1+4} = \sqrt{5}$

$|\vec{c}|.\vec{a} = \sqrt{5}.(2\hat{i} - 2\hat{j} + \hat{k})$

$\therefore \quad |\vec{c}|.\vec{a} = 2\sqrt{5}\hat{i} - 2\sqrt{5}\hat{j} + \sqrt{5}\hat{k}$

24. **(b)** $\sqrt{x} = \cos\theta$

$x \in \left(0, \frac{1}{2}\right)$ or $\sqrt{x} = \cos\theta \in \left(0, \frac{1}{\sqrt{2}}\right)$

or $\theta \in \left(\frac{\pi}{4}, \frac{\pi}{2}\right)$ or $2\theta \in \left(\frac{\pi}{2}, \pi\right)$

or $f(x) = 2\sin^{-1}\sqrt{1-\cos^2\theta} + \sin^{-1}(2\sqrt{\cos^2\theta\sin^2\theta})$

$= 2\sin^{-1}(\sin\theta) + \sin^{-1}(2\sin\theta\cos\theta)$

$= 2\theta + \sin^{-1}(\sin 2\theta) = 2\theta + \pi - 2\theta = \pi$

or $f'(x) = 0$.

25. **(c)** We have, R = {(1, 3); (1, 5); (2, 3); (2, 5); (3, 5); (4,5)}

R^{-1} = {(3, 1); (5, 1); (3, 2); (5, 2); (5, 3); (5,4)}

Hence RoR^{-1} = {(3, 3); (3, 5); (5, 3); (5, 5)}

26. **(d)** $S(p, q, r) = (\sim p) \vee [\sim(q \wedge r)]$

$S(\sim p, \sim q, \sim r) = \sim(\sim p) \vee [\sim(\sim q \wedge \sim r)]$

$= p \vee [\sim(\sim q) \vee \sim(\sim r)] = p \vee (q \vee r)$

27. **(c)** $\because\ PA^2 - PB^2 = k$

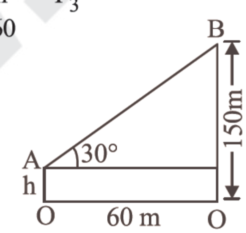
$\therefore\ [(x-2)^2 + (y-3)^2 + (z-4)^2]$
$\qquad - [(x+2)^2 + (y-5)^2 + (z+4)^2] = k$

or $-8x + 4y - 16z - 16 = k$,

28. **(b)** Desired number $= n^3 - {}^nP_3$

29. **(c)** $(150 - h)\cot 30° = 60$

$\Rightarrow \quad h = 150 - 20\sqrt{3}$



30. **(c)** Any point on the line 7x + 56y = 0 is

$\left(x_1, -\frac{7x_1}{56}\right)$, i.e., $\left(x_1, -\frac{x_1}{8}\right)$

$\therefore$ The perpendicular distance p and p' are

$p = \dfrac{3x_1 - \frac{4x_1}{8}}{5} = \dfrac{x_1}{2}$ and $p' = \dfrac{5x_1 + \frac{12x_1}{8}}{13} = \dfrac{x_1}{2}$

$\Rightarrow p = p'$

31. **(d)** Length of latus rectum = 2 × distance of focus from directrix $= 2 \times \dfrac{|1-4+3-24|}{5} = 10$

32. **(d)** $z = \dfrac{7-i}{3-4i} \times \dfrac{3+4i}{3+4i}$

$= \dfrac{21 + 25i + 4}{16 + 9} = \dfrac{25(1+i)}{25} = (1+i)$

$z^{14} = (1+i)^{14} = [(1+i)^2]^7 = (2i)^7 = 2^7 i^7 = -2^7 i$

33. **(c)** $\left(\frac{3}{4}\right)^{6x+10-x^2} < \frac{27}{64}$

$\Rightarrow \left(\frac{3}{4}\right)^{6x+10-x^2} < \left(\frac{3}{4}\right)^3$

$\Rightarrow \quad 6x + 10 - x^2 > 3 \qquad$ (as base (3/4) < 1)

$\therefore \quad x^2 - 6x - 7 < 0 \quad \therefore \quad (x+1)(x-7) < 0$

Thus, integral values of x are 0, 1, 2, 3, 4, 5 and 6.

34. **(c)** $\dfrac{\sin A}{\sin C} = \dfrac{\sin(A-B)}{\sin(B-C)} \Rightarrow \dfrac{\sin(B+C)}{\sin(A+B)} = \dfrac{\sin(A-B)}{\sin(B-C)}$

$\Rightarrow \sin^2 B - \sin^2 C = \sin^2 A - \sin^2 B$

$\Rightarrow \sin^2 A, \sin^2 B, \sin^2 C$ and hence a^2, b^2, c^2 are in A.P.

35. **(a)** Let the required three numbers of G.P. be $\frac{a}{r}, a$ and ar.

Then, their sum $= \frac{a}{r} + a + ar = 38$

$\Rightarrow \quad a\left(\frac{1 + r + r^2}{r}\right) = 38 \qquad$ ...(i)

product $= \frac{a}{r} \times a \times ar = 1728$

$\Rightarrow \quad a^3 = (12)^3 \quad \therefore \quad a = 12 \qquad$ ...(ii)

Substitute the value of a, in equation (i), we get

$\therefore \quad 12 \times \left(\frac{1 + r + r^2}{r}\right) = 38$

$\Rightarrow \quad 6 + 6r + 6r^2 = 19r \Rightarrow 6r^2 - 13r + 6 = 0$

$\Rightarrow \quad (3r-2)(2r-3) = 0 \quad \therefore \quad r = \frac{2}{3}$ or $\frac{3}{2}$

Hence, the required numbers are 18, 12, 8 or 8, 12, 18

$\therefore$ Greatest number = 18

36. **(a)** Since as per the give condition x > – 1, so x is non negative integer,
y > – 2 so y = –1 + b and similarly
z > 3 so z = – 2 + c
or $(x) + (-1 + b) + (-2 + c) = 23$
or $x + b + c = 23$
and we need to find the number of non negative integral solution of the equation x + b + c = 23 which is
$^{23+3-1}C_{3-1} = {}^{25}C_2 = {}^{25}C_{23}$

37. **(a)** $(1+x)^j = 1 + {}^jC_1x + {}^jC_2x^2 + {}^jC_3x^3 + ...$
$+ {}^jC_{100}x^{100} + ... + {}^jC_{200}x^{200}$
$\therefore$ Coefficient of x^{100} in the expansion of
$(1+x)^j = {}^jC_{100}$

Coefficient of x^{100} in the expansion of
$\sum_{j=0}^{200}(1+x)^j$ will be
equal to $\sum_{j=100}^{200} {}^jC_{100}$
$= {}^{100}C_{100} + {}^{101}C_{100} + {}^{102}C_{100} +$
$..... .... + {}^{200}C_{100}$

$= {}^{200}C_{100} = \binom{200}{100}$

38. **(b)** We have, $\frac{d}{dx}\left\{\left(\sqrt{x}+\frac{1}{\sqrt{x}}\right)^2\right\}$
$= \frac{d}{dx}\left\{x+\frac{1}{x}+2\right\}$
$= \frac{d}{dx}(x) + \frac{d}{dx}(x^{-1}) + \frac{d}{dx}(2) = 1 + (-1)\,x^{-2} + 0$
$= 1 - \frac{1}{x^2}$

39. **(a)** h o (g o f) (x) = h [g o f) (x)]=h[g(f(x)]
= h [g (x^2)] = h (tanx^2) = log (tanx^2)
At $x = \frac{\sqrt{\pi}}{2}$, value $= \log\left[\tan\left(\frac{\pi}{4}\right)\right] = \log 1 = 0$

40. **(c)** If $A = \begin{bmatrix} 3 & -2 & 4 \\ 1 & 2 & -1 \\ 0 & 1 & 1 \end{bmatrix}$

and $A^{-1} = \frac{1}{k}\text{adj}(A)$ ......(i)

Also, we know $A^{-1} = \frac{\text{adj}(A)}{|A|}$ ....(ii)

$\therefore$ By comparing (i) and (ii) $|A| = k$

$\Rightarrow |A| = \begin{vmatrix} 3 & -2 & 4 \\ 1 & 2 & -1 \\ 0 & 1 & 1 \end{vmatrix}$
$= 3(2+1) + 2(1+0) + 4(1-0) = 9 + 2 + 4 = 15$

41. **(b)** $f(0) = \sin 0 = 0,\ f(0^+) \to 0^+$
$f(0^-) = \lim_{x\to 0^-} \sin(x^2 - 3x) = \lim_{h\to 0} \sin(h^2 + 3h) \to 0^+$
Thus, $f(0^+) > f(0)$ and $f(0^-) > f(0)$.
Hence, $x = 0$ is a point of minima.

42. **(c)** $I = \int_{-\frac{3\pi}{2}}^{-\frac{\pi}{2}} [(x+\pi)^3 + \cos^2(x+3\pi)]dx$
Put $x + \pi = t$
$I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} [t^3 + \cos^2 t)dt = 2\int_0^{\frac{\pi}{2}} \cos^2 t dt$
$= \int_0^{\frac{\pi}{2}} (1+\cos 2t)dt = \frac{\pi}{2} + 0$

43. **(d)** We can write the given expression
$= \{\hat{i}.(\vec{p}\times\vec{q})\}\hat{i} + \{\hat{j}.(\vec{p}\times\vec{q})\}\hat{j} + \{\hat{k}.(\vec{p}\times\vec{q})\}\hat{k}$
$= \vec{p}\times\vec{q}$
Since for any vector $\vec{a}$,
$\vec{a} = (\vec{a}.\hat{i})\hat{i} + (\vec{a}.\hat{j})\hat{j} + (\vec{a}.\hat{k})\hat{k}$

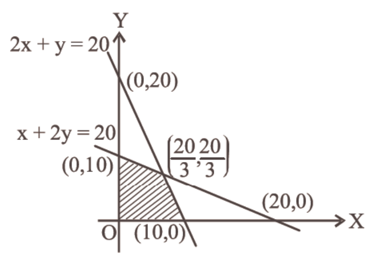
44. **(d)** Given $\int_1^b f(x)dx = \sqrt{b^2+1} - \sqrt{2}$

Differentiate with respect to b

$f(b) = \frac{b}{\sqrt{b^2+1}} \Rightarrow f(x) = \frac{x}{\sqrt{x^2+1}}$

45. **(c)** Obviously, $P = x + 3y$ will be maximm at (0, 10).

$\therefore P = 0 + 3 \times 10 = 30.$



46. **(b)** Let $A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$

$A^2 = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} = 2\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} = 2A$

$A^3 = 2^2\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}, A^4 = 2^3\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$

$A^3 = 2^2 A,$ $\quad A^4 = 2^3 A$

$\therefore \quad A^n = 2^{n-1}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$

$\Rightarrow A^{100} = 2^{100-1} A$

$\therefore A^{100} = 2^{99} A$

47. **(d)** For $x < 1$, $f(x) = \frac{x^2-1}{x^2+2x-3} = \frac{x+1}{x+3}$

$\therefore \lim_{x \to 1^-} f(x) = \frac{1}{2}$

For $x > 1$, $f(x) = \frac{x^2-1}{x^2-2x+1} = \frac{x+1}{x-1}$

$\therefore \lim_{x \to 1^+} f(x) = \infty$

$\therefore$ The function is not continuous at $x = 1$.

48. **(a)** Put $x = \tan\theta \Rightarrow dx = \sec^2\theta d\theta$

$I = \int e^\theta \frac{1+\tan\theta+\tan^2\theta}{1+\tan^2\theta}.\sec^2\theta d\theta$

$= \int e^\theta(\tan\theta + \sec^2\theta)d\theta$

$= e^\theta \tan\theta + c \quad = xe^{\tan^{-1}x} + C$

49. **(b)** The angle θ between the two lines

$\frac{x-x_1}{a_1} = \frac{y-y_1}{a_2} = \frac{z-z_1}{a_3}$

and $\frac{x-x_2}{b_1} = \frac{y-y_2}{b_2} = \frac{z-z_2}{b_3}$ is given by:

$\cos\theta = \frac{a_1b_1 + a_2b_2 + a_3b_3}{\sqrt{a_1^2+a_2^2+a_3^2}\sqrt{b_1^2+b_2^2+b_3^2}}$

Now in the given equation: $a_1 = 2, a_2 = 2, a_3 = -1$
$b_1 = 1, b_2 = 2, b_3 = 2$

$\therefore \cos\theta = \frac{2\times2+2\times2+(-2)\times1}{\sqrt{4+4+1}\sqrt{4+4+1}}$

$\Rightarrow \theta = \cos^{-1}\left(\frac{4}{9}\right).$

50. **(c)** Desired probability = probability of getting 3 sixes in first 9 throws × getting six in the 10throw

$= {}^9C_3\left(\frac{1}{6}\right)^3\left(\frac{5}{6}\right)^6 \times \frac{1}{6}$

(Mock Test-6)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(b)	**11**	(b)	**16**	(c)	**21**	(a)	**26**	(b)	**31**	(b)	**36**	(a)	**41**	(c)	**46**	(a)
2	(a)	**7**	(b)	**12**	(c)	**17**	(b)	**22**	(c)	**27**	(a)	**32**	(a)	**37**	(b)	**42**	(a)	**47**	(b)
3	(d)	**8**	(b)	**13**	(a)	**18**	(d)	**23**	(d)	**28**	(b)	**33**	(b)	**38**	(c)	**43**	(c)	**48**	(d)
4	(a)	**9**	(b)	**14**	(b)	**19**	(d)	**24**	(b)	**29**	(b)	**34**	(b)	**39**	(b)	**44**	(b)	**49**	(c)
5	(a)	**10**	(d)	**15**	(a)	**20**	(c)	**25**	(b)	**30**	(b)	**35**	(b)	**40**	(b)	**45**	(a)	**50**	(c)
CHEMISTRY																			
51	(c)	**56**	(b)	**61**	(b)	**66**	(d)	**71**	(d)	**76**	(a)	**81**	(b)	**86**	(c)	**91**	(a)	**96**	(a)
52	(c)	**57**	(d)	**62**	(b)	**67**	(c)	**72**	(d)	**77**	(b)	**82**	(a)	**87**	(b)	**92**	(b)	**97**	(c)
53	(b)	**58**	(b)	**63**	(c)	**68**	(a)	**73**	(a)	**78**	(a)	**83**	(d)	**88**	(a)	**93**	(d)	**98**	(d)
54	(b)	**59**	(b)	**64**	(d)	**69**	(c)	**74**	(b)	**79**	(b)	**84**	(d)	**89**	(b)	**94**	(b)	**99**	(c)
55	(c)	**60**	(a)	**65**	(b)	**70**	(b)	**75**	(d)	**80**	(c)	**85**	(d)	**90**	(a)	**95**	(d)	**100**	(d)
SECTION-B																			
MATHEMATICS																			
1	(d)	**6**	(b)	**11**	(c)	**16**	(a)	**21**	(b)	**26**	(c)	**31**	(d)	**36**	(b)	**41**	(b)	**46**	(a)
2	(c)	**7**	(c)	**12**	(d)	**17**	(d)	**22**	(d)	**27**	(c)	**32**	(c)	**37**	(c)	**42**	(c)	**47**	(c)
3	(a)	**8**	(c)	**13**	(a)	**18**	(c)	**23**	(b)	**28**	(b)	**33**	(a)	**38**	(a)	**43**	(a)	**48**	(b)
4	(a)	**9**	(b)	**14**	(d)	**19**	(d)	**24**	(d)	**29**	(b)	**34**	(a)	**39**	(d)	**44**	(c)	**49**	(a)
5	(a)	**10**	(d)	**15**	(a)	**20**	(c)	**25**	(d)	**30**	(a)	**35**	(c)	**40**	(b)	**45**	(c)	**50**	(a)

SECTION-A

PHYSICS

1. **(a)** Frequency does not depend upon radius. As length is doubled, fundamental frequency becomes half.

2. **(a)** We know that,

$$g = \frac{GM}{R^2} = \frac{G\left(\frac{4}{3}\pi R^3\right)\rho}{R^2} = \frac{4}{3}\pi G R \rho$$

$$\frac{g'}{g} = \frac{R'}{R} = \frac{0.2R}{R} = 0.2 \quad \therefore \; g' = 0.2g$$

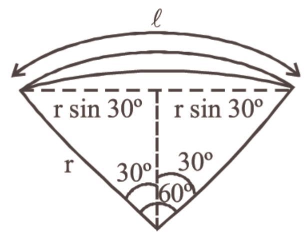
3. **(d)**

4. **(a)** Wavefront is the locus of all points, where the particles of the medium vibrate with the same phase.

5. **(a)** Magnetic dipole moment

$M = m \times \ell, M' = m \times r$

From figure



$\ell = \frac{\pi r}{3}$ or $r = \frac{3\ell}{\pi}$

so, $M' = m \times r = \frac{m \times 3\ell}{\pi} = \frac{3}{\pi}M$

6. **(b)**

7. **(b)**

8. **(b)** $\frac{1}{2}mv_1^2 = 2W_0 - W_0 = W_0$ and

$\frac{1}{2}mv_2^2 = 10W_0 - W_0 = 9W_0$

$\therefore \quad \frac{v_1}{v_2} = \sqrt{\frac{W_0}{9W_0}} = \frac{1}{3}$

9. **(b)** For two vectors to be perpendicular to each other

$\vec{A} \cdot \vec{B} = 0$

$(2\hat{i} + 3\hat{j} + 8\hat{k}) \cdot (4\hat{j} - 4\hat{i} + \alpha\hat{k}) = 0$

$-8 + 12 + 8\alpha = 0 \Rightarrow \alpha = -\frac{1}{2}$

10. **(d)** Density, $\rho = \frac{M}{V} = \frac{M}{\pi r^2 \ell}$

$\therefore \quad \frac{\Delta\rho}{\rho} \times 100 = \left[\frac{\Delta M}{M} + \frac{2\Delta r}{r} + \frac{\Delta \ell}{\ell}\right] \times 100$

$=$

$\left[\frac{0.003}{0.3} + 2\frac{0.005}{0.5} + \frac{0.06}{6}\right] \times 100 = 4$

11. **(b)** Current gain $= \frac{\Delta I_C}{\Delta I_B}$ when V_{CE} is constant.

$= \frac{2.5 \times 10^{-3}}{25 \times 10^{-6}} = 0.1 \times 10^3 = 100$

[$\Delta I_B = 125\ \mu A - 100\ \mu A = 25\ \mu A$
$\Delta I_C = 7.5\ mA - 5\ mA = 2.5\ mA$]

12. **(c)** Terminal velocity, $v_T = \frac{2r^2(d_1 - d_2)g}{9\eta}$

$\frac{v_{T_2}}{0.2} = \frac{(10.5 - 1.5)}{(19.5 - 1.5)} \Rightarrow v_{T_2} = 0.2 \times \frac{9}{18}$

$\therefore v_{T_2} = 0.1\ m/s$

13. **(a)** Here, initially $P_1 = P$, $V_1 = V + V = 2V$;
Finally, $P_2 = P$; $V_2 = V$

As $P_1V_1 = P_2V_2$ or $P_2 = \frac{P_1V_1}{V}$

$= \frac{P \times 2V}{V} = 2P$

14. **(b)** Change in internal energy do not depend upon the path followed by the process. It only depends on initial and final states i.e.,

$\Delta U_1 = \Delta U_2$

15. **(a)**

16. **(c)** If the current increases with time in loop A, then magnetic flux in B will increase. According to Lenz's law, loop -B is repelled by loop -A because current in loop B will be antiparallel to that in A.

17. **(b)** $r = \frac{mv\sin\theta}{Be} = \frac{3 \times 10^5 \sin 30°}{0.3 \times 10^8}$

$\frac{3 \times 10^5 \times \frac{1}{2}}{3 \times 10^7} = 0.5 \times 10^{-2}\ m = 0.5 cm.$

18. **(d)** Elastic energy $= \frac{1}{2} \times F \times x$

$F = 200\ N, x = 1\ mm = 10^{-3}\ m$

$\therefore \quad E = \frac{1}{2} \times 200 \times 1 \times 10^{-3} = 0.1 J$

19. **(d)** Given; speed = 10 m/s; radius r = 10 m

Angle made by the wire with the vertical

$$\tan\theta = \frac{v^2}{rg} = \frac{10^2}{10\times 10} = 1 \Rightarrow \theta = 45° = \frac{\pi}{4}$$

20. **(c)** $\mu = \frac{F}{R} = \frac{mg\sin\alpha}{mg\cos\alpha} = \tan\alpha$

21. **(a)** The magnetic dipole moment of diamagnetic material is zero as each of its pair of electrons have opposite spins, i.e., $\mu_d = 0$.

Paramagnetic substances have dipole moment > 0, i.e. $\mu_p \neq 0$, because of excess of electrons in its molecules spinning in the same direction.

Ferro-magnetic substances are very strong magnets and they also have permanent magnetic moment, i.e. $\mu_f \neq 0$.

22. **(c)** Wavelength for which maximum obtained at the hole has the maximum intensity on passing. So,

$$x = \frac{n\lambda D}{d}$$

$$\lambda = \frac{xd}{nD} = \frac{1\times 10^{-3}\times 0.5\times 10^{-3}}{n\times 50\times 10^{-2}}$$

$$= \frac{1\times 10^{-6}}{n} = \frac{1000\text{nm}}{n}$$

n = 1, λ = 1000 nm → Not in the given range

n = 2, λ = 500nm

23. **(d)**

24. **(b)** Apply Newton's law of cooling,

$$\frac{\Delta T}{t} = -k\,(T_{av} - T_\theta)$$

$$\frac{20}{10} = -k\,(70-30) \quad \text{..........(1)}$$

$$\frac{60-T}{10} = -k\left(\frac{60+T}{2} - 30\right) \quad \text{..........(2)}$$

Divide eq. (2) by eq. (1)

$$\frac{60-T}{20} = \frac{T/2}{40} \Rightarrow 120 - 2T = \frac{T}{2}$$

$\Rightarrow T = 48°C$

25. **(b)** Binding energy

$= 117\times 8.5 + 117\times 8.5 - 236\times 7.6$

$= 234\times 8.5 - 236\times 7.6$

$= 1989 - 1793.6 = 200$ MeV

Thus, in per fission of Uranium nearly 200 MeV energy is liberated

26. **(b)** Modulation index $= \frac{B}{A}$

B = 25, A = 60

$\Rightarrow$ M.I. $= \frac{25}{60} = 0.416 \Rightarrow$ m% = 41.6%

27. **(a)** As the ball, m = 10 g = 0.01 kg rebounds after striking the wall

$\therefore$ Change in momentum $= mv - (-mv) = 2mv$

Inpulse = Change in momentum = $2mv$

$$\therefore\ v = \frac{\text{Impulse}}{2m} = \frac{0.54\text{ N s}}{2\times 0.01\text{ kg}} = 27\text{ m s}^{-1}$$

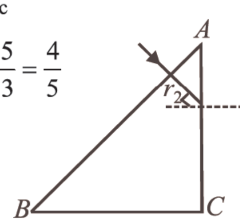
28. **(b)** $A = 90° - \theta$

$\Rightarrow r_2 = A = 90° - \theta > \theta_c$

$\cos\theta > \sin\theta_c = \frac{6/5}{2/3} = \frac{4}{5}$

(θ_c is critical angle)

$\theta < \cos^{-1}\frac{4}{5} = 37°$



29. **(b)** $\vec{v}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1+m_2} = \frac{2\times 2 + 4\times 10}{2+4} = 7.3 m/s$

30. **(b)** $I_A = I + 4I + 2\sqrt{I\times 4I}\cos\pi/2 = 5I$

and $I_B = I + 4I + 2\sqrt{I\times 4I}\cos\pi = I$

So $I_A - I_B = 5I - I = 4I$

31. **(b)** $B = \dfrac{\mu_0 i}{2\pi r}$ and so it is independent of thickness.

The current is same in both the wires, hence magnetic field induced will be same.

32. **(a)** The reactance of inductor, $X_L = \omega L$

The reactance of capacitor, $X_C = \dfrac{1}{\omega C}$

where $\omega = 2\pi n$ & n is the frequency of A.C source.

33. **(b)**

34. **(b)** The surface tension of oil is less than that of water, so the oil spreads as a thin layer.

35. **(b)** $176\left(\dfrac{v - v_0}{v - 22}\right) = 165\dfrac{v + v_0}{v}$

Here $v = 330$ m/s, after simplifying, we get $v_0 = 22$ m/s

36. **(a)** Maximum velocity,

$$v_{max} = a\omega \Rightarrow v_{max} = a \times \frac{2\pi}{T}$$

$$\Rightarrow T = \frac{2\pi a}{v_{max}} = \frac{2 \times 3.14 \times 7 \times 10^{-3}}{4.4} \approx 0.01 \text{ s}$$

37. **(b)** Orbital velocity of a satellite in a circular orbit of radius a is given by

$$v = \sqrt{\frac{GM}{a}} \Rightarrow v \propto \sqrt{\frac{1}{a}} \Rightarrow \frac{v_2}{v_1} = \sqrt{\frac{a_1}{a_2}}$$

$$\therefore \quad v_2 = v_1\sqrt{\frac{4R}{R}} = 2v_1 = 6V$$

38. **(c)** Given, refractive index, $\mu = \dfrac{4}{3}$

According to Brewster's law when unpolarised light strikes at polarising angle i_p on an interface then reflected and refracted rays are normal to each other and is given by :

$$\tan i_p = \mu$$

$$\therefore \; i_p = \tan^{-1}\left(\frac{4}{3}\right)$$

39. **(b)** $\dfrac{1}{\lambda} = R\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$

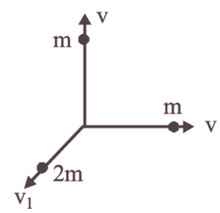
$$\frac{1}{\lambda_0} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5R}{36}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = R\left(\frac{1}{4} - \frac{1}{16}\right) = \frac{3R}{16}$$

$$\frac{\lambda}{\lambda_0} = \frac{5}{36} \times \frac{16}{3} = \frac{20}{27}$$

40. **(b)** By conservation of linear momentum

$$2mv_1 = \sqrt{2}mv \Rightarrow v_1 = \frac{v}{\sqrt{2}}$$



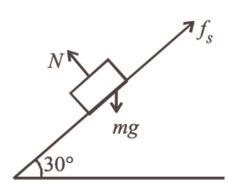
As two masses of each of mass m move perpendicular to each other.

Total KE generated

$$= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}(2m)v_1^2$$

$$= mv^2 + \frac{mv^2}{2} = \frac{3}{2}mv^2$$

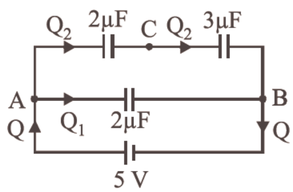
41. **(c)** mg $\sin\theta = f_s$ (for body to be at rest)



$$\Rightarrow m \times 10 \times \sin 30° = 10$$

$$\Rightarrow m \times 5 = 10 \Rightarrow m = 2.0 \text{ kg}$$

42. (a) The equivalent circuit diagram as shown in the figure.



The equivalent capacitance between A and B is

$$C_{eq} = \frac{2\mu F \times 3\mu F}{2\mu F + 3\mu F} + 2\mu F = \frac{16}{5}\mu F$$

Total charge of the given circuit is

$$Q = \frac{16}{5}\mu F \times 5V = 16\mu C$$

$$Q_1 = (2\mu F) \times 5V = 10\mu C$$

$\therefore$ $Q_2 = Q - Q_1 = 16\ \mu C - 10\ \mu C = 6\ \mu C$

$\therefore$ Voltage between B and C is

$$V_{BC} = \frac{Q_2}{3\mu F} = \frac{6\mu C}{3\mu F} = 2V$$

43. (c) Kinetic energy $K = \frac{1}{2}m\omega^2(a^2 - y^2)$

$$= \frac{1}{2} \times 10 \times \left(\frac{2\pi}{2}\right)^2 [10^2 - 5^2] = 375\ \pi^2\ erg$$

44. (b) As intensity of wave $\propto$ (amplitude)^2

$$\frac{I_1}{I_2} = \frac{9}{1} = \frac{a_1^2}{a_2^2} \qquad \Rightarrow \qquad \frac{a_1}{a_2} = \frac{3}{1}$$

$$\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{16}{4} \Rightarrow \text{ratio is } 4:1.$$

45. (a) $\omega = \frac{v_1}{r} = \frac{v\sin\theta}{a/\sin\theta} = \frac{v}{a}\sin^2\theta$

46. (a) Force acting on conductor B due to conductor A is given by relation

$$F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$$

l-length of conductor

r-distance between two conductors

$$\therefore F = \frac{4\pi \times 10^{-7} \times 10 \times 2 \times 2}{2 \times \pi \times 0.1} = 8 \times 10^{-5}\ N$$

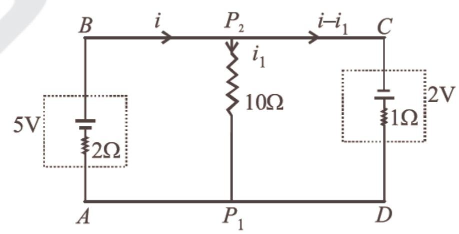
47. (b) $F = Y \times A \times \frac{l}{L} \Rightarrow F \propto r^2$ (Y, l and and L are constant)

If diameter is made four times then force required will be 16 times, i.e., 16×10^3 N

48. (d)

49. (c) Applying Kirchoff's loop law in ABP_2P_1A, we get

$$-2i + 5 - 10\ i_1 = 0 \qquad .....(i)$$



Again applying Kirchoff's loop law in $P_2CDP_1P_2$ we get, $\quad 10\ i_1 + 2 - i + i_1 = 0$ ....(ii)

From (i) and (ii) $11\ i_1 + 2 - \left[\frac{5 - 10i_1}{2}\right] = 0$

$$\Rightarrow i_1 = \frac{1}{32}\ \text{A from } P_2 \text{ to } P_1$$

50. (c) $h = \frac{2\sigma\cos\theta}{r\rho g} \Rightarrow \sigma \propto \frac{h\rho}{\cos\theta}$

$$\Rightarrow \frac{\sigma_w}{\sigma_m} = \frac{h_w \rho_w}{\cos\theta_w} \times \frac{\cos\theta_m}{h_m \rho_m}$$

$$= \frac{10 \times 1}{\cos 0°} \times \frac{\cos 135°}{-3.1 \times 13.6} \approx \frac{1}{6}$$

CHEMISTRY

51. (c) $Sm^{2+}(Z = 62)\ [Xe]4f^6\ 6s^0$ – 6 unpaired e^-
$Eu^{2+}(Z = 63)\ [Xe]4f^7\ 6s^0$ – 7 unpaired e^-
$Yb^{2+}(Z = 70)\ [Xe]4f^{14}\ 6s^0$ – 0 unpaired e^-
$Ce^{2+}(Z = 58)\ [Xe]4f^1\ 5d^1\ 6s^0$ – 2 unpaired e^-
Only Yb^{2+} is diamagnetic.

52. (c) AB is just like NaCl. Thus twelve A^+ are at edges and 1 within body of *fcc* i.e. in octahedral voids and six B^- at faces and 8 at corner.

53. (b) Let's take the example of oxygen

$$O(g) + e^- \xrightarrow[-EA_1]{} O^-(g) + e^- \xrightarrow[+EA_2]{} O^{2-}(g)$$

Energy is required to add an electron to the negatively charged species due to electron - electron repulsion.

54. (b)

55. (c) Xenon undergo sp^3 hybridization.

5s: ↑↓ 5p: ↑↓ ↑↓ ↑↓

5d: ☐ ☐ ☐ ☐ ☐ (ground state)

5s: ↑↓ 5p: ↑ ↑ ↑

5d: ↑ ↑ ↑ ☐ ☐ (third excited state)

In the fourth excited state xenon atom, has 8 unpaired electrons

5s: ↑ 5p: ↑ ↑ ↑

5d: ↑ ↑ ↑ ↑ ☐

One *s* and three *p* orbital undergo sp^3 hybridization. Four sp^3 hybrid orbitals form four σ bonds with oxygen atoms. They are σ_{sp^3-p}. Four $p\pi-d\pi$ bonds are also formed with oxygen atoms by the unpaired electrons.

56. (b) $CuSO_4 \rightleftharpoons Cu^{2+} + SO_4^{2-}$

$H_2O \rightleftharpoons H^+ + OH^-$

At cathode : $Cu^{2+} + 2e^- \rightarrow Cu$

At anode : $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

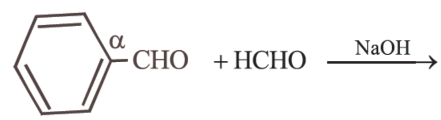
57. (d) $\dfrac{W_A}{E_A} = \dfrac{W_B}{E_B}$; $\dfrac{27}{108} = \dfrac{W_{Cu}}{31.8}$;

$\therefore W_{Cu} = 7.95g$

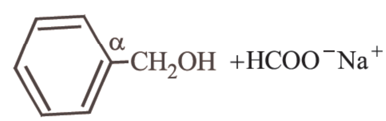
58. (b) $HF + XeF_6 \longrightarrow XeF_5^+ + HF_2^-$

59. (b)

60. (a) Benzaldyde and formaldehyde, both do not have α - hydrogen atom, so both will undergo Cannizzaro reaction; here formaldehyde will always be oxidised to formate while the other aldehyde (C_6H_5CHO or any other aldehyde not having α-H, viz- Me_3CCHO) will always be reduced to corresponding alcohol (crossed Cannizzaro reaction)



Benzaldehyde Formaldehyde



Benzyl alcohol sod. formate

61. (b) The molality involves weights of the solute and the solvent. Since weight does not change with the temperature, therefore molality does not depend upon the temperature.

62. (b) Among the given compounds naphthelene is volatile but benzoic acid is non-volatile (it forms a dimer). So, the best method for their separation is sublimation, which is applicable to compounds which can be converted directly into the vapour phase from its solid state on heating and back to the solid state on cooling. Hence it is the most appropriate method.

63. **(c)** $HOCl + H_2O_2 \longrightarrow H_3O^+ + Cl^- + O_2$

64. **(d)** Given concentration of NaOH $= 10^{-10}$ M

$$NaOH \longrightarrow Na^+ + OH^-$$
$$10^{-10}\,M \qquad 10^{-10}$$

$\therefore$ $[OH^-]$ from NaOH $= 10^{-10}$

We have to consider dissociation of H_2O

$[OH^-]$ from $H_2O = 10^{-7}$

Total $[OH^-] = 10^{-7} + 10^{-10}$

$= 10^{-7}(0.001+1) = 10^{-7}\left(\frac{1001}{1000}\right)$

$= 10^{-10} \times 1001$

$\therefore$ $pOH = -\log[OH^-]$

$= -(\log 1001 \times 10^{-10}) = -3.004 + 10 = 6.9996$

$pH = 14 - pOH = 14 - 6.996 = 7.004$

$\therefore$ pH of 10^{-10} M NaOH solution is nearest to 7.

65. **(b)** $2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3$

According to equation $\frac{3}{2}$ mole of O_2 combines with 2 mole Al.

2 mole Al = 54 g

66. **(d)**

67. **(c)** In a DNA molecule, A $\equiv$ T (Two H–bonds)

C $\equiv$ G (Three H–bonds)

Purine $\rightarrow$ Adenine (A), Guanine (G)

Pyrimidine $\rightarrow$ Cytosine (C), Thymine (T)

So the complimentary sequence of ATGCTTGA is TACGAACT.

68. **(a)** $CH_3-\underset{\substack{|\\CH_3}}{CH}-CH=CH_2 \xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } B_2H_6} CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_2-\underset{\substack{|\\OH}}{CH_2}$

$\downarrow H_2SO_4/140°C$

$CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_2-CH_2-O-CH_2-CH_2-\underset{\substack{|\\CH_3}}{CH}-CH_3$

Y

69. **(c)**

70. **(b)** During charging, the lead storage battery behaves like an electrolytic cell. So, at anode the reaction is

$$PbSO_4 + 2H_2O \longrightarrow PbO_2 + 4H^+ + SO_4^{2-} + 2e^-$$

71. **(d)** Due to + I-effect of the CH_3 group, toluene has much higher electron density in the ring than benzene, nitrobenzene and benzoic acid and hence it is most reactive towards nitration.

72. **(d)** Silk is protein fibre. Dacron is polyester fibre and nylon-6,6 is polyamide fibre.

73. **(a)** $H_3C-CH_2-CH_2-\underset{\substack{|\\CH_3}}{\overset{*}{CH}}-\underset{\substack{|\\CH_3}}{\overset{*}{CH}}-CH_2-CH_3$

(3, 4-dimethylheptane)

74. **(b)** $_{30}Zn$ and $_{80}Hg$ have their *d* orbitals completely filled, so they do not show any variable valency.

75. **(d)** All the given statements are correct.

76. **(a)** Stronger the acid, weaker the conjugate base. Since acid character follows the order

$H_2O > HC\equiv CH > NH_3 > CH_3-CH_3$

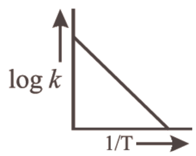
(Acid character),

the basic character of their conjugate bases decreases in the reverse order, i.e.,

$CH_3\ CH_2^- \equiv C^- > HC > NH_2^- > OH^-$

(Basic character)

77. **(b)** A graph plotted between log k vs $\frac{1}{T}$ for calculating activation energy is shown as



from Arrhenius equation

$$\log k = \log A - \frac{E_a}{2.303\,RT}$$

78. **(a)** $[Pt(NH_3)_2Cl_2]$ O.S. of Pt is +2; electronic configuration of $Pt^{2+} = [Xe]4f^{14}5d^8$. Ligand NH_3 results in pairing of *d*-electrons leaving one *d*-orbital empty therefore hybridisation is dsp^2 and geometry is square planar.

79. **(b)**

80. **(c)** The movement towards anode shows that sol is negative. For coagulation of negative sol cation with higher charge is more effective.

81. **(b)** At the anode, the following reaction are possible

$$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^- \quad ....(i)$$

$$2SO_4^{2-} \rightarrow S_2O_6^{2-}(aq) + 2e^- \quad ....(ii)$$

For dilute H_2SO_4 reaction (i) is preferred to produce O_2 gas. But for conc. H_2SO_4, reaction (ii) occurs.

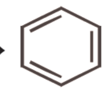
82. **(a)** EDTA has hexadentate four donor O atoms and 2 donor N atoms and for the formation of octahedral complex one molecule is required.

83. **(d)** The stability of lyophilic colloids is due to layer of dispersion medium around sol particles.

84. **(d)** Terylene is a fibre, and not a thermosetting plastic because on heating they melt and do not show plastic property while rest options are true regarding terylene.

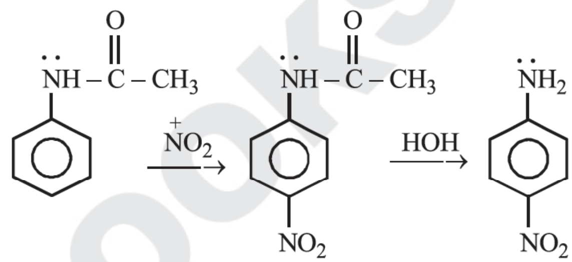
85. **(d)** Ideal gas cannot be liquefied at any value of P and T since there are no intermolecular interactions between molecules.

86. **(c)**

87. **(b)** $3HC \equiv CH \xrightarrow[500°C]{\text{Red hot tube}}$ 

88. **(a)** $CaCl_2$ acts as a non-volatile solute and results in depression in freezing point. Thus, snow fall is reduced and prevents blocking of roads in the polar region.

89. **(b)**



90. **(a)** For zero order reaction $t_{completion} = a/k$.

91. **(a)**

92. **(b)** $2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3$

According to equation $\frac{3}{2}$ mole of O_2 combines with 2 mole Al.

2 mole Al = 54 g

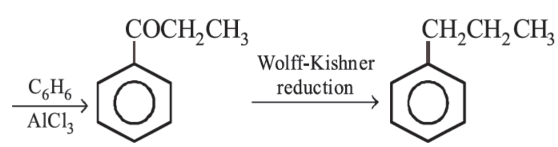
93. **(d)** Quaternary structure refers to the overall structure of a multiprotein complex whereas primary, secondary and tertiary structure refer to the different structural levels of a single protein.

94. **(b)**

95. **(d)** Solubility of alcohol in water decreases with increase in molecular mass due to increase in water repelling alkyl part in alcohol.

96. **(a)** $CH_3 - CH_2 - COOH \xrightarrow{PCl_3} CH_3 - CH_2 - CO - Cl$

(I)



(II) (III)

97. **(c)** Some drugs do not bind to the enzyme's active site but bind to a different site of enzyme which is called allosteric site, which changes the shape of the active site, in such a way that substrate cannot recognize it. If the bond formed between an enzyme and inhibitor is a strong covalent bond and cannot be broken easily the enzyme is blocked permanently. The body then degrades the enzyme-inhibitor complex and synthesises the new enzyme.

98. **(d)** Chlorine reacts with excess of ammonia to produce ammonium chloride and nitrogen.
$3Cl_2 + 8NH_3\,(\text{excess}) \longrightarrow 6NH_4Cl + N_2$

99. **(c)** $E^{\circ}_{MnO_4^-/Mn^{2+}}$ (acidic medium) $= 1.51\,V$;

$E^{\circ}_{MnO_4^-/MnO_2}$ (alkaline medium) $= 0.60\,V$

$E^{\circ}_{MnO_4^-/MnO_4^{2-}}$ (neutral medium) $= 0.56\,V$

100. **(d)** $3C_2H_5OH + PBr_3 \longrightarrow 3C_2H_5Br + \underset{[X]}{H_3PO_3}$

SECTION-B

MATHEMATICS

1. **(d)** $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
$= 12 + 9 - 4 = 17$
Now, $n((A \cup B)^C) = n(U) - n(A \cup B) = 20 - 17 = 3$

2. **(c)** $f(x) = \log x$, is not periodic.; $f(x) = e^x$, is not periodic.
$f(x) = x - [x] = \{x\}$, has period 1; $f(x) = x + [x]$, is not periodic.

3. **(a)** We have,

$$4\cos x(2 - 3\sin^2 x) + (\cos 2x + 1) = 0$$

$$\Rightarrow \quad 4\cos x(3\cos^2 x - 1) + 2\cos^2 x = 0$$

$$\Rightarrow \quad 2\cos x(6\cos^2 x + \cos x - 2) = 0$$

$$\Rightarrow \quad 2\cos x\,(3\cos x + 2)(2\cos x - 1) = 0$$

$\Rightarrow$ either $\cos x = 0$ which gives $x = \pi/2$ or $\cos x = -2/3$

Which gives no value of x for which $0 \le x \le \pi/2$

or $\cos x = 1/2$, which gives $x = \pi/3$

So, the required difference $= \pi/2 - \pi/3 = \pi/6$

4. **(a)** $S_{n+3} - 3S_{n+2} + 3S_{n+1} - S_n$

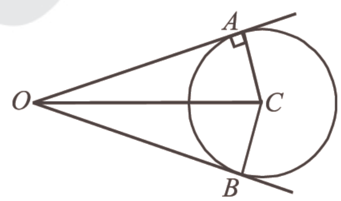
$= (S_{n+3} - S_{n+2}) - 2(S_{n+2} - S_{n+1}) + S_{n+1} - S_n$

$= t_{n+3} - 2t_{n+2} - t_{n+1} = 0$

5. **(a)** Any line parallel to x-axis of the form $y = p$ i.e. coefficient of $x = 0$
$\therefore$ In equation $(k-3)x - (4 - k^2)y + k^2 - 7k + 6 = 0$
Coefficient of $x = k - 3 = 0 \;\therefore\; k = 3$

6. **(b)** Area of quadrilateral = 2 [area of $\Delta\, OAC$]

$$= 2.\frac{1}{2} OA.AC = \sqrt{S_1}.\sqrt{g^2 + f^2 - c}$$



Point is (0, 0) $\Rightarrow S_1 = c$,

$\therefore$ Area $= \sqrt{c(g^2 + f^2 - c)}$

7. **(c)** $z = \log_2(1 + i) = \log_2(\sqrt{2}e^{i\pi/4})$

$$= \frac{1}{2} + i\frac{\pi}{4}\log_2 e$$

$\therefore \quad z + \bar{z} = 1$ and $z - \bar{z} = i\dfrac{\pi}{2}\log_2 e$

Hence, $(z + \bar{z}) + i(z - \bar{z})$

$$= 1 - \frac{\pi}{2}\log_2 e = 1 - \frac{\pi}{2\ln 2} = \frac{\ln 4 - \pi}{\ln 4}$$

8. **(c)** The number of ways of getting the different numbers 1, 2, ..., 6 in six dice = 6 !.
Total number of ways = 6^6
Hence, required probability

$$= \frac{6!}{6^6} = \frac{1 \times 2 \times 3 \times 4 \times 5 \times 6}{6^6} = \frac{5}{324}$$

9. **(b)** We have, $y=(1+x^{1/4})(1+x^{1/2})(1-x^{1/4})$

$$=(1-x^{1/2})(1+x^{1/2})=1-x$$

$\therefore \frac{dy}{dx}=-1$

10. **(d)** Since $\sim(p\vee q)\equiv\sim p\wedge\sim q$

(By De-Morgans' law)

$\therefore\ \sim(p\vee q)\neq\sim p\vee\sim q$

$\therefore$ (d) is the false statement

11. **(c)** Total sum of 13 observations $=14\times13=182$

Sum of 14 observation $=7\times12+7\times16=84\times112$
$=196$

So, the 7th observation $=196-182=14$

12. **(d)** It is obvious by fundamental property of circular permutations.

13. **(a)** Equating the components in

$\alpha(\hat{i}+2\hat{j}+3\hat{k})+\beta(2\hat{i}+3\hat{j}+\hat{k})+\gamma(3\hat{i}+\hat{j}+2\hat{k})$

$=-3(\hat{i}-\hat{k})$, we have

$\alpha+2\beta+3\gamma=-3$ ....(i)

$2\alpha+3\beta+\gamma=0$ ....(ii)

$3\alpha+\beta+2\gamma=3$ ....(iii)

Solving the equations (i), (ii), & (iii) we get

$\alpha=2,\ \beta=-1,\ \gamma=-1$.

14. **(d)** We know, any function f(x) has extreme value at the points where its first derivative is zero.

Given : $y=a\log x+bx^2+x$ ...(i)

Differentiate equation (i) $\frac{dy}{dx}=\frac{a}{x}+2bx+1$

$\left(\frac{dy}{dx}\right)_{x=1}=\frac{a}{1}+2b.1+1\Rightarrow a+2b+1=0$ ...(ii)

$\left(\frac{dy}{dx}\right)_{x=2}=\frac{a}{2}+2b.2+1\Rightarrow a+8b+2=0$

$\Rightarrow a+8b=-2$ ...(iii)

From equation (ii) and (iii), $a+2b=-1$

$a+8b=-2\Rightarrow -6b=1\Rightarrow b=-\frac{1}{6}$ and $a=-\frac{2}{3}$

15. **(a)** $l_1\,R\,l_1\Rightarrow l_1$ is not perpendicular to l_1

($\therefore$ R is not reflexive)

$l_1\,R\,l_2\Rightarrow l_1\perp l_2$

$\Rightarrow l_2\perp l_1\Rightarrow l_2\,R\,l_1$. Hence, R is symmetric

$l_1\,R\,l_2$ and $l_2\,R\,l_3\Rightarrow l_1\,R\,l_3$

($\therefore$ R is not transitive)

16. **(a)** Put $x+b=t\Rightarrow dx=dt$

Also, $\sin(x+a)=\sin(t-b+a)$

$=\sin t\cos(a-b)+\cos t\sin(a-b)$

$\therefore\ \int\frac{\sin(x+a)}{\sin(x+b)}dx$

$=\int\frac{\sin t\cos(a-b)+\cos t\sin(a-b)}{\sin t}dt$

$=\int\left[\cos(a-b)+\sin(a-b)\cot t\right]dt$

$=t\cos(a-b)+\sin(a-b)\log_e|\sin t|+C$

$=(x+b)\cos(a-b)+\sin(a-b)\log_e|\sin(x+b)|+C$

$=x\cos(a-b)+\sin(a-b)\log_e|\sin(x+b)|+C$

[Absorbing $b\cos(a-b)$ in C], $C\in\mathbf{R}$

17. **(d)** $A+B=I\Rightarrow B=I-A$

Now $B^2=(I-A)(I-A)=I^2-AI-IA+A^2$

$=I-A-A+A=I-A=B$

$\therefore$ B is idempotent

Now, $AB=A(I-A)=AI-A^2=A-A=O$

And $BA=(I-A)=IA-A^2=A-A=O$

18. **(c)** $2^{x/2}+3^{x/2}=(\sqrt{13})^{x/2}$

$\Rightarrow\left(\frac{2}{\sqrt{13}}\right)^{x/2}+\left(\frac{3}{\sqrt{13}}\right)^{x/2}=1$

Which is of the form $\cos^{x/2}\alpha+\sin^{x/2}\alpha=1$.

$\therefore\frac{x}{2}=2$.

19. **(d)** If $f(x)$ has an extremum at $x=\pi/3$, then $f'(x)=0$ at $x=\pi/3$. Now,

$f(x)=a\sin x+\frac{1}{3}\sin 3x$

$\therefore f'(x)=a\cos x+\cos 3x$; $f'(\pi/3)=0$

or $a\cos(\pi/3)+\cos\pi=0$ or $a=2$.

20. **(c)** Let the direction cosines of line L be l, m, n, then

$2l+3m+n=0$ ...(i)

and $l+3m+2n=0$ ...(ii)

on solving equations (i) and (ii), we get

$$\frac{l}{6-3}=\frac{m}{1-4}=\frac{n}{6-3} \Rightarrow \frac{l}{3}=\frac{m}{-3}=\frac{n}{3}$$

Now $\frac{l}{3}=\frac{m}{-3}=\frac{n}{3}=\frac{\sqrt{l^2+m^2+n^2}}{\sqrt{3^2+(-3)^2+3^2}}$

$\because l^2+m^2+n^2=1 \therefore \frac{l}{3}=\frac{m}{-3}=\frac{n}{3}=\frac{1}{\sqrt{27}}$

$$\Rightarrow \quad l=\frac{3}{\sqrt{27}}=\frac{1}{\sqrt{3}}, m=-\frac{1}{\sqrt{3}}, n=\frac{1}{\sqrt{3}}$$

Line L, makes an angle α with +ve x-axis

$\therefore l=\cos\alpha \Rightarrow \cos\alpha=\frac{1}{\sqrt{3}}$

21. **(b)** First we have to select 2 men for bow side and 3 for stroke side. The number of selections of the crew for two sides $= {}^5C_2 \times {}^3C_3$

For each selection there are 4 persons on both sides, who can be arranged in $4! \times 4!$ ways.

Required number of arrangement

$= {}^5C_2 \times {}^3C_3 \times 4! \times 4! = 5760$

22. **(d)** E_1 : Event that first drawn ball is red, second is blue and so on.

E_2 : Event that first drawn ball is blue, second is red and so on.

$\therefore \quad P(E_1)=\frac{4}{8}\times\frac{4}{7}\times\frac{3}{6}\times\frac{3}{5}$ and $P(E_2)$

$=\frac{4}{8}\times\frac{4}{7}\times\frac{3}{6}\times\frac{3}{5}$

$$P(E)=P(E_1)+P(E_2)=2\times\frac{4}{8}\cdot\frac{4}{7}\cdot\frac{3}{6}\cdot\frac{3}{5}=\frac{6}{35}$$

23. **(b)** If the given mid points be D, E, F; then the area of ΔDEF is given by

$$\Rightarrow \frac{1}{2}[0(2-4)+1(4-0)-3(0-2)]=\frac{1}{2}[0+4+6]=5$$

$\therefore$ Area of the triangle ABC $= 4\times 5 = 20$

24. **(d)**

$$\lim_{n\to\infty}\frac{5^{n+1}+3^n-2^{2n}}{5^n+2^n+3^{2n+3}}=\lim_{n\to\infty}\frac{5\cdot 5^n+3^n-4^n}{5^n+2^n+27\cdot 9^n}$$

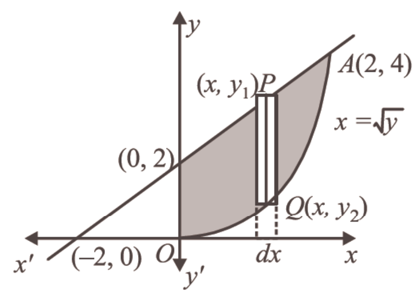
$$=\lim_{n\to\infty}\frac{5\cdot\frac{5^n}{9^n}+\frac{3^n}{9^n}-\frac{4^n}{9^n}}{\frac{5^n}{9^n}+\frac{2^n}{9^n}+27}=\frac{0+0-0}{0+0+27}=0.$$

25. **(d)** $p^2+q^2=(p+q)^2-2pq=\alpha^2-2\alpha+6$

$p^2+q^2=(\alpha-1)^2+5\ge 5$

26. **(c)** Required area $=\int_0^2 (y_1-y_2)dx$

$$=\int_0^2[(x+2)-(x^2)dx=\left[\frac{x^2}{2}+2x-\frac{x^3}{3}\right]_0^2=2+4-\frac{8}{3}=\frac{10}{3}$$



27. **(c)** f(x)=

$$\frac{2\cos^2\frac{x}{2}-2\sin\frac{x}{2}\cos\frac{x}{2}}{2\cos^2\frac{x}{2}+2\sin\frac{x}{2}\cos\frac{x}{2}}=\frac{\cos\frac{x}{2}-\sin\frac{x}{2}}{\cos\frac{x}{2}+\sin\frac{x}{2}}$$

$$=\tan\left(\frac{\pi}{4}-\frac{x}{2}\right) \text{ at } x=\pi, f(\pi)=-\tan\frac{\pi}{4}=-1.$$

28. **(b)** $T_{r+1} = \frac{3.5....(2r-1)}{r!}\left(\frac{1}{5}\right)^r$

$= \frac{\left(\frac{1}{2}\right)\left(\frac{3}{2}\right)\left(\frac{5}{2}\right)...\left(\frac{2r-1}{2}\right)}{r!}\left(\frac{2}{5}\right)^r$

$=$

$\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\left(-\frac{1}{2}-2\right)...\left(-\frac{1}{2}-r+1\right)}{r!}\left(-\frac{2}{5}\right)^r$

which is the $(r+1)^{th}$ term of $\left(1-\frac{2}{5}\right)^{-1/2}$

29. **(b)** If $A+B+C=\pi$,

then $\cos mA + \cos mB + \cos mC$

$= 1 - 4\sin\frac{mA}{2}\sin\frac{mB}{2}\sin\frac{mC}{2}$

$\therefore$ For $m=2$: $\cos 2A + \cos 2B + \cos 2C$

$= 1 - 4\sin A \sin B \sin C$

$\Rightarrow \cos 2A + \cos 2B + \cos 2C + 4\sin A \sin B \sin C = 1$

30. **(a)** The series is

$(x^2 + x^4 + x^6 + ...) + \left(\frac{1}{x^2} + \frac{1}{x^4} + \frac{1}{x^6} + ...\right) + (2+2+.....)$

$= \frac{x^2(x^{2n}-1)}{x^2-1} + \frac{\frac{1}{x^2}\left(1-\frac{1}{x^{2n}}\right)}{1-\frac{1}{x^2}} + 2n$

$= \frac{x^{2n}-1}{x^2-1} \times \frac{x^{2n+2}+1}{x^{2n}} + 2n$

31. **(d)** $y^2 + xy - 12x^2 = 0 \Rightarrow (y+4x)(y-3x) = 0$ $\therefore$

$\frac{y}{x} = 3, -4,$

The two pairs will have a line common if

3 or -4 will be a root of $b\left(\frac{y}{x}\right)^2 + 2h\left(\frac{y}{x}\right) + a = 0$

$\therefore$ $9b + 6h + a = 0$ or $16b - 8h + a = 0$

32. **(c)** Let the equation of the ellipse be

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

Let e be the eccentricity of the ellipse.

Since distance between foci = 2h

$\therefore$ $2ae = 2h \Rightarrow e = h$ ...(1)

Focal distance of one end of minor axis say (0, b) is k

$\therefore$ $a + e(0) = k \Rightarrow a = k$ ...(2)

From (1) and (2), $b^2 = a^2(1-e^2) = k^2 - h^2$

$\therefore$ The equation of the ellipse is

$\frac{x^2}{k^2} + \frac{y^2}{k^2-h^2} = 1.$

33. **(a)** We have,

$(1+\omega^2+2\omega)^{3n} - (1+\omega+2\omega^2)^{3n}$

We know that, $1+\omega+\omega^2 = 0$ and $\omega^3 = 1$

$\therefore$ given expression is equal to

$(2\omega-\omega)^{3n} - (2\omega^2-\omega^2)^{3n}$

$= (\omega)^{3n} - (\omega^2)^{3n} = (\omega^3)^n - (\omega^3)^{2n} = 1 - 1 = 0$

34. **(a)** Given that, p is a non-singular matrix such that

$1 + p + p^2 + ... + p^n = O$

$\Rightarrow$ $(1+p)(1+p+p^2+...+p^n) = O$

$\Rightarrow$ $1 - p^{n+1} = O$ $\Rightarrow$ $p^{n+1} = 1$

$\Rightarrow$ $p^n \times p^1 = 1$ $\Rightarrow$ $p^n = 1/p$

$\therefore$ $p^{-1} = p^n$

35. **(c)** Let $I = \int \frac{x\sin^{-1}x}{\sqrt{1-x^2}}dx$

Take, $\sin^{-1}x = t$ $\Rightarrow x = \sin t$

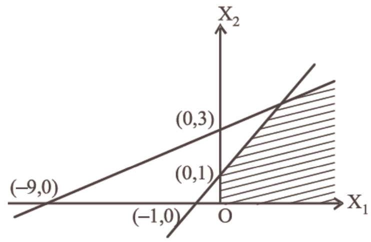
$\frac{1}{\sqrt{1-x^2}}dx = dt$, $\therefore$ $\cos t = \sqrt{1-x^2}$

$I = \int \sin t.t\,dt = t.(-\cos t) - \int(-\cos t)dt$

$= -t\cos t + \sin t + C$

$= -(\sqrt{1-x^2})\sin^{-1}x + x + C$

36. **(b)** It is clear from the graph, the constraints define the unbounded feasible space.



37. **(c)** $\tan^{-1}\sqrt{\dfrac{1-\cos x}{1+\cos x}} = \tan^{-1}\left(-\tan\dfrac{x}{2}\right)$

$$= \tan^{-1}\tan\left(4\pi - \frac{x}{2}\right) = 4\pi - \frac{x}{2}$$

$$\left[\because 7\pi < x < 8\pi \Rightarrow \frac{7\pi}{2} < \frac{x}{2} < 4\pi, \textit{ so } \tan\frac{x}{2} < 0\right]$$

38. **(a)** Consider first two equations :
$2x + 3y = -4$ and $3x + 4y = -6$

We have $\Delta = \begin{vmatrix} 2 & 3 \\ 3 & 4 \end{vmatrix} = -1 \neq 0$

$\Delta_x = \begin{vmatrix} -4 & 3 \\ -6 & 4 \end{vmatrix} = 2$ and $\Delta_y = \begin{vmatrix} 2 & -4 \\ 3 & -6 \end{vmatrix} = 0$

$\therefore$ $x = -2$ and $y = 0$
Now, this solution satisfies the third, so the equations are consistent with unique solution.

39. **(d)** Let $I = \displaystyle\int_0^{\frac{\pi}{4}} \log(1+\tan x)\,dx$ ...(i)

Then $I = \displaystyle\int_0^{\frac{\pi}{4}} \log\left\{1+\tan\left(\frac{\pi}{4}-x\right)\right\} dx$

$$= \int_0^{\frac{\pi}{4}} \log\left\{1+\frac{1-\tan x}{1+\tan x}\right\} dx = \int_0^{\frac{\pi}{4}} \log\left\{\frac{2}{1+\tan x}\right\} dx$$

$$= \int_0^{\frac{\pi}{4}} \{\log 2 - \log(1+\tan x)\} dx$$

$$= \int_0^{\frac{\pi}{4}} \log_e 2dx - \int_0^{\frac{\pi}{4}} \log_e(1+\tan x)\,dx$$

$$= \log_e 2\left[\frac{\pi}{4} - 0\right] - I$$

$$\therefore \quad 2I = \frac{\pi}{4}\log_e 2 \Rightarrow I = \frac{\pi}{8}\log_e 2$$

40. **(b)** $\because y = \log^n x$
On differentiating w.r.t. x, we get

$$x \log x \log^2 x \log^3 x \ldots \log^{n-1} x \log^n x \frac{dy}{dx}$$

$$= \frac{x \log x \log^2 x \log^3 x \ldots \log^{n-1} x \log^n x.1}{x \log x \log^2 x \log^3 x \ldots \log^{n-1} x}$$

$= \log^n x$

41. **(b)** Since $f'(x) = g(x)$, $f''(x) = g'(x)$
Put $f''(x) = -f(x)$. Hence $g'(x) = -f(x)$
we have $h'(x) = 2f(x)\,f'(x) + 2g(x)\,g'(x)$
$= 2[f(x)\,g(x) + g(x)\,[-f(x)]]$
$= 2\,[f(x)\,g(x) - f(x)\,g(x)] = 0$
$\therefore h(x) = C$, a constant $\therefore h(0) = C$ i.e. $C = 5$
$h(x) = 5$ for all x. Hence $h(10) = 5$.

42. **(c)** We have, $z = 0$ for the point where the line intersects the curve. Therefore,

$$\frac{x-2}{3} = \frac{y+1}{2} = \frac{0-1}{-1}$$

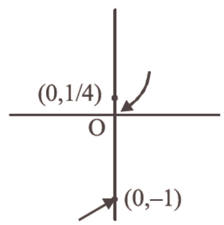
$$\Rightarrow \frac{x-2}{3} = 1 \text{ and } \frac{y+1}{2} = 1 \Rightarrow x = 5 \text{ and } y = 1$$

Put these value in $xy = c^2$, we get, $5 = c^2$

$\Rightarrow c = \pm\sqrt{5}$

43. **(a)** $f(4) = g(4) \Rightarrow 8 + a = 8 \Rightarrow a = 0$
$f(-1) = -2$ for $a = 0$; $f(-1) > f(4)$; $b + 3 > 8 \Rightarrow b > 5$

44. **(c)** Clearly from curve drawn of the given function f(x) is discontinuous at x = 0.



45. **(c)** Force $(\vec{F}) = 2i + j - k$ and its position vector of $A = 2i - j$. We know that the position vector of a force about origin $(r) = (2i - j) - (0i + 0j + 0k)$ or $r = 2i - j$.

Therefore, moment of the force about origin

$$= r \times \vec{F} = \begin{vmatrix} i & j & k \\ 2 & -1 & 0 \\ 2 & 1 & -1 \end{vmatrix} = i + 2j + 4k.$$

46. **(a)** We have $\frac{dy}{dx} = \frac{f'(x)}{f(x)} y - \frac{y^2}{f(x)}$

$$\Rightarrow \frac{dy}{dx} - \frac{f'(x)}{f(x)} y = -\frac{y^2}{f(x)}$$

Divide by y^2 $y^{-2}\frac{dy}{dx} - y^{-1}\frac{f'(x)}{f(x)} = -\frac{1}{f(x)}$

Put $y^{-1} = z \Rightarrow -y^{-2}\frac{dy}{dx} = \frac{dz}{dx}$

$$-\frac{dz}{dx} - \frac{f'(x)}{f(x)}(z) = -\frac{1}{f(x)}$$

$$\Rightarrow \frac{dz}{dx} + \frac{f'(x)}{f(x)} z = \frac{1}{f(x)}$$

$$\text{I.F.} = e^{\int \frac{f'(x)}{f(x)}dx} = e^{\log f(x)} = f(x)$$

$\therefore$ The solution is $z(f(x)) = \int \frac{1}{f(x)}(f(x))dx + c$

$$\Rightarrow y^{-1}(f(x)) = x + c \Rightarrow f(x) = y(x + c)$$

47. **(c)** $S_n = a_0C_0^2 + a_1C_1^2 + a_2C_2^2 + \dots\dots + a_nC_n^2$

$S_n = a_nC_n^2 + a_{n-1}C_{n-1}^2 + a_{n-2}^2 + \dots\dots + a_0C_0^2$

$2S_n = (a_0 + a_n)C_0^2 + (a_1 + a_{n-1})C_1^2 + \dots\dots + (a_n + a_0)C_n^1$

$= (2n + 2)(C_0^2 + C_1^2 + C_2^2 + \dots\dots\dots + C_n^2)$

$\therefore S_n = (n + 1)\,{}^{2n}C_n$

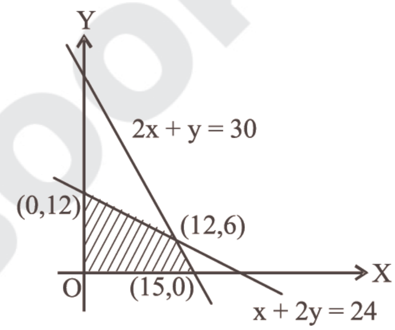
$[\because a_0 + a_n = a_1 + a_{n-1} + \dots\dots\dots = 2n + 2]$

48. **(b)** Here, $2x + y \le 30$, $x + 2y \le 24$, $x, y \ge 0$

The shaded region represents the feasible region, hence

$z = 6x + 8y$. Obviously it is maximum at (12, 6).

Hence $z = 12 \times 6 + 8 \times 6 = 120$



49. **(a)** Now $AA^{-1} = I$

So, $\begin{bmatrix} 2 & 1 \\ 0 & x \end{bmatrix} \cdot \begin{bmatrix} \frac{1}{2} & \frac{1}{6} \\ 0 & \frac{1}{x} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

$\Rightarrow \begin{bmatrix} 1 & \left(\frac{1}{3}\right) + \left(\frac{1}{x}\right) \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ So,

$$\frac{1}{3} + \frac{1}{x} = 0 \Rightarrow x = -3$$

50. **(a)** Standard deviation $\sigma = \sqrt{npq} \ge 0$

Now mean = np =25 and q < 1

So $\sigma = \sqrt{npq} < \sqrt{np} = 5$

$\therefore 0 \le \sigma < 5$

(Mock Test-7)

Answer KEYS

SECTION-A																			
PHYSICS																			
1	(b)	**6**	(c)	**11**	(c)	**16**	(b)	**21**	(b)	**26**	(a)	**31**	(d)	**36**	(d)	**41**	(d)	**46**	(a)
2	(b)	**7**	(b)	**12**	(d)	**17**	(d)	**22**	(a)	**27**	(b)	**32**	(d)	**37**	(b)	**42**	(a)	**47**	(b)
3	(b)	**8**	(a)	**13**	(a)	**18**	(a)	**23**	(c)	**28**	(a)	**33**	(d)	**38**	(c)	**43**	(a)	**48**	(c)
4	(c)	**9**	(d)	**14**	(a)	**19**	(b)	**24**	(d)	**29**	(b)	**34**	(a)	**39**	(c)	**44**	(a)	**49**	(c)
5	(d)	**10**	(d)	**15**	(b)	**20**	(c)	**25**	(c)	**30**	(d)	**35**	(c)	**40**	(c)	**45**	(c)	**50**	(d)
CHEMISTRY																			
51	(c)	**56**	(c)	**61**	(a)	**66**	(a)	**71**	(a)	**76**	(c)	**81**	(b)	**86**	(a)	**91**	(b)	**96**	(d)
52	(a)	**57**	(c)	**62**	(a)	**67**	(b)	**72**	(a)	**77**	(c)	**82**	(c)	**87**	(a)	**92**	(d)	**97**	(c)
53	(a)	**58**	(b)	**63**	(a)	**68**	(d)	**73**	(d)	**78**	(a)	**83**	(a)	**88**	(b)	**93**	(d)	**98**	(b)
54	(b)	**59**	(a)	**64**	(b)	**69**	(b)	**74**	(b)	**79**	(d)	**84**	(d)	**89**	(b)	**94**	(b)	**99**	(b)
55	(a)	**60**	(d)	**65**	(d)	**70**	(a)	**75**	(c)	**80**	(c)	**85**	(b)	**90**	(b)	**95**	(a)	**100**	(a)
SECTION-B																			
MATHEMATICS																			
1	(c)	**6**	(b)	**11**	(b)	**16**	(c)	**21**	(c)	**26**	(b)	**31**	(c)	**36**	(c)	**41**	(a)	**46**	(a)
2	(a)	**7**	(b)	**12**	(a)	**17**	(a)	**22**	(c)	**27**	(c)	**32**	(b)	**37**	(d)	**42**	(c)	**47**	(d)
3	(a)	**8**	(d)	**13**	(c)	**18**	(b)	**23**	(d)	**28**	(d)	**33**	(b)	**38**	(a)	**43**	(c)	**48**	(a)
4	(b)	**9**	(b)	**14**	(a)	**19**	(b)	**24**	(a)	**29**	(b)	**34**	(b)	**39**	(b)	**44**	(a)	**49**	(b)
5	(a)	**10**	(b)	**15**	(a)	**20**	(d)	**25**	(c)	**30**	(d)	**35**	(c)	**40**	(b)	**45**	(a)	**50**	(b)

SECTION-A

PHYSICS

1. **(b)** Since areal velocity $\vec{A}$ & angular momentum $\vec{L}$ of a planet are related by equation $\vec{A} = \frac{\vec{L}}{2M}$, where M is the mass of planet. Since in planetary motion $\vec{L}$ is constant ($\vec{\tau}_{ext.} = 0$), hence $\vec{A}$ is also constant.

2. **(b)**

3. **(b)**

4. **(c)** A slit would give divergent; a biprism would give double; a glass slab would give a parallel wavefront. Edge is downward.

5. **(d)** According to Gauss' Law

$$\oint E.ds = \frac{Q_{\text{enclosed by closed surface}}}{\varepsilon_o} = \text{flux}$$

so total flux = Q/ε_o

Since cube has six face, so flux coming out through one wall or one face is $Q/6\varepsilon_o$.

6. (c) $B_{axis} = \left(\frac{\mu_0 NI}{2x^3}\right)R^2$

$B \propto R^2$

So, when radius is doubled, magnetic field becomes four times.

7. (b) Let pole strength = m

So, $M = m\ell$

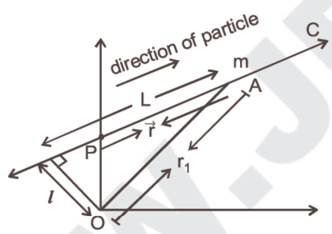
When wire is in form of arc, then the distance between poles = $\frac{2\ell}{\pi}$

So, $M' = \frac{m2\ell}{\pi} = \frac{2M}{\pi}$

8. (a) $\frac{1}{\lambda_{min}} = R\left[\frac{1}{(1)^2} - \frac{1}{\infty}\right] \Rightarrow \lambda_{min} = \frac{1}{R} \approx 910Å.$

9. (d)

10. (d) Let a particle A of mass m whose position vector is $\vec{r}$ w.r.t. the point P at any instant in an inertial frame.



From the formula, $\vec{p} = m\vec{v}$

Then, angular momentum $\vec{\ell} = \vec{r} \times \vec{p}$

$\Rightarrow \ell = r \times p \sin\theta$

θ is the angle between r and p.

Therefore, $\theta = 0^o$ So, $\ell = 0$

11. (c) If R is radius of bigger drop formed, then

$\frac{4}{3}\pi R^3 = 2 \times \frac{4}{3}\pi r^3$ or $R = 2^{1/3} r$

As $v_0 \propto r^2$

$\therefore \frac{v_{01}}{v_0} = \frac{R^2}{r^2} = \frac{(2^{1/3}r)^2}{r^2} = 2^{2/3}$

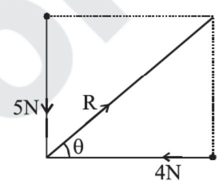
or $v_{01} = v_0 \times 2^{2/3} = 5 \times (4)^{1/3}$

12. (d)

13. (a) Since the attenuation of ground waves increases with increase in frequencies so only low frequency- radio waves uses this mode of propagation for short distances.

14. (a) $R = \sqrt{4^2 + 5^2} = \sqrt{41}N$

The angle θ will be given by



$\tan\theta = \frac{5}{4}$ or $\theta = \tan^{-1}\left(\frac{5}{4}\right)$

15. (b) $Y = \overline{\overline{A}.\overline{B}} = (A+B)$

16. (b)

17. (d)

18. (a) $K.E. = h\nu - h\nu_{th} = eV_0$ (V_0 = cut off voltage)

$\Rightarrow V_0 = \frac{h}{e}(8.2 \times 10^{14} - 3.3 \times 10^{14}) \approx 2V.$

19. (b) Gravitational potential energy (GPE) on the surface of earth,

$E_1 = -\frac{GMm}{R}$

GPE at $3R$, $E_2 = -\frac{GMm}{(R+3R)} = -\frac{GMm}{4R}$

$\therefore$ Change in GPE

$= E_2 - E_1 = -\frac{GMm}{4R} + \frac{GMm}{R} = \frac{3GMm}{4R}$

$= \frac{3gR^2m}{4R}$ $\left(\because g = \frac{GM}{R^2}\right)$

$= \frac{3}{4}mgR$

20. (c) Centripetal acc. $= \omega^2 r = 4\pi^2 v^2 r$

$$= 4 \times (3.14)^2 \times \frac{120}{60} \times \frac{30}{100} = 23.7\ \text{ms}^{-2}$$

$[\because \omega = 2\pi v]$

21. (b) $\because$ $q \propto V$ for $q = CV$

$\Rightarrow$ as charge on capacitor increases means P.D. between plates increases.

22. (a) Here, $y_1 = a \sin(\omega t + kx + 0.57)$

and $y_2 = a \cos(\omega t + kx)$

$$= a \sin\left[\frac{\pi}{2} + (\omega t + kx)\right]$$

Phase difference, $\Delta\phi = \phi_2 - \phi_1 = \frac{\pi}{2} - 0.57$

$$= \frac{3.14}{2} - 0.57 = 1.57 - 0.57 = 1 \text{ radian}$$

23. (c)

24. (d) $F_{req} = mg + 2[T(2\pi R)]$ $[T = 75 \times 10^{-3}\ \text{N/m}]$

$= 0.1 + 2[75 \times 10^{-3}(0.2)] = 0.130\ \text{N}$

25. (c) Let ρ be the resistance per unit length then, $P = 36\rho$, $Q = 64\rho$

$$R = \frac{12X}{X+12},\ S = 16$$

Now, for meter bridge

$$\frac{P}{Q} = \frac{R}{S} = \frac{12X}{(X+12)16} = \frac{36}{64}$$

$12X = 9X + 108 = X = 36\Omega$

26. (a) According, to Faraday's law of induction

Induced e.m.f. $\varepsilon = -\frac{d\phi}{dt} = -(100t)$

Induced current i at $t = 2$ sec.

$$= \left|\frac{\varepsilon}{R}\right| = +\frac{100 \times 2}{400} = +0.5\ \text{Amp}$$

27. (b) $m = 10$ kg, $x = (t^3 - 2t - 10)$ m

$$\frac{dx}{dt} = v = 3t^2 - 2,\ \frac{d^2x}{dt^2} = a = 6t$$

At the end of 4 seconds, $a = 6 \times 4 = 24\ \text{m/s}^2$

$F = ma = 10 \times 24 = 240$ N

28. (a) At magnetic north pole of earth, $H = 0$ and $\delta = 90^\circ$, maximum.

29. (b) $I = 2 \times 5 \times (0.2)^2 + 2 \times 2 \times (0.4)^2 = 1\text{kg} \times \text{m}^2$

30. (d) $N_1 = N_0 e^{-10\lambda t}$, $N_2 = N_0 e^{-\lambda t}$

$$\frac{N_1}{N_2} = e^{-9\lambda t} = e^{-1};\quad 9\lambda t = 1 \Rightarrow t = \frac{1}{9\lambda}$$

31. (d) $V_A = 2V_B$; $T_A = 2T_B$; $P_A = 2P_B$

$$\frac{P_A V_A}{TA} = \frac{P_B V_B}{T_B} = n_A R = n_B R$$

$$\therefore \frac{\eta_A}{\eta_B} = \frac{P_A V_A T_B}{P_B V_B T_A}$$

$$= \frac{(2P_B)(2V_B)(T_B)}{P_B V_B (2T_B)} = 2$$

32. (d)

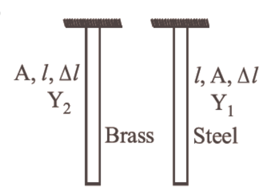
33. (d) For dark fringe

$$x = (2n-1)\frac{\lambda D}{2d}$$

$$\therefore \lambda = \frac{2xd}{(2n-1)D} = \frac{2 \times 10^{-3} \times 0.9 \times 10^{-3}}{(2 \times 2 - 1) \times 1}$$

$$\lambda = 0.6 \times 10^{-6}\ \text{m} = 6 \times 10^{-5}\ \text{cm}$$

34. (a) Young's modulus



$$Y = \frac{W}{A} \cdot \frac{l}{\Delta l}$$

$$\frac{W_1}{Y_1} = \frac{W_2}{Y_2}$$

$[\because A, l, \Delta l$ same for both brass and steel$]$

$$\frac{W_1}{W_2} = \frac{Y_1}{Y_2} = 2\ [Y_{steel}/Y_{brass} = 2 \text{ given}]$$

35. (c)

36. **(d)** By junction rule at point B

$-I + 1A + 2A = 0$

So, $I = 3A$

By Loop rule,

$-3 \times 2 - 1 \times 1 - E + 12 = 0$

$E = 5V$

37. **(b)** $e = M\dfrac{di}{dt} = 0.005 \times \dfrac{d}{dt}(i_0 \sin \omega t)$

$= 0.0005 \times i\,\omega \cos \omega t$

$\therefore e_{max} = 0.005 \times 10 \times 100\pi = 5\pi \quad [\because \cos \omega t = 1]$

38. **(c)** Using, $\dfrac{\mu}{v} - \dfrac{1}{u} = \dfrac{\mu - 1}{R}$ or $\dfrac{2}{v} - \dfrac{1}{\infty} = \dfrac{2-1}{R}$

$\therefore \quad v = 2R$

39. **(c)** $x = \dfrac{(2n+1)\lambda\ D}{2a}$

For red light, $x = \dfrac{(4+1)D}{2a} \times 6500 Å$

For other light, $x = \dfrac{(6+1)D}{2a} \times \lambda Å$

x is same for each.

$\therefore \ 5 \times 6500 = 7 \times \lambda \Rightarrow \lambda = \dfrac{5}{7} \times 6500 = 4642.8\,Å$.

40. **(c)** Frequency of the echo detected by the driver of the train is

(According to Doppler effect in sound)

$f' = \left(\dfrac{v+u}{v-u}\right) f$

where f = original frequency of source of sound

f' = Apparent frequency of source because of the relative motion between source and observer.

$f' = \left(\dfrac{330+220}{330-220}\right)1000 = 5000\,\text{Hz}$

41. **(d)** At mean position velocity is maximum

i.e., $v_{max} = \omega a \Rightarrow \omega = \dfrac{v_{max}}{a} = \dfrac{16}{4} = 4$

$\therefore v = \omega\sqrt{a^2 - y^2} \Rightarrow 8\sqrt{3} = 4\sqrt{4^2 - y^2}$

$\Rightarrow 192 = 16(16 - y^2) \Rightarrow 12 = 16 - y^2 \Rightarrow y = 2cm.$

42. **(a)** Given : Mass (m) = 0.4 kg

Its frequency (n) = 2 rev/sec

Radius (r) = 1.2 m. We know that linear velocity of the body (v) = ωr = (2πn)r

$= 2 \times 3.14 \times 1.2 \times 2 = 15.08$ m/s.

Therefore, tension in the string when the body is at the top of the circle (T)

$= \dfrac{mv^2}{r} - mg$

$= \dfrac{0.4 \times (15.08)^2}{2} - (0.4 \times 9.8)$

$= 45.78 - 3.92 = 41.56\,N$

43. **(a)** For solid sphere rolling without slipping on inclined plane, acceleration

$$a_1 = \frac{g \sin \theta}{1 + \frac{K^2}{R^2}}$$

For solid sphere slipping on inclined plane without rolling, acceleration

$a_2 = g \sin \theta$

Therefore required ratio $= \dfrac{a_1}{a_2}$

$$= \frac{1}{1 + \frac{K^2}{R^2}} = \frac{1}{1 + \frac{2}{5}} = \frac{5}{7}$$

44. **(a)**

45. **(c)** Power radiated by the sun at t°C

$= \sigma(t + 273)^4 4\pi r^2$

Power received by a unit surface

$$= \frac{\sigma(t+273)^4 4\pi r^2}{4\pi R^2} = \frac{r^2 \sigma(t+273)^4}{R^2}$$

46. **(a)** Lorentz force acting on the particle

$$\vec{F} = q\left[\vec{E} + \vec{v} \times \vec{B}\right]$$

$$= q\left[3\hat{i} + \hat{j} + 2\hat{k} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 4 & 1 \\ 1 & 1 & -3 \end{vmatrix}\right]$$

$$= q\left[3\hat{i} + \hat{j} + 2\hat{k} + \hat{i}(-12-1) - \hat{j}(-9-1) + k(3-4)\right]$$

$$F_y = 11q\hat{j}$$

47. **(b)** We know that frequency of electrical oscillation in L.C. circuit is

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$

Now, $L = 2L$ & $C = 4C$

$$f' = \frac{1}{2\pi}\sqrt{\frac{1}{2L \cdot 4C}} = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} \times \frac{1}{2\sqrt{2}}$$

$$\Rightarrow f' = \frac{1}{2\sqrt{2}} \times f$$

48. **(c)**

49. **(c)**

50. **(d)** Though an equal and opposite force acts on the road but since road does not undergo any displacement, hence no work is done on the road.

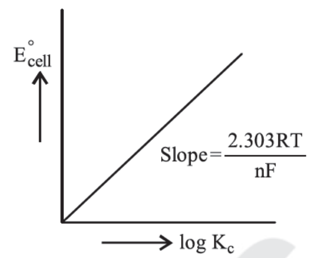
CHEMISTRY

51. **(c)**

Compound		**Oxidation number of nitrogen**
N_2H_4	=	–2
NH_3	=	–3
N_3H	=	–1/3
NH_2OH	=	–1

52. **(a)** $\Delta G^\circ = -2.303\, RT \log K_c$ ....(i)

and also $\Delta G^\circ = -nFE^\circ_{cell}$ ....(ii)



From (i) and (ii), we get

$-nF\, E^\circ_{cell} = -2.303\, RT \log K_c$

$$E^\circ_{cell} = \frac{2.303RT}{nF}\log K_c \quad \text{....(iii)}$$

Comparing equation (3) with y = mx + c

$$c = 0, m = \frac{2.303RT}{nF}$$

53. **(a)**

$CH_3 - X \xrightarrow{Zn} CH_4$ Frankland's Reaction.

54. **(b)** $8.27 = \dfrac{4 \times 128}{6.023 \times 10^{23}\, a^3}$

$\Rightarrow a = 46.8 \times 10^{-9}$ cm = 4.68 Å

$$r_{O^{2-}} + r_{Cd^{2+}} = \frac{a}{2}$$

$$1.24Å + r_{Cd^{2+}} = \frac{4.68Å}{2}$$

$$r_{Cd^{2+}} = 1.1Å$$

55. **(a)**

56. **(c)** $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

28 g   96 g

$\because$ 28 g of C_2H_4 undergo complete combustion by = 96 g of O_2

$\therefore$ 2.8 kg of C_2H_4 undergo complete combustion by = 9.6 kg of O_2.

57. **(c)** Aldehydes are more reactive than ketones due to +I effect of $-CH_3$ group. There are two $-CH_3$ group in acetone which reduces +ve charge density on carbon atom of carbonyl group. More hindered carbonyl group too becomes less reactive. So in the given case CH_3CHO is the right choice.

58. **(b)** Most of the Ln^{3+} compounds except La^{3+} and Lu^{3+} are coloured due to the presence of *f*-electrons.

59. **(a)** Mol $dm^{-3}\ s^{-1}$ units are for zero order.

60. **(d)** This is because zinc has higher oxidation potential than Ni, Cu and Sn. The process of coating of iron surface with zinc is known as galvanization. Galvanized iron sheets maintain their lustre due to the formation of protective layer of basic zinc carbonate.

61. **(a)** The charge carried by 1 mole of electrons is one faraday. Thus for a reaction

$M^{n+} + ne^- \longrightarrow M$

nF = 1 mole of M

$$\underset{\substack{3F \\ 1F}}{Al^{3+} + 3e^-} \longrightarrow \underset{\substack{1\text{ mol} \\ 1/3\text{ mol}}}{Al}$$

$$\underset{\substack{2F \\ 1F}}{Cu^{2+} + 2e^-} \longrightarrow \underset{\substack{1\text{ mol} \\ 1/2\text{ mol}}}{Cu}$$

$$\underset{1F}{Na^{+} + e^-} \longrightarrow \underset{1\text{ mol}}{Na}$$

The mole ratio of Al, Cu and Na deposited at the respective cathode is $\frac{1}{3}:\frac{1}{2}:1$ or 2 : 3 : 6.

62. **(a)** Producer gas is a fuel gas and is a mixture of CO and N_2.

63. **(a)** A fusion reaction between hydrogen nuclei is difficult because positively charged nuclei repel each other. However, at very high temperatures of the order of 10^6 to 10^7 K, the nuclei may have sufficient energy to overcome the repulsive forces and thus fuse. This is why, fusion reactions are also called thermonuclear reactions.

64. **(b)** $3Fe\,(s) + 4H_2O\,(steam) \rightleftharpoons Fe_3O_4\,(s) + 4\,H_2\,(g)$

$K_p = \dfrac{(p_{H_2})^4}{(p_{H_2O})^4}$ (only gaseous products and reactants are considered).

65. **(d)**

	A	$\longrightarrow$ B
t = 0	0.8	0
t = 1	0.8 – 0.6	0.6
t = 0	0.9	0
t = ?	0.9 – 0.675	0.675

In first case $\dfrac{a}{a-x} = \dfrac{0.8}{0.2} = 4$

In second case $\dfrac{a}{a-x} = \dfrac{0.9}{0.225} = 4$

Since the ratio is the same, hence time will be same. Therefore 1 hr.

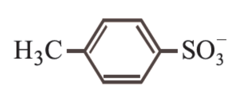
66. **(a)** **67.** **(b)**

68. **(d)** For positive charge colloids coagulating power $\uparrow$ coagulation value $\downarrow$. $[Fe(CN)_6]^{4-}$.

69. **(b)** The stronger the base the more is the nucleophilic character and vice versa.

Basic character order is

$CH_3O^- > CN^- > CH_3COO^- >$



Hence the nucleophilic character is above the same.

70. **(a)** LiH is an ionic hydride, in which an electron is transferred from Li hence Li^+ and H^- are formed.

71. **(a)** $\Delta E = \Delta Q - W$

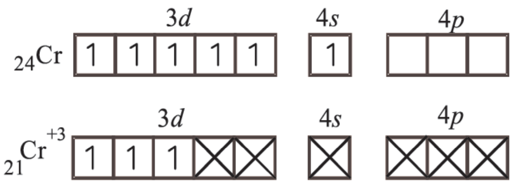
For adiabatic expansion, $\Delta Q = 0$

$\Rightarrow \Delta E = -W$

The negative sign shows decrease in internal energy, which is equal to the work done on the system by the surroundings.

72. (a) In this reaction, one molecule is oxidised and other is reduced simultaneously.

73. (d) In $[Cr(NH_3)_6]Br_3$, Cr is in +3 oxidation state



74. (b) For orthorhombic system, $\alpha = \beta = \gamma = 90°$.

75. (c) $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g); \Delta S$ increases.

Hence, as the temperature increases, $T\Delta S$ increases and hence ΔG $(\Delta H - T\Delta S)$ decreases. In other words, the slope of the curve for formation of CO decreases. However, for all other oxides, it increases.

76. (c) $SO_2 + \frac{1}{2}O_2 \longrightarrow SO_3$

$$\Delta H = \Delta H_f^\circ(SO_3) - \Delta H_f^\circ(SO_2)$$

$$= -98.2 + 298.2 = 200 \text{ kJ/mol}$$

77. (c) Basicity of oxides decreases in a period and increases in a group.

$\therefore$ SnO_2, Al_2O_3 and ZnO are amphoteric oxides.

78. (a) FeO is capable forming slag with SiO_2

$$SiO_2 + FeO \rightarrow FeSiO_3$$

79. (d) (i) The first ionization energy of xenon (1, 170 kJ mol^{-1}) is quite close to that of dioxygen (1,180 kJ mol^{-1}).

(ii) The molecular diameters of xenon and dioxygen are almost identical.

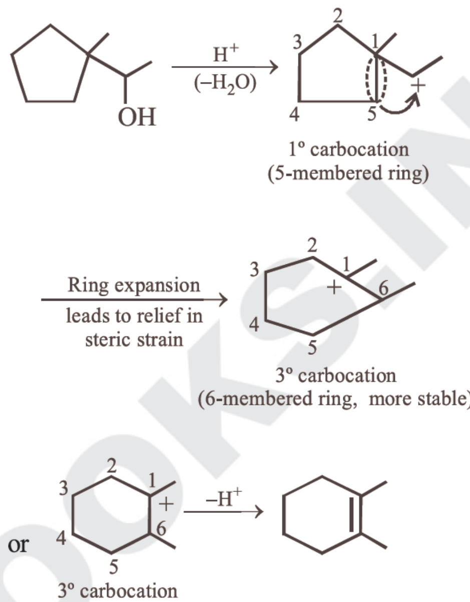
Based on the above similarities Barlett (who prepared $O_2^+[PtF_6]^-$ compound) suggested that since oxygen combines with PtF_6, so xenon should also form similar compound with PtF_6.

80. (c) Similarity between optical and geometrical isomerism is that both are included in stereo isomerism.

81. (b) Electronic configuration of gadolinium is

$$[Xe]\,4f^7 5d^1 6s^2$$

82. (c)



83. (a)

84. (d) Due to + M effect of the – OH group in phenol, electron density in the ortho and para positions of the phenol nucleus increases hence phenol will undergo electrophilic substitution easily than benzene. The other three compounds have electron withdrawing groups, hence they will undergo electrophilic substitution with a difficulty than benzene.

85. (b) Solution will be neutral. Concentration of each will be 0.05 M since volume got doubled.

86. (a) The green colour appears due to the formation of Cr^{3+} ion

$$Cr_2O_7^{2-} + 3SO_3^{2-} + 8H^+ \longrightarrow$$

$$3SO_4^{2-} + 2Cr^{3+} + 4H_2O$$

87. (a) N-Phenylacetanilide precipitates out to form a complex with anhydrous $AlCl_3$.

88. (b) Vinyl alcohol, CH_2=CHOH, monomer of polyvinyl alcohol exists mainly as CH_3CHO ; hence polyvinyl alcohol is best prepared by the alkaline hydrolysis of polyvinyl acetate which in turn is prepared by the polymerisation of vinyl acetate.

89. **(b)** Biodegradable polymer is Nylon-2-Nylon-6 which is copolymer of glycine (H_2N-CH_2-COOH) and amino caproic acid ($H_2N-(CH_2)_5-COOH$).

$$\underset{\text{glycine}}{nH_2N-CH_2-COOH} + \underset{\text{amino caproic acid}}{nH_2N-(CH_2)_5-COOH}$$

$$\downarrow$$

$$\underset{\text{nylon}-2-\text{nylon}-6}{\left(HN-CH_2-\overset{\overset{\large O}{\|}}{C}-HN-(CH_2)_5-\overset{\overset{\large O}{\|}}{C} \right)_n}$$

90. **(b)**

$$(CH_3)_2CHOCH_3 + HI \longrightarrow CH_3I + \underset{\text{2-Propanol}}{(CH_3)_2CHOH}$$

91. **(b)** Mango swells due to osmosis.

92. **(d)** $[Ni(CN)_4]^{2-}$ is dsp^2 hybridised.

$[Ni(PPh_3)_2Cl_2]$ i.e., Ni(II) : $3d^8 4s^0 4p^0$

(sp^3 hybridisation as weak field ligands PPh_3 and Cl do not force the two unpaired $3d$ electrons to be paired up.

93. **(d)**

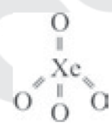
94. **(b)** $\Delta H < 0, \Delta S < 0, \Delta G < 0$

95. **(a)** $CH_3CH_2Cl \xrightarrow{NaCN} \underset{X}{CH_3CH_2CN} \xrightarrow{Ni/H_2} \underset{Y}{CH_3CH_2CH_2NH_2} \xrightarrow{(CH_3CO)_2O} \underset{Z}{CH_3CH_2CH_2NHCOCH_3}$

96. **(d)** The appearance of colour in solid alkali metal halide is due to presence of F-centre defect in the crystal structure.

97. **(c)** V_2O_5 is used as catalyst in contact process of manufacturing H_2SO_4.

98. **(b)**



99. **(b)** Phenol is most acidic because its conjugate base is stabilised due to resonance, while the rest three compounds are alcohols, hence, their corrosponding conjugate bases do not exhibit resonance.

100. **(a)** Starch is also known as amylum which occurs in all green plants. A molecule of starch $(C_6H_{10}O_5)_n$ is built of a large number of α-glucose rings joined through oxygen atom.

SECTION-B

MATHEMATICS

1. **(c)** We have

min n (A ∪ B) = max {n(A), n (B)} = max {3, 6} = 6

Max n (A ∪ B) = n (A) + n (B) = 9; ∴ 6 ≤ n (A ∪ B) ≤ 9

2. **(a)** $f(2a-x) = f(a-(x-a)) = f(a)f(x-a) - f(0)$

$f(x) = f(a)f(x-a) - f(x) = -f(x)$

$[\because x = 0, y = 0,\ f(0) = f^2(0) - f^2(a)$

$\Rightarrow f^2(a) = 0 \Rightarrow f(a) = 0]$

$\Rightarrow f(2a-x) = -f(x)$

3. **(a)** Let $\sqrt{3}+1 = r\cos\alpha$, and $\sqrt{3}-1 = r\sin\alpha$

$\therefore\quad r^2 = \left(\sqrt{3}+1\right)^2 + \left(\sqrt{3}-1\right)^2 = 8$ i.e. $\alpha = \pi/12$

From the equation, $r\cos(\theta-\alpha) = 2$

$\Rightarrow\quad \cos(\theta - \pi/12) = 1/\sqrt{2} = \cos(\pi/4)$

$\therefore\quad \theta = 2n\pi \pm \pi/4 + \pi/12$

4. **(b)** $a_1 = \sqrt{7} < 7$. Let $a_m < 7$

Then $a_{m+1} = \sqrt{7 + a_m}$

$\Rightarrow a^2_{m+1} = 7 + a_m < 7 + 7 < 14.$

$\Rightarrow a_{m+1} < \sqrt{14} < 7;$ So by the principle of mathematical induction $a_n < 7\ \forall\ n$.

5. **(a)** $|x_1z_1 - y_1z_2|^2 + |y_1z_1 - x_1z_2|^2$

$= |x_1z_1|^2 + |y_1z_2|^2 - 2\text{Re}(x_1y_1z_1z_2)$
$\quad + |y_1z_1|^2 + |x_1z_2|^2 + 2\text{Re}(x_1y_1z_1z_2)$

$= x_1^2|z_1|^2 + y_1^2|z_2|^2 + y_1^2|z_1|^2 + x_1^2|z_2|^2$

$= x_1^2|z_1|^2 + y_1^2|z_2|^2 + y_1^2|z_1|^2 + x_1^2|z_2|^2$

$= 2(x_1^2 + y_1^2)(4^2) = 32(x_1^2 + y_1^2)$

6. **(b)** $\because f(x) = x \sin x$

$$\Rightarrow f'(x) = \frac{d}{dx}(x \sin x)$$

$$= \sin x \frac{d}{dx} x + x \frac{d}{dx} \sin x = \sin x + x \cos x$$

$$\Rightarrow f'\left(\frac{\pi}{2}\right) = \sin\frac{\pi}{2} + \frac{\pi}{2}\cos\frac{\pi}{2} = 1$$

7. **(b)** By definition only $f(x) = x^2 + 4x - 5$ with domain $[0, \infty)$ is one to one.

8. **(d)** The given system of lines passes through the point of intersection of the straight lines $2x + y - 3 = 0$ and $3x + 2y - 5 = 0$ [$L_1 + \lambda L_2 = 0$ form], which is (1, 1).
The required line will also pass through this point. Further, the line will be farthest from point (4, –3) if it is in direction perpendicular to line joining (1, 1) and (4, –3).
$\therefore$ The equation of the required line is

$$y - 1 = \frac{-1}{\dfrac{-3-1}{4-1}}(x-1) \Rightarrow 3x - 4y + 1 = 0$$

9. **(b)** $f(a) = 0$

$$\lim_{x\to a-} f(x) = \lim_{x\to a-}\left(\frac{x^2}{a} - a\right) = \lim_{h\to 0}\left\{\frac{(a-h)^2}{a} - a\right\} = 0$$

and $$\lim_{x\to a+} f(x) = \lim_{h\to 0}\left\{a - \frac{(a+h)^2}{a}\right\} = 0$$

Hence it is continuous at x = a.

10. **(b)** Here $n(S) = 6^2 = 36$
Let E be the event "getting sum more than 7" *i.e.* sum of pair of dice = 8, 9, 10, 11, 12

$$i.e.\ E = \begin{Bmatrix} (2,6) & (3,5) & (4,4) & (5,3) & (6,2) \\ (3,6) & (4,5) & (5,4) & (6,3) & \\ (4,6) & (5,5) & (6,4) & & \\ (5,6) & (6,5) & (6,6) & & \end{Bmatrix}$$

$\therefore\ n(E) = 15$

$$\therefore \text{ Req. probability} = \frac{n(E)}{n(S)} = \frac{15}{36} = \frac{5}{12}$$

11. **(b)** $$I = \int \frac{1 + 1/x^2}{x^2 + 1 + 1/x^2}\,dx = \int \frac{d(x - 1/x)}{(x - 1/x)^2 + 3}$$

$$= \frac{1}{\sqrt{3}} \tan^{-1}\frac{(x - 1/x)}{\sqrt{3}} + c$$

$$= \frac{1}{\sqrt{3}} \tan^{-1}\left(\frac{(x^2 - 1)}{\sqrt{3}x}\right) + c$$

12. **(a)** Let $y = e^{(2x^2 - 2x - 1)\sin^2 x}$

and $u = (2x^2 - 2x - 1)\sin^2 x$

$$\text{Now } \frac{du}{dx} = (2x^2 - 2x - 1)\,2\sin x\cos x + (4x - 2)\sin^2 x$$
$$= \sin x\,[2(2x^2 - 2x)\cos x + (4x - 2)\sin x]$$

$$\frac{du}{dx} = 0 \Rightarrow \sin x = 0 \Rightarrow x = n\pi$$

$$\frac{d^2u}{dx^2} = \sin x \frac{d}{dx}[2(2x^2 - 2x - 1)\cos x + (4x - 2)\sin x]$$
$$+ \cos x\,[2\cos x\,(2x^2 - 2x - 1) + (4x - 2)\sin x]$$

$$\text{At } x = n\pi,\ \frac{d^2u}{dx^2} = 0 + 2\cos^2 n\pi(2n^2\pi^2 - 1) > 0$$

Hence at $x = n\pi$, the value of u and so its corresponding the value of y is minimum and minimum value $= e^0 = 1$

13. **(c)** $|2 - |1 - |x||| = 1 \Rightarrow 2 - |1 - |x|| = \pm 1$

$\Rightarrow |1 - |x|| = 1$ *or* 3

If $|1 - |x|| = 1 \Rightarrow 1 - |x| = \pm 1 \Rightarrow |x| = 0$ *or* 2

$\Rightarrow x = 0 \ or \pm 2$

If $|1-|x|| = 3 \Rightarrow 1-|x| = \pm 3 \Rightarrow |x| = -2$ or 4

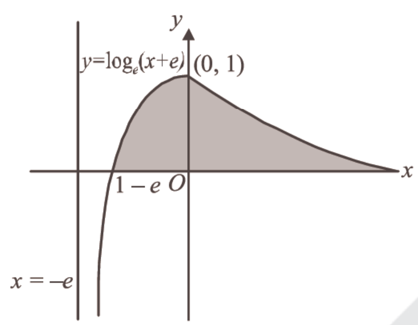
$\Rightarrow |x| = 4 \Rightarrow x = \pm 4 \qquad [\because |x| \neq -2]$

$\therefore$ Solution set is $\{-4, -2, 0, 2, 4\}$, hence 5 real roots in all.

14. **(a)** $(x+1)(x+4).(x+9)(x+16)......(x+400)$
$= x^{20} + (1^2+2^2+3^2+......+20^2)x^{19} + ...$

$\therefore \quad$ coeff. of $x^{19} = \dfrac{20(20+1)(2\times 20+1)}{6} = 2870$

15. **(a)** The required area



$= \int_{1-e}^{0} \log_e(x+e) + \int_0^{\infty} e^{-x}\, dx$

$= \left[x\log(x+e) - \int \dfrac{x}{x+e}dx\right]_{1-e}^{0} - [e^{-x}]_0^{\infty}$

$= [x\log(x+e) - x + e\log(x+e)]_{1-e}^{0} + 1$

$= e + (1-e) + 1 = 2$ sq. unit.

16. **(c)** Words start with D are 6! = 720, start with E are 720. start with MD are 5! = 120 and start with ME are 120. Now the first word starts with MO is nothing but MODESTY. Hence rank of MODESTY is 1681.

17. **(a)** Given differential equation is $y'(y^2 - x) = y$

$\Rightarrow \dfrac{dy}{dx}(y^2 - x) = y \quad \Rightarrow \dfrac{dx}{dy} = y - \dfrac{x}{y}$

$\Rightarrow \dfrac{dx}{dy} + x.\dfrac{1}{y} = y$

This is the Linear differential equation in x

$\therefore$ If $= e^{\int \frac{1}{y}dy} = e \log y = y$

Solution is

$y \,.\, x = \int y.y\ dy + A \quad \Rightarrow xy = \dfrac{y^3}{3} + A$

$\Rightarrow y^3 - 3xy = C \quad$ Where $C = -3A$

18. **(b)** The equation of two concentric circles differ only in constant terms. So let the equation of the required circle be : $x^2 + y^2 - 3x + 4y + \lambda = 0$

It passes through $(-1, -2)$, so we have $1 + 4 + 3 - 8 + \lambda = 0 \Rightarrow \lambda = 0$,

Hence required equation is $x^2 + y^2 - 3x + 4y = 0$

19. **(b)** $\lim\limits_{x\to 0} \dfrac{(4^x - 1)^3}{\sin\dfrac{x^2}{4}\log(1+3x)}$

$= \lim\limits_{x\to 0} \dfrac{(4^x-1)^3}{x^3}.\dfrac{(x/2)^2}{\sin x^2/4}.\dfrac{3x}{\log(1+3x)}.\dfrac{4}{3}$

$= \dfrac{4}{3}(\log_e 4)^3.1.\log_e(e) = \dfrac{4}{3}(\log_e 4)^3.$

20. **(d)** $[(\vec{a}+3\vec{b})\times(3\vec{a}+\vec{b})]^2 = [\vec{a}\times\vec{b} + 9\vec{b}\times\vec{a}]^2$

$= (-8\vec{a}\times\vec{b})^2 = 64(|\vec{a}||\vec{b}|\sin 120°\hat{n})^2$

$= 64a^2b^2\sin^2 120°\hat{n}.\hat{n} = 64\times 1\times 4\times\dfrac{3}{4}\times 1 = 192$

21. **(c)** $\begin{vmatrix} p & q-y & r-z \\ p-x & q & r-z \\ p-x & q-y & r \end{vmatrix} = 0$

Apply $R_1 \to R_1 - R_3$ and $R_2 \to R_2 - R_3$, we get

$\begin{vmatrix} x & 0 & -z \\ 0 & y & -z \\ p-x & q-y & r \end{vmatrix} = 0$

$\Rightarrow x[yr + z(q-y)] - z[0 - y(p-x)] = 0$

[Expansion along first row]

$\Rightarrow xyr + zxq + yzp = 2xyz \Rightarrow \dfrac{p}{x} + \dfrac{q}{y} + \dfrac{r}{z} = 2$

22. **(c)** For b = –1, cosx = b $\Rightarrow \cos x = -1$ which is satisfied for $x = \pi, 3\pi, 5\pi$ etc. which forms an A.P. with common difference 2π.

For no. other value of x out of $\frac{1}{2}$ and $\frac{\sqrt{3}}{2}$, the roots will form an A.P.

23. **(d)** Foot of perpendicular from (6, 5, 8) on Y-axis is (0, 5, 9).

Required distance = $\sqrt{(6-0)^2+(5-5)^2+(8-0)^2}$ = 10 unit

$\Rightarrow \; 5\lambda = 10 \Rightarrow \lambda = \frac{10}{5} = 2$

24. **(a)** The planes x + y = 0 i.e. x = – y and y + z = 0 i.e. z = –y meet in the line $\frac{x}{1} = \frac{y}{-1} = \frac{z}{1}$. Any point on this line is (t, –t, t). This point lies in the plane x + z = 0 if t + t = 0 $\Rightarrow t = 0$. So the three planes meet in a unique point (0, 0, 0).

25. **(c)** We have $\sin^{-1}x + \sin^{-1}y + \sin^{-1}z = \frac{3\pi}{2}$

and $\sin^{-1}x \le \frac{\pi}{2}$ it is possible only when

$\sin^{-1}x = \frac{\pi}{2} \Rightarrow x = 1$

$\sin^{-1}y = \frac{\pi}{2} \Rightarrow y = 1$; $\sin^{-1}z = \frac{\pi}{2} \Rightarrow z = 1$

$\therefore \; x^{100} + y^{100} + z^{100} - \frac{3}{x^{101}+y^{101}+z^{101}}$

$= 3 - 1 = 2.$

26. **(b)** The probability of getting a double -six in one throw $= \frac{1}{36}$

The probability of not getting a double -six in one throw

$= 1 - \frac{1}{36} = \frac{35}{36}$

So the probability of not getting a double -six in n throw $= \left(\frac{35}{36}\right)^n$

$\therefore$ Probability of obtaining a double-six atleast once $= 1 - \left(\frac{35}{36}\right)^n$

27. **(c)** Let $I = \int (e^x+1)^{-1}dx = \int \frac{1}{e^x+1}dx$

$= \int \frac{e^{-x}}{1+e^{-x}}dx$

Let $1 + e^{-x} = t \;\Rightarrow\; -e^{-x}dx = dt$

$\therefore \; I = -\int \frac{1}{t}dt = -\log t + c = -\log(1+e^{-x}) + c$

28. **(d)** By definition of continuity, we know that

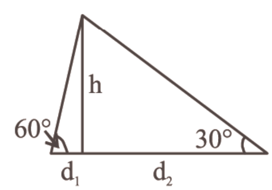
$\lim_{x \to 3^+} f(x) = f(3) = \lim_{x \to 3^-} f(x)$

$\Rightarrow \lim_{x \to 3^-} f(x) = 4$

or $\lim_{h \to 0} 3 - h + \lambda = 4 \Rightarrow 3 + \lambda = 4 \Rightarrow \lambda = 1$

29. **(b)** $d_2 = h\cot 30° = 500\sqrt{3},$

and $d_1 = \frac{500}{\sqrt{3}}$



Diameter $d = 500\sqrt{3} + \frac{500}{3}\sqrt{3} = \frac{2000}{\sqrt{3}}m$

30. **(d)** $z - 2 - 3i = x + iy - 2 - 3i = (x-2) + i(y-3)$

$\tan^{-1}\left(\frac{y-3}{x-2}\right) = \frac{\pi}{4} \Rightarrow \frac{y-3}{x-2} = \tan\frac{\pi}{4} = 1$

$\Rightarrow x - y + 1 = 0$

31. **(c)** Given quadratic eqn. is $x^2+px+\frac{3p}{4}=0$

So, $\alpha+\beta=-p, \alpha\beta=\frac{3p}{4}$

Now, given $|\alpha-\beta|=\sqrt{10} \Rightarrow \alpha-\beta=\pm\sqrt{10}$
$\Rightarrow (\alpha-\beta)^2=10 \Rightarrow \alpha^2+\beta^2-2\alpha\beta=10$
$\Rightarrow (\alpha+\beta)^2-4\alpha\beta=10$

$\Rightarrow p^2-4\times\frac{3p}{4}=10 \Rightarrow p^2-3p-10=0$

$\Rightarrow p=-2, 5 \Rightarrow p\in\{-2, 5\}$

32. **(b)** The common chord will be the diameter of the smaller circle, whose circumference is bisected.

33. **(b)** We know from the above given formula that probability that no letter is in right envelope out of n letters and n envelopes is given by

$=\left[\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}-..........(-1)^n\frac{1}{n!}\right]$

Since all 4 letters are to be placed in wrong envelopes then required probability

$=\left[\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}\right]=\frac{1}{2}-\frac{1}{6}+\frac{1}{24}=\frac{3}{8}$

34. **(b)** Let the order of B be $m\times n$.
Since, A is 3×2 matrix $\therefore$ A' is 2×3 matrix.
Given that, A'B is defined.
$\therefore$ Number of column of A' must be equal to number of rows of B $\therefore m=3$
Also, since BA' is defined.
$\therefore$ Number of columns of B must be equal to number of rows of A' $\therefore n=2$ $\therefore$ order of B is 3×2.

35. **(c)** Let p and q be two proposition given by
$p: 2^2=5, q:$ 1 get first class
Here give statement is $p\to q$
So contrapositive of $p\to q$ is $\sim q\to\sim p$
i.e. if I do not get first class then $2^2\neq 5$.

36. **(c)** $\lim_{x\to 0}\left(\frac{f(1+x)}{f(1)}\right)^{1/x}=e^{\lim_{x\to 0}\frac{1}{x}\left(\frac{f(1+x)-f(1)}{f(1)}\right)}$

$$=e^{\frac{f'(1)}{f(1)}}=e^2$$

37. **(d)** Clearly g(x) will be inverse of f(x)
$\Rightarrow g(x)=\sqrt{x}-1$

38. **(a)** By given condition, $\sum|\bar{p}|^2=50$
$|\bar{p}+\bar{q}+\bar{r}|^2=\sum|\bar{p}|^2$
$=50\Rightarrow |\bar{p}+\bar{q}+\bar{r}|=5\sqrt{2}$

39. **(b)** Number of triangles formed $={}^{12}C_3-{}^7C_3=185$

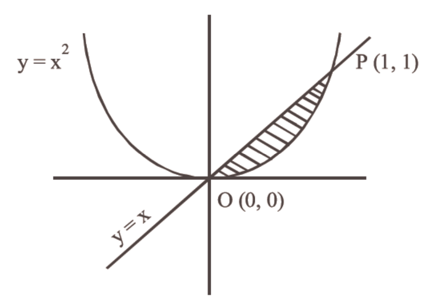
40. **(b)** Given $\frac{T_7}{T_{n-7+2}}=\frac{1}{6}\Rightarrow\frac{T_7}{T_{n-s}}=\frac{1}{6}$

$$\Rightarrow\frac{{}^nC_6\left(\sqrt[3]{2}\right)^{n-6}\left(\frac{1}{\sqrt[3]{3}}\right)^6}{{}^nC_{n-6}\left(\sqrt[3]{2}\right)^6\left(\frac{1}{\sqrt[3]{3}}\right)^{n-6}}=\frac{1}{6}$$

$$\Rightarrow 2^{\frac{n-12}{3}}.3^{\frac{n-12}{3}}=\frac{1}{6}\Rightarrow 6^{\frac{n-12}{3}}=6^{-1}$$

$$\therefore\frac{n-12}{3}=-1\Rightarrow n=9$$

41. **(a)** For points of intersection of the equation of parabola
$y=x^2$ ... (i)
and equation of straight line: $y=x$ ... (ii)
We have : $x^2-x=0\Rightarrow x(x-1)=0$
$\therefore$ $x=0$ or $x=1\Rightarrow y=0$ or $y=1$
Hence, the coordinates of their points of intersection are O (0, 0) and P (1, 1).



$\therefore$ Required area (shaded region)

$$= \int_0^1 (x - x^2)dx = \left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1$$

$$= \left[\left(\frac{1}{2} - \frac{1}{3}\right) - 0\right] = \frac{1}{6} \text{ sq. units}$$

42. (c)

$$\Delta = \begin{vmatrix} 1+a^2+a^4 & 1+ab+a^2b^2 & 1+ac+a^2c^2 \\ 1+ab+a^2b^2 & 1+b^2+b^4 & 1+bc+b^2c^2 \\ 1+ac+a^2c^2 & 1+bc+b^2c^2 & 1+c^2+c^4 \end{vmatrix}$$

$$= \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = (a-b)^2 (b-c)^2 (c-a)^2$$

43. (c) Equation of ellipse is $\frac{x^2}{16} + \frac{y^2}{8} = 1$

where, $a = 4$, $b = 2\sqrt{2}$

Eccentricity, $e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{8}{16}} = \frac{1}{\sqrt{2}}$

Area is maximum when vertex is $(0, b)$

$\therefore$ Maximum area $= \frac{1}{2} \times 2ae \times b$

$= \frac{1}{2} \times 2 \times 4 \times 2\sqrt{2} \times \frac{1}{\sqrt{2}} = 8$ sq. units

44. (a) Since $|r| > 1$, $\frac{1}{|r|} < 1$

$$\therefore \ x = \frac{a}{1 - \frac{1}{r}} = \frac{ar}{r-1}$$

Similarly, $y = \dfrac{b}{1 - \left(-\frac{1}{r}\right)} = \dfrac{br}{r+1}$ and

$$z = \frac{c}{1 - \frac{1}{r^2}} = \frac{cr^2}{r^2 - 1} \qquad ..(1)$$

$$\therefore \ xy = \frac{ar}{r-1} \times \frac{br}{r+1} = \frac{abr^2}{r^2 - 1} \qquad ...(2)$$

Dividing (2) by (1), we get

$$\frac{xy}{z} = \frac{abr^2}{r^2 - 1} \times \frac{r^2 - 1}{cr^2} = \frac{ab}{c}$$

45. (a) Let $I = \int_0^{\frac{\pi}{2}} x \sin^2 x \cos^2 x \, dx \qquad ...(i)$

$$I = \int_0^{\frac{\pi}{2}} \left(\frac{\pi}{2} - x\right) \sin^2 x \cos^2 x \, dx \qquad ...(ii)$$

By adding (i) and (ii) : $2I = \frac{\pi}{2} \int_0^{\frac{\pi}{2}} \sin^2 x \cos^2 x \, dx$

or $\quad 2I = \frac{\pi}{8} \int_0^{\frac{\pi}{2}} \sin^2 2x \, dx$

$[\because \sin 2x = 2 \sin x \cos x]$

$$= \frac{\pi}{8} \int_0^{\frac{\pi}{2}} (1 - \cos 4x) \, dx$$

$$\Rightarrow \ 2I = \frac{\pi}{8} \left[x - \frac{\sin 4x}{4}\right]_0^{\frac{\pi}{2}}$$

$$\Rightarrow \ 2I = \frac{\pi}{8} \left[\frac{\pi}{2} - 0\right] \Rightarrow \ I = \frac{\pi^2}{32}$$

46. (a) Let $y = e^{(2x^2 - 2x - 1)\sin^2 x}$

and $u = (2x^2 - 2x - 1) \sin^2 x$

Now $\frac{du}{dx} = (2x^2 - 2x - 1) 2 \sin x \cos x + (4x - 2) \sin^2 x$

$= \sin x \, [2(2x^2 - 2x) \cos x + (4x - 2) \sin x]$

$$\frac{du}{dx} = 0 \Rightarrow \sin x = 0 \Rightarrow x = n\pi$$

$$\frac{d^2u}{dx^2} = \sin x \frac{d}{dx}[2(2x^2-2x-1)\cos x + (4x-2)\sin x]$$
$$+ \cos x\,[2\cos x\,(2x^2-2x-1) + (4x-2)\sin x]$$

At $x = n\pi$, $\frac{d^2u}{dx^2} = 0 + 2\cos^2 n\pi(2n^2\pi^2 - 1) > 0$

Hence at x = nπ, the value of u and so its corresponding the value of y is minimum and minimum value $= e^0 = 1$

47. **(d)** Each point (x, y) has an image in line $y = 0$ as $(x, -y)$. So, replacing y by $-y$ in the given equation, we get the image as $ax^2 - 2hxy + by^2 = 0$.

48. **(a)** $\frac{70\times 75 + 30\times x}{100} = 72 \Rightarrow x = 65$

49. **(b)** $f(x) = \begin{cases} x, & x \le 1 \\ x^2 + bx + c, & x > 1 \end{cases}$

$\therefore f'(x) = \begin{cases} 1, & x < 1 \\ 2x + b, & x > 1 \end{cases}$

$f(x)$ is differentiable at $x = 1$.
Then, it must be continuous at $x = 1$ for which

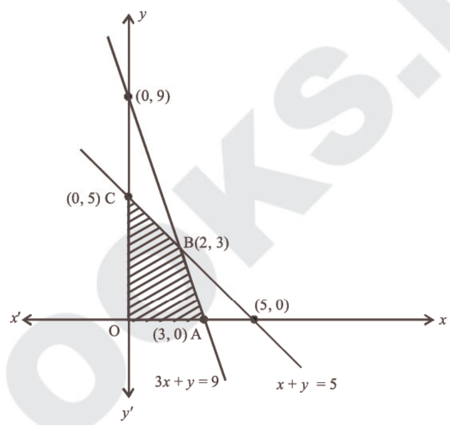
$\lim_{x\to 1^+} f(x) = \lim_{x\to 1^-} f(x)$ or $1 + b + c = 1$

or $b + c = 0$ ...(1)

Also, $f'(1^+) = f'(1^-)$ or $\lim_{x\to 1^+} f'(x) = \lim_{x\to 1^-} f'(x)$

or $2 + b = 1$ or $b = -1$ $\therefore c = 1$. [From (1)]

50. **(b)** Given, constraints are $x \ge 0, y \ge 0, x + y \le 5$ and $3x + y \le 9$ and $z = 12x + 3y$



Here, feasible region of OABC
At point O (0, 0), z = 12 (0) + 3 (0) = 0
At point A (3, 0), z = 12 (3) + 3 (0) = 36
At point B (2, 3), z = 12 (2) + 3 (3) = 33
At point C (0, 5), z = 12 (0) + 3 (5) = 15
Hence, maximum value is 36.