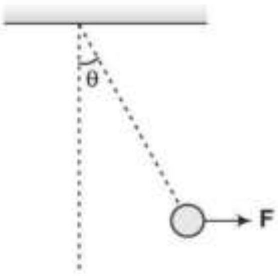
## Physics

1. **Two photons of energy 2.5 eV and 3.5 eV fall on a metal surface of work function 1.5 eV . The ratio of the maximum velocities of the photoelectrons emitted from the metal surface is**
   (a) $1:4$ (b) $2:1$
   (c) $1:2$ (d) $1:\sqrt{2}$
2. **Calculate the wavelength of the $k_a$ line for $z = 31$, when $a = 5 \times 10^7\ Hz^{1/2}$ for a characteristic X-ray spectrum.**
   (a) 1.33Å (b) 1.33 nm
   (c) $133 \times 10^{-10}$ m (d) 133 nm
3. **If 200 MeV of energy is released in the fission of one nucleus of $^{236}_{92}U$, the number of nuclei that must undergo fission to release an energy of 1000 J is**
   (a) $3.125 \times 10^{13}$ (b) $6.25 \times 10^{13}$
   (c) $12.5 \times 10^{13}$ (d) $3.125 \times 10^{14}$
4. **In a $p - n$ junction diode, the thickness of deplection layer is $2 \times 10^{-6}$ m and barrier potential is 0.3 V . The intensity of the electric field at the junction is**
   (a) $0.6 \times 10^{-6} Vm^{-1}$ from n to p side
   (b) $0.6 \times 10^{-6} Vm^{-1}$ from p to n side
   (c) $1.5 \times 10^{5} Vm^{-1}$ from n to p side
   (d) $1.5 \times 10^{5} Vm^{-1}$ from p to n side
5. **The dimensional formula of $\frac{1}{2}\mu_0 H^2$ ( $\mu =$ permeability of free space and $H =$ magnetic field intensity) is**
   (a) $[MLT^{-1}]$ (b) $[ML^2\ T^{-2}]$
   (c) $[ML^{-1}\ T^{-2}]$ (d) $[ML^2\ T^{-1}]$
6. **A certain vector in the xy-plane has an x-component of 4 m and a y-component of 10 m . It is then rotated in the xy-plane so that its x-component is doubled. Then its new y-component is (approximately)**
   (a) 20 m (b) 7.2 m
   (c) 5.0 m (d) 4.5 m
7. **A police party is moving in a jeep at a constant speed v. They saw a thief at a distance x on a motorcycle which is at rest. The moment the police saw the thief, the thief started at constant acceleration a. Which of the following relations is true if the police is able to catch the thief?**
   (a) $v^2 < ax$ (b) $v^2 < 2ax$
   (c) $v^2 \geq 2ax$ (d) $v^2 = ax$
8. **A 1 N pendulum bob is held at an angle $\theta$ from the vertical by a 2 N horizontal force F as shown in the figure. The tension in the string supporting the pendulum bob (in newton) is**




(a) $\cos\theta$ (b) $\frac{2}{\cos\theta}$
(c) $\sqrt{5}$ (d) 1

9. **The maximum tension a rope can withstand is $60$ kg $-$ wt. The ratio of maximum acceleration with which two boys of masses 20 kg and 30 kg can climb up the rope at the same time is**
   (a) $1:2$ (b) $2:1$
   (c) $4:3$ (d) $3:2$
10. **A ball is let fall from a height $h_0$. It makes n collisions with the earth. After n collisions it rebounds with a velocity $v_n$ and the ball rises to a height $h_n$, then coefficient of restitution is given by**

(a) $e = \left[\frac{h_n}{h_0}\right]^{1/2n}$ (b) $e = \left[\frac{h_0}{h_n}\right]^{1/2n}$
(c) $e = \frac{1}{n}\sqrt{\frac{h_n}{h_0}}$ (d) $e = \frac{1}{n}\sqrt{\frac{h_0}{h_n}}$

**11. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the discs touch. The centre of mass of the new disc is at a distance $\alpha$R from the centre of the bigger disc. The value of $\alpha$ is**
(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{4}$ (d) $\frac{1}{6}$

**12. A uniform chain of length L is lying on the horizontal table. If the coefficient of friction between the chain and the table top is $\mu$, what is the maximum length of the chain that can hang over the edge of the table without disturbing the rest of the chain on the table?**
(a) $\frac{L}{(1+\mu)}$ (b) $\frac{\mu L}{(1+\mu)}$
(c) $\frac{L}{(1-\mu)}$ (d) $\frac{\mu L}{(1-\mu)}$

**13. Two uniform circular discs having the same mass and the same thickness, but different radii are made from different materials. The disc with the smaller rotational inertia is**
(a) the one made from the more dense material
(b) the one made from the less dense material
(c) the disc with the larger angular velocity
(d) the disc with the larger torque

**14. A thin hollow sphere of mass m is completely filled with a liquid of mass m. When the sphere rolls with a velocity v, kinetic energy of the system is (neglect friction)**
(a) $\frac{1}{2}mv^2$ (b) $mv^2$
(c) $\frac{4}{3}mv^2$ (d) $\frac{4}{5}mv^2$

**15. Assertion A An astronaut inside a massive spaceship orbiting around the earth will experience a finite but small gravitational force.**
**Reason R The centripetal force necessary to keep the spaceship in orbit around the earth is provided by the gravitational force between the earth and the spaceship.**
(a) Both (A) and (R) are true and (R) is the correct explanation of (A)
(b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
(c) (A) is true but (R) is not true
(d) (A) is not true but (R) is true

**16. A simple harmonic oscillator consists of a particle of mass m and an ideal spring with spring constant k. The particle oscillates with a time period T. The spring is cut into two equal parts. If one part oscillates with the same particle, the time period will be**
(a) 2T (b) $\sqrt{2}T$
(c) $\frac{T}{\sqrt{2}}$ (d) $\frac{T}{2}$

**17. Two blocks of masses 1 kg and 2 kg are connected by a metal wire going over a smooth pulley. The breaking stress of metal is $\frac{40}{3\pi} \times 10^6 Nm^{-2}$. What should be the minimum radius of wire used if it should not break? $(g = 10\ ms^{-2})$**
(a) 0.5 mm (b) 1 mm
(c) 1.5 mm (d) 2 mm

**18. If two soap bubbles of different radii are connected by a tube, then**
(a) air flows from bigger bubble to the smaller bubble till sizes become equal
(b) air flows from bigger bubble to the smaller bubble till sizes are interchanged
(c) air flows from smaller bubble to bigger
(d) there is no flow of air

**19. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth 4y from the top. When the tank is completely filled with water, the quantities of water flowing out per second from the two holes are the same. Then value of R is**
(a) $\frac{L}{\sqrt{2\pi}}$ (b) $2\pi L$
(c) $L\sqrt{\frac{2}{\pi}}$ (d) $\frac{L}{2\pi}$

**20. A non-conducting body floats in a liquid at $20^\circ$C with $\frac{2}{3}$ of its volume immersed in the liquid. When liquid temperature is increased to $100^\circ$C, $\frac{3}{4}$ of body's volume is immersed in the liquid. Then the coefficient of real expansion of the liquid is (neglecting the expansion of container of the liquid)**

(a) $15.6 \times 10^{-40}C^{-1}$
(b) $156 \times 10^{-4\circ}C^{-1}$
(c) $1.56 \times 10^{-4}\,{}^{\circ}C^{-1}$
(d) $0.156 \times 10^{4}\,{}^{\circ}C^{-1}$

**21. An insulated cylindrical vessel filled with an insulated piston of negligible weight and negligible thickness at the mid - point of the vessel. The cylinder contains a gas at $0^{\circ}C$. When the gas is heated to $100^{\circ}C$, the piston moves through a length of 5 cm . Length of the cylindrical vessel in cm is**
(a) 13.65 (b) 27.3
(c) 38.6 (d) 64.6

**22. A reversible engine converts one-sixth of the heat supplied into work. When the temperature of the sink is reduced by $62^{\circ}C$, the efficiency of the engine is doubled. The temperatures of the source and sink are**
(a) $99^{\circ}C, 37^{\circ}C$ (b) $80^{\circ}C, 37^{\circ}C$
(c) $95^{\circ}C, 37^{\circ}C$ (d) $90^{\circ}C, 37^{\circ}C$

**23. During an adiabatic process, the pressure of a gas is proportional to the cube of its temperature. The value of $C_p/C_V$ for that gas is**
(a) $\frac{7}{5}$ (b) $\frac{4}{5}$ (c) $\frac{5}{3}$ (d) $\frac{3}{2}$

**24. Two slabs A and B of different materials but of the same thickness are joined end to end to form a composite slab. The thermal conductivities of A and B are $k_1$ and $k_2$ respectively. A steady temperature difference of $12^{\circ}C$ is maintained across the composite slab. If $k_1 = \frac{k_2}{2}$, the temperature difference across slab A is**
(a) $4^{\circ}C$ (b) $6^{\circ}C$
(c) $8^{\circ}C$ (d) $10^{\circ}C$

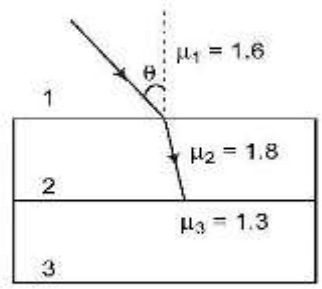
**25. The wavelengths of two sound notes in air are $\frac{40}{195}$ m and $\frac{40}{193}$ m. Each note produces 9 beats per second separately with a third note of fixed frequency. The velocity of sound in air in m/s is**
(a) 360 (b) 320
(c) 300 (d) 340

**26. Two uniform stretched strings A and B, made of steel, are vibrating under the same tension. If the first overtone of A is equal to the second overtone of B and if the radius of A is twice that of B, the ratio of the lengths of the strings is**
(a) $2:3$ (b) $1:2$
(c) $1:3$ (d) $1:4$

**27. The focal length of a lens of dispersive power 0.45 which should be placed in contact with a convex lens of focal length 84 cm and dispersive power 0.21 to make the achromatic combination from the two lenses, in cm is**
(a) 45 (b) 90
(c) 180 (d) -180

**28. Which of the following statements are true in the context of a Compound Microscope?**
**(A) Each lens produces a virtual and inverted image.**
**(B) The objective has a very short focal length.**
**(C) The eyepiece is used as a simple magnifying glass.**
**(D) The objective and eyepiece are convex and concave lenses respectively.**
(a) (A), (B) and (D) (b) (B) and (C)
(c) (A), (C) and (D) (d) (B) and (D)

**29. A ray of light refracts from medium 1 into a thin layer of medium 2 , crosses the layer and is incident at the critical angle on the interface between the medium 2 and 3 as shown in the figure. If the angle of incidence of ray is θ, the value of θ is**



(a) $\sin^{-1}\left(\frac{8}{9}\right)$ (b) $\sin^{-1}\left(\frac{13}{18}\right)$
(c) $\sin^{-1}\left(\frac{13}{16}\right)$ (d) $\sin^{-1}\left(\frac{8}{13}\right)$

**30. In the Young's double slit experiment, the resultant intensity at a point on the screen is 75% of the maximum intensity of the bright fringe. Then the phase difference between the two interfering rays at that point is**

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

**31. If a bar magnet of pole strength m and magnetic moment M is cut equally 5 times parallel to its axis and again 3 times perpendicular to its axis, then the pole strength and magnetic moment of each piece are respectively**

(a) $\frac{m}{20}, \frac{M}{4}$ (b) $\frac{m}{5}, \frac{M}{20}$
(c) $\frac{m}{6}, \frac{M}{24}$ (d) $\frac{m}{5}, \frac{M}{24}$

**32. Some physical quantities are given in the List I and the related units are given in the List II. Match the correct pairs in the lists.**

| | List I | | List II |
|---|---|---|---|
| (A) | Magnetic field intensity | (i) | $Am^{-2}$ |
| (B) | Magnetic flux | (ii) | $Wbm^{-2}$ |
| (C) | Magnetic pole strength | (iii) | Wb |
| (D) | Magnetic induction | (iv) | $Am^{-1}$ |
| | | (v) | $Am^2$ |

(a) (A)-(i), (B)-(ii), (C)-(iii), (D)-(v)
(b) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)
(c) (A)-(iv), (B)-(i), (C)-(v), (D)-(ii)
(d) (A)-(ii), (B)-(iii), (C)-(i), (D)-(iv)

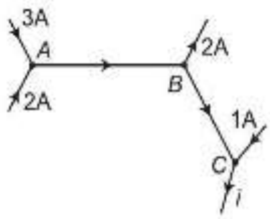
**33. A fully charged capacitor has a capacitance C. It is discharged through a small coil of resistance wire, embedded in a block of specific heat s and mass m under thermally isolated conditions. If the temperature of the block is raised by ΔT, the potential difference V across the capacitor initially is**

(a) $\left(\frac{2ms\Delta T}{C}\right)^2$ (b) $\left(\frac{2ms\Delta T}{C}\right)^{1/2}$
(c) $\left(\frac{2ms\Delta T}{C}\right)$ (d) $2ms\Delta TC$

**34. Two identical condensers M and N are connected in series with a battery. The space between the plates of M is completely filled with a dielectric medium of dielectric constant 8 and a copper plate of thickness $\frac{d}{2}$ is introduced between the plates of N. ( d is the distance between the plates). Then potential differences across M and N are, respectively, in the ratio**

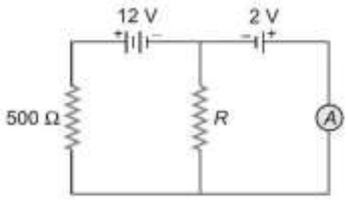
(a) 1: 4 (b) 4: 1
(c) 3: 8 (d) 1: 6

**35. The electric current i in the circuit shown is**




(a) 6 A (b) 2 A
(c) 3 A (d) 4 A

**36. In the circuit shown below, the ammeter reading is zero. Then the value of the resistance R is**




(a) 50Ω (b) 100Ω
(c) 200Ω (d) 400Ω

**37. The thermo emf of a hypothetical thermocouple varies with the temperature $\theta$ of hot junction as $E = a\theta + b\theta^2$ in volts, where the ratio $a/b$ is $700^\circ C$. If the cold junction is kept at $0^\circ C$, then the neutral temperature is**

(a) $700^\circ C$
(b) $1400^\circ C$
(c) $-350^\circ C$
(d) no neutral temperature is possible for this thermocouple

**38. Match the following and find the correct pairs.**

| | List I | | List II |
|---|---|---|---|
| (A) | Fleming's left-hand rule | (i) | Direction of induced current |
| (B) | Right hand thumb rule | (ii) | Magnitude and direction of magnetic induction |
| (C) | Biot-Savart law | (iii) | Direction of force due to magnetic induction |
| (D) | Fleming's right -hand rule | (iv) | Direction of magnetic lines due to current |

(a) (A)-(iii), (B)-(i), (C)-(ii), (D)-(iv)
(b) (A)-(iii), (B)-(iv), (C)-(ii), (D)-(i)
(c) (A)-(ii), (B)-(iv), (C)-(iii), (D)-(i)
(d) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)

**39. A constant voltage of 25 V is applied to a series $L - R$ circuit at $t = 0$, by closing a switch. What is the potential difference across the resistor and the inductor at time $t = 0$ ?**

(a) $0\ V, 25\ V$ (b) $12.5\ V, 1.25\ V$
(c) $10\ V, 15\ V$ (d) $25\ V, 0\ V$

**40. The sensitivity of a galvanometer is 60 division/A. When a shunt is used, its sensitivity becomes 10 division/A. If the galvanometer is of resistance 20Ω, the value of shunt used is**

(a) 4Ω (b) 5Ω
(c) 20Ω (d) 2Ω

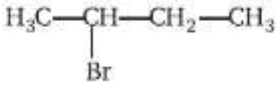
## Chemistry

**41. $C_6H_6 + O_3 \longrightarrow X \xrightarrow{Zn/H_2O} Y$; X and Y are respectively**

(a) diozonide, glycol
(b) triozonide, glyoxalic acid
(c) triozonide, glyoxal
(d) monoozonide, oxalic acid

**42. Which one of the following exhibits enantiomerism?**

(a) $BrCH_2-CH_2-CH_2-CH_2Br$

(b) 

(c) $H_3C-CH_2-CH_2-CH_2Br$

(d) $H_3C-CH_2-CBr_2-CH_3$

**43. Phosgene is formed slowly from which one of the following on exposure to air and sunlight?**

(a) $CHCl_3$ (b) $H_3CCl$

(c) $H_3COH$ (d) $C_2H_5Cl$

**44. The order of reactivity of phenol (I), nitrobenzene (II) and benzene (III) towards nitration is**

(a) (III) > (I) > (II) (b) (II) > (III) > (I)

(c) (I) > (III) > (II) (d) (I) > (II) > (III)

**45. The reagent used in the Wolff-Kishner reduction is**

(a) $H_2N-NH_2/KOH$ (b) $H_2/Ni$

(c) $Sn/HCl$ (d) $LiAlH_4$

**46. The $pK_a$ values of four carboxylic acids are 4.76, 4.19, 0.23 and 3.41 respectively. The $pK_a$ value of strongest carboxylic acid among them is**

(a) 4.19 (b) 3.41

(c) 0.23 (d) 4.76

**47. Nitrobenzene on reduction using zinc in alkaline medium results in X. The number of sigma ( $\sigma$ ) and pi ( $\pi$ ) bonds in X is**

(a) $24\sigma, 7\pi$ (b) $24\sigma, 6\pi$

(c) $27\sigma, 7\pi$ (d) $27\sigma, 6\pi$

**48. Which one of the following is not a biopolymer?**

(a) Cellulose (b) Nylon-6

(c) Insulin (d) DNA

**49. Which one of the following statements is not correct?**

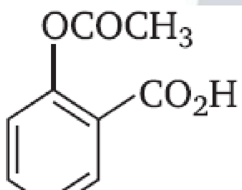
(a) Except glycine all other naturally occurring α-amino acids are optically active

(b) α-amino acids have maximum solubility at their isoelectric point

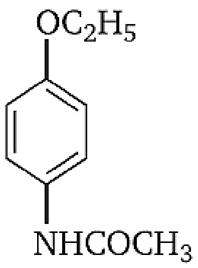
(c) A tripeptide has two peptide bonds

(d) α-amino acids exist as Zwitter ions

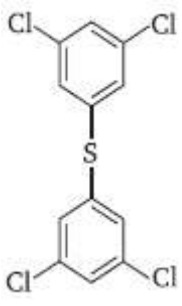
**50. Which one of the following is an artificial sweetening agent?**



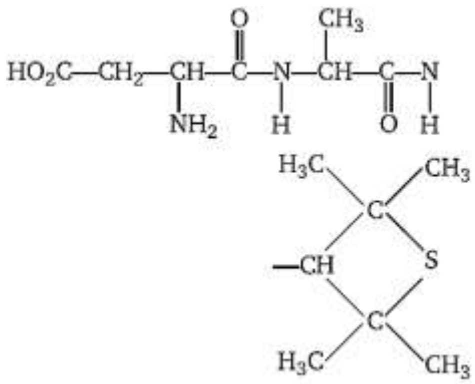
(a)



(b)



(c)

(d) 

**51. The volume in mL of 0.1 M solution of NaOH required to completely neutralise 100 mL of 0.3 M solution of $H_3PO_3$ is**

(a) 60 (b) 600
(c) 300 (d) 30

**52. Match the following**

| | List I | | List II |
|---|---|---|---|
| (A) | Potential of hydrogen electrode at pH = 10 | (I) | 0.76 V |
| (B) | $Cu^{2+} \mid Cu$ | (II) | 0.059 |
| (C) | $Zn \mid Zn^{2+}$ | (III) | −0.591 V |
| (D) | $\frac{2.303RT}{F}$ | (IV) | 0.337 V |
| | | (V) | −0.76 V |

| | A | B | C | D |
|---|---|---|---|---|
| (a) | (III) | (I) | (II) | (V) |
| (b) | (II) | (V) | (I) | (IV) |
| (c) | (III) | (IV) | (I) | (II) |
| (d) | (V) | (I) | (IV) | (II) |

**53. If the values of $\Lambda_\infty$ of $NH_4Cl$, NaOH and NaCl are 130, 217 and 109ohm$^{-1}$ cm$^2$ equiv $^{-1}$ respectively, the $\Lambda_\infty$ of $NH_4OH$ in ohm $^{-1}$ cm$^2$ equiv $^{-1}$ is**

(a) 238 (b) 196
(c) 22 (d) 456

**54. The number of unit cells present in 39 g of potassium if it crystallizes as body centred cube is ( N = Avogadro number, At. wt. of potassium = 39)**

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

**55. Which one of the following is true for an exothermic reaction $A \rightleftharpoons B$, if $E_f$ and $E_b$ are the activation energies of forward and backward reactions respectively?**

(a) $E_f > E_b$ (b) $E_f = E_b$
(c) $E_f = -E_b$ (d) $E_f < E_b$

**56. If the equilibrium constant for the reaction $2AB \rightleftharpoons A_2 + B_2$ is 49 , what is the equilibrium constant for $AB \rightleftharpoons \frac{1}{2}A_2 + \frac{1}{2}B_2$ ?**

(a) 7 (b) $\frac{1}{7}$
(c) 24.5 (d) 49

**57. The pH of 0.05 M acetic acid is $(K_a = 2 \times 10^{-5})$**

(a) 2 (b) 11
(c) $10^{-3}$ (d) 3

**58. What is the entropy change in $JK^{-1}$ during the melting of 27.3 g of ice at 0°C ? (Latent heat of fusion of ice = $330Jg^{-1}$ )**

(a) 330 (b) 12.1
(c) 3.3 (d) 33

**59. Which one of the following gives a straight line for Freundlich adsorption isotherm?**
(a) $\log\frac{x}{m}$ vs $\log p$ (b) $\frac{x}{m}$ vs $\frac{1}{p}$
(c) $\log\frac{x}{m}$ vs $\log\frac{1}{p}$ (d) $\frac{x}{m}$ vs $p$

**60. Which property among the following is same for both hydrogen and deuterium molecules?**
(a) Bond energy (b) Melting point
(c) Boiling point (d) Bond length

**61. In which of the following reactions hydrogen is not liberated?**
(a) Reaction of fused NaOH with C
(b) Reaction of NaOH with sulphur
(c) Heating the concentrated NaOH with Si
(d) Reaction of zinc with NaOH

**62. Which one of the following statements is not correct?**
(a) Moissan boron is amorphous
(b) The reaction between boron and concentrated $HNO_3$ gives $N_2O$
(c) Amorphous boron on heating with oxygen forms $B_2O_3$
(d) Boron is a non-conductor of electricity

**63. Which one of the following is a correct set?**
(a) Diamond, $sp^2$ (b) Graphite, $sp^3$
(c) Diamond, sp (d) Graphite, $sp^2$

**64. The total number of σ and π-bonds in pyrophosphoric acid are respectively**
(a) 8,2 (b) 10,2
(c) 12,2 (d) 8,4

**65. What are the products formed when moist chlorine gas is reacted with hypo?**
(a) $Na_2SO_4$, S, HCl
(b) $Na_2SO_3$, S, HCl
(c) $Na_2S_4O_6$, $Na_2SO_3$, HCl
(d) $Na_2S_4O_6$, NaCl, HCl

**66. What is the bond angle in $ClO_2$ (OClO) ?**
(a) 90° (b) 118°
(c) 105° (d) 111°

**67. The hybridisation of Xe and the number of lone pairs of electrons on it in $XeF_6$ are**
(a) $sp^3d^2$, 1 (b) $sp^3d^3$, 2
(c) $sp^3d^2$, 2 (d) $sp^3d^3$, 1

**68. Identify the order in which the spin only magnetic moment (in BM) increases for the following four ions**
**(I) $Fe^{2+}$** **(II) $Ti^{2+}$**
**(III) $Cu^{2+}$** **(IV) $V^{2+}$**
(a) I, II, IV, III (b) IV, I, II, III
(c) III, IV, I, II (d) III, II, IV, I

**69. Which one of the following oxides is reduced by water gas to obtain the metal during its extraction?**
(a) NiO (b) ZnO
(c) $WO_3$ (d) $Fe_2O_3$

**70. Which air pollutant is responsible for Bhopal gas tragedy?**
(a) PIC (b) CFC
(c) MIC (d) CO

**71. 0.16 g of an organic compound containing sulphur produces 0.233 g of $BaSO_4$. Percentage of sulphur in the compound is**
(a) 20 (b) 80 (c) 50 (d) 10

**72. Assertion (A) Cyclohexane is the most stable cycloalkane.**
**Reason (R) Cyclopropane and cyclobutane are less stable due to angle strain and torsional strain.**
**The correct answer is**
(a) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(b) (A) is true but (R) is not true.

(c) (A) is not true but (R) is true.
(d) Both (A) and (R) are true and (R) is the correct explanation of (A).

**73. Which one of the following frequencies of radiation (in Hz ) has a wavelength of 600 nm ?**

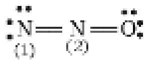
(a) $2.0 \times 10^{13}$ (b) $5.0 \times 10^{16}$
(c) $2.0 \times 10^{14}$ (d) $5.0 \times 10^{14}$

**74. According to Bohr's theory which one of the following values of angular momentum of hydrogen atom is not permitted?**

(a) $\frac{1.25h}{\pi}$ (b) $\frac{h}{\pi}$
(c) $\frac{1.5h}{\pi}$ (d) $\frac{0.5h}{\pi}$

**75. Which one of the following is correct order of second ionisation potential of Na, Ne, Mg and Al ?**

(a) $Al < Na < Mg < Ne$
(b) $Ne < Al < Na < Mg$
(c) $Mg < Al < Ne < Na$
(d) $Na < Mg < Ne < Al$

**76. The formal charges of $N_{(1)}, N_{(2)}$ and O atoms in**  **are respectively**

(a) $+1,-1,0$ (b) $-1,+1,0$
(c) $+1,+1,0$ (d) $-1,-1,0$

**77. In which of the following pairs, the central atoms have the same number of lone pairs of electrons?**

(a) $PCl_5, BrF_5$ (b) $XeF_2, ICl$
(c) $XeF_4, ClO_4^-$ (d) $SCl_4, CH_4$

**78. 19 g of a mixture containing $NaHCO_3$ and $Na_2CO_3$ on complete heating liberated 1.12 L of $CO_2$ at STP. The weight of the remaining solid was 15.9 g . What is the weight (in g) of $Na_2CO_3$ in the mixture before heating?**

(a) 8.4 (b) 15.9
(c) 4.0 (d) 10.6

**79. Under which one of the following conditions do real gases approach the ideal gas behaviour?**

(a) Low temperature and high pressure
(b) High temperature and high pressure
(c) High temperature and low pressure
(d) Low temperature and low pressure

**80. Which one of the following is the ratio of the lowering of vapour pressure of 0.1 M aqueous solutions of $BaCl_2$, NaCl and $Al_2(SO_4)_3$ respectively?**

(a) 3: 2: 5 (b) 5: 2: 3
(c) 5: 3: 2 (d) 2: 3: 5

## Mathematics

**81. $\lim_{x\to 8} \frac{\sqrt{1+\sqrt{1+x}}-2}{x-8}$ is equal to**

(a) $\frac{3}{2}$ (b) $\frac{1}{4}$ (c) $\frac{1}{24}$ (d) $\frac{1}{12}$

**82. If [x] denotes the greatest integer not exceeding x and if the function f defined by**

$$f(x) = \begin{cases} \dfrac{a+2\cos x}{x^2} & ,x<0 \\ b\tan\dfrac{\pi}{[x+4]} & ,x \geq 0 \end{cases}$$

**is continuous at $x = 0$, then the ordered pair $(a, b)$ is equal to**

(a) $(-2,1)$ (b) $(-2,-1)$
(c) $(-1,\sqrt{3})$ (d) $(-2,-\sqrt{3})$

**83. If $y=(1+x)(1+x^2)(1+x^4)\dots(1+x^{2n})$, then $\left(\frac{dy}{dx}\right)_{x=0}$ is equal to**

(a) 0 (b) $\frac{1}{2}$ (c) 1 (d) 2

**84. If $\cos^{-1}\left(\frac{x^2-y^2}{x^2+y^2}\right)=k$ (a constant), then $\frac{dy}{dx}$ is equal to**

(a) $\frac{y}{x}$ (b) $\frac{x}{y}$ (c) $\frac{x^2}{y^2}$ (d) $\frac{y^2}{x^2}$

**85. If $f(x)=|x|+|\sin x|$ for $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$, then its left hand derivative at $x=0$ is**

(a) 0 (b) -1 (c) -2 (d) -3

**86. If $y=\frac{\log_e x}{x}$ and $z=\log_e x$, then $\frac{d^2y}{dz^2}+\frac{dy}{dz}$ is equal to**

(a) $e^{-z}$ (b) $2e^{-z}$

(c) $ze^{-z}$ (d) $-e^{-z}$

**87. If $1^\circ=\alpha$ radians, then the approximate value of $\cos(60^\circ 1')$ is**

(a) $\frac{1}{2}+\frac{\alpha\sqrt{3}}{120}$ (b) $\frac{1}{2}-\frac{\alpha}{120}$

(c) $\frac{1}{2}-\frac{\alpha\sqrt{3}}{120}$ (d) $\frac{1}{2}+\frac{\alpha}{120}$

**88. If the distance $s$ travelled by a particle in time $t$ is given by $s=t^2-2t+5$, then its acceleration is**

(a) 0 (b) 1 (c) 2 (d) 3

**89. The length of the subtangent at any point $(x_1,y_1)$ on the curve $y=5^x$ is**

(a) $5^{x_1}$ (b) $y_1 5^{x_1}$

(c) $\log_e 5$ (d) $\frac{1}{\log_e 5}$

**90. If $u\equiv u(x,y)=\sin(y+ax)-(y+ax)^2$, then it implies**

(a) $u_{xx}=a^2\cdot u_{yy}$ (b) $u_{yy}=a^2u_{xx}$

(c) $u_{xx}=-a^2\cdot u_{yy}$ (d) $u_{yy}=-a^2u_{xx}$

**91. $\int\left(\sqrt{\frac{a+x}{a-x}}+\sqrt{\frac{a-x}{a+x}}\right)dx$ is equal to**

(a) $2\sin^{-1}\left(\frac{x}{a}\right)+C$ (b) $2a\sin^{-1}\left(\frac{x}{a}\right)+C$

(c) $2\cos^{-1}\left(\frac{x}{a}\right)+C$ (d) $2a\cos^{-1}\left(\frac{x}{a}\right)+C$

**92. If $\int\frac{\sin^8 x-\cos^8 x}{1-2\sin^2 x\cos^2 x}dx=A\sin 2x+B$, then A is equal to**

(a) $-\frac{1}{2}$ (b) -1 (c) $\frac{1}{2}$ (d) 1

**93. $\int\frac{1+\cos 4x}{\cot x-\tan x}dx$ is equal to**

(a) $-\frac{1}{4}\cos 4x+C$

(b) $\frac{1}{8}\cos 4x+C$

(c) $\frac{1}{4}\sin 4x+C$

(d) $-\frac{1}{8}\cos 4x+C$

**94. The area (in square units) of the region bounded by the curves $x=y^2$ and $x=3-2y^2$ is**

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

**95. If $I_n=\int_0^{\pi/4}\tan^n\theta d\theta$ for $n=1,2,3,\dots$, then $I_{n-1}+I_{n+1}$ is equal to**

(a) 0 (b) 1 (c) $\frac{1}{n}$ (d) $\frac{1}{n+1}$

**96. Let $f(0)=1, f(0.5)=\frac{5}{4}, f(1)=2, f(1.5)=\frac{13}{4}$ and $f(2)=5$. Using Simpson's rule, $\int_0^2 f(x)dx$ is equal to**

(a) $\frac{14}{3}$ (b) $\frac{7}{6}$ (c) $\frac{14}{9}$ (d) $\frac{7}{9}$

**97. The solution of the differential equation $\frac{dy}{dx} = \frac{y}{x} + \frac{\phi(y/x)}{\phi'(y/x)}$ is**

(a) $x\phi\left(\frac{y}{x}\right) = k$ (b) $\phi\left(\frac{y}{x}\right) = kx$

(c) $y\phi\left(\frac{y}{x}\right) = k$ (d) $\phi\left(\frac{y}{x}\right) = ky$

**98. If $y = y(x)$ is the solution of the differential equation $\left(\frac{2+\sin x}{y+1}\right)\frac{dy}{dx} + \cos x = 0$ with $y(0) = 1$, then $y\left(\frac{\pi}{2}\right)$ is equal to**

(a) $\frac{1}{3}$ (b) $\frac{2}{3}$ (c) 1 (d) $\frac{4}{3}$

**99. If $f: [2, \infty) \to B$ defined by $f(x) = x^2 - 4x + 5$ is a bijection, then B is equal to**

(a) $[0, \infty)$ (b) $[1, \infty)$

(c) $[4, \infty)$ (d) $[5, \infty)$

**100. If $f: R \to R$ is defined by $f(x) = \left[\frac{x}{5}\right]$ for $x \in R$, where $[y]$ denotes the greatest integer not exceeding y, then $\{f(x): |x| < 71\}$ is equal to**

(a) $\{-14, -13, \dots, 0, \dots 13, 14\}$

(b) $\{-14, -13, \dots, 0, \dots, 14, 15\}$

(c) $\{-15, -14, \dots, 0, \dots, 14, 15\}$

(d) $\{-15, -14, \dots, 0, \dots, 13, 14\}$

**101. If a, b and n are natural numbers, then $a^{2n-1} + b^{2n-1}$ is divisible by**

(a) $a + b$ (b) $a - b$

(c) $a^3 + b^3$ (d) $a^2 + b^2$

**102. A bag contains n white and n black balls. Pairs of balls are drawn at random without replacement successively, until the bag is empty. If the number of ways in which each pair consists of one white and one black ball is 14400 , then n is equal to**

(a) 6 (b) 5 (c) 4 (d) 3

**103. The number of five-digit numbers divisible by 5 that can be formed using the numbers 0, 1, 2, 3, 4, 5 without repetition is**

(a) 240 (b) 216

(c) 120 (d) 96

**104. $^{15}P_8 = A + 8 \cdot {}^{14}P_7 \Rightarrow A =$**

(a) $^{14}P_6$ (b) $^{14}P_8$

(c) $^{15}P_7$ (d) $^{16}P_9$

**105. If $^{(n-1)}C_3 + {}^{(n-1)}C_4 > {}^nC_3$, then the minimum value of n is**

(a) 5 (b) 6 (c) 7 (d) 8

**106. If the coefficients of r th and $(r + 1)$ th terms in the expansion of $(3 + 7x)^{29}$ are equal, then r is equal to**

(a) 14 (b) 15 (c) 18 (d) 21

**107. $\frac{x^2+x+1}{(x-1)(x-2)(x-3)} = \frac{A}{x-1} + \frac{B}{x-2} + \frac{C}{x-3} \Rightarrow A + C =$**

(a) 4 (b) 5 (c) 6 (d) 8

**108. $\sum_{n=1}^{\infty} \frac{2n}{(2n+1)!}$ is equal to**

(a) $\frac{1}{e}$ (b) $\frac{e}{2}$ (c) e (d) 2e

**109. If $a > 0$ and $b^2 - 4ac = 0$, then the curve $y = ax^2 + bx + c$**

(a) cuts the x-axis

(b) touches the x-axis and lies below it

(c) lies entirely above the x-axis

(d) touches the x-axis and lies above it

**110.** **If $\tan A$ and $\tan B$ are the roots of the quadratic equation $x^2 - px + q = 0$, then $\sin^2(A+B)$ is equal to**

(a) $\frac{p^2}{p^2+q^2}$ (b) $\frac{p^2}{(p+q)^2}$

(c) $1 - \frac{p}{(1-q)^2}$ (d) $\frac{p^2}{p^2+(1-q)^2}$

**111.** **The value of a for which the equations $x^3 + ax + 1 = 0$ and $x^4 + ax^2 + 1 = 0$ have a common root is**

(a) -2 (b) -1 (c) 1 (d) 2

**112.** **If x is real, then the value of $\frac{x^2-3x+4}{x^2+3x+4}$ lies in the interval**

(a) $\left[\frac{1}{3}, 3\right]$ (b) $\left[\frac{1}{5}, 5\right]$

(c) $\left[\frac{1}{6}, 6\right]$ (d) $\left[\frac{1}{7}, 7\right]$

**113.** $A(\alpha, \beta) = \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix} \Rightarrow [A(\alpha, \beta)]^{-1} =$

(a) $A(-\alpha, \beta)$ (b) $A(-\alpha, -\beta)$

(c) $A(\alpha, -\beta)$ (d) $A(\alpha, \beta)$

**114.** **If A is a matrix such that**

$\begin{bmatrix} 2 & 1 \\ 3 & 2 \end{bmatrix} A \begin{bmatrix} 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$

**then A is equal to**

(a) $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 0 \\ -1 & 1 \end{bmatrix}$ (d) $\begin{bmatrix} 2 \\ -3 \end{bmatrix}$

**115.** $A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix} \Rightarrow A^2 - 2A =$

(a) $A^{-1}$ (b) $-A^{-1}$

(c) I (d) $-I$

**116.** $\begin{vmatrix} 24 & 25 & 26 \\ 25 & 26 & 27 \\ 26 & 27 & 27 \end{vmatrix}$ **is equal to**

(a) 0 (b) -1 (c) 1 (d) 2

**117.** **Let $z = a - \frac{i}{2}; a \in R$. Then $|i+z|^2 - |i-z|^2$ is equal to**

(a) 2 (b) -2 (c) 4 (d) -4

**118.** **The locus of the complex number z such that $\arg\left(\frac{z-2}{z+2}\right) = \frac{\pi}{3}$ is**

(a) a circle (b) a straight line

(c) a parabola (d) an ellipse

**119.** $\frac{(1+i)^{2011}}{(1-i)^{2009}}$ **is equal to**

(a) -1 (b) 1 (c) 2 (d) -2

**120.** **If $f: R \to R$ is defined by $f(x) = 7 + \cos(5x+3)$ for $x \in R$, then the period of f is**

(a) $2\pi$ (b) $\pi$ (c) $\frac{\pi}{5}$ (d) $\frac{2\pi}{5}$

**121.** $\cos A = \frac{3}{4} \Rightarrow 32\sin\left(\frac{A}{2}\right)\sin\left(\frac{5A}{2}\right) =$

(a) 7 (b) 8 (c) 13 (d) 11

**122.** **If $f(x) = \sin^6 x + \cos^6 x$ for $x \in R$, then $f(x)$ lies in the interval**

(a) $\left[\frac{7}{8}, \frac{5}{4}\right]$ (b) $\left[\frac{1}{2}, \frac{5}{8}\right]$

(c) $\left[\frac{1}{4}, 1\right]$ (d) $\left[\frac{1}{4}, \frac{1}{2}\right]$

**123. The most general value of $\theta$ which satisfies both the equations $\tan 8 = -1$ and $\cos\theta = \frac{1}{\sqrt{2}}$ is**

(a) $n\pi + \frac{7\pi}{4}$ (b) $2n\pi + \frac{7\pi}{4}$
(c) $n\pi + (-1)^n \frac{7\pi}{4}$ (d) $\frac{7n\pi}{4}$
Here, n is any integer.

**124. $\left(\tan^{-1} x\right)^2 + \left(\cot^{-1} x\right)^2 = \frac{5\pi^2}{8} \Rightarrow x =$**

(a) -1 (b) 1
(c) 0 (d) $\pi\sqrt{\frac{5}{8}}$

**125. For $0 < x \le \pi$, $\sin h^{-1}(\cot x)$ is equal to**

(a) $\log\left(\cot\frac{x}{2}\right)$ (b) $\log\left(\tan\frac{x}{2}\right)$
(c) $\log(1+\cot x)$ (d) $\log(1+\tan x)$

**126. In a $\triangle$ ABC, if $a\cos^2\frac{C}{2} + c\cos^2\frac{A}{2} = \frac{3b}{2}$, then the sides of the triangle are in**

(a) an arithmetic progression
(b) a geometric progression
(c) a harmonic progression
(d) an arithmetico-geometric progression

**127. In a $\triangle$ ABC, if $\frac{\cos A}{a} = \frac{\cos B}{b} = \frac{\cos C}{c}$, then $\triangle$ ABC is**

(a) right angled
(b) isosceles right angled
(c) equilateral
(d) scalene

**128. The angle of elevation of a stationary cloud from a point 2500 m above a lake is $15^\circ$ and from the same point the angle of depression of its reflection in the lake is $45^\circ$. The height (in metres) of the cloud above the lake, given that $\cot 15^\circ = 2+\sqrt{3}$, is**

(a) 2500 (b) $2500\sqrt{2}$
(c) $2500\sqrt{3}$ (d) 5000

**129. The magnitude of the projection of the vector $a = 4i - 3j + 2k$ on the line which makes equal angles with the coordinate axes is**

(a) $\sqrt{2}$ (b) $\sqrt{3}$ (c) $\frac{1}{\sqrt{3}}$ (d) $\frac{1}{\sqrt{2}}$

**130. If the vectors $i - 2xj - 3yk$ and $i + 3xj + 2yk$ are orthogonal to each other, then the locus of the point $(x, y)$ is**

(a) a circle (b) an ellipse
(c) a parabola (d) a straight line

**131. For any vector r**
**$i \times (r \times i) + j \times (r \times j) + k \times (r \times k)$ is equal to**

(a) 0 (b) $2\mathbf{r}$ (c) $3\mathbf{r}$ (d) $4\mathbf{r}$

**132. If the vectors $AB = -3i + 4k$ and $AC = 5i - 2j + 4k$ are the sides of a $\triangle$ ABC, then the length of the median through A is**

(a) $\sqrt{14}$ (b) $\sqrt{18}$
(c) $\sqrt{25}$ (d) $\sqrt{29}$

**133. If $|a| = 1, |b| = 2$ and the angle between a and b is $120^\circ$, then $\{(a+3b)\times(3a-b)\}^2$ is equal to**

(a) 425 (b) 375
(c) 325 (d) 300

**134. Let $v = 2i + j - k$ and $w = i + 3k$. If u is any unit vector, then the maximum value of the scalar triple product $[u\ v\ w]$ is**

(a) 1 (b) $\sqrt{10}+\sqrt{6}$
(c) $\sqrt{59}$ (d) $\sqrt{60}$

**135. A class has fifteen boys and five girls. Suppose three students are selected at random from the class. The probability that there are two boys and one girl is**
(a) $\frac{35}{76}$ (b) $\frac{35}{38}$ (c) $\frac{7}{76}$ (d) $\frac{35}{72}$

**136. Seven white balls and three black balls are randomly arranged in a row. The probability that no two black balls are placed adjacently is**
(a) $\frac{1}{2}$ (b) $\frac{7}{15}$ (c) $\frac{2}{15}$ (d) $\frac{1}{3}$

**137. Let A and B be events in a sample space S such that $P(A) = 0.5$, $P(B) = 0.4$ and $P(A \cup B) = 0.6$. Observe the following lists.**

| | List I | | List II |
|---|---|---|---|
| (i) | $P(A \cap B$ | (1) | 0.4 |
| (ii) | $P(A \cap \bar{B})$ | (2) | 0.2 |
| (iii) | $P(\bar{A} \cap B)$ | (3) | 0.3 |
| (iv) | $P(\bar{A} \cap \bar{B})$ | (4) | 0.1 |

**The correct match of List I from List II is**

| | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|
| (a) | (1) | (2) | (3) | (4) |
| (b) | (3) | (2) | (4) | (1) |
| (c) | (3) | (2) | (1) | (4) |
| (d) | (3) | (1) | (2) | (4) |

**138. The probability distribution of a random variable X is given below.**

| $X = x$ | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| $P(X) = x$ | $\frac{1}{10}$ | $\frac{2}{10}$ | $\frac{3}{10}$ | $\frac{4}{10}$ |

**Then the variance of X is**
(a) 1 (b) 2 (c) 3 (d) 4

**139. The probability that an individual suffers a bad reaction from an injection is 0.001 . The probability that out of 2000 individuals exactly three will suffer bad reaction is**
(a) $\frac{1}{e^2}$ (b) $\frac{2}{3e^2}$
(c) $\frac{8}{3e^2}$ (d) $\frac{4}{3e^2}$

**140. The locus of a point such that the sum of its distances from the points $(0, 2)$ and $(0, -2)$ is 6 , is**
(a) $9x^2 - 5y^2 = 45$ (b) $5x^2 + 9y^2 = 45$
(c) $9x^2 + 5y^2 = 45$ (d) $5x^2 - 9y^2 = 45$

**141. The number of points $P(x, y)$ with natural numbers as coordinates that lie inside the quadrilateral formed by the lines $2x + y = 2$, $x = 0$, $y = 0$ and $x + y = 5$ is**
(a) 12 (b) 10 (c) 6 (d) 4

**142. The image of the point $(3, 8)$ in the line $x + 3y = 7$ is**
(a) (1,4) (b) (4,1)
(c) $(-1, -4)$ (d) $(-4, -1)$

**143. The line joining the points $A(2, 0)$ and $B(3, 1)$ is rotated through an angle of $45^\circ$, about A in the anti-clockwise direction. The coordinates of B in the new position**
(a) $(2, \sqrt{2})$ (b) $(\sqrt{2}, 2)$
(c) (2,2) (d) $(\sqrt{2}, \sqrt{2})$

**144. If one of the lines in the pair of straight line given by $4x^2 + 6xy + ky^2 = 0$ bisects the angle between the coordinate axes, then $k \in$**

(a) $\{-2,-10\}$ (b) $\{-2,10\}$
(c) $\{-10,2\}$ (d) $\{2,10\}$

**145.** **If $ax^2+2hxy+by^2+2gx+2fy+c=0$ represents a pair of parallel lines, then $\sqrt{\frac{g^2-ac}{f^2-bc}}$, is equal to**

(a) $\frac{a}{b}$ (b) $\sqrt{\frac{a}{b}}$ (c) $\sqrt{\frac{b}{a}}$ (d) $\frac{b}{a}$

**146.** **If s and p are respectively the sum and the product of the slopes of the lines $3x^2-2xy-15y^2=0$, then $s:p$ is equal to**

(a) $4:3$ (b) $2:3$
(c) $3:5$ (d) $3:4$

**147.** **If the line $y=2x+c$ is a tangent to the circle $x^2+y^2=5$, then a value of c is**

(a) 2 (b) 3 (c) 4 (d) 5

**148.** **A line segment $AM=a$ moves in the XOY plane such that AM is parallel to the X-axis. If A moves along the circle $x^2+y^2=a^2$, then the locus of M is**

(a) $x^2+y^2=4a^2$
(b) $x^2+y^2=2ax$
(c) $x^2+y^2=2ay$
(d) $x^2+y^2=2ax+2ay$

**149.** **If the lines $3x+4y-14=0$ and $6x+8y+7=0$ are both tangents to a circle, then its radius is**

(a) 7 (b) $\frac{7}{2}$ (c) $\frac{7}{4}$ (d) $\frac{7}{6}$

**150.** **If the circle $x^2+y^2+8x-4y+c=0$ touches the circle $x^2+y^2+2x+4y-11=0$ externally and cuts the circle $x^2+y^2-6x+8y+k=0$ orthogonally, then k is equal to**

(a) 59 (b) -59 (c) 19 (d) -19

**151.** **The point of contact of the circles**

$$x^2+y^2+2x+2y+1=0$$
**and** $x^2+y^2-2x+2y+1=0$ **is**

(a) $(0,1)$ (b) $(0,-1)$
(c) $(1,0)$ (d) $(-1,0)$

**152.** **If a chord of the parabola $y^2=4x$ passes through its focus and makes an angle $\theta$ with the X-axis, then its length is**

(a) $4\cos^2\theta$ (b) $4\sin^2\theta$
(c) $4\operatorname{cosec}^2\theta$ (d) $4\sec^2\theta$

**153.** **If the straight line $y=mx+c$ is parallel to the axis of the parabola $y^2=lx$ and intersects the parabola at $\left(\frac{c^2}{8},c\right)$, then the length of the latusrectum is**

(a) 2 (b) 3 (c) 4 (d) 8

**154.** **The eccentricity of the ellipse $x^2+4y^2+2x+16y+13=0$ is**

(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{1}{2}$ (c) $\frac{1}{\sqrt{3}}$ (d) $\frac{1}{\sqrt{2}}$

**155.** **The angle between the asymptotes of the hyperbola $x^2-3y^2=3$ is**

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

**156.** **The polar equation of the line perpendicular to the line $\sin\theta-\cos\theta=\frac{1}{r}$ and passing through the point $\left(2,\frac{\pi}{6}\right)$ is**

(a) $\sin\theta+\cos\theta=\frac{\sqrt{3}+1}{r}$

(b) $\sin\theta - \cos\theta = \frac{\sqrt{3}+1}{r}$

(c) $\sin\theta + \cos\theta = \frac{\sqrt{3}-1}{r}$

(d) $\cos\theta - \sin\theta = \frac{\sqrt{3}}{r}$

**157. The ratio in which the line joining $(2, -4, 3)$ and $(-4, 5, -6)$ is divided by the plane $3x + 2y + z - 4 = 0$ is**

(a) $2:1$ (b) $4:3$

(c) $-1:4$ (d) $2:3$

**158. If the angles made by a straight line with the coordinate axes are $\alpha, \frac{\pi}{2} - \alpha, \beta$, then $\beta$ is equal to**

(a) 0 (b) $\frac{\pi}{6}$ (c) $\frac{\pi}{2}$ (d) $\pi$

**159. A plane passes through (2, 3, -1) and is perpendicular to the line having direction ratios $3, -4, 7$. The perpendicular distance from the origin to this plane is**

(a) $\frac{3}{\sqrt{74}}$ (b) $\frac{5}{\sqrt{74}}$

(c) $\frac{6}{\sqrt{74}}$ (d) $\frac{13}{\sqrt{74}}$

**160. The radius of the circle given by**

$$x^2 + y^2 + z^2 + 2x - 2y - 4z - 19 = 0$$
$$= x + 2y + 2z + 7, \text{ is}$$

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