# MHT CET 2024

*Question Paper with Solutions*

**Physics, Chemistry & Mathematics (PCM)**

Conducted by State Common Entrance Test Cell, Government of Maharashtra

## General Instructions

**Read the following instructions very carefully and strictly follow them:**

1. This question paper consists of **150 questions** and the duration of the test is **3 Hours**.
2. There are three parts in the question paper consisting of **Physics, Chemistry and Mathematics** having 50 questions in each part of equal weightage.
3. **Section-A:** Physics and Chemistry — 50 Questions each.
4. **Section-B:** Mathematics — 50 Questions.
5. Each question with correct response shall be awarded **one (1) mark**. There shall be **no negative marking**.
6. No mark shall be granted for marking two or more answers of same question, scratching or overwriting.

## PHYSICS

**1. Force between two point charges $q_1$ and $q_2$ placed in vacuum at a distance $r$ cm apart is $F$. Force between them when placed in a medium having dielectric $K = 5$ at $r/5$ cm apart will be:**

(1) $F/25$

(2) $5F$

(3) $F/5$

(4) $25F$

**2. A thin circular disc of mass $M$ and radius $R$ is rotating in a horizontal plane about an axis passing through its center and perpendicular to its plane with angular velocity $\omega$. If another disc of the same dimensions but of mass $M/2$ is placed gently on the first disc co-axially, then the new angular velocity of the system is:**

(1) $\frac{4}{5}\omega$
(2) $\frac{5}{4}\omega$
(3) $\frac{2}{3}\omega$
(4) $\frac{3}{2}\omega$

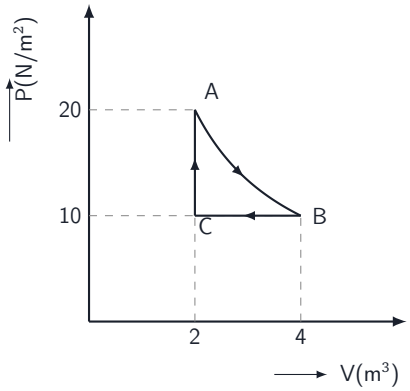
**3. Correct Bernoulli's equation is (symbols have their usual meaning):**

(1) $P + mgh + \frac{1}{2}mv^2 = \text{constant}$
(2) $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$
(3) $P + \rho gh + \rho v^2 = \text{constant}$
(4) $P + \frac{1}{2}\rho gh + \frac{1}{2}\rho v^2 = \text{constant}$

**4. Two projectiles are projected at $30^\circ$ and $60^\circ$ with the horizontal with the same speed. The ratio of the maximum height attained by the two projectiles respectively is:**

(1) $2 : \sqrt{3}$
(2) $\sqrt{3} : 1$
(3) $1 : 3$
(4) $1 : \sqrt{3}$

**5. A real gas within a closed chamber at $27^\circ$C undergoes the cyclic process as shown in the figure. The gas obeys the equation $PV^3 = RT$ for the path A to B. The net work done in the complete cycle is (assuming $R = 8$ J/molK):**




(1) 225 J

(2) 205 J

(3) 20 J

(4) −20 J

**6. Light emerges out of a convex lens when a source of light is kept at its focus. The shape of the wavefront of the light is:**

(1) Both spherical and cylindrical

(2) Cylindrical

(3) Spherical

(4) Plane

**7. A monkey of mass 50 kg climbs on a rope which can withstand the tension $T = 350\,\text{N}$. If the monkey initially climbs down with an acceleration of $4\,\text{m/s}^2$ and then climbs up with an acceleration of $5\,\text{m/s}^2$, choose the correct option ($g = 10\,\text{m/s}^2$):**

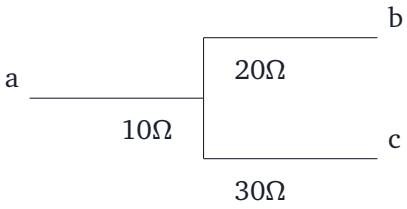
(1) $T = 700\,\text{N}$ while climbing upward

(2) $T = 350\,\text{N}$ while going downward

(3) Rope will break while climbing upward

(4) Rope will break while going downward

**8. Figure shows a part of an electric circuit. The potentials at points $a$, $b$, and $c$ are $30\,V$, $12\,V$, and $2\,V$, respectively. The current through the $20\,\Omega$ resistor will be:**




**(1)** $0.4\,A$

**(2)** $0.2\,A$

**(3)** $0.6\,A$

**(4)** $1.0\,A$

**9. A current of $200\,\mu A$ deflects the coil of a moving coil galvanometer through $60°$. The current to cause deflection through $\frac{\pi}{10}$ radian is:**

**(1)** $30\,\mu A$

**(2)** $120\,\mu A$

**(3)** $60\,\mu A$

**(4)** $180\,\mu A$

**10. The value of acceleration due to gravity at Earth's surface is $9.8\,m/s^2$. The altitude above its surface at which the acceleration due to gravity decreases to $4.9\,m/s^2$ is close to: (Radius of Earth $R = 6.4 \times 10^6\,m$)**

**(1)** $2.6 \times 10^6\,m$

**(2)** $6.4 \times 10^6\,m$

**(3)** $9.0 \times 10^6\,m$

**(4)** $1.6 \times 10^6\,m$

**11. Relative permittivity and permeability of a material are $\varepsilon_r$ and $\mu_r$, respectively. Which of the following values of these quantities are allowed for a diamagnetic material?**

(1) $\varepsilon_r = 0.5, \mu_r = 1.5$

(2) $\varepsilon_r = 1.5, \mu_r = 0.5$

(3) $\varepsilon_r = 0.5, \mu_r = 0.5$

(4) $\varepsilon_r = 1.5, \mu_r = 1.5$

**12. The magnetic flux through a coil perpendicular to its plane is varying according to the relation $\phi = 5t^3 + 4t^2 + 2t - 5$. If the resistance of the coil is $5\,\Omega$, then the induced current through the coil at $t = 2$ sec will be:**

(1) 15.6 A

(2) 16.6 A

(3) 17.6 A

(4) 18.6 A

**13. A solid metallic cube having total surface area $24\,m^2$ is uniformly heated. If its temperature is increased by $10^\circ$ C, calculate the increase in volume of the cube.**

(Given: $\alpha = 5.0 \times 10^{-4}\,C^{-1}$)

(1) $2.4 \times 10^6\,cm^3$

(2) $1.2 \times 10^5\,cm^3$

(3) $6.0 \times 10^4\,cm^3$

(4) $4.8 \times 10^5\,cm^3$

**14. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon:**

(1) the rates at which currents are changing in the two coils

(2) the relative position and orientation of the two coils

(3) the materials of the wires of the coils

(4) the currents in the two coils

**15. A proton, an electron, and an alpha particle have the same energies. Their de-Broglie wavelengths will be compared as:**

**(1)** $\lambda_e > \lambda_\alpha > \lambda_p$
**(2)** $\lambda_\alpha < \lambda_p < \lambda_e$
**(3)** $\lambda_p < \lambda_e < \lambda_\alpha$
**(4)** $\lambda_p > \lambda_e > \lambda_\alpha$

**16. An ice cube has a bubble inside. When viewed from one side, the apparent distance of the bubble is $12$ cm. When viewed from the opposite side, the apparent distance of the bubble is $4$ cm. If the side of the ice cube is $24$ cm, the refractive index of the ice cube is:**

**(1)** $\frac{4}{3}$
**(2)** $\frac{3}{2}$
**(3)** $\frac{2}{3}$
**(4)** $\frac{6}{5}$

**17. The longest wavelength associated with the Paschen series is:**

(Given $R_H = 1.097 \times 10^7$ SI unit).

**(1)** $1.094 \times 10^{-6}$ m
**(2)** $2.973 \times 10^{-6}$ m
**(3)** $3.646 \times 10^{-6}$ m
**(4)** $1.876 \times 10^{-6}$ m

**18. The ratio of the mass densities of nuclei of $^{40}$Ca and $^{16}$O is close to:**

**(1)** 1

(2) 0.1

(3) 5

(4) 2

**19. Point charge of $10\,\mu C$ is placed at the origin. At what location on the X-axis should a point charge of $40\,\mu C$ be placed so that the net electric field is zero at $x = 2$ cm on the X-axis?**

(1) 6 cm

(2) 4 cm

(3) 8 cm

(4) $-4$ cm

**20. A magnetic needle is kept in a non-uniform magnetic field. It experiences:**

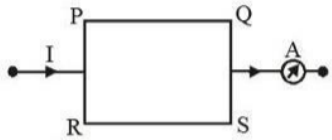
(1) neither a force nor a torque

(2) a torque but not a force

(3) a force but not a torque

(4) a force and a torque

**21. A current-carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If the ammeter current reading changes from $I$ to $2I$, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $F^{I}_{PQ} : F^{2I}_{PQ}$ is:**




(1) 1 : 2

(2) 1 : 4

(3) 1 : 5

(4) 1 : 3

**22. At which temperature will the r.m.s. velocity of a hydrogen molecule be equal to that of an oxygen molecule at $47^\circ$C?**

**(1)** 80 K
**(2)** $-73$ K
**(3)** 4 K
**(4)** 20 K

**23. A light-emitting diode (LED) is fabricated using GaAs semiconductor material whose band gap is 1.42 eV. The wavelength of light emitted from the LED is:**

**(1)** 650 nm
**(2)** 1243 nm
**(3)** 875 nm
**(4)** 1400 nm

**24. A steel wire with mass per unit length $7.0 \times 10^{-3}$ kg/m is under a tension of 70 N. The speed of transverse waves in the wire will be:**

**(1)** 100 m/s
**(2)** 50 m/s
**(3)** 10 m/s
**(4)** $200\pi$ m/s

**25. Two vessels $A$ and $B$ are of the same size and are at the same temperature. Vessel $A$ contains 1 g of hydrogen and vessel $B$ contains 1 g of oxygen. $P_A$ and $P_B$ are the pressures of the gases in $A$ and $B$ respectively. Then $\frac{P_A}{P_B}$ is:**

**(1)** 8

(2) 16

(3) 32

(4) 4

**26. A wire of length 1 m moving with velocity 8 m/s at right angles to a magnetic field of 2 T. The magnitude of induced emf between the ends of the wire will be:**

(1) 20 V

(2) 8 V

(3) 12 V

(4) 16 V

**27. Two identical particles each of mass $m$ go around a circle of radius $a$ under the action of their mutual gravitational attraction. The angular speed of each particle will be:**

(1) $\sqrt{\frac{Gm}{2a^3}}$

(2) $\sqrt{\frac{Gm}{8a^3}}$

(3) $\sqrt{\frac{Gm}{4a^3}}$

(4) $\sqrt{\frac{Gm}{a^3}}$

**28. In an unbiased $p$-$n$ junction, electrons diffuse from $n$-region to $p$-region because:**

(1) holes in $p$-region attract them

(2) electrons travel across the junction due to potential difference

(3) only electrons move from $n$-region to $p$-region and not the vice-versa

(4) electron concentration in $n$-region is more compared to that in $p$-region

**29. A particle is executing Simple Harmonic Motion (SHM). The ratio of potential energy and kinetic energy of the particle when its displacement is half of its amplitude will be:**

(1) 1 : 1

(2) 2 : 1

(3) 1 : 4

(4) 1 : 3

**30. Eight equal drops of water are falling through air with a steady speed of 10 cm/s. If the drops coalesce, the new velocity is:**

(1) 10 cm/s

(2) 40 cm/s

(3) 16 cm/s

(4) 5 cm/s

**31. In a coil, the current changes from −2 A to +2 A in 0.2 s and induces an emf of 0.1 V. The self-inductance of the coil is:**

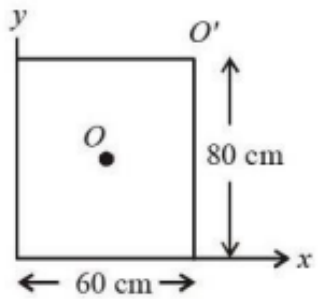
(1) 5 mH

(2) 1 mH

(3) 2.5 mH

(4) 4 mH

**32. For a uniform rectangular sheet shown in the figure, the ratio of moments of inertia about the axes perpendicular to the sheet and passing through $O$ (the center of mass) and $O'$ (corner point) is:**



(1) $\frac{2}{3}$
(2) $\frac{1}{4}$
(3) $\frac{1}{8}$
(4) $\frac{1}{2}$

**33. If $n$ is the number density and $d$ is the diameter of the molecule, then the average distance covered by a molecule between two successive collisions (i.e., mean free path) is represented by:**

(1) $\frac{1}{\sqrt{2\pi nd^2}}$
(2) $\sqrt{2n\pi d^2}$
(3) $\frac{1}{\sqrt{2n\pi d^2}}$
(4) $\frac{1}{\sqrt{2n^2\pi^2 d^2}}$

**34. A mixture of one mole of monoatomic gas and one mole of diatomic gas (rigid) are kept at room temperature (27°C). The ratio of specific heat of gases at constant volume respectively is:**

(1) $\frac{7}{5}$
(2) $\frac{3}{2}$
(3) $\frac{3}{5}$
(4) $\frac{5}{3}$

**35. In an a.c. circuit, voltage and current are given by:**

$$V = 100\sin(100t)\,\text{V} \quad \text{and} \quad I = 100\sin\left(100t + \frac{\pi}{3}\right)\,\text{mA}.$$

The average power dissipated in one cycle is:

(1) 10 W
(2) 2.5 W

(3) 25 W

(4) 5 W

**36. The difference between threshold wavelengths for two metal surfaces $A$ and $B$ having work functions $\phi_A = 9$ eV and $\phi_B = 4.5$ eV is:**

(Given: $hc = 1242$ eV nm)

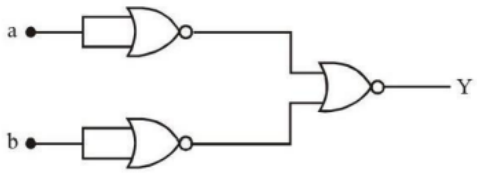
(1) 264 nm

(2) 138 nm

(3) 276 nm

(4) 540 nm

**37. The logic performed by the circuit shown in the figure is equivalent to:**




(1) $AND$

(2) $NAND$

(3) $OR$

(4) $NOR$

**38. A particle performs simple harmonic motion with amplitude $A$. Its speed is tripled at the instant that it is at a distance $\frac{2A}{3}$ from the equilibrium position. The new amplitude of the motion is:**

(1) $A\sqrt{3}$

(2) $\frac{7A}{3}$

(3) $\frac{A}{3}\sqrt{41}$

(4) $3A$

**39. The mass of proton, neutron, and helium nucleus are respectively $1.0073\,\mathbf{u}$, $1.0087\,\mathbf{u}$, $4.0015\,\mathbf{u}$. The binding energy of the helium nucleus is:**

(1) $14.2\,\text{MeV}$

(2) $56.8\,\text{MeV}$

(3) $28.4\,\text{MeV}$

(4) $7.1\,\text{MeV}$

**40. A series LCR circuit is subjected to an AC signal of $200\,\text{V}, 50\,\text{Hz}$. If the voltage across the inductor ($L = 10\,\text{mH}$) is $31.4\,\text{V}$, then the current in this circuit is:**

(1) $68\,\text{A}$

(2) $63\,\text{A}$

(3) $10\,\text{A}$

(4) $10\,\text{mA}$

**41. When two soap bubbles of radii $a$ and $b$ ($b > a$) coalesce, the radius of curvature of the common surface is:**

(1) $\frac{ab}{b-a}$

(2) $\frac{ab}{a+b}$

(3) $\frac{b-a}{ab}$

(4) $\frac{a+b}{ab}$

**42. A liquid is allowed to flow into a tube of truncated cone shape. Identify the correct statement:**

(1) The speed is high at the wider end and high at the narrow end.

(2) The speed is low at the wider end and high at the narrow end.

(3) The speed is same at both ends in a streamline flow.

(4) The liquid flows with uniform velocity in the tube.

**43. The velocity of sound in a gas in which two wavelengths $4.08\,\text{m}$ and $4.16\,\text{m}$ produce 40 beats in 12 seconds will be:**

(1) $2.828\,\text{ms}^{-1}$

(2) $175.5\,\text{ms}^{-1}$

(3) $353.6\,\text{ms}^{-1}$

(4) $707.2\,\text{ms}^{-1}$

**44. $\sigma$ is the uniform surface charge density of a thin spherical shell of radius $R$. The electric field at any point on the surface of the spherical shell is:**

(1) $\frac{\sigma}{\varepsilon_0 R}$

(2) $\frac{\sigma}{2\varepsilon_0}$

(3) $\frac{\sigma}{\varepsilon_0}$

(4) $\frac{\sigma}{4\varepsilon_0}$

**45. An electric field is given by $\vec{E} = (6\hat{i} + 5\hat{j} + 3\hat{k})\,\text{N/C}$. The electric flux through a surface area $30\hat{i}\,\text{m}^2$ lying in the YZ-plane (in SI units) is:**

(1) 180

(2) 90

(3) 150

(4) 60

**46. A big drop is formed by coalescing 1000 small droplets of water. The surface energy will become:**

(1) $\frac{1}{100}$th
(2) $\frac{1}{10}$th
(3) 100 times
(4) 10 times

**47. If $M$ is the mass of water that rises in a capillary tube of radius $r$, then the mass of water which will rise in a capillary tube of radius $2r$ is:**

(1) $M$
(2) $\frac{M}{2}$
(3) $4M$
(4) $2M$

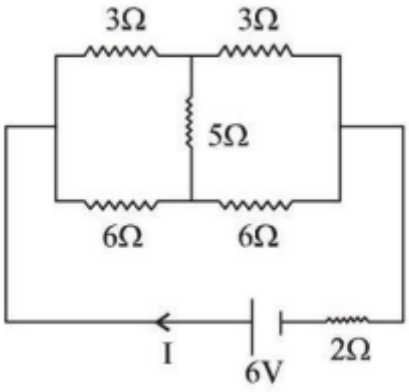
**48. A closed organ pipe (closed at one end) is excited to support the third overtone. It is found that air in the pipe has:**

(1) Three nodes and three antinodes
(2) Three nodes and four antinodes
(3) Four nodes and three antinodes
(4) Four nodes and four antinodes

**49. The electrostatic potential due to an electric dipole at a distance $r$ varies as:**

(1) $r$
(2) $\frac{1}{r^2}$
(3) $\frac{1}{r^3}$
(4) $\frac{1}{r}$

**50. A battery of 6 V is connected to the circuit as shown below. The current $I$ drawn from the battery is:**




**(1)** 1 A

**(2)** 2 A

**(3)** $\frac{6}{11}$ A

**(4)** $\frac{4}{3}$ A

## CHEMISTRY

**51. If the length of the body diagonal of a FCC unit cell is $x$ Å, the distance between two octahedral voids in the cell in Å is:**

**(1)** $\frac{x}{\sqrt{2}}$

**(2)** $\frac{x}{\sqrt{3}}$

**(3)** $\frac{x}{\sqrt{6}}$

**(4)** $\frac{x}{\sqrt{8}}$

**52. Ortho-sulphobenzimide is used as:**

**(1)** Antioxidant

(2) Artificial sweetener
(3) Food preservative
(4) Food supplement

**53. Volume of a gas at NTP is $1.12 \times 10^{-7}$ cm$^3$. The number of molecules in it is:**

(1) $3.01 \times 10^{12}$
(2) $3.01 \times 10^{24}$
(3) $3.01 \times 10^{23}$
(4) $3.01 \times 10^{20}$

**54. The wavelength of the radiation emitted, when a hydrogen atom electron falls from infinity to stationary state 1, would be: (Rydberg constant $R = 1.097 \times 10^7$ m$^{-1}$)**

(1) 406 nm
(2) 192 nm
(3) 91 nm
(4) $9.1 \times 10^{-8}$ nm

**55. In $NO_3^-$ ion, the number of bond pairs and lone pairs of electrons on the nitrogen atom are:**

(1) 2, 2
(2) 3, 1
(3) 1, 3
(4) 4, 0

**56. In which of the compounds does 'manganese' exhibit the highest oxidation number?**

(1) $MnO_2$

(2) $Mn_3O_4$

(3) $K_2MnO_4$

(4) $MnSO_4$

**57. Alkali metals are powerful reducing agents because:**

(1) They are metals

(2) They are monovalent

(3) Their ionic radii are large

(4) Their ionisation energies are low

**58. A balloon filled with an air sample occupies 3 L volume at 35°C. On lowering the temperature to $T$, the volume decreases to 2.5 L. The temperature $T$ is:** *[Assume P-constant]*

(1) 16°C

(2) −16°C

(3) 24°C

(4) −20°C

**59. Which one of the following is used as an eye lotion?**

(1) Milk of magnesia

(2) Silver sol

(3) Colloidal antimony

(4) Chromium salt sol

**60. Identify ortho and para directing groups from the following:**

$$-CHO, -NHCOCH_3, -OCH_3, -SO_3H.$$

(1) III, IV

(2) II, III

(3) II, IV

(4) I, IV

**61. Which one of the carbanions is the least stable?**

(1) $\overset{\ominus}{C}H_2 - NO_2$

(2) $\overset{\ominus}{C}H_2 - CHO$

(3) $\overset{\ominus}{C}H_2 - CH_3$

(4) $\overset{\ominus}{C}H_3$

**62. In $O_2^-$, $O_2$, and $O_2^{2-}$ molecular species, the total number of antibonding electrons respectively are:**

(1) 7, 6, 8

(2) 1, 0, 2

(3) 6, 6, 6

(4) 8, 6, 8

**63. People living at high altitudes often reported a problem of feeling weak and inability to think clearly. The reason for this is:**

(1) At high altitudes the partial pressure of oxygen is less than at the ground level.

(2) At high altitudes the partial pressure of oxygen is more than at the ground level.

(3) At high altitudes the partial pressure of oxygen is equal to that at the ground level.

(4) None of these

**64. Specific conductance of $0.1\,\text{M}\,HNO_3$ is $6.3 \times 10^{-2}\,\text{ohm}^{-1}\,\text{cm}^{-1}$. The molar conductance of the solution is:**

**(1)** $100\,\text{ohm}^{-1}\,\text{cm}^2\,\text{mol}^{-1}$

**(2)** $515\,\text{ohm}^{-1}\,\text{cm}^2\,\text{mol}^{-1}$

**(3)** $630\,\text{ohm}^{-1}\,\text{cm}^2\,\text{mol}^{-1}$

**(4)** $6300\,\text{ohm}^{-1}\,\text{cm}^2\,\text{mol}^{-1}$

**65. The rate constant for a first-order reaction whose half-life is 480 seconds is:**

**(1)** $2.88 \times 10^{-3}\,\text{s}^{-1}$

**(2)** $2.72 \times 10^{-3}\,\text{s}^{-1}$

**(3)** $1.44 \times 10^{-3}\,\text{s}^{-1}$

**(4)** $1.44\,\text{s}^{-1}$

**66. If the activation energy for the forward reaction is $150\,\text{kJ/mol}$ and that of the reverse reaction is $260\,\text{kJ/mol}$, what is the enthalpy change for the reaction?**

**(1)** $410\,\text{kJ/mol}$

**(2)** $-110\,\text{kJ/mol}$

**(3)** $110\,\text{kJ/mol}$

**(4)** $-410\,\text{kJ/mol}$

**67. For $As_2S_3$ sol, the most effective coagulating agent is:**

**(1)** $CaCO_3$

**(2)** NaCl

**(3)** $FeCl_3$

**(4)** $Clay$

**68. Element not showing variable oxidation state is:**

(1) Bromine
(2) Iodine
(3) Chlorine
(4) Fluorine

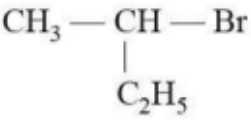
**69. Which of the following arrangements does not represent the correct order of the property stated against it?**

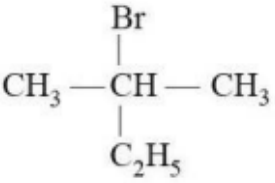
(1) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: Paramagnetic behaviour
(2) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: Ionic size
(3) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$: Stability in aqueous solution
(4) Sc < Ti < Cr < Mn: Number of oxidation states

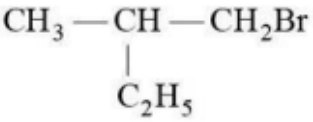
**70. The IUPAC name for the complex $[Co(ONO)(NH_3)_5]Cl_2$ is:**

(1) $Pentaammine-nitrito-O-cobalt(II)chloride$
(2) $Pentaammine-nitrito-O-cobalt(III)chloride$
(3) $Nitrito-N-pentaamminecobalt(III)chloride$
(4) $Nitrito-N-pentaamminecobalt(II)chloride$

**71. Which of the following compounds will give racemic mixture on nucleophilic substitution by $OH^-$ ion?**

(i) 

(ii) 

(iii) 

(1) $(i)$

(2) $(i), (ii), and (iii)$

(3) $(ii) and (iii)$

(4) $(i) and (iii)$

**72. Which one of the following is not correct for an ideal solution?**

(1) $It must obey Raoult's law.$

(2) $\Delta H = 0.$

(3) $\Delta H = \Delta V \neq 0.$

(4) $All are correct.$

**73. For the relation $\Delta_r G = -nFE_{cell}$, $E_{cell} = E^{\circ}_{cell}$, in which of the following conditions?**

(1) $Concentration of any one of the reacting species should be unity.$

(2) $Concentration of all the product species should be unity.$

(3) $Concentration of all the reactant and product species should be unity.$

(4) $Concentration of all reacting and product species should be unity.$

**74. Which one of the lanthanoids given below is the most stable in divalent form?**

**(1)** Ce (Atomic Number 58)

**(2)** Sm (Atomic Number 62)

**(3)** Eu (Atomic Number 63)

**(4)** Yb (Atomic Number 70)

**75. The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is:**

**(1)** $d^5$ (in strong ligand field)

**(2)** $d^3$ (in weak as well as strong fields)

**(3)** $d^4$ (in weak ligand fields)

**(4)** $d^4$ (in strong ligand fields)

**76. Chlorobenzene reacts with Mg in dry ether to give a compound (*A*) which further reacts with ethanol to yield:**

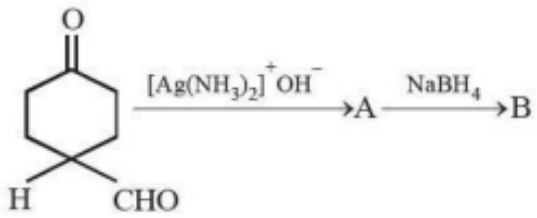
**(a)** Phenol

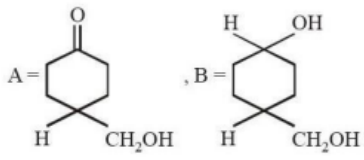
**(b)** Benzene

**(c)** Ethylbenzene

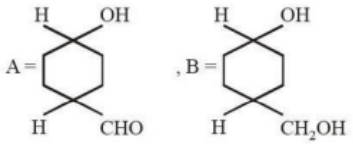
**(d)** Phenyl ether

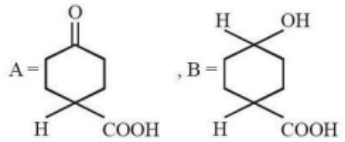
**77. The products formed in the following reaction, A and B, are:**

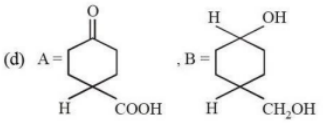



**(1)** 

**(2)**

(2) 


(3) 


(4) 


**78. Which of the following represents the correct order of acidity in the given compounds?**

(1) $FCH_2COOH > CH_3COOH > BrCH_2COOH > ClCH_2COOH$

(2) $BrCH_2COOH > ClCH_2COOH > FCH_2COOH > CH_3COOH$

(3) $FCH_2COOH > ClCH_2COOH > BrCH_2COOH > CH_3COOH$

(4) $CH_3COOH > BrCH_2COOH > ClCH_2COOH > FCH_2COOH$

**79. Ethyl alcohol can be prepared from Grignard reagent by the reaction of:**

(1) HCHO

(2) $R_2CO$

(3) RCN

(4) RCOCl

**80. Which of the following is most acidic?**

(1) Benzyl alcohol

(2) Cyclohexanol

(3) Phenol

(4) *m*-chlorophenol

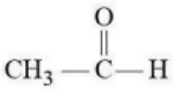
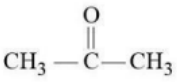
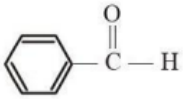
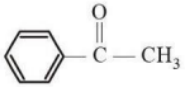
**81. Nitration of the compound is carried out. This compound gives red-orange precipitate with 2,4-DNP, undergoes Cannizzaro reaction but not aldol, then the possible product due to nitration is:**

(1) 3-nitroacetophenone
(2) (2-nitro)-2-phenylethanol
(3) (2-nitro)-1-phenylpropan-2-one
(4) 3-nitrobenzaldehyde

**82. Which of the following reactions will not give a primary amine?**

(1) $CH_3CONH_2 \xrightarrow{Br_2/KOH}$
(2) $CH_3CN \xrightarrow{LiAlH_4}$
(3) $CH_3NC \xrightarrow{LiAlH_4}$
(4) $CH_3CONH_2 \xrightarrow{LiAlH_4}$

**83. Which of the following compounds is most reactive towards nucleophilic addition reactions?**

(1) 
(2) 
(3) 
(4) 

**84. Molecules whose mirror image is non-superimposable over them are known as chiral. Which of the following molecules is chiral in nature?**

(1) 2-bromobutane
(2) 1-bromobutane
(3) 2-bromopropane
(4) 2-bromopropan-2-ol

**85. The most reactive amine towards dilute hydrochloric acid is:**

(1) $CH_3NH_2$
(2) $(CH_3)_2NH$
(3) $(CH_3)_3N$
(4) $C_6H_5NH_2$

**86. One of essential $\alpha$-amino acids is:**

(1) Lysine
(2) Serine
(3) Glycine
(4) Proline

**87. Which of the following statements is true about a peptide bond (RCONHR')?**

(1) It is non-planar.
(2) It is capable of forming a hydrogen bond.
(3) The cis configuration is favoured over the trans configuration.
(4) Single bond rotation is permitted between nitrogen and the carbonyl group.

**88. Which of the following is an example for chain-growth polymer?**

(1) Bakelite

(2) Teflon
(3) Nylon
(4) Terylene

**89. Which of the following polymers is formed due to the co-polymerization of $1,3$-butadiene and phenylethene?**

(1) Buna-N
(2) Neoprene
(3) Novolac
(4) Buna-S

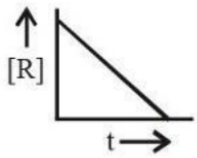
**90. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point?**

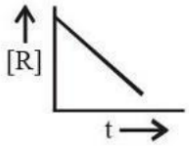
(1) $[Co(H_2O)_6]Cl_3$
(2) $[Co(H_2O)_5Cl]Cl_2 \cdot H_2O$
(3) $[Co(H_2O)_4Cl_2]Cl \cdot 2H_2O$
(4) $[Co(H_2O)_3Cl_3] \cdot 3H_2O$

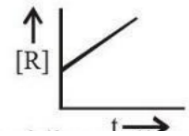
**91. Which of the following expressions correctly represents molar conductivity?**

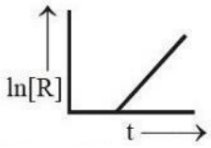
(1) $\Lambda_m = \frac{K}{C}$
(2) $\Lambda_m = \frac{KA}{l}$
(3) $\Lambda_m = KV$
(4) All of these

**92. The plot that represents the zero-order reaction is:**

(1) 


(2) 


(3) 


(4) 


**93. In acidic medium, which of the following does not change its colour?**

(1) $MnO_4^-$
(2) $MnO_4^{2-}$
(3) $CrO_4^{2-}$
(4) $FeO_4^{2-}$

**94. Which of the following is the life-saving mixture for an asthma patient?**

(1) Mixture of helium and oxygen
(2) Mixture of neon and oxygen
(3) Mixture of xenon and nitrogen
(4) Mixture of argon and oxygen

**95. The compounds $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$ constitute a pair of:**

(1) Coordination isomers

(2) Linkage isomers

(3) Ionization isomers

(4) Optical isomers

**96. Tincture of iodine is the common name for:**

(1) Iodoform

(2) 2-iodopropane

(3) 2-3% iodine solution in alcohol-water

(4) Iodobenzene

**97. The monomers of Buna-S rubber are:**

(1) Isoprene and butadiene

(2) Butadiene and phenol

(3) Styrene and butadiene

(4) Vinyl chloride and sulphur

**98. The number of nearest neighbours in a BCC unit cell is:**

(1) 12

(2) 8

(3) 6

(4) 4

**99. The cell potential for the following cell notation is approximately:**

$M(s)|M^{3+}(aq, 0.1M)||N^{2+}(aq, 0.1M)|N(s)$

$$E^{\circ}_{M^{3+}/M} = 0.6\,V, \quad E^{\circ}_{N^{2+}/N} = 0.1\,V.$$

(1) 0.51 V

(2) 1.5 V

(3) 2.0 V

(4) 2.5 V

**100. In Williamson synthesis, if tertiary alkyl halide is used, then:**

(1) Ether is obtained in good yield.

(2) Ether is obtained in poor yield.

(3) Alkene is the only reaction product.

(4) A mixture of alkene as a major product and ether as a minor product forms.

## MATHEMATICS

**101. If $A = \begin{bmatrix} 1 & 0 \\ 1/2 & 1 \end{bmatrix}$, then $A^{50}$ is:**

(1) $\begin{bmatrix} 1 & 0 \\ 0 & 50 \end{bmatrix}$

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

(3) $\begin{bmatrix} 1 & 25 \\ 0 & 1 \end{bmatrix}$

(4) None of these

**102. The range of the function $f(x) = \sin^{-1}(x - \sqrt{x})$ is equal to:**

(1) $\left[\sin^{-1}\left(\frac{1}{4}\right), \frac{\pi}{2}\right]$
(2) $\left[\sin^{-1}\left(\frac{1}{2}\right), \frac{\pi}{2}\right]$
(3) $\left[-\sin^{-1}\left(\frac{1}{4}\right), \frac{\pi}{2}\right]$
(4) $\left[-\sin^{-1}\left(\frac{1}{2}\right), \frac{\pi}{2}\right]$

**103. If $\mathbf{a} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$ and $\mathbf{b} = 2\mathbf{i} - 3\mathbf{j} - 5\mathbf{k}$, then:**

(1) $|\mathbf{a} - \mathbf{b}| > |\mathbf{a}| + |\mathbf{b}|$
(2) $|\mathbf{a} - \mathbf{b}| > |\mathbf{b}| - |\mathbf{a}|$
(3) $|\mathbf{a} + \mathbf{b}| < |\mathbf{a} - \mathbf{b}|$
(4) $|\mathbf{a}| - |\mathbf{b}| > |\mathbf{a} - \mathbf{b}|$

**104. If $\sqrt{\frac{y}{x}} + 4\sqrt{\frac{x}{y}} = 4$, then $\frac{dy}{dx}$:**

(1) $xy$
(2) $\frac{x}{y}$
(3) $-4$
(4) $4$

**105. The function $f(x) = \tan^{-1}(\sin x + \cos x)$ is an increasing function in:**

(1) $\left(0, \frac{\pi}{2}\right)$
(2) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$
(3) $\left(\frac{\pi}{4}, \frac{\pi}{2}\right)$
(4) $\left(-\frac{\pi}{2}, \frac{\pi}{4}\right)$

**106. If $f(x) = |x| - |1|$, then points where $f(x)$ is not differentiable, is/are:**

(1) $0, 1$

(2) $\pm 1, 0$

(3) 0

(4) 1 only

**107.** $\int_{\pi/11}^{9\pi/22} \frac{dx}{1+\sqrt{\tan x}}$ **is equal to:**

(1) $\frac{\pi}{4}$

(2) $\frac{\pi}{22}$

(3) $\frac{\pi}{11}$

(4) $\frac{7\pi}{44}$

**108.** **Let** $\vec{a} = \hat{i} + 2\hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$, **and** $\vec{c} = \hat{i} + \hat{j} - \hat{k}$. **A vector in the plane of** $\vec{a}$ **and** $\vec{b}$ **whose projection on** $\vec{c}$ **is** $\frac{1}{\sqrt{3}}$, **is:**

(1) $4\hat{i} - \hat{j} + 4\hat{k}$

(2) $3\hat{i} + \hat{j} - 3\hat{k}$

(3) $2\hat{i} + \hat{j} - 2\hat{k}$

(4) $4\hat{i} + \hat{j} - 4\hat{k}$

**109.** **Let** $p$ : **I am brave,** $q$ : **I will climb the Mount Everest. The symbolic form of a statement, 'I am neither brave nor I will climb the Mount Everest' is:**

(1) $p \wedge q$

(2) $\sim (p \wedge q)$

(3) $\sim p \wedge \sim q$

(4) $\sim p \wedge q$

**110.** **If** $x \neq 0$, **then**

$$\frac{\sin(\pi + x)\cos\left(\frac{\pi}{2} + x\right)\tan\left(\frac{3\pi}{2} - x\right)\cot(2\pi - x)}{\sin(2\pi - x)\cos(2\pi + x)\csc(-x)\sin\left(\frac{3\pi}{2} + x\right)} =$$

(1) 0

(2) $-1$

(3) 1

(4) 2

**111. Evaluate $i^2 + i^3 + \cdots + i^{4000}$:**

(1) 1

(2) 0

(3) $i$

(4) $-i$

**112. The number of all four-digit numbers which begin with 4 and end with either zero or five is**

(1) 200

(2) 64

(3) 256

(4) 32

**113. The number of ways of distributing 500 dissimilar boxes equally among 50 persons is**

(1) $\frac{500!}{(10!)^{50} \cdot 50!}$

(2) $\frac{500!}{(50!)^{10} \cdot 10!}$

(3) $\frac{500!}{(50!)^{10}}$

(4) $\frac{500!}{(10!)^{50}}$

**114. Given, the function $f(x) = \frac{a^x + a^{-x}}{2}$ $(a > 2)$, then $f(x+y) + f(x-y)$ is equal to**

(1) $f(x)-f(y)$

(2) $f(y)$

(3) $2f(x)f(y)$

(4) $f(x)f(y)$

**115. The point on the line $4x-y-2=0$ which is equidistant from the points $(-5,6)$ and $(3,2)$ is**

(1) $(2,6)$

(2) $(4,14)$

(3) $(1,2)$

(4) $(3,10)$

**116. The equation of a circle with center $(5,4)$ and touching the $Y$-axis is:**

(1) $x^2+y^2-10x-8y-16=0$

(2) $x^2+y^2-10x-8y-16=0$

(3) $x^2+y^2+10x+8y+16=0$

(4) $x^2+y^2-10x-8y+16=0$

**117. Evaluate the following limit:**

$$\lim_{\theta\to-\frac{\pi}{4}}\frac{\cos\theta+\sin\theta}{\theta+\frac{\pi}{4}}.$$

(1) 0

(2) 1

(3) $\sqrt{2}$

(4) $\frac{1}{\sqrt{2}}$

**118. Marks of 5 students of a group are $8,12,13,15,22$. Find the variance.**

(1) 22.1

(2) 23.0

(3) 20.2

(4) 21.2

**119. If two numbers $p$ and $q$ are chosen randomly from the set $\{1, 2, 3, 4\}$ with replacement, what is the probability that $p^2 \geq 4q$?**

(1) $\frac{1}{4}$

(2) $\frac{3}{16}$

(3) $\frac{1}{2}$

(4) $\frac{7}{16}$

**120. Let $F(\alpha) = \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$, where $\alpha \in \mathbb{R}$. Then $[F(\alpha)]^{-1}$ is equal to:**

(1) $F(-\alpha)$

(2) $[F(\alpha)]^{-1}$

(3) $F(2\alpha)$

(4) None of these

**123. If one of the lines given by $6x^2 - xy + 4cy^2 = 0$ is $3x + 4y = 0$, then $c$ equals**

(1) $-3$

(2) 1

(3) 3

(4) $-1$

**124. If $x = a(\cos\theta + \theta\sin\theta)$, $y = a(\sin\theta - \theta\cos\theta)$, then $\frac{d^2y}{dx^2}$ equals**

(1) $\frac{\sec^3\theta}{a\theta}$

(2) $\frac{\sec^2\theta}{a}$

(3) $a\theta\cos^3\theta$

(4) $\frac{\sec^2\theta}{a\theta}$

**125. The absolute maximum value of the function $f(x)=2x^3-3x^2-36x+9$ defined on $[-3,3]$ is**

(1) 36

(2) 53

(3) 63

(4) 72

**126. Define $f(x)=\begin{cases}x^2+bx+c, & x<1\\ x, & x\geq 1\end{cases}$. If $f(x)$ is differentiable at $x=1$, then $b-c$ is equal to**

(1) $-2$

(2) 0

(3) 1

(4) 2

**127. The Boolean expression $(\sim(p\wedge q))\vee q$ is equivalent to:**

(1) $q\rightarrow(p\wedge q)$

(2) $p\rightarrow q$

(3) $p\sim(p\rightarrow q)$

(4) $p\rightarrow(p\vee q)$

**128. If $x=\frac{1-t^2}{1+t^2}$ and $y=\frac{2t}{1+t^2}$, then $\frac{dy}{dx}$ is equal to:**

(1) $-\frac{y}{x}$
(2) $\frac{y}{x}$
(3) $-\frac{x}{y}$
(4) $\frac{x}{y}$

**129. The tangent at the point $(x_1, y_1)$ on the curve $y = x^3 + 3x^2 + 5$ passes through the origin. Then $(x_1, y_1)$ does NOT lie on the curve:**

(1) $x^2 + \frac{y^2}{81} = 2$
(2) $\frac{y^2}{9} - x^2 = 8$
(3) $y = 4x^2 + 5$
(4) $\frac{x}{3} - y^2 = 2$

**130. The value of $\int \frac{x \sin^{-1} x}{\sqrt{1-x^2}} dx$ is equal to:**

(1) $\sqrt{(1-x^2)} \sin^{-1} x + C$
(2) $x \sin^{-1} x + C$
(3) $x - \sqrt{(1-x^2)} \sin^{-1} x + C$
(4) $\sqrt{(\sin^{-1} x)} + C$

**131. The value of $\int \frac{x+1}{x(1+xe^x)} dx$ is equal to:**

(1) $\log \left| \frac{1+xe^x}{xe^x} \right| + C$ (2)
(3) $\log \left| \frac{xe^x}{1+xe^x} \right| + C$
(4) $\log |xe^x(1 + xe^x)| + C$
(5) $\log |1 + xe^x| + C$

**132. The order and degree of the differential equation $\sqrt{\frac{dy}{dx}} - 4\frac{dy}{dx} - 7x = 0$ are respectively**

(1) 1 and $\frac{1}{2}$

(2) 2 and 1

(3) $-1$ and 1

(4) 1 and 2

**133. Let $\vec{a}=\hat{i}+\hat{j}+\hat{k}$, $\vec{b}=\hat{i}+3\hat{j}+5\hat{k}$ and $\vec{c}=7\hat{i}+9\hat{j}+11\hat{k}$. Then the area of a parallelogram having diagonals $\vec{a}+\vec{b}$ and $\vec{b}+\vec{c}$ is:**

(1) $4\sqrt{6}$ sq units

(2) $4\sqrt{6}$ sq units

(3) $\sqrt{6}$ sq units

(4) $6\sqrt{6}$ sq units

**134. If $X$ is a random variable such that $P(X=-2)=P(X=-1)=P(X=2)=P(X=1)=\frac{1}{6}$, and $P(X=0)=\frac{1}{3}$, then the mean of $X$ is**

(1) $\frac{5}{3}$

(2) 1

(3) 0

(4) $\frac{3}{5}$

**135. The integral $\int e^x \frac{2+\sin 2x}{1+\cos 2x}\,dx$ is equal to**

(1) $e^x \sec x + C$

(2) $e^x \tan x + C$

(3) $e^x \cot x + C$

(4) $e^x \csc x + C$

**136. The solution of the differential equation $y^2dx+(x^2-xy+y^2)dy=0$ is**

(1) $\tan^{-1}\left(\frac{x}{y}\right)+\ln y+C=0$

(2) $2\tan^{-1}\left(\frac{x}{y}\right)+\ln x+C=0$

(3) $\ln(v+\sqrt{x^2+y^2})+\ln y+C=0$

(4) $\ln(x+\sqrt{x^2+y^2})+C=0$

**137. The line whose vector equations are $\vec{r}_1=2\hat{i}-3\hat{j}+7\hat{k}+\lambda(2\hat{i}+p\hat{j}+5\hat{k})$ and $\vec{r}_2=\hat{i}+2\hat{j}+3\hat{k}+\mu(3\hat{i}-p\hat{j}+p\hat{k})$ are perpendicular for all values of $\lambda$ and $\mu$. The value of $p$ is:**

(1) $-1$

(2) 2

(3) 5

(4) 6

**138. Evaluate $\sin\left(\tan^{-1}\frac{4}{5}+\tan^{-1}\frac{4}{3}+\tan^{-1}\frac{1}{9}-\tan^{-1}\frac{1}{7}\right)$:**

(1) $\frac{1}{2}$

(2) $\frac{1}{\sqrt{2}}$

(3) $\frac{\sqrt{3}}{2}$

(4) 1

**139. Let $f(x)=\frac{2-\sqrt{x+4}}{\sin 2x}$, $x\neq 0$. In order that $f(x)$ is continuous at $x=0$, $f(0)$ is to be defined as:**

(1) $-\frac{1}{8}$

(2) $\frac{1}{2}$

(3) 1

(4) $\frac{1}{8}$

**140. Evaluate $\int_0^{\pi/4}\frac{\cos^2 x}{\cos^2 x+4\sin^2 x}\,dx$:**

(1) $\frac{\pi}{4} + \frac{2}{3}\tan^{-1} 2$

(2) $-\frac{\pi}{3} + \frac{2}{3}\tan^{-1} 3$

(3) $-\frac{\pi}{12} + \frac{2}{3}\tan^{-1} 2$

(4) $\frac{\pi}{6} - \frac{2}{3}\tan^{-1} 4$

**141. The area of the region described by $\{(x, y) \mid x^2 + y^2 \leq 1$ and $y^2 \leq 1 - x\}$ is:**

(1) $\frac{\pi}{2} - \frac{2}{3}$

(2) $\frac{\pi}{2} + \frac{2}{3}$

(3) $\frac{\pi}{2} + \frac{4}{3}$

(4) $\frac{\pi}{2} - \frac{4}{3}$

**142. Two players A and B are alternately throwing a coin and a die together. A player who first throws a head and a 6 wins the game. If A starts the game, then the probability that B wins the game is:**

(1) $\frac{12}{23}$

(2) $\frac{11}{23}$

(3) $\frac{5}{119}$

(4) $\frac{12}{119}$

**143. Let the following system of equations:**

$$kx + y + z = 1, \quad x + ky + z = k, \quad x + y + kz = k^2$$

**have no solution. Find $|k|$:**

(1) 0

(2) 1

(3) 2

(4) 3

**144. If $f(x)$ is differentiable at $x = 1$ and**

$$\lim_{h \to 0} \frac{1}{h} f(1+h) = 5,$$

**then $f'(1)$ is equal to:**

**(1)** 6

**(2)** 5

**(3)** 4

**(4)** 3

**145. The area of the region $\{(x, y) : 0 \le y \le x^2 + 1, 0 \le y \le x + 1, 0 \le x \le 2\}$ is:**

**(1)** $\frac{23}{6}$

**(2)** $2\sqrt{2} + 5$

**(3)** $\frac{9}{2}$

**(4)** None of these

**146. The solution of the differential equation $\sqrt{1-y^2}\,dx + x\,dy - \sin^{-1} y\,dy = 0$ is:**

**(1)** $x = \sin^{-1} y - 1 + ce^{-\sin^{-1} y}$

**(2)** $y = x\sqrt{1-y^2} + \sin^{-1} y + c$

**(3)** $x = 1 + \sin^{-1} y + ce^{\sin^{-1} y}$

**(4)** $y = \sin^{-1} y - 1 + x\sqrt{1-y^2} + c$

**147. Let $X$ be the discrete random variable representing the number $(x)$ appeared on the face of a biased die when it is rolled. The probability distribution of $X$ is as follows:**

$$X = x : \quad 1, 2, 3, 4, 5, 6$$

$$P(X = x): \quad 0.1, 0.15, 0.3, 0.25, k, k$$

The variance of $X$ is:

**(1)**

1.64

1.93

2.16

2.28

**148. If the vector equation of the line**

$$\frac{x-2}{2} = \frac{2y-5}{-3} = z+1,$$

**is given by:**

$$\vec{r} = \left(2\hat{i} + \frac{5}{2}\hat{j} - \hat{k}\right) + \lambda\left(2\hat{i} - \frac{3}{2}\hat{j} + p\hat{k}\right),$$

**then $p$ is equal to:**

**(1)** 0

**(2)** 1

**(3)** 2

**(4)** 3

**149. Which of the following is correct?**

**(1)** $B'AB$ is symmetric if $A$ is symmetric.

**(2)** $B'AB$ is skew-symmetric if $A$ is symmetric.

**(3)** $B'AB$ is symmetric if $A$ is skew-symmetric.

**(4)** $B'AB$ is skew-symmetric if $A$ is skew-symmetric.

**150. A spherical iron ball $10\,\text{cm}$ in radius is coated with a layer of ice of uniform thickness that melts at a rate of $50\,\text{cm}^3/\text{min}$. When the thickness of ice is $15\,\text{cm}$, then the rate at which the thickness of ice decreases is:**

(1) $\frac{5}{6\pi}$ cm/min
(2) $\frac{1}{54\pi}$ cm/min
(3) $\frac{1}{18\pi}$ cm/min
(4) $\frac{1}{36\pi}$ cm/min