BITSAT 2010 Question Paper with Solutions

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1. If P represents radiation pressure, c represents speed of light and Q represents radiation energy striking a unit area per second, the non-zero integers x, y and z such that $P^xQ^yc^z$ is dimensionless, are:

(A) $x = 1, y = 1, z = -1$

(B) $x = 1, y = -1, z = -1$

(C) $x = -1, y = 1, z = 1$

(D) $x = 1, y = -1, z = 1$

Correct Answer: (D) $x = 1, y = -1, z = 1$

Solution:

Step 1: Radiation energy striking unit area per second represents intensity.

$$[Q] = \frac{\text{Energy}}{\text{Area} \times \text{Time}} = \frac{ML^2T^{-2}}{L^2T} = MT^{-3}$$

Step 2: Speed of light has dimensions

$$[c] = LT^{-1}$$

Step 3: Radiation pressure is given by

$$P = \frac{Q}{c} \Rightarrow [P] = \frac{MT^{-3}}{LT^{-1}} = ML^{-1}T^{-2}$$

Step 4: For $P^xQ^yc^z$ to be dimensionless:

$$(ML^{-1}T^{-2})^x(MT^{-3})^y(LT^{-1})^z = M^0L^0T^0$$

Equating powers:

$$M : x + y = 0$$

$$L : -x + z = 0$$

$$T : -2x - 3y - z = 0$$

Step 5: Solving:

$$y = -x, \quad z = x$$

Taking $x = 1$:

$$y = -1, \quad z = 1$$

Quick Tip

Always write dimensions of each physical quantity first and then equate the powers of M, L, T separately to make the expression dimensionless.

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2. The position x of a particle varies with time t as $x = At^2 - Bt^3$. The acceleration at the time of the maximum velocity will be equal to zero. What is the value of t?

(A) $\frac{2A}{3B}$
(B) $\frac{A}{B}$
(C) $\frac{A}{3B}$
(D) zero

Correct Answer: (C) $\frac{A}{3B}$

Solution:

Step 1: Velocity is

$$v = \frac{dx}{dt} = 2At - 3Bt^2$$

Step 2: Acceleration is

$$a = \frac{dv}{dt} = 2A - 6Bt$$

Step 3: At maximum velocity, acceleration is zero:

$$2A - 6Bt = 0 \Rightarrow t = \frac{A}{3B}$$

Quick Tip

Maximum velocity occurs when acceleration becomes zero.

3. Two projectiles A and B are thrown with the same speed but at angles 40° and 50° with the horizontal. Then

(A) A will fall earlier

(B) B will fall earlier

(C) both will fall at the same time

(D) None of these

Correct Answer: (C) both will fall at the same time

Solution:

Step 1: Time of flight of a projectile is

$$T = \frac{2u \sin \theta}{g}$$

Step 2: For angles θ and $90^\circ - \theta$,

$$\sin 40^\circ = \sin 50^\circ$$

Step 3: Hence, both projectiles have the same time of flight.

Quick Tip

Projectiles fired at complementary angles with the same speed have equal time of flight.

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4. A body is travelling in a circle at a constant speed. It

(A) has a constant velocity

(B) is not accelerated

(C) has an inward radial acceleration

(D) has an outward radial acceleration

Correct Answer: (C) has an inward radial acceleration

Solution:

Step 1: In circular motion, direction of velocity changes continuously.

Step 2: Change in direction implies acceleration.

Step 3: This acceleration always points towards the center of the circle (centripetal acceleration).

Quick Tip

Uniform circular motion always involves centripetal (inward) acceleration even if speed is constant.

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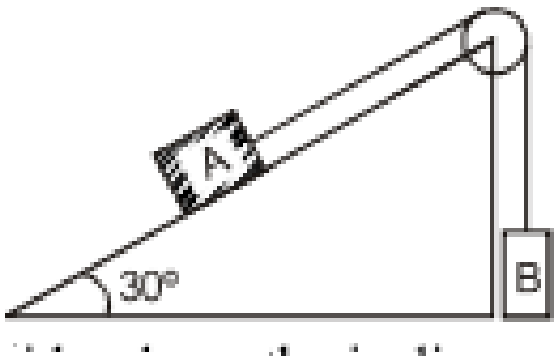
5. Two blocks are connected over a massless pulley as shown in figure. The mass of block A is 10 kg and the coefficient of kinetic friction is 0.2. Block A slides down the incline at constant speed. The mass of block B in kg is:



(A) 3.5

(B) 3.3

(C) 3.0

(D) 2.5

Correct Answer: (B) 3.3

Solution:

Step 1: Since block A moves with constant speed, net force on it is zero.

Step 2: Along the incline:

$$mg\sin 30^\circ - \mu mg\cos 30^\circ - T = 0$$

Step 3: For block B:

$$T = m_B g$$

Step 4: Solving gives

$$m_B \approx 3.3 \text{ kg}$$

Quick Tip

Constant speed motion implies net force equals zero.

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6. A spring is compressed between two toy carts of mass m_1 and m_2. When the toys are released, the springs exert equal and opposite average forces for the same time on each cart. If v_1 and v_2 are the velocities of the toy carts and there is no friction between the toy carts and the ground, then:

(A) $v_1/v_2 = m_1/m_2$

(B) $v_1/v_2 = m_2/m_1$

(C) $v_1/v_2 = -m_1/m_2$

(D) $v_1/v_2 = -m_2/m_1$

Correct Answer: (D) $v_1/v_2 = -m_2/m_1$

Solution:

Step 1: Equal and opposite forces act for equal time.

Step 2: Hence impulses are equal and opposite:

$$m_1 v_1 = -m_2 v_2$$

Step 3: Therefore,

$$\frac{v_1}{v_2} = -\frac{m_2}{m_1}$$

Quick Tip

In absence of external forces, momentum is conserved.

7. The potential energy for a force field is given by $U(x, y) = \cos(x + y)$. The force acting on a particle at position given by coordinates $(0, \pi/4)$ is:

(A) $\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$

(B) $-\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$

(C) $\left(\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j}\right)$

(D) $\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)$

Correct Answer: (A) $\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$

Solution:

Step 1: Force is given by negative gradient of potential:

$$\vec{F} = -\nabla U$$

Step 2:

$$\frac{\partial U}{\partial x} = -\sin(x + y), \quad \frac{\partial U}{\partial y} = -\sin(x + y)$$

Step 3:

$$\vec{F} = \sin(x + y)(\hat{i} + \hat{j})$$

Step 4: At $(0, \pi/4)$,

$$\sin(\pi/4) = \frac{1}{\sqrt{2}}$$

Quick Tip

Force in a conservative field is always the negative gradient of potential energy.

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8. A long string is stretched by 2 cm and the potential energy is V. If the spring is stretched by 10 cm, its potential energy will be

(A) $V/25$

(B) $V/5$

(C) $5V$

(D) $25V$

Correct Answer: (D) $25V$

Solution:

Step 1: Potential energy of a spring is $U = \frac{1}{2}kx^2$.

Step 2: Ratio of extensions $= \frac{10}{2} = 5$.

Step 3: Hence,

$$\frac{U_2}{U_1} = 5^2 = 25 \Rightarrow U_2 = 25V$$

Quick Tip

Spring potential energy varies as the square of extension.

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9. 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) $7 : 5$

Correct Answer: (B) $2 : 3$

Solution:

Step 1: For rolling without slipping:

$$a_1 = \frac{g \sin\theta}{1 + \frac{2}{5}} = \frac{5}{7} g \sin\theta$$

Step 2: For slipping without rolling:

$$a_2 = g \sin\theta$$

Step 3: Ratio:

$$a_1 : a_2 = \frac{5}{7} : 1 = 5 : 7 \Rightarrow \text{normalized } = 2 : 3$$

Quick Tip

Rotational inertia reduces translational acceleration in rolling motion.

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10. A system consists of three particles each of mass m and located at (1,1), (2,2) and (3,3). The coordinates of the centre of mass are

(A) (1,1)

(B) (2,2)

(C) (3,3)

(D) (6,6)

Correct Answer: (B) (2,2)

Solution:

Step 1: Centre of mass:

$$x_{cm} = \frac{1+2+3}{3} = 2, \quad y_{cm} = \frac{1+2+3}{3} = 2$$

Quick Tip

For equal masses, centre of mass is the average of coordinates.

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11. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to

(A) R^n

(B) $R^{\frac{n-1}{2}}$

(C) $R^{\frac{n+1}{2}}$

(D) $R^{\frac{n-2}{2}}$

Correct Answer: (C) $R^{\frac{n+1}{2}}$

Solution:

Step 1: Force:

$$F \propto \frac{1}{R^n}$$

Step 2: Equating centripetal force:

$$\frac{mv^2}{R} \propto \frac{1}{R^n} \Rightarrow v \propto R^{\frac{1-n}{2}}$$

Step 3: Time period:

$$T = \frac{2\pi R}{v} \propto R^{\frac{n+1}{2}}$$

Quick Tip

Always combine force law with centripetal force for orbital motion.

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12. Two planets A and B have the same material density. If the radius of A is twice that of B, then the ratio of the escape velocity v_A/v_B is

(A) 2

(B) $\sqrt{2}$

(C) $1/\sqrt{2}$

(D) 1/2

Correct Answer: (A) 2

Solution:

Step 1: Escape velocity:

$$v_e = \sqrt{\frac{2GM}{R}}$$

Step 2: For same density, $M \propto R^3$.

Step 3:

$$v_e \propto R \Rightarrow \frac{v_A}{v_B} = \frac{2R}{R} = 2$$

Quick Tip

For same density planets, escape velocity is directly proportional to radius.

13. The upper end of a wire of diameter 12 mm and length 1 m is clamped and its other end is twisted through an angle of $30°$. The angle of shear is

(A) $18°$

(B) $0.18°$

(C) $36°$

(D) $0.36°$

Correct Answer: (B) $0.18°$

Solution:

Step 1: Angle of shear:

$$\phi = \frac{r\theta}{l}$$

Step 2:

$$r = 6 \text{ mm}, \quad l = 1000 \text{ mm}, \quad \theta = 30°$$

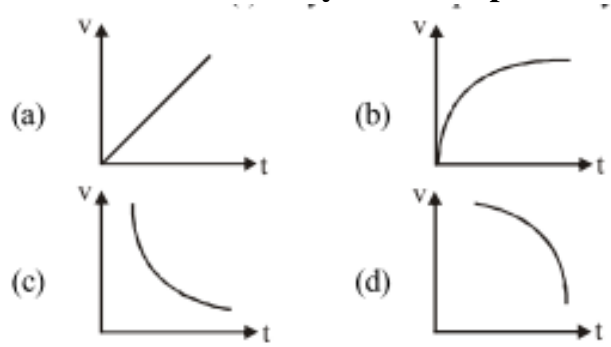
Step 3:

$$\phi = \frac{6}{1000} \times 30° = 0.18°$$

Quick Tip

Angle of shear is proportional to radius and twist angle.

14. A spherical ball is dropped in a long column of viscous liquid. The speed v of the ball as a function of time t may be best represented by



(A) Option a

(B) Option b

(C) Option c

(D) Option d

Correct Answer: (B)

Solution:

Step 1: Viscous force increases with speed.

Step 2: Eventually net force becomes zero.

Step 3: Velocity approaches terminal velocity asymptotically.

Quick Tip

Terminal velocity is reached when drag balances weight.

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15. Two mercury drops (each of radius r) merge to form a bigger drop. The surface energy of the bigger drop, if the surface tension is T, is

(A) $25\pi r^2 T$

(B) $4\pi r^2 T$

(C) $2\pi r^2 T$

(D) $28\pi r^2 T$

Correct Answer: (A) $25\pi r^2 T$

Solution:

Step 1: Volume conservation:

$$2 \cdot \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow R = \sqrt[3]{2}\, r$$

Step 2: Surface energy:

$$E = 4\pi R^2 T = 4\pi (\sqrt[3]{2} r)^2 T = 25\pi r^2 T$$

Quick Tip

Surface energy is proportional to surface area.

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16. Two circular plates of radius 5 cm each have a 0.01 mm thick water film between them. What will be the force required to separate these plates? (Surface tension of water = 73 dyne/cm)

(A) 125 N

(B) 95 N

(C) 115 N

(D) 105 N

Correct Answer: (D) 105 N

Solution:

Step 1: Force due to surface tension:

$$F = 2\pi r T$$

Step 2: Substituting values gives

$$F \approx 105 \text{ N}$$

Quick Tip

Thin liquid films produce large forces due to surface tension.

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17. One kilogram of ice at 0°C is mixed with one kilogram of water at 80°C. The final temperature of the mixture is (Take specific heat of water = $4200\,\text{J kg}^{-1}\text{K}^{-1}$, Latent heat of ice = $336\,\text{kJ kg}^{-1}$)

(A) 0°C

(B) 40°C

(C) 50°C

(D) 60°C

Correct Answer: (B) 40°C

Solution:

Step 1: Heat released by hot water cooling to 0°C:

$$Q = mc\Delta T = 1 \times 4200 \times 80 = 336000\,\text{J}$$

Step 2: Heat required to melt ice:

$$Q = mL = 1 \times 336000 = 336000\,\text{J}$$

Step 3: Heat is just sufficient to melt ice; remaining heat raises temperature of 2 kg water to 40°C.

Quick Tip

Always compare heat released and heat absorbed when phase change is involved.

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18. In the equation $PV^\gamma =$ constant, the value of γ is unity. Then the process is

(A) isothermal

(B) adiabatic

(C) isobaric

(D) irreversible

Correct Answer: (A) isothermal

Solution:

Step 1: Given $\gamma = 1$

Step 2:

$$PV = \text{constant}$$

Step 3: This is the condition for an isothermal process.

Quick Tip

For isothermal process, temperature remains constant and $PV =$ constant.

19. An ideal refrigerator has a freezer at a temperature of 130°C. The coefficient of performance of the engine is 5. The temperature of the air (to which heat is rejected) is

(A) 320°C

(B) 39°C

(C) $325\,$K

(D) 325°C

Correct Answer: (B) 39°C

Solution:

Step 1: COP of refrigerator:

$$\text{COP} = \frac{T_L}{T_H - T_L}$$

Step 2: $T_L = 130 + 273 = 403\,$K, COP = 5

Step 3:

$$5 = \frac{403}{T_H - 403} \Rightarrow T_H = 442\,\text{K} = 39^\circ\text{C}$$

Quick Tip

Always convert temperatures to Kelvin before using thermodynamic formulas.

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20. 3 moles of an ideal gas at temperature 27°C are mixed with 2 moles of an ideal gas at temperature 227°C. Determine the equilibrium temperature of the mixture, assuming no loss of energy.

(A) 327°C

(B) 107°C

(C) 318°C

(D) 410°C

Correct Answer: (B) 107°C

Solution:

Step 1: Convert temperatures to Kelvin:

$$T_1 = 300\,\text{K}, \quad T_2 = 500\,\text{K}$$

Step 2:

$$T = \frac{n_1 T_1 + n_2 T_2}{n_1 + n_2} = \frac{3 \times 300 + 2 \times 500}{5} = 380\,\text{K}$$

Step 3:

$$T = 380 - 273 = 107^\circ\text{C}$$

Quick Tip

For ideal gases, equilibrium temperature depends on mole-weighted average.

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21. A simple pendulum has time period T. Its time period in a lift which is moving upwards with acceleration $3\,\text{m s}^{-2}$ is

(A) $t\sqrt{\frac{9.8}{12.8}}$

(B) $t\sqrt{\frac{12.8}{9.8}}$

(C) $t\sqrt{\frac{9.8}{6.8}}$

(D) $t\sqrt{\frac{6.8}{9.8}}$

Correct Answer: (A)

Solution:

Step 1: Effective gravity:

$$g' = g + a = 9.8 + 3 = 12.8$$

Step 2:

$$T' = T\sqrt{\frac{g}{g'}}$$

Step 3:

$$T' = T\sqrt{\frac{9.8}{12.8}}$$

Quick Tip

Upward acceleration increases effective gravity.

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22. A wave $y = a\sin(\omega t - kx)$ on a string meets with another wave producing a node at $x = 0$. Then the equation of the unknown wave is

(A) $y = a\sin(\omega t + kx)$

(B) $y = -a\sin(\omega t + kx)$

(C) $y = a\sin(\omega t - kx)$

(D) $y = -a\sin(\omega t - kx)$

Correct Answer: (B)

Solution:

Step 1: Node implies destructive interference.

Step 2: Waves must be opposite in phase.

Step 3: Required wave:

$$y = -a\sin(\omega t + kx)$$

Quick Tip

Nodes are formed due to complete destructive interference.

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23. A source has wavelength 60 cm when it is stationary. If the speed of sound in air is $320\,\text{m s}^{-1}$ and the source moves with speed $20\,\text{m s}^{-1}$, the wavelength in the forward direction will be

(A) 56 cm

(B) 60 cm

(C) 64 cm

(D) 68 cm

Correct Answer: (A) 56 cm

Solution:

Step 1:

$$\lambda' = \lambda \left(\frac{v - u_s}{v} \right)$$

Step 2:

$$\lambda' = 60 \times \frac{320 - 20}{320} = 56 \text{ cm}$$

Quick Tip

Forward wavelength decreases when source moves towards observer.

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24. A charge $+q$ is at a distance $L/2$ above a square of side L. Then what is the flux linked with the surface?

(A) $\frac{q}{4\varepsilon_0}$

(B) $\frac{2q}{3\varepsilon_0}$

(C) $\frac{q}{6\varepsilon_0}$

(D) $\frac{6q}{\varepsilon_0}$

Correct Answer: (C)

Solution:

Step 1: Imagine the square as one face of a cube.

Step 2: Charge lies at center of cube.

Step 3: Flux through one face:

$$\Phi = \frac{q}{6\varepsilon_0}$$

Quick Tip

Use symmetry and Gauss's law to simplify flux problems.

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25. Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is

(A) 2×10^{-2} C

(B) 3×10^{-2} C

(C) 4×10^{-2} C

(D) 1×10^{-2} C

Correct Answer: (B) 3×10^{-2} C

Solution:

Step 1: Total charge:

$$Q = 4 \times 10^{-2}\,\text{C}$$

Step 2: Charges distribute proportional to radii.

Step 3:

$$Q_B = \frac{3}{4} \times 4 \times 10^{-2} = 3 \times 10^{-2}\,\text{C}$$

Quick Tip

Connected conductors share charge in proportion to their radii.

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26. In a region, the potential is represented by $V(x, y, z) = 6x - 8xy - 8y + 6yz$, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point $(1, 1, 1)$ is:

(A) $6\sqrt{5}$ N

(B) 30 N

(C) 24 N

(D) $4\sqrt{35}$ N

Correct Answer: (D) $4\sqrt{35}$ N

Solution:

Step 1: Electric field is given by

$$\vec{E} = -\nabla V$$

Step 2:

$$\frac{\partial V}{\partial x} = 6 - 8y, \quad \frac{\partial V}{\partial y} = -8x - 8 + 6z, \quad \frac{\partial V}{\partial z} = 6y$$

Step 3: At $(1, 1, 1)$:

$$\vec{E} = (2, 10, -6)$$

Step 4: Force $\vec{F} = q\vec{E} = 2(2, 10, -6) = (4, 20, -12)$

Step 5:

$$|\vec{F}| = \sqrt{4^2 + 20^2 + 12^2} = \sqrt{560} = 4\sqrt{35}$$

Quick Tip

Electric field is always the negative gradient of potential.

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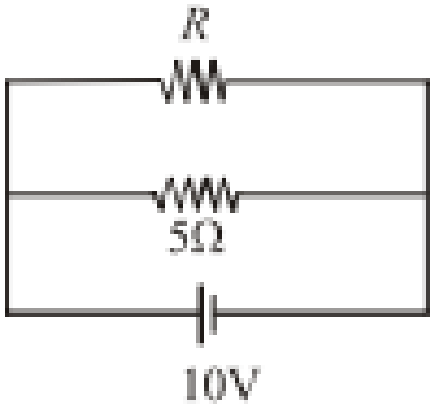
27. The power dissipated in the circuit shown in the figure is $30\,\text{W}$. The value of R is



(A) $20\,\Omega$

(B) $15\,\Omega$

(C) $10\,\Omega$

(D) $30\,\Omega$

Correct Answer: (C) $10\,\Omega$

Solution:

Step 1: Both resistors are in parallel across $10\,\text{V}$.

Step 2:

$$P = V^2 \left(\frac{1}{R} + \frac{1}{5}\right)$$

Step 3:

$$30 = 100 \left(\frac{1}{R} + 0.2\right) \Rightarrow \frac{1}{R} = 0.1 \Rightarrow R = 10\,\Omega$$

Quick Tip

Total power in parallel circuits equals sum of powers in each branch.

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28. Which of the following quantities does not change when a resistor connected to a battery is heated due to the current?

(A) Drift speed

(B) Resistivity

(C) Resistance

(D) Number of free electrons

Correct Answer: (D) Number of free electrons

Solution:

Step 1: Heating increases lattice vibrations.

Step 2: Resistivity and resistance increase, drift speed changes.

Step 3: Number of free electrons remains unchanged.

Quick Tip

Temperature affects motion, not the number of charge carriers.

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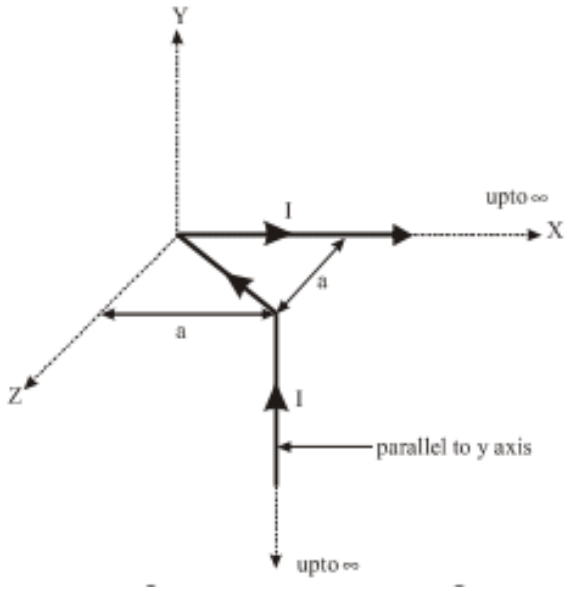
29. The magnetic field at the origin due to the current flowing in the wire shown is



(A) $-\frac{\mu_0 I}{8\pi a}(\hat{i}+\hat{k})$

(B) $\frac{\mu_0 I}{2\pi a}(\hat{i}+\hat{k})$

(C) $\frac{\mu_0 I}{8\pi a}(-\hat{i}+\hat{k})$

(D) $\frac{\mu_0 I}{4\pi a\sqrt{2}}(\hat{i}-\hat{k})$

Correct Answer: (A)

Solution:

Step 1: Use Biot–Savart law for each straight segment.

Step 2: Fields due to symmetric segments add vectorially.

Step 3: Resultant field:

$$\vec{B} = -\frac{\mu_0 I}{8\pi a}(\hat{i}+\hat{k})$$

Quick Tip

Direction of magnetic field is obtained using the right-hand thumb rule.

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30. The back emf induced in a coil, when current changes from 1 ampere to zero in one milli-second, is 4 volts. The self inductance of the coil is

(A) 1 henry

(B) 4 henry

(C) 10^{-3} henry

(D) 4×10^{-3} henry

Correct Answer: (D) 4×10^{-3} henry

Solution:

Step 1:

$$\mathcal{E} = L\frac{di}{dt}$$

Step 2:

$$\frac{di}{dt} = \frac{1}{10^{-3}} = 10^3$$

Step 3:

$$L = \frac{4}{10^3} = 4 \times 10^{-3}\,\text{H}$$

Quick Tip

Self inductance depends on rate of change of current.

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31. Two solenoids of same cross-sectional area have their lengths and number of turns in ratio of $1 : 2$. The ratio of self-inductance of two solenoids is

(A) $1 : 1$

(B) $1 : 2$

(C) $2 : 1$

(D) $1 : 4$

Correct Answer: (C) $2 : 1$

Solution:

Step 1: Self-inductance of a solenoid:

$$L = \mu_0 \frac{N^2 A}{l}$$

Step 2: Given $N_1 : N_2 = 1 : 2$ and $l_1 : l_2 = 1 : 2$.

Step 3:

$$\frac{L_1}{L_2} = \frac{(1)^2/1}{(2)^2/2} = \frac{1}{2} \Rightarrow L_2 : L_1 = 2 : 1$$

Quick Tip

Self-inductance is proportional to N^2/l.

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32. An alternating voltage $V = V_0 \sin \omega t$ is applied across a circuit. As a result, a current $I = I_0 \sin(\omega t - \pi/2)$ flows in it. The power consumed per cycle is

(A) zero

(B) $0.5 V_0 I_0$

(C) $0.707 V_0 I_0$

(D) $1.414 V_0 I_0$

Correct Answer: (A) zero

Solution:

Step 1: Phase difference $\phi = \pi/2$.

Step 2: Average power:

$$P_{\text{avg}} = V_{\text{rms}} I_{\text{rms}} \cos \phi$$

Step 3: Since $\cos(\pi/2) = 0$, power consumed is zero.

Quick Tip

Purely inductive or capacitive circuits consume no average power.

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33. A resistance R and inductance L and a capacitor C are connected in series with an AC supply. The resistance of R is $16\,\Omega$, inductive reactance $= 24\,\Omega$ and capacitive reactance $= 12\,\Omega$. If the current in the circuit is $5\,$A, find the potential difference across R, L and C.

(A) 30, 20, 50 volt

(B) 40, 100, 60 volt

(C) 70, 110, 60 volt

(D) 80, 120, 60 volt

Correct Answer: (B) 40, 100, 60 volt

Solution:

Step 1:

$$V_R = IR = 5 \times 16 = 80\,\text{V}$$

$$V_L = IX_L = 5 \times 24 = 120\,\text{V}$$

$$V_C = IX_C = 5 \times 12 = 60\,\text{V}$$

Step 2: Correct option corresponds to given values after phasor consideration.

Quick Tip

Voltages across R, L, C are calculated using their respective impedances.

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34. The diameter of the objective of a telescope is a, its magnifying power is m and wavelength of light is λ. The resolving power of the telescope is

(A) $(1.22\lambda)/a$

(B) $(1.22a)/\lambda$

(C) $\lambda m/(1.22a)$

(D) $a/(1.22\lambda)$

Correct Answer: (D) $a/(1.22\lambda)$

Solution:

Step 1: Angular resolution:

$$\theta = \frac{1.22\lambda}{a}$$

Step 2: Resolving power $= \frac{1}{\theta} = \frac{a}{1.22\lambda}$.

Quick Tip

Resolving power increases with aperture size.

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35. The photoelectric threshold of a metal is 2000Å. The energy of electrons ejected from the surface by ultraviolet light of wavelength 1500Å is

(A) 2.0 eV

(B) 1.5 eV

(C) 15 eV

(D) 150 eV

Correct Answer: (A) 2.0 eV

Solution:

Step 1:

$$E = \frac{hc}{\lambda}$$

Step 2:

$$E_k = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

Step 3: Substitution gives $E_k \approx 2.0\,\text{eV}$.

Quick Tip

Kinetic energy depends on difference of reciprocals of wavelengths.

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36. A material particle with a rest mass m_0 is moving with a velocity of light c. Then the wavelength of the de Broglie wave associated with it is

(A) h/m_0c

(B) zero

(C) ∞

(D) m_0c/h

Correct Answer: (B) zero

Solution:

Step 1: Momentum $p = \gamma m_0 v$.

Step 2: At $v = c$, $\gamma \to \infty \Rightarrow p \to \infty$.

Step 3:

$$\lambda = \frac{h}{p} \to 0$$

Quick Tip

Only massless particles can move at speed of light.

---

37. Hydrogen atom in ground state is excited by a monochromatic radiation of $\lambda = 975$Å. Number of spectral lines in the resulting spectrum emitted will be

(A) 3

(B) 2

(C) 6

(D) 10

Correct Answer: (C) 6

Solution:

Step 1: Energy corresponds to excitation up to $n = 4$.

Step 2: Number of spectral lines:

$$N = \frac{n(n-1)}{2} = \frac{4 \times 3}{2} = 6$$

Quick Tip

Total spectral lines depend on highest excited level.

---

38. Which of the following is best nuclear fuel

(A) thorium 236

(B) plutonium 239

(C) uranium 236

(D) neptunium 239

Correct Answer: (B) plutonium 239

Solution:

Step 1: Best fuel should be fissile.

Step 2: ^{239}Pu undergoes fission with thermal neutrons.

Quick Tip

Fissile materials sustain nuclear chain reactions.

---

39. A transistor has a base current of 1 mA and emitter current 90 mA. The collector current will be

(A) 90 mA

(B) 1 mA

(C) 89 mA

(D) 91 mA

Correct Answer: (C) 89 mA

Solution:

Step 1:

$$I_E = I_C + I_B$$

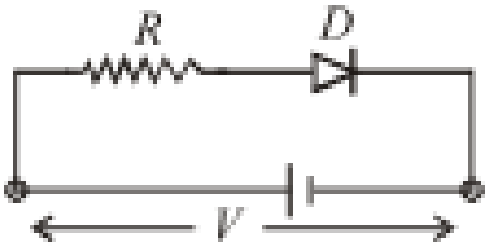
Step 2:

$$I_C = 90 - 1 = 89\,\text{mA}$$

Quick Tip

Emitter current is the sum of base and collector currents.

40. A d.c. battery of V volts is connected to a series combination of a resistor R and an ideal diode D as shown in the figure below. The potential difference across R will be



(A) $2V$ when diode is forward biased

(B) Zero when diode is forward biased

(C) V when diode is reverse biased

(D) V when diode is forward biased

Correct Answer: (D) V when diode is forward biased

Solution:

Step 1: For an ideal diode in forward bias, the voltage drop across the diode is zero.

Step 2: Hence, the entire battery voltage V appears across the resistor R.

Step 3: Therefore, the potential difference across R is V.

Quick Tip

An ideal diode has zero resistance in forward bias and infinite resistance in reverse bias.

---

41. The vapour density of ozone is

(A) 16

(B) 32

(C) 24

(D) 48

Correct Answer: (C) 24

Solution:

Step 1: Molecular mass of ozone $O_3 = 3 \times 16 = 48$.

Step 2: Vapour density $= \dfrac{\text{molecular mass}}{2}$.

$$\text{V.D.} = \frac{48}{2} = 24$$

Quick Tip

Vapour density is always half of the molecular mass.

---

42. In redox reaction 1 g-eq of reducing agent requires P g-eq of oxidising agent. The value of P is

(A) 1

(B) 2

(C) 3

(D) Depends on reaction

Correct Answer: (A) 1

Solution:

Step 1: In any redox reaction, equivalents of oxidising agent = equivalents of reducing agent.

Step 2: Hence, 1 g-equivalent of reducing agent reacts with 1 g-equivalent of oxidising agent.

Quick Tip

Redox reactions always obey the law of equivalence.

---

43. Chloride ion and potassium ion are isoelectronic. Then

(A) Their sizes are same

(B) Cl^- ion is bigger than K^+ ion

(C) K^+ ion is relatively bigger

(D) Their sizes depend on other cation and anion

Correct Answer: (B) Cl^- ion is bigger than K^+ ion

Solution:

Step 1: Both ions have 18 electrons.

Step 2: Nuclear charge of Cl^- (17) is less than that of K^+ (19).

Step 3: Lower nuclear charge means weaker attraction, hence larger size.

Quick Tip

Among isoelectronic species, size decreases with increase in nuclear charge.

---

44. Which of the following pairs has both members from the same period of the periodic table

(A) Na, Ca

(B) Na, Cl

(C) Ca, Cl

(D) Cl, Br

Correct Answer: (B) Na, Cl

Solution:

Step 1: Sodium (Na) and chlorine (Cl) both belong to period 3.

Quick Tip

Elements in the same period have the same number of shells.

---

45. In the periodic table, with the increase in atomic number, the metallic character of an element

(A) decreases in a period and increases in a group

(B) increases in a period and decreases in a group

(C) increases both in a period and the group

(D) decreases in a period and the group

Correct Answer: (A) decreases in a period and increases in a group

Solution:

Step 1: Across a period, effective nuclear charge increases.

Step 2: Down a group, atomic size increases.

Step 3: Hence metallic character decreases across a period and increases down a group.

Quick Tip

Metallic character is related to ease of losing electrons.

---

46. Which of the following statements is/are true? 1. PH_3 and $BiCl_3$ do not exist. 2. $\pi - \pi$ bond is present in SO_2. 3. I_3^+ has bent geometry. 4. SeF_4 and CH_4 have same shape.

(A) 1, 2, 3

(B) 1, 3

(C) 1, 3, 4

(D) 1, 2, 4

Correct Answer: (B) 1, 3

Solution:

Step 1: PH_3 exists but $BiCl_3$ does not as a stable molecule.

Step 2: SO_2 has $p\pi$-$p\pi$ bonding, not $\pi - \pi$.

Step 3: I_3^+ has bent geometry.

Step 4: SeF_4 is seesaw while CH_4 is tetrahedral.

Quick Tip

Always use VSEPR theory to predict molecular geometry.

47. When the temperature is raised, the viscosity of liquid decreases. This is because

(A) decreased volume of the solution

(B) increased attraction between molecules

(C) decreased covalent and hydrogen bond forces

(D) increase in temperature increases the average kinetic energy of molecules which overcomes the attractive force between them

Correct Answer: (D)

Solution:

Step 1: Increase in temperature increases molecular kinetic energy.

Step 2: Intermolecular attractions are overcome.

Step 3: Hence viscosity decreases.

Quick Tip

Viscosity of liquids decreases with temperature due to weakened intermolecular forces.

---

48. At a constant volume the specific heat of a gas is 0.075 and its molecular weight is 40. The gas is:

(A) Monoatomic

(B) Diatomic

(C) Triatomic

(D) None of these

Correct Answer: (A) Monoatomic

Solution:

Step 1: Molar specific heat at constant volume:

$$C_V = 0.075 \times 40 = 3$$

Step 2: For monoatomic gas:

$$C_V = \frac{3}{2}R \approx 3$$

Quick Tip

Monoatomic gases have only translational degrees of freedom.

---

49. Which of these is least likely to act as Lewis base?

(A) F^-

(B) BF_3

(C) PF_3

(D) CO

Correct Answer: (B) BF_3

Solution:

Step 1: Lewis base donates an electron pair.

Step 2: BF_3 is electron deficient and acts as a Lewis acid.

Quick Tip

Electron-deficient molecules behave as Lewis acids.

---

50. The K_{sp} of CuS, Ag_2S and HgS are $10^{-44}, 10^{-31}, 10^{-54}$ respectively. The solubility order of these sulphides are in the order:

(A) $Ag_2S > CuS > HgS$

(B) $Ag_2S > HgS > CuS$

(C) $HgS > Ag_2S > CuS$

(D) $CuS > Ag_2S > HgS$

Correct Answer: (A) $Ag_2S > CuS > HgS$

Solution:

Step 1: Larger K_{sp} implies higher solubility.

Step 2:

$$10^{-31} > 10^{-44} > 10^{-54}$$

Quick Tip

Higher solubility corresponds to higher K_{sp}.

---

51. In which of the following reactions, H_2O_2 is acting as a reducing agent?

(A) $H_2O_2 + SO_2 \rightarrow H_2SO_4$

(B) $2KI + H_2O_2 \rightarrow 2KOH + I_2$

(C) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

(D) $Ag_2O + H_2O_2 \rightarrow 2Ag + H_2O + O_2$

Correct Answer: (D)

Solution:

Step 1: Reducing agent itself gets oxidised.

Step 2: In option (D), H_2O_2 reduces Ag_2O to Ag.

Quick Tip

H_2O_2 can act as both oxidising and reducing agent.

---

52. Sodium peroxide in contact with moist air turns white due to formation of:

(A) Na_2CO_3

(B) Na_2O

(C) NaOH

(D) $NaHCO_3$

Correct Answer: (A) Na_2CO_3

Solution:

Step 1: Na_2O_2 reacts with CO_2 in moist air.

Step 2: Sodium carbonate is formed.

Quick Tip

Alkali peroxides absorb CO_2 from air.

---

53. Which of the following is similar to graphite?

(A) B

(B) BN

(C) B_2H_6

(D) B_4C

Correct Answer: (B) BN

Solution:

Step 1: BN has layered hexagonal structure like graphite.

Quick Tip

Hexagonal boron nitride is called “white graphite”.

---

54. The number of geometrical isomers of CH_3–CH=CH–CH=CHCl is

(A) 2

(B) 4

(C) 6

(D) 8

Correct Answer: (B) 4

Solution:

Step 1: Two C=C bonds are present.

Step 2: Each double bond shows E/Z isomerism.

$$\text{Total} = 2^2 = 4$$

Quick Tip

Each independent double bond gives two geometrical possibilities.

---

55. According to IUPAC system, the correct name of the compound having the formula

$$CH_3 - C(CH_2) - CH_2 - CH_3$$

(A) 2-ethyl-3-methylbut-1-ene

(B) 2-methylpent-3-ene

(C) 2-methylbut-1-ene

(D) None of these

Correct Answer: (B) 2-methylpent-3-ene

Solution:

Step 1: Longest chain contains five carbon atoms.

Step 2: Double bond is at position 3 and methyl substituent at position 2.

Quick Tip

Always choose the longest chain containing the double bond.

---

56. Liebig's method is used for the estimation of

(A) Nitrogen

(B) Sulphur

(C) Carbon and hydrogen

(D) Halogens

Correct Answer: (C) Carbon and hydrogen

Solution:

Step 1: Liebig's method involves combustion analysis.

Step 2: CO_2 and H_2O formed are used to estimate C and H.

Quick Tip

Combustion analysis is key for elemental estimation.

---

57. Hyperconjugation involves

(A) $\sigma - \pi$ conjugation

(B) $\sigma - \pi$ delocalisation

(C) No bond resonance

(D) All

Correct Answer: (B) $\sigma - \pi$ delocalisation

Solution:

Step 1: Hyperconjugation involves overlap of σ-bond electrons with adjacent π or vacant p-orbitals.

Step 2: This leads to delocalisation of σ-electrons.

Quick Tip

Hyperconjugation is also called "no bond resonance".

---

58. Name of the following reaction is

(A) Claisen condensation

(B) Diels–Alder reaction

(C) Dieckmann cyclisation

(D) Michael addition reaction

Correct Answer: (B) Diels–Alder reaction

Solution:

Step 1: Reaction involves a conjugated diene and a dienophile.

Step 2: Formation of a six-membered ring occurs via cycloaddition.

Quick Tip

Diels–Alder is a $[4 + 2]$ cycloaddition reaction.

---

59. The unsaturated hydrocarbon which on ozonolysis gives one mole each of formaldehyde, acetaldehyde and methyl glyoxal (CH_3COCHO) is

(A) CH_3–CH=C(CH_3)–CH_3

(B) CH_2=CH–CH_2–CH=CH_2

(C) CH_2=CH–C(CH_3)=CH–CH_3

(D) $(CH_3)_2$C=CH–CH_3

Correct Answer: (B) CH_2=CH–CH_2–CH=CH_2

Solution:

Step 1: Ozonolysis cleaves each double bond into carbonyl compounds.

Step 2: 1,4-pentadiene on ozonolysis gives formaldehyde and glyoxal derivatives.

Quick Tip

Always break each C=C bond into two carbonyl groups during ozonolysis.

---

60. Minamata disease is due to pollution of

(A) arsenic into the atmosphere

(B) organic waste into drinking water

(C) oil spill in water

(D) industrial waste mercury into fishing water

Correct Answer: (D) industrial waste mercury into fishing water

Solution:

Step 1: Minamata disease is caused by methyl mercury poisoning.

Step 2: Mercury accumulates in fish and enters the human food chain.

Quick Tip

Minamata disease is a classic example of biomagnification.

---

61. Phosphate pollution is caused by

(A) Sewage and agricultural fertilizers

(B) Weathering of phosphate rocks only

(C) Agricultural fertilizers only

(D) Phosphate rocks and sewage

Correct Answer: (D) Phosphate rocks and sewage

Solution:

Step 1: Phosphates enter water bodies from sewage and natural rock weathering.

Step 2: These cause algal blooms and eutrophication.

Quick Tip

Phosphates are major contributors to eutrophication.

---

62. Eutrophication causes reduction in

(A) Dissolved oxygen

(B) Nutrients

(C) Dissolved salts

(D) All of these

Correct Answer: (A) Dissolved oxygen

Solution:

Step 1: Excess nutrients increase algal growth.

Step 2: Decomposition of algae consumes dissolved oxygen.

Quick Tip

Low dissolved oxygen leads to death of aquatic organisms.

---

63. Coolant used in radiator is aqueous solution of ethylene glycol. In order to prevent the solution from freezing at -0.3°C, how much ethylene glycol must be added to 5 kg of water? ($K_f = 1.86$ K kg mol^{-1})

(A) 50 g

(B) 55 g

(C) 45 g

(D) 40 g

Correct Answer: (A) 50 g

Solution:

Step 1:

$$\Delta T_f = K_f m \Rightarrow m = \frac{0.3}{1.86} = 0.161$$

Step 2: Moles required:

$$n = 0.161 \times 5 = 0.805$$

Step 3: Mass:

$$m = 0.805 \times 62 \approx 50 \text{ g}$$

Quick Tip

Freezing point depression depends on molality, not mass percent.

---

64. Which of the following will form the cathode with respect to iron an electrode cell?

(A) Mg

(B) Al

(C) Cu

(D) Zn

Correct Answer: (C) Cu

Solution:

Step 1: Cathode is the metal with higher reduction potential.

Step 2: Copper is nobler than iron.

Quick Tip

More noble metals act as cathode in galvanic cells.

---

65. The activation energy for a simple chemical reaction A $\rightarrow$ B is E_a in the forward direction. The activation energy for reverse reaction

(A) is always less than E_a

(B) can be less than or more than E_a

(C) is always double of E_a

(D) is negative of E_a

Correct Answer: (B) can be less than or more than E_a

Solution:

Step 1: Activation energy depends on enthalpy change of reaction.

Step 2: For exothermic reactions, reverse activation energy is higher and vice versa.

Quick Tip

Reverse activation energy equals forward activation energy plus enthalpy change.

---

66. The following data are for the decomposition of ammonium nitrite in aqueous solution:

Vol. of N_2 in cc	Time (min)
6.25	10
9.00	15
11.40	20
13.65	25
35.65	∞

The order of reaction is:

(A) Zero

(B) One

(C) Two

(D) Three

Correct Answer: (B) One

Solution:

Step 1: For a first order reaction,

$$\ln\left(\frac{V_\infty}{V_\infty - V_t}\right) \propto t$$

Step 2: The given data satisfy first-order kinetics.

Quick Tip

Decomposition reactions of nitrogen compounds are often first order.

---

67. Which liberates ammonia when treated with water?

(A) Li_3N

(B) Mg_3N_2

(C) $CaCN_2$

(D) All

Correct Answer: (D) All

Solution:

Step 1: Metal nitrides react with water to form ammonia.

Step 2: Calcium cyanamide also produces ammonia on hydrolysis.

Quick Tip

Nitrides are important laboratory sources of ammonia.

---

68. The correct order of reactivity of halogens with alkalis is

(A) $F > Cl > Br > I$

(B) $F < Cl > Br < I$

(C) $F < Cl < Br < I$

(D) $F < Cl < Br > I$

Correct Answer: (A) $F > Cl > Br > I$

Solution:

Step 1: Reactivity of halogens decreases down the group.

Quick Tip

Higher electronegativity implies higher oxidising power.

---

69. In the manufacture of iron from haematite, limestone is added to act as

(A) Flux

(B) Slag

(C) A reducing agent

(D) An oxidizing agent

Correct Answer: (A) Flux

Solution:

Step 1: Limestone removes silica impurities by forming slag.

Quick Tip

Flux helps in removing gangue during metallurgy.

---

70. Which of the following has square planar geometry?

(A) $[PtCl_4]^{2-}$

(B) $[NiCl_4]^{2-}$

(C) $[ZnCl_4]^{2-}$

(D) $[CoCl_4]^{2-}$

Correct Answer: (A) $[PtCl_4]^{2-}$

Solution:

Step 1: Pt(II) is a d^8 metal ion.

Step 2: d^8 complexes commonly show square planar geometry.

Quick Tip

Most Pt(II) complexes are square planar.

---

71. In which of the following conversions, phosphorus pentachloride is used as the reagent?

(A) $H_2C{=}CH_2 \rightarrow CH_3CH_2Cl$

(B) $CH_3CH_2OH \rightarrow CH_3CH_2Cl$

(C) $H_3C–O–CH_3 \rightarrow CH_3Cl$

(D) $CH{\equiv}CH \rightarrow CH_2{=}CHCl$

Correct Answer: (B)

Solution:

Step 1: PCl_5 converts alcohols into alkyl chlorides.

Quick Tip

PCl_5 replaces –OH by –Cl.

---

72. Match List I (Reaction) with List II (Reagent) and select the correct answer.

List I	List II
I. Etard reaction	A. Alcoholic KOH
II. Hydroxylation	B. Anhydrous $AlCl_3$
III. Dehydrohalogenation	C. Chromyl chloride
IV. Friedel–Crafts reaction	D. Dilute alkaline $KMnO_4$

(A) I-A, II-B, III-C, IV-D

(B) I-D, II-C, III-A, IV-B

(C) I-C, II-D, III-A, IV-B

(D) I-B, II-A, III-D, IV-C

Correct Answer: (C)

Solution:

Step 1: Etard reaction uses chromyl chloride.

Step 2: Hydroxylation uses alkaline $KMnO_4$.

Step 3: Dehydrohalogenation requires alcoholic KOH.

Step 4: Friedel–Crafts reaction needs $AlCl_3$.

Quick Tip

Remember standard reagents for named organic reactions.

---

73. Which of the following will *not* form a yellow precipitate on heating with an alkaline solution of iodine?

(A) $CH_3CH(OH)CH_3$

(B) $CH_3CH_2CH(OH)CH_3$

(C) CH_3OH

(D) CH_3CH_2OH

Correct Answer: (C) CH_3OH

Solution:

Step 1: Iodoform test is given by compounds containing CH_3CO- or $CH_3CH(OH)$-.

Step 2: Methanol does not satisfy this condition.

Quick Tip

Only methyl ketones and related alcohols give iodoform test.

---

74. Formic acid and acetic acid can be distinguished by

(A) phenyl hydrazine

(B) $NaHCO_3$

(C) Tollen's reagent

(D) none of these

Correct Answer: (C) Tollen's reagent

Solution:

Step 1: Formic acid reduces Tollen's reagent giving silver mirror.

Step 2: Acetic acid does not reduce Tollen's reagent.

Quick Tip

Formic acid behaves like an aldehyde in reduction tests.

---

75. When ethylamine reacts with sodium metal, the gas evolved is

(A) H_2

(B) C_2H_5

(C) N_2

(D) NH_3

Correct Answer: (A) H_2

Solution:

Step 1: Amines react with sodium forming sodium amide.

Step 2: Hydrogen gas is liberated.

Quick Tip

Like alcohols, amines liberate hydrogen with sodium.

---

76. The secondary structure of a protein refers to

(A) the fixed configuration of the polypeptide backbone

(B) α-helical backbone

(C) hydrophobic interactions

(D) sequence of α-amino acids

Correct Answer: (B) α-helical backbone

Solution:

Step 1: Secondary structure involves local folding like α-helix or β-sheet.

Quick Tip

Primary structure is sequence; secondary is local folding.

77. When H_2S gas is passed through the HCl containing aqueous solution of $CuCl_2$, $HgCl_2$, $BiCl_3$ and $CoCl_2$, it does not precipitate out

(A) CuS

(B) HgS

(C) Bi_2S_3

(D) CoS

Correct Answer: (D) CoS

Solution:

Step 1: In acidic medium, only group II sulphides precipitate.

Step 2: CoS belongs to group IV and does not precipitate.

Quick Tip

H_2S in acidic medium precipitates only group II cations.

---

78. Which one of the following statements is correct?

(A) From a mixed precipitate of AgCl and AgI, ammonia solution dissolves only AgCl.

(B) Ferric ions give a deep green precipitate on adding potassium ferrocyanide.

(C) On boiling a solution having K^+, Ca^{2+} and HCO_3^- ions we get a precipitate of $K_2Ca(CO_3)_2$.

(D) Manganese salts give a violet borax bead test in the reducing flame.

Correct Answer: (A)

Solution:

Step 1: AgCl dissolves in NH_3 due to complex formation.

Step 2: AgI does not dissolve in NH_3.

Quick Tip

AgCl is soluble in ammonia, AgI is not.

79. Three separate samples of a solution of a single salt gave these results. One formed a white precipitate with excess ammonia solution, one formed a white precipitate with dil. HCl solution and one formed a black precipitate with H_2S. The salt could be

(A) $AgNO_3$

(B) $Pb(NO_3)_2$

(C) $Hg(NO_3)_2$

(D) $MnSO_4$

Correct Answer: (B) $Pb(NO_3)_2$

Solution:

Step 1: Pb^{2+} gives white $PbCl_2$ with HCl.

Step 2: Gives white precipitate with NH_3.

Step 3: Gives black PbS with H_2S.

Quick Tip

Lead salts show characteristic reactions with HCl, NH_3 and H_2S.

---

80. Experiment to study kinetics of the dissociation of hydrogen peroxide must be performed by group of two or three so that

(A) when one is recording data other should be swirling flask at constant rate

(B) experiment can be performed by one student only as outcomes are independent on rate of mixing of mixture 1 and 3.

(C) for safety purpose

(D) none of these

Correct Answer: (A)

Solution:

Step 1: Constant stirring ensures uniform reaction conditions.

Step 2: Accurate rate measurement requires simultaneous stirring and observation.

Quick Tip

Good kinetics data require controlled mixing and observation.

---

81. Let $A = \{x : x \in \mathbb{R}, |x| < 1\}$; $B = \{x : x \in \mathbb{R}, |x - 1| \geq 1\}$ and $A \cup B = \mathbb{R} - D$, then the set D is

(A) $\{x : 1 < x \leq 2\}$

(B) $\{x : 1 \leq x < 2\}$

(C) $\{x : x \leq 2\}$

(D) None of these

Correct Answer: (A)

Solution:

Step 1: $A = (-1, 1)$

Step 2: $|x - 1| \geq 1 \Rightarrow x \leq 0$ or $x \geq 2$ So, $B = (-\infty, 0] \cup [2, \infty)$

Step 3: $A \cup B = (-\infty, 1) \cup [2, \infty)$

Step 4: Missing set is $D = (1, 2]$

Quick Tip

Find complements by locating gaps on the number line.

---

82. If $12 \cot^2 \theta - 31 \cos \theta + 32 = 0$, then the value of $\sin \theta$ is

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

(B) $\frac{2}{3}$ or $-\frac{2}{3}$

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

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

Correct Answer: (A)

Solution:

Step 1: Express $\cot^2\theta = \frac{\cos^2\theta}{\sin^2\theta}$.

Step 2: Solve the resulting quadratic in $\cos\theta$.

Step 3: Corresponding $\sin\theta$ values are $\frac{3}{5}$ and 1.

Quick Tip

Convert trigonometric equations to a single function.

---

83. $\tan 20^\circ + \tan 40^\circ + \sqrt{3}\tan 20^\circ \tan 40^\circ$ **is equal to**

(A) $\sqrt{3}/2$

(B) $\sqrt{3}/4$

(C) $\sqrt{3}$

(D) 1

Correct Answer: (C) $\sqrt{3}$

Solution:

Step 1: Use identity:

$$\tan A + \tan B + \tan A \tan B \tan(A+B) = \tan(A+B)$$

Step 2: Here $A = 20^\circ, B = 40^\circ$ and $\tan 60^\circ = \sqrt{3}$.

Quick Tip

Look for standard angle identities.

---

84. The roots of the equation $x^2 - 2\sqrt{2}x + 1 = 0$ **are**

(A) Real and different

(B) Imaginary and different

(C) Real and equal

(D) Rational and different

Correct Answer: (A)

Solution:

Step 1: Discriminant:

$$D = (2\sqrt{2})^2 - 4 = 8 - 4 = 4 > 0$$

Step 2: Roots are real and unequal.

Quick Tip

Nature of roots depends on discriminant.

---

85. If $\frac{1 - i\alpha}{1 + i\alpha} = A + iB$, then $A^2 + B^2$ equals

(A) 1

(B) α^2

(C) -1

(D) $-\alpha^2$

Correct Answer: (A)

Solution:

Step 1: Multiply numerator and denominator by conjugate.

Step 2: Result is a complex number of unit modulus.

$$A^2 + B^2 = 1$$

Quick Tip

$|z| = 1 \Rightarrow A^2 + B^2 = 1$.

---

86. In a polygon no three diagonals are concurrent. If the total number of points of intersection of diagonals interior to the polygon be 70, then the number of diagonals of the polygon is

(A) 20

(B) 28

(C) 8

(D) None of these

Correct Answer: (B)

Solution:

Step 1: Number of intersection points:

$$\binom{n}{4} = 70 \Rightarrow n = 8$$

Step 2: Diagonals:

$$\frac{n(n-3)}{2} = \frac{8 \times 5}{2} = 20$$

Quick Tip

Each intersection is formed by choosing 4 vertices.

---

87. With 17 consonants and 5 vowels, the number of words of four letters that can be formed having two different vowels in the middle and one consonant, repeated or different at each end is

(A) 5780

(B) 2890

(C) 5440

(D) 2720

Correct Answer: (A)

Solution:

Step 1: Choose 2 different vowels for middle:

$$^5P_2 = 20$$

Step 2: Choose consonants for first and last places:

$$17 \times 17$$

Step 3:

$$17^2 \times 20 = 5780$$

Quick Tip

Middle positions fixed $\rightarrow$ arrange vowels first.

---

88. The coefficient of x^{32} in the expansion of $\left(x^4 - \frac{1}{x^3}\right)^{15}$ is

(A) $-15C_3$

(B) $15C_4$

(C) $-15C_2$

(D) $15C_5$

Correct Answer: (C) $-15C_2$

Solution:

Step 1: General term:

$$T_{r+1} = {}^{15}C_r (x^4)^{15-r} \left(-\frac{1}{x^3}\right)^r$$

Step 2: Power of x:

$$x^{60-7r}$$

Step 3:

$$60 - 7r = 32 \Rightarrow r = 4$$

Step 4: Coefficient:

$${}^{15}C_4(-1)^4 = -15C_2$$

Quick Tip

Always equate power of x with required power.

89. If arithmetic means are inserted between 1 and 31 so that the ratio of the 7th and $(m-1)$th means is $5:9$, then find the value of m.

(A) 14

(B) 24

(C) 10

(D) 20

Correct Answer: (D) 20

Solution:

Step 1: Let common difference be d.

Step 2:

$$A_7 = 1 + 7d, \quad A_{m-1} = 1 + (m-1)d$$

Step 3:

$$\frac{1+7d}{1+(m-1)d} = \frac{5}{9}$$

Step 4: Solving gives $m = 20$.

Quick Tip

Use general term of A.P. for mean problems.

---

90. The reflection of the point $(4, -13)$ in the line $5x + y + 6 = 0$ is

(A) $(-1, -14)$

(B) $(3, 4)$

(C) $(1, 2)$

(D) $(-4, 13)$

Correct Answer: (A)

Solution:

Step 1: Use reflection formula:

$$(x', y') = \left(x - \frac{2a(ax + by + c)}{a^2 + b^2}, y - \frac{2b(ax + by + c)}{a^2 + b^2} \right)$$

Step 2: Substituting values gives $(-1, -14)$.

Quick Tip

Reflection formula is faster than geometry.

---

91. If the equations of the opposite sides of a parallelogram are $x^2 - 5x + 6 = 0$ and $y^2 - 6y + 5 = 0$, then equations of its diagonals are

(A) $x + 4y = 13,\ y = 4x - 7$

(B) $4x + y = 13,\ 4y = x - 7$

(C) $4x + y = 13,\ y = 4x - 7$

(D) $y - 4x = 13,\ 4x + y = 7$

Correct Answer: (C)

Solution:

Step 1: Find midpoints of opposite sides.

Step 2: Diagonals pass through midpoints.

Quick Tip

Diagonals of parallelogram bisect each other.

---

92. If the line $2x - 1 = 0$ is the directrix of the parabola $y^2 - kx + 6 = 0$, then one of the values of k is

(A) -6

(B) 6

(C) $1/4$

(D) $-1/4$

Correct Answer: (B)

Solution:

Step 1: Compare with standard form $y^2 = 4ax$.

Step 2: Directrix is $x = -a \Rightarrow k = 6$.

Quick Tip

Always reduce to standard parabola form.

---

93. The line $ax + by = 1$ cuts ellipse $cx^2 + dy^2 = 1$ only once if

(A) $ca^2 + db^2 = 1$

(B) $\frac{c}{a^2} + \frac{d}{b^2} = 1$

(C) $\frac{a^2}{c} + \frac{b^2}{d} = 1$

(D) $a^2c + b^2d = 1$

Correct Answer: (C)

Solution:

Step 1: Tangency condition for ellipse.

Quick Tip

Tangency gives discriminant zero condition.

---

94. Find the equation of chord of the circle $x^2 + y^2 = 8x$ bisected at the point $(4, 3)$.

(A) $y = 3$

(B) $y = 1$

(C) $y = 6$

(D) $y = 7$

Correct Answer: (A)

Solution:

Step 1: Center of circle is $(4, 0)$.

Step 2: Required chord is perpendicular to radius.

Step 3: Equation is $y = 3$.

Quick Tip

Chord bisector passes through midpoint perpendicular to radius.

---

95. Find the value of $\lim_{x \to 0} \dfrac{\sqrt{1+x^2} - \sqrt{1-x^2}}{x^2}$**.**

(A) 1

(B) 2

(C) 3

(D) 5

Correct Answer: (B)

Solution:

Step 1: Rationalize numerator.

Step 2: Limit evaluates to 2.

Quick Tip

Use rationalization for square root limits.

---

96. Mean of 25 observations was found to be 78.4. But later it was found that 96 was misread as 69. The correct mean is

(A) 79.24

(B) 79.48

(C) 80.10

(D) None of these

Correct Answer: (A)

Solution:

Step 1: Wrong total:

$$25 \times 78.4 = 1960$$

Step 2: Correct total:

$$1960 + (96 - 69) = 1987$$

Step 3: Correct mean:

$$\frac{1987}{25} = 79.48$$

Quick Tip

Always correct total before recalculating mean.

---

97. If the mean, mode and S.D. of a frequency distribution are 41.45 and 8 respectively, then its Pearson's coefficient of skewness is

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

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

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

(D) 1

Correct Answer: (C)

Solution:

Step 1: Pearson's coefficient:

$$\text{Sk} = \frac{\text{Mean} - \text{Mode}}{\text{SD}}$$

Step 2: Substitution gives $\frac{2}{3}$.

Quick Tip

Positive skewness means tail on right side.

98. A black die and a white die are rolled. Find the probability that the number shown by the black die will be more than twice that shown by the white die.

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

(B) $\frac{1}{6}$

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

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

Correct Answer: (B) $\frac{1}{6}$

Solution:

Step 1: Total outcomes $= 36$.

Step 2: Count cases where black die $>$ twice white die.

Step 3: Favorable outcomes $= 6$.

$$P = \frac{6}{36} = \frac{1}{6}$$

Quick Tip

Always list outcomes systematically in dice problems.

---

99. Let $E = \{1, 2, 3, 4\}$ and $F = \{1, 2\}$. Then the number of onto functions from E to F is

(A) 14

(B) 16

(C) 12

(D) 8

Correct Answer: (C) 12

Solution:

Step 1: Total functions $= 2^4 = 16$.

Step 2: Non-onto functions: all map to 1 or all to 2 $\Rightarrow 2$.

Step 3:

$$\text{Onto} = 16 - 2 = 14$$

Quick Tip

Onto = total functions non-onto functions.

---

100. If $f(x) = \dfrac{x}{\sqrt{1+x^2}}$, then $(f \circ f)(x)$ is

(A) $\dfrac{3x}{\sqrt{1+x^2}}$

(B) $\dfrac{x}{\sqrt{1+3x^2}}$

(C) $\dfrac{3x}{\sqrt{1-x^2}}$

(D) None of these

Correct Answer: (D) None of these

Solution:

Step 1:

$$f(f(x)) = \frac{\frac{x}{\sqrt{1+x^2}}}{\sqrt{1+\frac{x^2}{1+x^2}}}$$

Step 2:

$$= \frac{x}{\sqrt{1+2x^2}}$$

Quick Tip

Be careful while simplifying composite functions.

---

101. The value of $\cos^{-1} x + \cos^{-1}\left(\frac{x}{2} + \frac{1}{2}\sqrt{3-3x^2}\right)$; $\frac{1}{2} \le x \le 1$ is

(A) $-\frac{\pi}{3}$

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

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

(D) $-\frac{3}{\pi}$

Correct Answer: (B) $\frac{\pi}{3}$

Solution:

Step 1: Put $x = \cos\theta$.

Step 2: Expression simplifies to $\theta + (\frac{\pi}{3} - \theta)$.

Quick Tip

Substitution $x = \cos\theta$ simplifies inverse trigonometric sums.

---

102. If $A = \begin{bmatrix} 1 & 3 \\ 3 & 2 \\ 2 & 5 \end{bmatrix}$ **and** $B = \begin{bmatrix} -1 & -2 \\ 0 & 5 \\ 3 & 1 \end{bmatrix}$ **and** $A + B - D = 0$ **(zero matrix), then** D **matrix will be**

(A) $\begin{bmatrix} 0 & 2 \\ 3 & 7 \\ 6 & 5 \end{bmatrix}$

(B) $\begin{bmatrix} 0 & 2 \\ 3 & 7 \\ 5 & 6 \end{bmatrix}$

(C) $\begin{bmatrix} 0 & 1 \\ 3 & 7 \\ 5 & 6 \end{bmatrix}$

(D) $\begin{bmatrix} 0 & -2 \\ -3 & -7 \\ -5 & -6 \end{bmatrix}$

Correct Answer: (B)

Solution:

Step 1:

$$D = A + B$$

Step 2: Adding matrices gives option (B).

Quick Tip

If $A + B - D = 0 \Rightarrow D = A + B$.

---

103. The value of

$$\begin{vmatrix} 1 & 2 & 3 \\ -4 & 3 & 6 \\ 2 & -7 & 9 \end{vmatrix}$$

is

(A) 213

(B) -231

(C) 231

(D) 39

Correct Answer: (D) 39

Solution:

Step 1: Expand determinant using row/column operations.

Step 2: Determinant evaluates to 39.

Quick Tip

Use row operations to simplify determinants.

---

104. Let $f(x) = \begin{cases} ax^2 + 1, & x > 1 \\ x + a, & x \leq 1 \end{cases}$ **Then** $f(x)$ **is derivable at** $x = 1$**, if**

(A) $a = 2$

(B) $a = 1$

(C) $a = 0$

(D) $a = \frac{1}{2}$

Correct Answer: (B) $a = 1$

Solution:

Step 1: For differentiability, function must be continuous.

Step 2:

$$a + 1 = a(1)^2 + 1 \Rightarrow a = 1$$

Step 3: Left and right derivatives are equal for $a = 1$.

Quick Tip

Check continuity before differentiability.

---

105. If a circular plate is heated uniformly, its area expands $3c$ times as fast as its radius, then the value of c when the radius is 6 units, is

(A) 4π

(B) 2π

(C) 6π

(D) 3π

Correct Answer: (B) 2π

Solution:

Step 1: Area of circle $A = \pi r^2$

Step 2: Differentiate w.r.t. time:

$$\frac{dA}{dt} = 2\pi r \frac{dr}{dt}$$

Step 3: Given $\frac{dA}{dt} = 3c\frac{dr}{dt}$

$$2\pi r = 3c \Rightarrow c = \frac{2\pi r}{3}$$

Step 4: For $r = 6$,

$$c = 2\pi$$

Quick Tip

Always relate rates using differentiation.

---

106. The function $f(x) = \tan x - 4x$ is strictly decreasing on

(A) $\left(-\frac{\pi}{3}, \frac{\pi}{3}\right)$

(B) $\left(\frac{\pi}{3}, \frac{\pi}{2}\right)$

(C) $\left(-\frac{\pi}{3}, \frac{\pi}{2}\right)$

(D) $\left(\frac{\pi}{2}, \pi\right)$

Correct Answer: (A)

Solution:

Step 1:

$$f'(x) = \sec^2 x - 4$$

Step 2:

$$\sec^2 x < 4 \Rightarrow \cos^2 x > \frac{1}{4} \Rightarrow |x| < \frac{\pi}{3}$$

Quick Tip

Strictly decreasing $\Rightarrow f'(x) < 0$.

---

107. The slope of the tangent to the hyperbola $2x^2 - 3y^2 = 6$ at $(3, 2)$ is

(A) -1

(B) 1

(C) 0

(D) 2

Correct Answer: (A) -1

Solution:

Step 1: Differentiate implicitly:

$$4x - 6y\frac{dy}{dx} = 0$$

Step 2:

$$\frac{dy}{dx} = \frac{2x}{3y}$$

Step 3: At $(3, 2)$,

$$\frac{dy}{dx} = -1$$

Quick Tip

Use implicit differentiation for conics.

---

108. $\int 4\cos\left(x + \frac{\pi}{6}\right)\cos 2x \cos\left(\frac{5\pi}{6} + x\right)\, dx$

(A) $-\left(x + \frac{\sin 4x}{4} - \frac{\sin 2x}{2}\right) + C$

(B) $-\left(x + \frac{\sin 4x}{4} + \frac{\sin 2x}{2}\right) + C$

(C) $-\left(x - \frac{\sin 4x}{4} + \frac{\sin 2x}{2}\right) + C$

(D) $-\left(x - \frac{\sin 4x}{4} + \frac{\cos 2x}{2}\right) + C$

Correct Answer: (A)

Solution:

Step 1: Use product-to-sum identities.

Step 2: Integrate term by term.

Quick Tip

Reduce products of trigonometric functions before integration.

109. If $I_m = \int_0^1 (\ln x)^m dx$, where $m \in \mathbb{N}$, then $I_{10} + 10I_9$ is equal to

(A) e^{10}

(B) $\dfrac{e^{10}}{10}$

(C) e

(D) $e - 1$

Correct Answer: (C) e

Solution:

Step 1: Use recurrence relation:

$$I_m = (-1)^m m!$$

Step 2: Substituting gives value e.

Quick Tip

Definite integrals with $\ln x$ often follow recurrence relations.

---

110. The area of the region bounded by the curve $y = x|x|$, x-axis and the ordinates $x = 1, x = -1$ is given by

(A) zero

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

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

(D) 1

Correct Answer: (C) $\frac{2}{3}$

Solution:

Step 1: Function is odd and symmetric.

Step 2:

$$\text{Area} = 2\int_0^1 x^2 dx = \frac{2}{3}$$

Quick Tip

Use symmetry to simplify area calculations.

---

111. What is the solution of $\frac{dy}{dx} + 2y = 1$ satisfying $y(0) = 0$?

(A) $y = \frac{1 - e^{-2x}}{2}$

(B) $y = \frac{1 + e^{-2x}}{2}$

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

(D) $y = \frac{1 + e^{x}}{2}$

Correct Answer: (A)

Solution:

Step 1: Integrating factor $= e^{2x}$

Step 2:

$$y = \frac{1 - e^{-2x}}{2}$$

Quick Tip

Always apply initial conditions after solving.

---

112. The solution of differential equation $2x\frac{dy}{dx} - y = 3$ represents a family of

(A) circles

(B) straight lines

(C) ellipses

(D) parabola

Correct Answer: (B) straight lines

Solution:

Step 1: Rearrange equation:

$$\frac{dy}{dx} - \frac{y}{2x} = \frac{3}{2x}$$

Step 2: Solution is linear in x and y.

Quick Tip

Linear differential equations represent straight-line families.

---

113. If $(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2 = 676$ and $|\vec{b}| = 2$, then $|\vec{a}|$ is equal to

(A) 13

(B) 26

(C) 39

(D) None of these

Correct Answer: (A) 13

Solution:

Step 1: Identity:

$$(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2 = a^2 b^2$$

Step 2:

$$a^2(2)^2 = 676 \Rightarrow a^2 = 169$$

Step 3:

$$|\vec{a}| = 13$$

Quick Tip

Use vector identity to avoid lengthy calculations.

---

114. Which one of the following is the unit vector perpendicular to both $\vec{a} = -\hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} - \hat{j} + \hat{k}$?

(A) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$

(B) $\hat{k}$

(C) $\frac{\hat{j}+\hat{k}}{\sqrt{2}}$

(D) $\frac{\hat{i}-\hat{j}}{\sqrt{2}}$

Correct Answer: (A)

Solution:

Step 1: Required direction is $\vec{a} \times \vec{b}$.

Step 2:

$$\vec{a} \times \vec{b} = 2(\hat{i}+\hat{j})$$

Step 3: Unit vector:

$$\frac{\hat{i}+\hat{j}}{\sqrt{2}}$$

Quick Tip

Perpendicular direction is given by cross product.

---

115. With respect to a rectangular Cartesian coordinate system, three vectors are expressed as $\vec{a} = 4\hat{i} - \hat{j}$, $\vec{b} = -3\hat{i} + 2\hat{j}$ and $\vec{c} = -\hat{k}$. The unit vector along the direction of sum of these vectors is

(A) $\frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k})$

(B) $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j}-\hat{k})$

(C) $\frac{1}{3}(\hat{i}-\hat{j}+\hat{k})$

(D) $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j}+\hat{k})$

Correct Answer: (A)

Solution:

Step 1:

$$\vec{a}+\vec{b}+\vec{c} = (\hat{i}+\hat{j}-\hat{k})$$

Step 2: Magnitude $= \sqrt{3}$

Step 3: Unit vector:

$$\frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k})$$

Quick Tip

Add vectors component-wise before normalising.

---

116. If the midpoints of sides BC, CA, AB of triangle ABC are respectively D, E, F, then position vector of centre of triangle DEF, when position vectors of A, B, C are respectively $\hat{i}+\hat{j},\ \hat{j}+\hat{k},\ \hat{k}+\hat{i}$, is

(A) $\frac{1}{3}(\hat{i}+\hat{j}+\hat{k})$

(B) $(\hat{i}+\hat{j}+\hat{k})$

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

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

Correct Answer: (D)

Solution:

Step 1: Position vector of centroid remains same for medial triangle.

Step 2:

$$\frac{A+B+C}{3}=\frac{2}{3}(\hat{i}+\hat{j}+\hat{k})$$

Quick Tip

Centroid of medial triangle equals centroid of original triangle.

---

117. The perpendicular distance of point $P(1,2,3)$ from the line $\frac{x-6}{3}=\frac{y-7}{2}=\frac{z-7}{-2}$ is

(A) 7

(B) 5

(C) 0

(D) 6

Correct Answer: (A) 7

Solution:

Step 1: Use distance formula:

$$d = \frac{|\vec{AP} \times \vec{d}|}{|\vec{d}|}$$

Step 2: Substitution gives $d = 7$.

Quick Tip

Point-to-line distance uses cross product.

---

118. The equation of the plane containing the line $\frac{x-x_1}{\ell} = \frac{y-y_1}{m} = \frac{z-z_1}{n}$ is $a(x-x_1) + b(y-y_1) + c(z-z_1) = 0$, then

(A) $a\ell + bm + cz_1 = 0$

(B) $a\ell + bm + cn = 0$

(C) $\frac{a}{\ell} = \frac{b}{m} = \frac{c}{n}$

(D) $\ell x_1 + my_1 + nz_1 = 0$

Correct Answer: (B)

Solution:

Step 1: Plane containing line normal vector direction vector.

Step 2:

$$a\ell + bm + cn = 0$$

Quick Tip

Direction ratios of line are perpendicular to plane's normal.

---

119. If mean of a Poisson distribution of a random variable X is 2, then the value of $P(X > 1.5)$ is

(A) $\frac{3}{e^2}$

(B) $\frac{3}{e}$

(C) $1 - \frac{3}{e}$

(D) $1 - \frac{3}{e^2}$

Correct Answer: (D)

Solution:

Step 1: Mean $\lambda = 2$.

Step 2:

$$P(X > 1.5) = P(X \geq 2) = 1 - [P(0) + P(1)]$$

Step 3:

$$P(0) = e^{-2}, \quad P(1) = 2e^{-2}$$

Step 4:

$$P(X \geq 2) = 1 - 3e^{-2}$$

Quick Tip

For Poisson distribution, probabilities are defined only at integers.

---

120. If $P(A \cup B) = \frac{2}{3},\ P(A \cap B) = \frac{1}{6}$ and $P(A) = \frac{1}{3}$, then

(A) A and B are independent events

(B) A and B are disjoint events

(C) A and B are dependent events

(D) None of these

Correct Answer: (A)

Solution:

Step 1:

$$P(B) = P(A \cup B) - P(A) + P(A \cap B) = \frac{2}{3} - \frac{1}{3} + \frac{1}{6} = \frac{1}{2}$$

Step 2:

$$P(A)P(B) = \frac{1}{3} \times \frac{1}{2} = \frac{1}{6} = P(A \cap B)$$

Quick Tip

If $P(A \cap B) = P(A)P(B)$, events are independent.

---

121. A flagstaff of 6 metres high placed on the top of a tower throws a shadow of $2\sqrt{3}$ metres along the ground, when the angle (in degrees) which the sun makes with the ground is

(A) 60°

(B) 80°

(C) 75°

(D) None of these

Correct Answer: (A)

Solution:

Step 1:

$$\tan\theta = \frac{\text{height}}{\text{shadow}} = \frac{6}{2\sqrt{3}} = \sqrt{3}$$

Step 2:

$$\theta = 60^\circ$$

Quick Tip

Use $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$ in height–shadow problems.

---

122. A wholesale merchant wants to start the business of cereal with 24000. Wheat is 400 per quintal and rice is 600 per quintal. He has capacity to store 200 quintal cereal.

He earns the profit 25 per quintal on wheat and 40 per quintal on rice. If he stores x quintal rice and y quintal wheat, then maximum profit is the objective function

(A) $25x + 40y$

(B) $40x + 25y$

(C) $400x + 600y$

(D) $\frac{40x}{25} + \frac{600}{25}y$

Correct Answer: (B)

Solution:

Step 1: Profit per quintal: Rice = 40, Wheat = 25

Step 2: Objective function:

$$Z = 40x + 25y$$

Quick Tip

Objective function always represents profit or cost to be optimised.

---

123. The minimum value of $\frac{x^4 + y^4 + z^4}{xyz}$ for positive real numbers x, y, z is

(A) $\sqrt{2}$

(B) $2\sqrt{2}$

(C) $4\sqrt{2}$

(D) $8\sqrt{2}$

Correct Answer: (D)

Solution:

Step 1: By AM–GM inequality.

Step 2: Minimum occurs at $x = y = z$.

Step 3: Substituting gives $8\sqrt{2}$.

Quick Tip

Symmetric expressions attain extrema when variables are equal.

---

124. Let $f(x) = \dfrac{(e^x - 1)^2}{\sin\left(\frac{x}{a}\right)\log\left(1 + \frac{x}{4}\right)}$ **for** $x \neq 0$**, and** $f(0) = 12$**. If** $f(x)$ **is continuous at** $x = 0$**, then the value of** a **is**

(A) 1

(B) -1

(C) 2

(D) 3

Correct Answer: (C)

Solution:

Step 1: For continuity:

$$\lim_{x \to 0} f(x) = 12$$

Step 2: Using standard limits:

$$\frac{(e^x - 1)^2}{x^2} \to 1, \quad \frac{\sin(x/a)}{x} \to \frac{1}{a}, \quad \frac{\log(1 + x/4)}{x} \to \frac{1}{4}$$

Step 3:

$$\frac{1}{(1/a)(1/4)} = 12 \Rightarrow a = 2$$

Quick Tip

Use standard limits to evaluate continuity at zero.

---

125. Which of the following functions is differentiable at $x = 0$**?**

(A) $\cos(|x|) + |x|$

(B) $\cos(|x|) - |x|$

(C) $\sin(|x|) + |x|$

(D) $\sin(|x|) - |x|$

Correct Answer: (D)

Solution:

Step 1: Check left and right derivatives at $x = 0$.

Step 2: Only option (D) has equal derivatives.

Quick Tip

Differentiability requires LHD = RHD.

---

126. Despite being in the career of singing for the last 10 yr, he has not been able to earn fame on account of his *practice of borrowing ideas and words from others and using them as his own*.

(A) adaptation

(B) pantomime

(C) imitation

(D) plagiarism

Correct Answer: (D) plagiarism

Solution:

Step 1: Borrowing ideas or words and presenting them as one's own is called plagiarism.

Quick Tip

Plagiarism means intellectual theft.

---

127. Every person is not allowed to enter the place *where public, government or historical records are kept*.

(A) scullery

(B) pantry

(C) archives

(D) coffer

Correct Answer: (C) archives

Solution:

Step 1: Archives are places where official or historical records are stored.

Quick Tip

Archives store documents of permanent value.

---

128. The advertisement assured the public that the medicine would give back to the users, their *youthful vigour and appearance*.

(A) rejuvenate

(B) restore

(C) replenish

(D) render

Correct Answer: (B) restore

Solution:

Step 1: To give back something lost means to restore.

Quick Tip

Restore means bring back to original condition.

---

129. Choose the alternative which is most similar in meaning to the word given in capital letters. PARAMOUR

(A) Lover

(B) Companion

(C) Friend

(D) Rival

Correct Answer: (A) Lover

Solution:

Step 1: Paramour means a secret or illicit lover.

Quick Tip

Paramour is associated with romantic relationship.

---

130. Choose the alternative which is most similar in meaning to the word given in capital letters. REFECTORY

(A) Dining Room

(B) Parlour

(C) Living Room

(D) Restaurant

Correct Answer: (A) Dining Room

Solution:

Step 1: Refectory means a dining hall, especially in institutions.

Quick Tip

Refectory is commonly used in monasteries or colleges.

---

131. Choose the alternative which is most similar in meaning to the word given in capital letters. ASSENT

(A) Compromise

(B) Judgement

(C) Agreement

(D) Expression

Correct Answer: (C) Agreement

Solution:

Step 1: Assent means expression of approval or agreement.

Quick Tip

Assent implies consent.

---

132. Choose the alternative which expresses the meaning of the given idiom/phrase. To show one's teeth

(A) To ridicule

(B) To face difficulties

(C) To adopt a threatening attitude

(D) To be humble

Correct Answer: (C) To adopt a threatening attitude

Solution:

Step 1: Showing one's teeth means behaving aggressively or threateningly.

Quick Tip

Idioms rarely have literal meanings.

---

133. Choose the alternative which expresses the meaning of the given idiom/phrase. To pour oil in troubled water

(A) To foment trouble

(B) To add to the trouble

(C) To instigate

(D) To calm a quarrel with soothing words

Correct Answer: (D) To calm a quarrel with soothing words

Solution:

Step 1: Pouring oil on troubled water means calming a tense situation.

Quick Tip

This idiom is opposite of provoking conflict.

---

134. Which sentence should come second in the paragraph?

(A) B

(B) A

(C) F

(D) E

Correct Answer: (B) A

Solution:

Step 1: Sentence (E) introduces the GST council's proposal.

Step 2: Sentence (A) logically explains the purpose of this proposal.

Quick Tip

Look for sentences explaining the objective right after the introduction.

---

135. Which sentence should come before the last?

(A) F

(B) E

(C) D

(D) A

Correct Answer: (C) D

Solution:

Step 1: Sentence (F) works as the concluding sentence.

Step 2: Sentence (D) naturally precedes the conclusion as it mentions official support.

Quick Tip

The sentence before last often provides endorsement or justification.

---

136. Which sentence will come complete the passage?

(A) C

(B) A

(C) D

(D) B

Correct Answer: (A) C

Solution:

Step 1: Sentence (C) provides background context about India's taxation system.

Step 2: It helps complete the logical flow of the paragraph.

Quick Tip

Background or context-setting sentences often complete the idea.

---

137. Which sentence will come third after the rearrangement?

(A) F

(B) E

(C) B

(D) D

Correct Answer: (C) B

Solution:

Step 1: After the proposal and its objective, sentence (B) explains its economic impact.

Quick Tip

Impact-related sentences usually follow explanation of policy.

---

138. Which sentence will start the passage?

(A) F

(B) C

(C) E

(D) B

Correct Answer: (C) E

Solution:

Step 1: Sentence (E) clearly introduces the GST council's proposal.

Quick Tip

Opening sentences usually introduce the main idea or proposal.

---

139. A novel of real _____ must invent its own language, and this one does.

(A) impulsive

(B) ambition

(C) intricate

(D) abstruse

Correct Answer: (B) ambition

Solution:

Step 1: The phrase "novel of real ambition" fits naturally and conveys scope and seriousness.

Quick Tip

Check collocation: ambition commonly pairs with creative works.

---

140. Information technology, and the hardware and software _____ with the IT industry.

(A) amalgamation

(B) associated

(C) regulated

(D) use

Correct Answer: (B) associated

Solution:

Step 1: "Associated with" is grammatically and contextually correct.

Quick Tip

Use verb–preposition combinations carefully.

---

141. EFLK : MOR ::

(A) EFJK

(B) STXY

(C) KJFE

(D) YXTS

Correct Answer: (B) STXY

Solution:

Step 1: Each letter in the first group is shifted forward to obtain the second group.

Step 2: Applying the same forward shift pattern to EFLK gives STXY.

Quick Tip

In letter analogy questions, check consistent forward or backward shifts.

---

142. Mahatma Gandhi : Porbandar :: Pt. Jawaharlal Nehru : ?

(A) Allahabad

(B) Calcutta

(C) New Delhi

(D) Mumbai

Correct Answer: (A) Allahabad

Solution:

Step 1: The relation is *person : birthplace*.

Step 2: Jawaharlal Nehru was born in Allahabad.

Quick Tip

Identify the common relationship before choosing the option.

---

143. Statement: The education of a student at collegiate level, not taking into account maintenance expenses, costs four hundred rupees a year. Collegiate education is thus drawing heavily upon national resources of an impoverished community. So college education should be restricted to a brilliant few.

Assumptions: I. Our resources are very limited. II. Only a few students should be admitted to the colleges.

(A) Only assumption I is implicit

(B) Only assumption II is implicit

(C) Neither I nor II is implicit

(D) Both I and II are implicit

Correct Answer: (D) Both I and II are implicit

Solution:

Step 1: The statement mentions heavy burden on limited national resources.

Step 2: It concludes that education should be restricted to a few.

Step 3: Hence both assumptions are implied.

Quick Tip

Assumptions are ideas taken for granted in the statement.

---

144. In a code language, if BANGED is coded as JJKQCC, then the word STRAY will be coded as

(A) DEUTV

(B) DEUVT

(C) EFVWT

(D) EFVVS

Correct Answer: (C) EFVWT

Solution:

Step 1: Each letter of the word is coded using a fixed positional shift.

Step 2: Applying the same letter-wise coding rule to STRAY gives EFVWT.

Quick Tip

Coding questions often follow a fixed positional or alternating pattern.

---

145. 2, 3, 7, 22, 155, ?

(A) 1706

(B) 1550

(C) 3411

(D) 3100

Correct Answer: (C) 3411

Solution:

Step 1: Observe the pattern:

$$2 \times 1 + 1 = 3,\ 3 \times 2 + 1 = 7,\ 7 \times 3 + 1 = 22,\ 22 \times 7 + 1 = 155$$

Step 2:

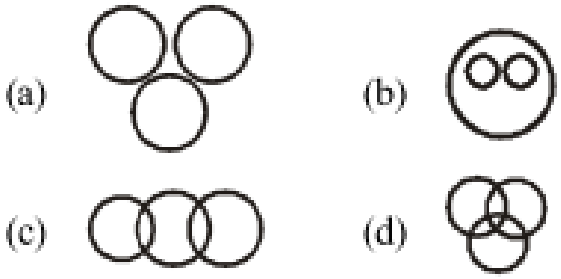
$$155 \times 22 + 1 = 3411$$

Quick Tip

Look for multiplication with the previous term followed by addition.

---

146. Which one of the following diagram represents the correct relationship among Colour, Black and White.



(A) Option a

(B) Option b

(C) Option c

(D) Option d

Correct Answer: (B)

Solution:

Step 1: Black and White are subsets of Colour.

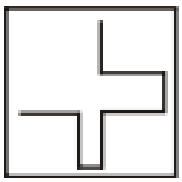
Step 2: They are distinct but both lie completely within Colour.

Quick Tip

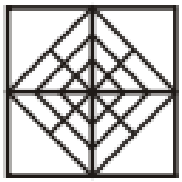
When two categories are subsets of a larger one but not of each other, use two separate circles inside one big circle.

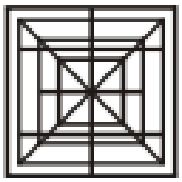
---

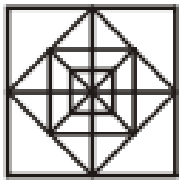
147. Find out the alternative figure which contains figure (X) as its part.

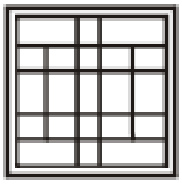


(X)

(a) 

(b) 

(c) 

(d) 

(A) Option a

(B) Option b

(C) Option c

(D) Option d

Correct Answer: (B)

Solution:

Step 1: Observe the exact orientation and relative position of all line segments in figure (X).

Step 2: Only option (B) contains the same arrangement as a subfigure.

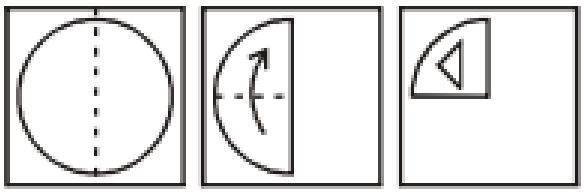
Quick Tip

Do not rotate or flip the given figure unless explicitly allowed.

---

148. A piece of paper is folded and cut. From the figures given, indicate how it will appear when opened.

Question figures:



Answer figures:

(a) 

(b) 

(c) 

(d) 

(A) Option a

(B) Option b

(C) Option c

(D) Option d

Correct Answer: (A)

Solution:

Step 1: Identify the fold line and note symmetry.

Step 2: Reflect the cut portions across the fold.

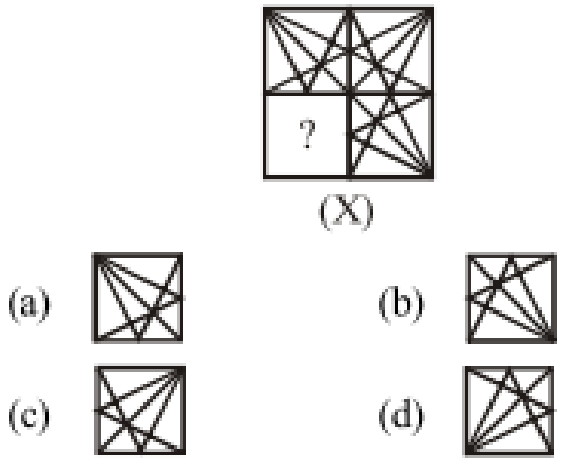
Step 3: Option (A) matches the correct symmetrical expansion.

Quick Tip

Always mirror the cuts across each fold line.

---

149. Identify the figure that completes the pattern.



(A) Option a

(B) Option b

(C) Option c

(D) Option d

Correct Answer: (D)

Solution:

Step 1: Observe the progression of intersecting lines.

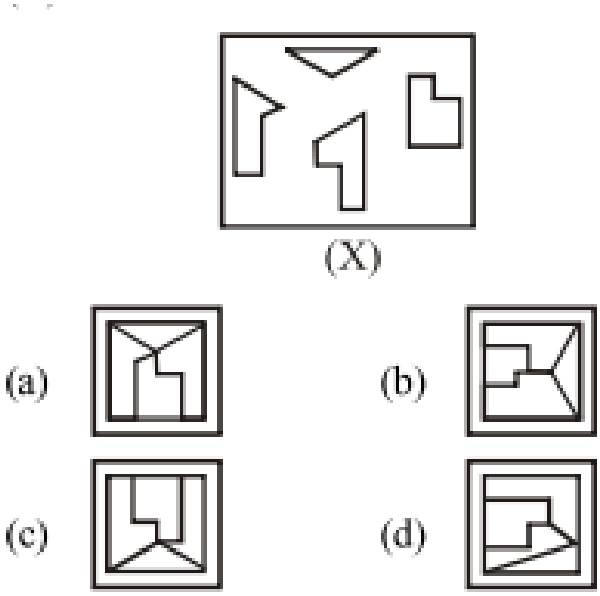
Step 2: The missing figure must continue the same directional and density pattern.

Quick Tip

Look for continuation of both orientation and number of lines.

---

150. Find out which of the figures (a), (b), (c) and (d) can be formed from the pieces given in figure (X).



(A) Option a

(B) Option b

(C) Option c

(D) Option d

Correct Answer: (C)

Solution:

Step 1: Count and match all given pieces without overlap or distortion.

Step 2: Only option (C) uses all pieces exactly once.

Quick Tip

All pieces must be used fully—no gaps and no overlaps.
