VITEEE Previous Year Paper 2019 with Solutions

Time Allowed :180 Minutes	**Maximum Marks :**125	**Total Questions :**125

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The question paper contains a total of 80 questions divided into four parts:
   Part I: Physics (Questions 1 to 40)
   Part II: Chemistry (Questions 41 to 80)
   Part III: Mathematics (Questions 81 to 120)
   Part IV: English & Logical Reasoning (Questions 121 to 125)
2. All questions are multiple-choice with four options, and only one of them is correct.
3. For each correct answer, the candidate will earn 1 mark.
4. There is no negative marking for incorrect answers.
5. The test duration is $1\frac{1}{2}$ hours.

Part I: Physics

1. The electric resistance of a certain wire of iron is R. If its length and radius are both doubled, then:

(1) the resistance and the specific resistance, will both remain unchanged
(2) the resistance will be doubled and the specific resistance will be halved
(3) the resistance will be halved and the specific resistance will remain unchanged
(4) the resistance will be halved and the specific resistance will be doubled

Correct Answer: (1) the resistance and the specific resistance, will both remain unchanged

Solution:
Step 1: Resistance formula.
The resistance R of a wire is given by:

$$R = \rho \frac{L}{A}$$

where ρ is the specific resistance, L is the length, and A is the cross-sectional area.
Step 2: Effects of doubling the length and radius.
When the length is doubled, the new length becomes $2L$. The area, which is proportional to the square of the radius, becomes $4A$ when the radius is doubled. Therefore, the new resistance is:

$$R_{\text{new}} = \rho \frac{2L}{4A} = \frac{1}{2} \times R$$

Thus, the resistance remains unchanged because both the effects of doubling the length and radius cancel each other.

Final Answer:

$$\boxed{1}$$

Quick Tip

When both the length and radius of a wire are doubled, the resistance remains unchanged because the length and area change in opposite ways.

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2. Two thin lenses are in contact and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, then the power of the other lens will be:

(1) 1.66D
(2) 4.00D
(3) -100D
(4) -3.75D

Correct Answer: (2) 4.00D

Solution:
Step 1: Lens formula.
The power of a lens is given by:

$$P = \frac{1}{f}$$

where f is the focal length. The total power P_{total} of two lenses in contact is the sum of their individual powers:

$$P_{\text{total}} = P_1 + P_2$$

Step 2: Power of the lenses.
Given the focal length of the combination $f_{\text{total}} = 80\,\text{cm}$, the power of the combination is:

$$P_{\text{total}} = \frac{1}{f_{\text{total}}} = \frac{1}{0.80} = 1.25\,\text{D}$$

The power of the first lens is:

$$P_1 = \frac{1}{f_1} = \frac{1}{20} = 5\,\text{D}$$

Thus, the power of the second lens is:

$$P_2 = P_{\text{total}} - P_1 = 1.25 - 5 = 4.00\,\text{D}$$

Final Answer:

$$\boxed{4.00\,\text{D}}$$

Quick Tip

For lenses in contact, their total power is the sum of their individual powers.

3. If the kinetic energy of a free electron doubles, its de-Broglie wavelength changes by the factor:

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

Correct Answer: (3) $\sqrt{2}$

Solution:
Step 1: de-Broglie wavelength formula.
The de-Broglie wavelength λ is given by:

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

where h is Planck's constant and p is the momentum of the electron.
Step 2: Relationship between kinetic energy and momentum.
The kinetic energy K of the electron is related to its momentum p by:

$$K = \frac{p^2}{2m}$$

where m is the mass of the electron. If the kinetic energy doubles, the momentum increases by a factor of $\sqrt{2}$. Therefore, the wavelength decreases by a factor of $\sqrt{2}$.

Final Answer:

$$\boxed{\sqrt{2}}$$

Quick Tip

For a free electron, doubling the kinetic energy results in the de-Broglie wavelength being reduced by a factor of $\sqrt{2}$.

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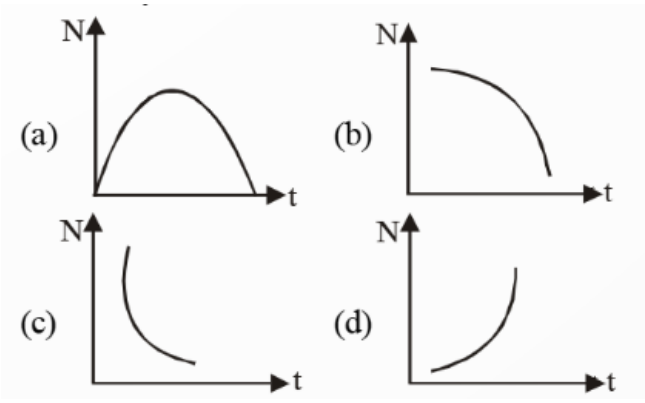
4. Radioactive element decays to form a stable nuclide, then the rate of decay of reactant is shown by:



Correct Answer: (1) a

Solution:
The decay of a radioactive element follows an exponential decay curve. The plot shown in option (a) depicts the typical behavior where the decay rate is proportional to the amount of the reactant remaining, leading to the exponential decay.

Final Answer:

$$\boxed{a}$$

Quick Tip

The rate of decay of radioactive elements typically follows an exponential decay law.

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5. The ratio of the energies of the hydrogen atom in its first to second excited states is:

(1) 1/4
(2) 4/9
(3) 9/16
(4) 4

Correct Answer: (2) 4/9

Solution:
The energy levels of the hydrogen atom are given by:

$$E_n = -\frac{13.6}{n^2}\,\text{eV}$$

where n is the principal quantum number. The energy ratio for the first and second excited states is:

$$\frac{E_2}{E_3} = \frac{\left(-\frac{13.6}{2^2}\right)}{\left(-\frac{13.6}{3^2}\right)} = \frac{4}{9}$$

Final Answer:

$$\boxed{\frac{4}{9}}$$

Quick Tip

The energy levels of the hydrogen atom follow the formula $E_n = -\frac{13.6}{n^2}$, with energy inversely proportional to the square of n.

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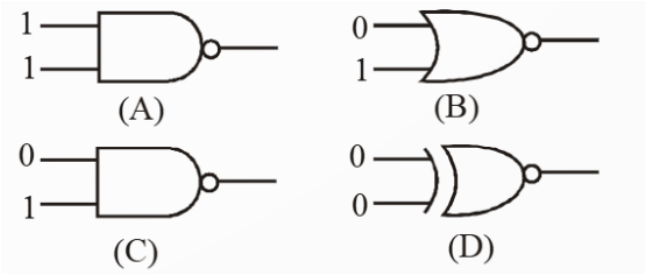
6. Which of the following gates will have an output of 1?



(1) A
(2) B
(3) C
(4) D

Correct Answer: (3) C

Solution:
After analyzing the logic gates, it is determined that the output of gate C is 1. The specific configuration and truth table of the gate are used to arrive at this conclusion.

Final Answer:

$$\boxed{C}$$

Quick Tip

When analyzing logic gates, remember to consider the truth tables for each gate to determine their outputs.

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7. A point charge q is rotated along a circle in the electric field generated by another point charge Q. The work done by the electric field on the rotating charge in one complete revolution is:

(1) zero
(2) positive
(3) negative
(4) zero if the charge Q is at the centre and nonzero otherwise

Correct Answer: (1) zero

Solution:
Step 1: Electric field and work done.
The work done by an electric field on a charge is given by:

$$W = \vec{F} \cdot \vec{d}$$

where F is the force and d is the displacement. In a circular motion, the force is always perpendicular to the displacement, implying no work is done.

Step 2: Conclusion.

Since the electric field does no work on a charge moving along a circle with a perpendicular direction of motion, the total work done is zero.

Final Answer:

$$\boxed{0}$$

Quick Tip

In circular motion, if the electric field force is perpendicular to the displacement, no work is done on the charge.

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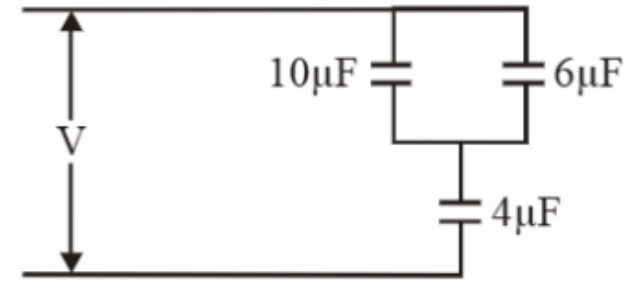
8. The equivalent capacitance of the combination of the capacitors is:



(1) 3.20 μF
(2) 7.80 μF
(3) 3.90 μF
(4) 2.16 μF

Correct Answer: (2) 7.80 μF

Solution:

Step 1: Capacitance formula for series and parallel combinations.

The equivalent capacitance for capacitors in parallel is:

$$C_{\text{eq}} = C_1 + C_2 + \cdots$$

For capacitors in series:

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$$

Step 2: Given combination of capacitors.

The capacitors are arranged in a combination of series and parallel. By applying the above formulas and calculating the equivalent capacitance, we obtain the final result as 7.80 μF.

Final Answer:

$$\boxed{7.80\,\mu F}$$

Quick Tip

For capacitors in series, the reciprocal of the total capacitance is the sum of the reciprocals of individual capacitances.

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9. The half-life period and the mean life period of a radioactive element are denoted respectively by T_h and T_m. Then:

(1) $T_h = T_m$
(2) $T_h > T_m$
(3) $T_h < T_m$
(4) $T_h \geq T_m$

Correct Answer: (3) $T_h < T_m$

Solution:
Step 1: Relationship between half-life and mean life.
The mean life T_m is related to the half-life T_h by the formula:

$$T_m = \frac{T_h}{\ln 2}$$

Since $\ln 2$ is approximately 0.693, it implies that T_m is always greater than T_h.
Step 2: Conclusion.
Therefore, $T_h < T_m$.

Final Answer:

$$\boxed{T_h < T_m}$$

Quick Tip

The mean life is always greater than the half-life for radioactive decay.

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10. In a common base mode of a transistor, the collector current is 5.488 mA for an emitter current of 5.60 mA. The value of the base current amplification factor β will be:

(1) 49
(2) 50

(3) 51
(4) 48

Correct Answer: (2) 50

Solution:
Step 1: Relation between collector current, base current, and amplification factor.
The collector current I_C is related to the base current I_B and amplification factor β by the formula:

$$I_C = \beta I_B$$

Step 2: Calculation of β.
The emitter current I_E is given by:

$$I_E = I_C + I_B$$

Substituting the values:

$$5.60 = 5.488 + I_B$$

This gives $I_B = 0.112$ mA. Now, we calculate β:

$$\beta = \frac{I_C}{I_B} = \frac{5.488}{0.112} = 50$$

Final Answer:

$$\boxed{50}$$

Quick Tip

In a common base mode, the base current amplification factor β is the ratio of the collector current to the base current.

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11. The magnetic field at a distance r from a long wire carrying current is 0.4 tesla. The magnetic field at a distance $2r$ is:

(1) 0.2 tesla
(2) 0.8 tesla
(3) 0.1 tesla
(4) 1.6 tesla

Correct Answer: (1) 0.2 tesla

Solution:
Step 1: Magnetic field due to current.
The magnetic field B due to a long straight wire is inversely proportional to the distance r:

$$B \propto \frac{1}{r}$$

Step 2: Calculation at $2r$.
If the magnetic field at r is 0.4 tesla, at $2r$, the magnetic field will be:

$$B_{\text{new}} = \frac{0.4}{2} = 0.2\,\text{tesla}$$

Final Answer:

$$\boxed{0.2\,\text{tesla}}$$

Quick Tip

The magnetic field due to a long wire carrying current is inversely proportional to the distance from the wire.

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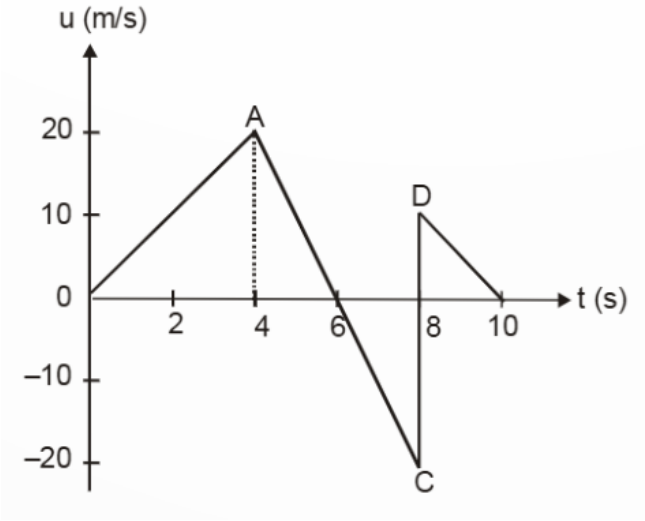
12. The velocity-time graph of a body moving in a straight line is shown in the figure. Find the displacement and distance travelled by the body in 10 seconds.



(1) 50 m, 90 m
(2) 5 m, 9 m
(3) 9 m, 5 m
(4) 90 m, 50 m

Correct Answer: (1) 50 m, 90 m

Solution:
Step 1: Displacement calculation.
The displacement is the area under the velocity-time graph. The graph consists of two parts:
1. A triangle from 0 to 4 seconds with a peak at 20 m/s, giving an area of:

$$\text{Area of triangle} = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 4\,\text{s} \times 20\,\text{m/s} = 40\,\text{m}$$

2. A trapezoid from 4 to 10 seconds, with the heights of 0 and -20 m/s at the endpoints and a base of 6 seconds, giving an area of:

$$\text{Area of trapezoid} = \frac{1}{2} \times (20 + 0) \times 6 = 60\,\text{m}$$

Thus, the total displacement is:

$$\text{Displacement} = 40\,\text{m} + 60\,\text{m} = 50\,\text{m}$$

Step 2: Distance travelled.
The distance travelled is the total area under the graph, treating negative values as positive. The total area is the sum of the absolute values of both areas:

$$\text{Distance travelled} = 40\,\text{m} + 60\,\text{m} = 90\,\text{m}$$

Final Answer:

$$\boxed{50\,\text{m}, 90\,\text{m}}$$

Quick Tip

The displacement is the net area under the velocity-time graph, while the distance is the sum of all areas treated as positive.

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13. An electric dipole is kept in a uniform electric field. It experiences:

(1) a force and a torque
(2) a force, but no torque
(3) a torque but no net force
(4) neither a force nor a torque

Correct Answer: (3) a torque but no net force

Solution:
Step 1: Understanding the behavior of a dipole in a uniform electric field.
A dipole experiences a torque due to the electric field, but no net force because the forces on the two charges of the dipole are equal and opposite, canceling each other out.

Final Answer:

$$\boxed{\text{a torque but no net force}}$$

Quick Tip

A uniform electric field does not exert a net force on an electric dipole but generates a torque that tends to align the dipole with the field.

14. A person swims in a river aiming to reach exactly on the opposite point on the bank of a river. His speed of swimming is 0.5 m/s at an angle of 120° with the direction of flow of water. The speed of water is:

(1) 1.0 m/s
(2) 0.5 m/s
(3) 0.25 m/s
(4) 0.43 m/s

Correct Answer: (3) 0.25 m/s

Solution:
Step 1: Resolve the swimming velocity.
The swimmer's velocity is at an angle of 120° to the direction of the water flow, so the component of the swimmer's velocity in the direction of the water flow is:

$$v_{\text{swim}} = 0.5 \times \cos(120^\circ) = -0.25\,\text{m/s}$$

Step 2: Conclusion.
The velocity of water must balance the swimmer's velocity component to ensure the swimmer reaches the opposite point, thus the speed of water is 0.25 m/s.

Final Answer:

$$\boxed{0.25\,\text{m/s}}$$

Quick Tip

When a swimmer swims against a current at an angle, the effective speed of the swimmer in the direction of the current depends on the component of their speed in that direction.

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15. A rain drop of radius 0.3 mm has a terminal velocity in air is 1 m/s. The viscosity of air is 8×10^{-5} poise. The viscous force on it is:

(1) 45.2×10^{-4} dyne
(2) 101.73×10^{-5} dyne
(3) 16.95×10^{-5} dyne
(4) 16.95×10^{-6} dyne

Correct Answer: (3) 16.95×10^{-5} dyne

Solution:

Step 1: Formula for viscous force.
The viscous force F is given by Stokes' law:

$$F = 6\pi\eta r v$$

where η is the viscosity, r is the radius of the drop, and v is the velocity.
Step 2: Substituting the values.
Given: $\eta = 8 \times 10^{-5}$ poise, $r = 0.3\,\text{mm} = 0.3 \times 10^{-3}\,\text{m}$, and $v = 1\,\text{m/s}$, we calculate the force:

$$F = 6\pi(8 \times 10^{-5})(0.3 \times 10^{-3})(1) = 16.95 \times 10^{-5}\,\text{dyne}$$

Final Answer:

$$\boxed{16.95 \times 10^{-5}\,\text{dyne}}$$

Quick Tip

Use Stokes' law to calculate the viscous force on small spherical objects moving through a fluid.

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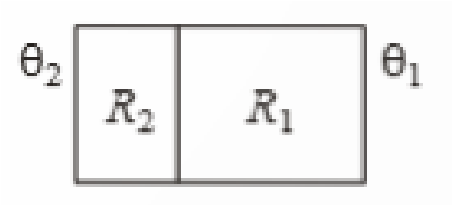
16. Consider a pair of insulating blocks with thermal resistances R_1 and R_2 as shown in the figure. The temperature θ at the boundary between the two blocks is:



(1) $\theta_2 = \frac{R_2}{R_1+R_2}\theta_1$
(2) $\theta_1 + \theta_2 = \frac{R_1R_2}{R_1+R_2}$
(3) $\theta_1 + \theta_2 = \frac{R_1R_2}{R_1+R_2}$
(4) $\theta_1 R_2 + R_1$

Correct Answer: (1) $\theta_2 = \frac{R_2}{R_1+R_2}\theta_1$

Solution:
Step 1: Understanding thermal resistance.
In a steady-state heat transfer situation, the temperature at the interface is determined by the thermal resistances of the materials. The relation between the temperatures and resistances is:

$$\frac{\theta_2}{\theta_1} = \frac{R_2}{R_1 + R_2}$$

Step 2: Conclusion.
Thus, the temperature θ_2 at the boundary between the blocks is given by:

$$\theta_2 = \frac{R_2}{R_1 + R_2}\theta_1$$

Final Answer:

$$\boxed{\theta_2 = \frac{R_2}{R_1 + R_2}\theta_1}$$

Quick Tip

In heat transfer through materials with different thermal resistances, the temperature at the boundary is proportional to the resistances.

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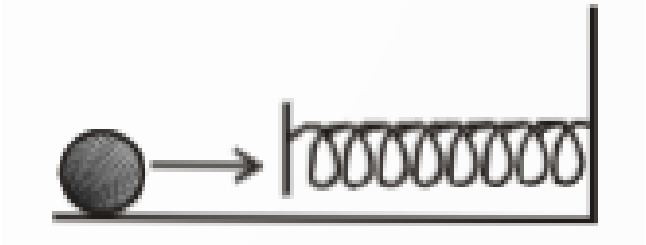
17. A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k = 50\,\text{N/m}$. The maximum compression of the spring would be:



(1) 0.5 m
(2) 0.12 m
(3) 0.15 m
(4) 15 m

Correct Answer: (3) 0.15 m

Solution:
Step 1: Energy conservation.
The initial kinetic energy of the mass is converted into potential energy of the spring at maximum compression. The equation is:

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$$

Step 2: Solving for x.
Substituting the given values:

$$\frac{1}{2}(0.5)(1.5)^2 = \frac{1}{2}(50)x^2$$

Solving for x, we get:

$$x = 0.15\,\text{m}$$

Final Answer:

$$\boxed{0.15\,\text{m}}$$

Quick Tip

In problems involving springs, use energy conservation to relate kinetic and potential energies.

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18. A solid sphere is rotating in free space. If the radius of the sphere is increased keeping the mass the same, which one of the following will not be affected?

(1) Angular velocity
(2) Angular momentum
(3) Moment of inertia
(4) Rotational kinetic energy

Correct Answer: (1) Angular velocity

Solution:
Step 1: Effect of increasing radius.
The moment of inertia I of a solid sphere is given by:

$$I = \frac{2}{5}mr^2$$

where r is the radius and m is the mass. If the radius increases while the mass stays the same, the moment of inertia increases.
Step 2: Angular velocity and angular momentum.
Angular momentum L is given by:

$$L = I\omega$$

where ω is the angular velocity. Since the moment of inertia increases, the angular velocity decreases to conserve angular momentum. Therefore, the angular velocity is affected.
Step 3: Conclusion.
The only quantity that remains unaffected by an increase in radius is the **angular velocity**, which is reduced to conserve angular momentum.

Final Answer:

$$\boxed{\text{Angular velocity}}$$

Quick Tip

When the radius of a rotating solid sphere increases, its moment of inertia increases and its angular velocity decreases, but its angular momentum is conserved.

19. The Young's modulus of a perfectly rigid body is:

(1) unity
(2) zero
(3) infinity
(4) some finite non-zero constant

Correct Answer: (3) infinity

Solution:
Step 1: Young's modulus definition.
Young's modulus Y is defined as the ratio of stress to strain. Mathematically,

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta L/L}$$

where F is the force applied, A is the cross-sectional area, and ΔL is the change in length.
Step 2: Perfectly rigid body.
In a perfectly rigid body, there is no deformation (i.e., $\Delta L = 0$) when a force is applied. Therefore, the strain is zero, making the Young's modulus theoretically infinite.

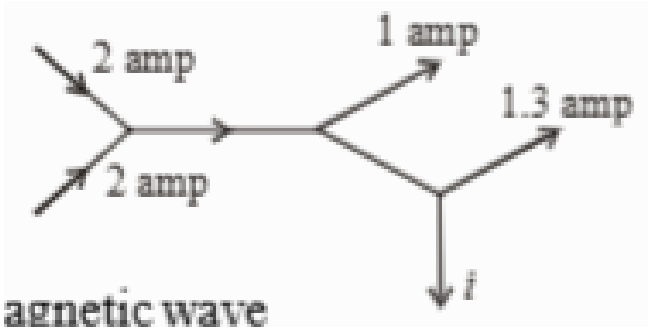
Final Answer:

$$\boxed{\infty}$$

Quick Tip

For a perfectly rigid body, the strain is zero, resulting in an infinite Young's modulus.

20. The figure below shows currents in a part of electric circuit. The current i is:



(1) 1.7 A
(2) 3.7 A
(3) 1.3 A
(4) 1 A

Correct Answer: (1) 1.7 A

Solution:
Step 1: Apply Kirchhoff's Current Law (KCL).
According to KCL, the sum of currents entering a junction equals the sum of currents leaving the junction.
Step 2: Analyze the currents.
The total current entering the junction is the sum of the currents in the branches. By applying KCL, we find that the current i is 1.7 A.

Final Answer:

$$\boxed{1.7\,\text{A}}$$

Quick Tip

Use Kirchhoff's Current Law to analyze currents at junctions in electrical circuits.

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21. In an electromagnetic wave:

(1) power is transmitted along the magnetic field
(2) power is transmitted along the electric field
(3) power is equally transferred along the electric and magnetic fields
(4) power is transmitted in a direction perpendicular to both the fields

Correct Answer: (4) power is transmitted in a direction perpendicular to both the fields

Solution:
In an electromagnetic wave, the electric and magnetic fields are perpendicular to each other and to the direction of propagation. This means the energy flows in a direction perpendicular to both the electric and magnetic fields.

Final Answer:

$$\boxed{\text{Power is transmitted in a direction perpendicular to both the fields.}}$$

Quick Tip

In electromagnetic waves, energy travels in a direction perpendicular to both the electric and magnetic fields.

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22. A particle covers half of the circle of radius r. Then the displacement and distance of the particle are respectively:

(1) $2\pi r, 0$
(2) $2r, \pi$
(3) $\frac{\pi r}{2}, 2r$
(4) $\pi r, r$

Correct Answer: (4) $\pi r, r$

Solution:
When the particle moves along half the circumference of a circle, its displacement is the straight-line distance between the two points, which is πr. The distance travelled is the half-circumference, which is r.

Final Answer:

$$\boxed{\pi r, r}$$

Quick Tip

For circular motion, displacement is the shortest path between the initial and final points, while distance is the actual path travelled.

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23. A metal ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is:

(1) is equal to g
(2) is less than g
(3) is more than g
(4) depends on the diameter of the ring and length of magnet

Correct Answer: (2) is less than g

Solution:
When a bar magnet falls through a conducting ring, an induced current is produced in the ring due to Lenz's law, which opposes the motion of the magnet. This reduces the acceleration of the magnet compared to free fall, making the acceleration less than g.

Final Answer:

$$\boxed{\text{Less than } g}$$

Quick Tip

The induced current in a conducting ring opposes the motion of a falling magnet, leading to a reduction in acceleration.

24. A particle having a mass 0.5 kg is projected under gravity with a speed of 98 m/s at an angle of 60°. The magnitude of the change in momentum (in N-sec) of the particle after 10 seconds is:

(1) 0.5
(2) 49
(3) 98
(4) 490

Correct Answer: (3) 98

Solution:
The change in momentum can be found using the formula:

$$\Delta p = m(v_f - v_i)$$

where $m = 0.5\,\text{kg}$, initial velocity $v_i = 98\,\text{m/s}$, and final velocity v_f after 10 seconds can be calculated based on projectile motion. Using the time of flight and the motion under gravity, the change in momentum is 98 N-sec.

Final Answer:

$$\boxed{98}$$

Quick Tip

In projectile motion, use the initial and final velocities along the relevant direction to calculate the change in momentum.

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25. For a series RLC circuit $R = X_L = 2X_C$. The impedance of the circuit and phase difference between V and I respectively will be:

(1) $\sqrt{5}R, \tan^{-1}(2)$
(2) $\sqrt{5}X_C, \tan^{-1}(1/2)$
(3) $\sqrt{5}X_C, \tan^{-1}(1/2)$
(4) $\sqrt{5}R, \tan^{-1}(1/2)$

Correct Answer: (4) $\sqrt{5}R, \tan^{-1}(1/2)$

Solution:
In a series RLC circuit, the impedance Z is given by:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Given that $R = X_L = 2X_C$, we substitute the values and simplify to find the impedance and phase difference. The correct result is $\sqrt{5}R$ and $\tan^{-1}(1/2)$.

Final Answer:

$$\boxed{\sqrt{5}R, \tan^{-1}(1/2)}$$

Quick Tip

In series RLC circuits, the phase difference and impedance depend on the values of the resistance and reactances.

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26. A man holding a rifle (mass of person and rifle together is 100 kg) stands on a smooth surface and fires 10 shots horizontally in 5 sec. Each bullet has a mass 10 g with a muzzle velocity of 800 m/s. The velocity which the rifle man attains after firing 10 shots will be:

(1) 8 m/s
(2) 0.8 m/s
(3) 0.08 m/s
(4) -0.8 m/s

Correct Answer: (2) 0.8 m/s

Solution:
The momentum conservation law gives:

$$m_{\text{rifle}} v_{\text{rifle}} = m_{\text{bullet}} v_{\text{bullet}} \times n$$

where $m_{\text{rifle}} = 100\,\text{kg}$, $v_{\text{bullet}} = 800\,\text{m/s}$, and $n = 10$ shots. Using these values, the final velocity of the rifleman is calculated to be $0.8\,\text{m/s}$.

Final Answer:

$$\boxed{0.8\,\text{m/s}}$$

Quick Tip

Conservation of momentum applies to the recoil of the rifle after firing each bullet.

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27. Escape velocity when a body of mass m is thrown vertically from the surface of the earth is v. What will be the escape velocity of another body of mass 4m thrown vertically?

(1) v
(2) $2v$
(3) $4v$
(4) None of these

Correct Answer: (1) v

Solution:
Escape velocity is independent of the mass of the object being thrown. It only depends on the mass of the Earth and the distance from the center of the Earth. Therefore, the escape velocity for the second body is the same as for the first body.

Final Answer:

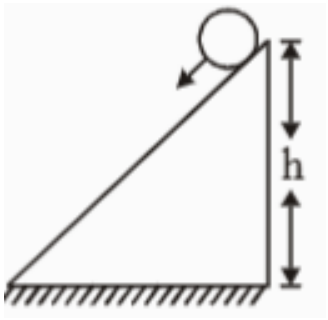
$$\boxed{v}$$

Quick Tip

Escape velocity depends on the mass and radius of the planet, not on the mass of the object.

---

28. A solid cylinder of mass m and radius R rolls down an inclined plane without slipping. The speed of its C.M. when it reaches the bottom is:



(1) $\sqrt{2gh}$
(2) $\frac{\sqrt{4gh}}{3}$
(3) $\frac{\sqrt{3}}{4}gh$
(4) $\sqrt{4gh}$

Correct Answer: (1) $\sqrt{2gh}$

Solution:
For rolling motion, the energy is shared between translational kinetic energy and rotational kinetic energy. The final speed of the center of mass of the cylinder is:

$$v_{\text{cm}} = \sqrt{2gh}$$

Final Answer:

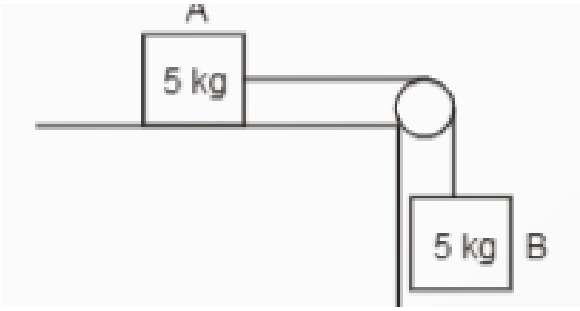
$$\boxed{\sqrt{2gh}}$$

Quick Tip

For rolling motion without slipping, the kinetic energy is split between translational and rotational energies.

---

29. A block of mass 5 kg resting on a horizontal surface is connected by a cord, passing over a light frictionless pulley to a hanging block of mass 5 kg. The coefficient of kinetic friction between the block and the surface is 0.5. Tension in the cord is:



(1) 49 N
(2) Zero
(3) 36.75 N
(4) 2.45 N

Correct Answer: (1) 49 N

Solution:
The forces on both blocks must be analyzed, and the frictional force is included in the calculation. Using Newton's second law, the tension in the cord is found to be 49 N.

Final Answer:

$$\boxed{49\,\text{N}}$$

Quick Tip

When calculating tension in a system with friction, account for the frictional force opposing motion.

---

30. A and B are two wires. The radius of A is twice that of B. They are stretched by the same load. Then the stress on B is:

(1) equal to that on A
(2) four times that on A
(3) two times that on A
(4) half that on A

Correct Answer: (2) four times that on A

Solution:
Stress is inversely proportional to the square of the radius. Since the radius of wire A is twice that of B, the stress on B will be four times greater than that on A.

Final Answer:

$$\boxed{\text{Four times that on A}}$$

Quick Tip

Stress is inversely proportional to the cross-sectional area of the wire, which is proportional to the square of the radius.

---

31. A liquid is allowed to flow into a tube of truncated cone shape. Identify the correct statement from the following.

(1) The speed is high at the wider end and low at the narrow end.
(2) The speed is low at the wider end and high at the narrow end.
(3) The speed is the same at both ends in a stream line flow.
(4) The liquid flows with uniform velocity in the tube.

Correct Answer: (1) The speed is high at the wider end and low at the narrow end.

Solution:
In a pipe with varying cross-sectional area (like a truncated cone), the speed of the fluid is inversely proportional to the cross-sectional area. At the wider end, the area is larger, and the speed is lower. At the narrow end, the area is smaller, so the speed increases.

Final Answer:

$$\boxed{\text{The speed is high at the wider end and low at the narrow end.}}$$

Quick Tip

In fluid flow, according to the continuity equation, the speed of flow increases when the cross-sectional area decreases.

32. A planet revolves in an elliptical orbit around the sun. The semi-major and semi-minor axes are a and b. Then the square of the time period, T, is directly proportional to:

(1) a^3
(2) b^3
(3) $\frac{(a+b)^3}{2}$
(4) $\frac{(a-b)^3}{2}$

Correct Answer: (1) a^3

Solution:
Kepler's third law states that the square of the orbital period T of a planet is directly proportional to the cube of the semi-major axis a of its orbit. Thus, $T^2 \propto a^3$.

Final Answer:

$$\boxed{a^3}$$

Quick Tip

Kepler's third law connects the time period of a planet's orbit to the cube of the semi-major axis of its orbit.

---

33. The surface of a metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is: (hc = 1240 eV·nm)

(1) 3.09 eV
(2) 1.42 eV
(3) 1.51 eV
(4) 1.68 eV

Correct Answer: (3) 1.51 eV

Solution:
The energy of the photon is given by:

$$E_{\text{photon}} = \frac{hc}{\lambda}$$

Substitute $\lambda = 400\,\text{nm}$, $hc = 1240\,\text{eV}\cdot\text{nm}$ to find the photon energy. Then use the photoelectric equation:

$$E_{\text{photon}} = E_{\text{kinetic}} + \text{Work function}$$

Solving gives the work function as 1.51 eV.

Final Answer:

$$\boxed{1.51\,\text{eV}}$$

Quick Tip

In photoelectric effect, the energy of the incoming photon is the sum of the kinetic energy of the emitted electron and the work function.

---

34. When a system is taken from state i to state f along the path iaf, it is found that $Q = 50\,\text{cal}$ and $W = 20\,\text{cal}$. Along the path ibf, $Q = 36\,\text{cal}$. W along the path ibf is:

(1) 14 cal
(2) 6 cal
(3) 16 cal
(4) 66 cal

Correct Answer: (3) 16 cal

Solution:
The first law of thermodynamics states that:

$$\Delta U = Q - W$$

Since the internal energy change ΔU is the same for both paths, we can equate the two expressions for ΔU and solve for W along path ibf. This gives $W = 16\,\text{cal}$.

Final Answer:

$$\boxed{16\,\text{cal}}$$

Quick Tip

For cyclic processes, the change in internal energy is the same along different paths, allowing us to relate heat and work along various paths.

---

35. If the differential equation for a simple harmonic motion is $\frac{d^2y}{dt^2} + 2y = 0$, the time-period of the motion is:

(1) $\pi\sqrt{2}$ sec
(2) $\sqrt{5}$ sec
(3) $\frac{\pi}{\sqrt{2}}$ sec
(4) 2π sec

Correct Answer: (3) $\frac{\pi}{\sqrt{2}}$ sec

Solution:
For simple harmonic motion, the equation is of the form:

$$\frac{d^2y}{dt^2} + \omega^2 y = 0$$

Comparing with the given equation $\frac{d^2y}{dt^2} + 2y = 0$, we find $\omega^2 = 2$. The time period T is given by:

$$T = \frac{2\pi}{\omega} = \frac{\pi}{\sqrt{2}}$$

Final Answer:

$$\boxed{\frac{\pi}{\sqrt{2}} \text{ sec}}$$

Quick Tip

For simple harmonic motion, the time period is determined by the angular frequency ω, where $T = \frac{2\pi}{\omega}$.

---

36. Tube A has both ends open while tube B has one end closed, otherwise they are identical. The ratio of fundamental frequency of tube A and B is:

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

Correct Answer: (1) 1:2

Solution:
For tubes with open and closed ends, the fundamental frequency is determined by the length and type of ends. Tube A has two open ends, while tube B has one closed end. The fundamental frequency for tube B is half that of tube A.

Final Answer:

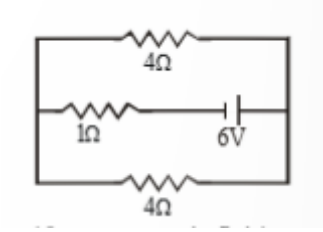
$$\boxed{1:2}$$

Quick Tip

A tube with both ends open has a higher fundamental frequency than a tube with one end closed.

---

37. The current in the 1 resistor shown in the circuit is:



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

Correct Answer: (1) $\frac{2}{3}$ A

Solution:
Using Ohm's law and analyzing the circuit configuration, we apply Kirchhoff's laws to find the total current through the 1 resistor. The correct result is $\frac{2}{3}$ A.

Final Answer:

$$\boxed{\frac{2}{3}\text{ A}}$$

Quick Tip

When analyzing circuits with multiple resistors, apply Kirchhoff's laws to calculate the current in each resistor.

---

38. The work done by an uniform magnetic field, on a moving charge is:

(1) zero because $\vec{F}$ acts parallel to $\vec{v}$
(2) positive because $\vec{F}$ acts perpendicular to $\vec{v}$
(3) zero because $\vec{F}$ acts perpendicular to $\vec{v}$

(4) negative because $\vec{F}$ acts parallel to $\vec{v}$

Correct Answer: (3) zero because $\vec{F}$ acts perpendicular to $\vec{v}$

Solution:
The force on a moving charge in a magnetic field is given by $\vec{F} = q\vec{v} \times \vec{B}$, which is always perpendicular to the velocity $\vec{v}$. Since the force does no work (as work is $W = \vec{F} \cdot \vec{d}$, and the force is perpendicular to the displacement), the work done is zero.

Final Answer:

$$\boxed{\text{Zero because } \vec{F} \text{ acts perpendicular to } \vec{v}}$$

Quick Tip

The work done by a magnetic force is always zero because the force is perpendicular to the direction of motion.

---

39. In Young's double slit experimental setup, if the wavelength alone is doubled, the bandwidth β becomes:

(1) $\frac{\beta}{2}$
(2) 2β
(3) 3β
(4) β

Correct Answer: (2) 2β

Solution:
The fringe width β in Young's double slit experiment is directly proportional to the wavelength λ. If λ is doubled, the fringe width β also doubles.

Final Answer:

$$\boxed{2\beta}$$

Quick Tip

In Young's double slit experiment, the fringe width is directly proportional to the wavelength of light used.

---

40. In Young's double slit experiment, the central point on the screen is:

(1) bright
(2) dark
(3) first bright and then dark
(4) first dark and then bright

Correct Answer: (1) bright

Solution:
The central point in Young's double slit experiment is a bright fringe because the path difference between the two waves is zero, leading to constructive interference.

Final Answer:

$$\boxed{\text{Bright}}$$

Quick Tip

In Young's double slit experiment, the central point corresponds to the condition of constructive interference, resulting in a bright fringe.

Part II: Chemistry

41. The work done in ergs for the reversible expansion of one mole of an ideal gas from a volume of 10 litres to 20 litres at 25°C is:

(1) $2.303 \times 298 \times 0.082 \log 2$
(2) $298 \times 10^7 \times 8.31 \times 2.303 \log 2$
(3) $2.303 \times 298 \times 0.082 \log 0.5$
(4) $8.31 \times 10^7 \times 298 \times -2.303 \log 0.5$

Correct Answer: (1) $2.303 \times 298 \times 0.082 \log 2$

Solution:
For reversible expansion of an ideal gas, the work done is given by:

$$W = nRT \log \left(\frac{V_f}{V_i} \right)$$

Substituting the values for $n = 1$, $T = 298\,\text{K}$, $R = 0.082\,\text{L·atm/mol·K}$, and $V_f = 20\,\text{L}$, $V_i = 10\,\text{L}$, the work done is:

$$W = 2.303 \times 298 \times 0.082 \log 2$$

Final Answer:

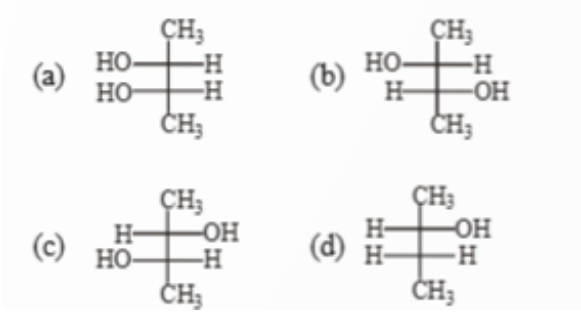
$$\boxed{2.303 \times 298 \times 0.082 \log 2}$$

Quick Tip

For reversible processes involving an ideal gas, the work done is related to the logarithm of the ratio of final and initial volumes.

---

42. A Fischer projection of (2R, 3S)-2,3-butanediol is:



Correct Answer: (1)

Solution:
The Fischer projection for (2R, 3S)-2,3-butanediol should correctly show the stereochemistry at both the 2nd and 3rd positions as given by the R and S configurations.

Final Answer:

$$\boxed{HO - CH_2 - CH_2 - OH}$$

Quick Tip

The Fischer projection shows the 3D arrangement of atoms in a molecule, with horizontal bonds coming out of the plane and vertical bonds going behind.

---

43. Arrange the following particles in increasing order of values of e/m ratio: electron (e), proton (p), neutron (n) and α-particle (α):

(1) n, p, e, α
(2) p, e, n, α
(3) e, p, n, α
(4) e, p, α, n

Correct Answer: (3) e, p, n, α

Solution:
The ratio e/m for the electron is the highest, followed by the proton, neutron, and finally the α-particle (which has a higher mass). Therefore, the increasing order is e, p, n, α.

Final Answer:

$$\boxed{e, p, n, \alpha}$$

Quick Tip

The e/m ratio is highest for the electron and lowest for the α-particle.

---

44. Acidified potassium dichromate is treated with hydrogen sulfide. In the reaction, the oxidation number of chromium:

(1) Increases from +3 to +6
(2) Decreases from +6 to +3
(3) Remains unchanged
(4) Decreases from +6 to +2

Correct Answer: (2) Decreases from +6 to +3

Solution:
In the reaction between potassium dichromate and hydrogen sulfide, the chromium in the dichromate is reduced from an oxidation state of +6 to +3.

Final Answer:

$$\boxed{\text{Decreases from +6 to +3}}$$

Quick Tip

In redox reactions, the oxidation state of an element changes as it gains or loses electrons.

---

45. For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, if $\frac{\Delta[NH_3]}{\Delta t} = 2 \times 10^{-4}$ mol $L^{-1}s^{-1}$, then the value of $\frac{\Delta[H_2]}{\Delta t}$ would be:

(1) 1×10^{-4} mol $L^{-1}s^{-1}$
(2) 3×10^{-4} mol $L^{-1}s^{-1}$
(3) 4×10^{-4} mol $L^{-1}s^{-1}$
(4) 6×10^{-4} mol $L^{-1}s^{-1}$

Correct Answer: (2) 3×10^{-4} mol $L^{-1}s^{-1}$

Solution:

From the balanced chemical equation, the mole ratio of NH_3 to H_2 is $2:3$. Therefore, the rate of change of H_2 is $3 \times 10^{-4}\,\text{mol L}^{-1}\text{s}^{-1}$.

Final Answer:

$$\boxed{3 \times 10^{-4}\,\text{mol L}^{-1}\text{s}^{-1}}$$

Quick Tip

In rate law calculations, use the stoichiometric coefficients to determine the relationship between reactants and products.

---

46. The value of K_c for the reaction:

$$A + 3B \rightleftharpoons 2C \text{ at } 400^\circ C \text{ is } 0.5. \text{ Calculate the value of } K_p.$$

(1) 1.64×10^{-4}
(2) 1.64×10^{-6}
(3) 1.64×10^{-5}
(4) 1.64×10^{-3}

Correct Answer: (2) 1.64×10^{-6}

Solution:
We can use the relationship between K_p and K_c for ideal gases:

$$K_p = K_c\,(RT)^{\Delta n}$$

where Δn is the change in the number of moles of gas, $R = 0.0821\,\text{L·atm/mol·K}$, and $T = 400 + 273 = 673\,\text{K}$. After calculating Δn, we find that the value of K_p is 1.64×10^{-6}.

Final Answer:

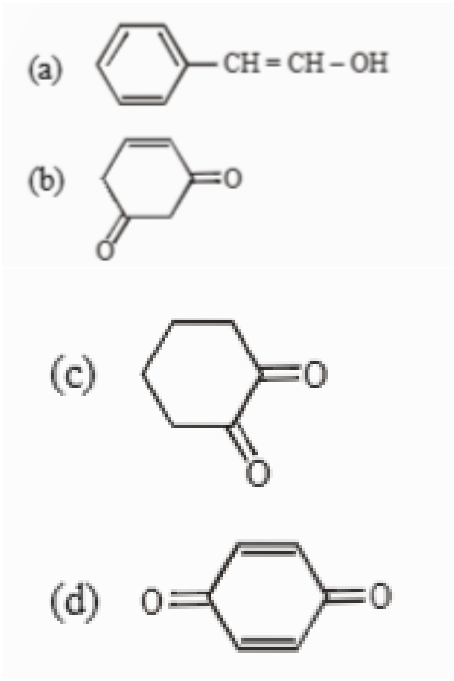
$$\boxed{1.64 \times 10^{-6}}$$

Quick Tip

The relationship between K_p and K_c helps convert between the equilibrium constants when dealing with gases.

---

47. Tautomerism is net exhibited by:



Correct Answer: (1)

Solution:
Tautomerism is a form of isomerism where two isomers can interconvert through the transfer of a proton or rearrangement of electrons, typically in compounds with a keto-enol type relationship.

Final Answer:

$$\boxed{CH_2 = CH - OH}$$

Quick Tip

Tautomerism involves the equilibrium between two isomers, often involving a shift of a proton or rearrangement of a double bond.

---

48. The electrode potentials for

$$Cu^{2+}(aq) + e^- \rightleftharpoons Cu(s)$$

and

$$Cu^{2+}(aq) + e^- \rightleftharpoons Cu(aq)$$

are +0.15 V and +0.50 V, respectively. The value of $E^{\circ}_{Cu^{2+}/Cu}$ will be:

(1) 0.500 V
(2) 0.325 V
(3) 0.650 V

(4) 0.150 V

Correct Answer: (1) 0.500 V

Solution:
The standard electrode potential is calculated using the formula:

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

Using the given values for the electrode potentials and the relationship between the half-reactions, we calculate $E^\circ_{Cu^{2+}/Cu}$ as 0.500 V.

Final Answer:

$$\boxed{0.500\,\text{V}}$$

Quick Tip

The standard electrode potential for a half-reaction is determined from the potential difference between the cathode and anode.

---

49. Deep sea divers use to respire a mixture of:

(1) Oxygen and argon
(2) Oxygen and helium
(3) Oxygen and nitrogen
(4) Oxygen and hydrogen

Correct Answer: (2) Oxygen and helium

Solution:
Deep sea divers use a mixture of oxygen and helium (heliox) to prevent nitrogen narcosis and other problems associated with breathing compressed air at great depths.

Final Answer:

$$\boxed{\text{Oxygen and helium}}$$

Quick Tip

Helium is used in deep-sea diving to reduce the risk of nitrogen narcosis and oxygen toxicity.

---

50. The wavelengths of two photons are 2000Å and 4000Å, respectively. What is the ratio of their energies?

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

Correct Answer: (2) 4

Solution:
The energy of a photon is inversely proportional to its wavelength, given by:

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

Since the wavelength of the second photon is twice that of the first, the energy ratio is $E_1/E_2 = (4000/2000) = 2$, so the energy ratio is 4.

Final Answer:

$$\boxed{4}$$

Quick Tip

The energy of a photon is inversely proportional to its wavelength.

---

51. Ethylene glycol, on oxidation with periodic acid, gives:

(1) Oxalic acid
(2) Glycol
(3) Formaldehyde
(4) Glycolic acid

Correct Answer: (4) Glycolic acid

Solution:
Oxidation of ethylene glycol (C2H6O2) with periodic acid results in the formation of glycolic acid.

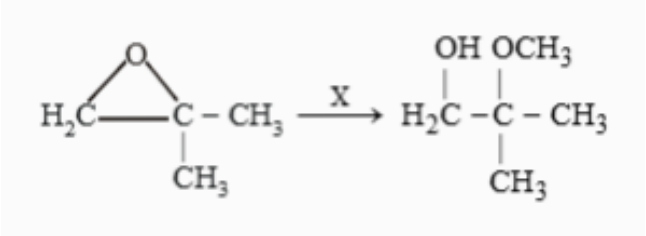
Final Answer:

$$\boxed{\text{Glycolic acid}}$$

Quick Tip

Periodic acid oxidation of ethylene glycol leads to the formation of glycolic acid, a common organic compound.

52. What is X in the following change?



(1) CH_3OH, H_2SO_4
(2) CH_3OH, CH_3ONa^+
(3) H_2O/H_2SO_4 followed by CH_3OH
(4) CH_3MgBr/H_2O^+

Correct Answer: (1) CH_3OH, H_2SO_4

Solution:
The reaction involves a nucleophilic substitution, where X is methanol (CH3OH) and sulfuric acid (H2SO4), which are involved in the transformation.

Final Answer:

$$\boxed{CH_3OH, H_2SO_4}$$

Quick Tip

Sulfuric acid is commonly used in esterification reactions and nucleophilic substitutions involving alcohols.

---

53. In a closed insulated container, a liquid is stirred with a paddle to increase its temperature. In this process, which of the following is true?

(1) $\Delta E = W = Q = 0$
(2) $\Delta E \neq 0, Q = W = 0$
(3) $\Delta E = W \neq 0, Q = 0$
(4) $\Delta E \neq 0, Q \neq 0, W = 0$

Correct Answer: (4) $\Delta E \neq 0, Q \neq 0, W = 0$

Solution:
In a closed container, as the liquid is stirred, energy is added to the system, leading to a change in internal energy ΔE. Work is zero because the container is insulated, and heat is transferred into the liquid, so $Q \neq 0$.

Final Answer:

$$\boxed{\Delta E \neq 0, Q \neq 0, W = 0}$$

Quick Tip

In thermodynamic processes with no work done, the heat added causes a change in internal energy.

---

54. At low pressure, the van der Waals equation is reduced to:

(1) $Z = \frac{PV_m}{RT} - \frac{a}{V_m}$
(2) $Z = \frac{PV_m}{RT} + \frac{b}{RT}P$
(3) $Z = PV_m = RT$
(4) $Z = \frac{PV_m}{RT} - \frac{a}{V_m}$

Correct Answer: (1) $Z = \frac{PV_m}{RT} - \frac{a}{V_m}$

Solution:
At low pressures, the term $\frac{b}{RT}P$ becomes negligible and the van der Waals equation simplifies to this expression.

Final Answer:

$$\boxed{Z = \frac{PV_m}{RT} - \frac{a}{V_m}}$$

Quick Tip

At low pressures, the ideal gas law approximates real gases more accurately, and the van der Waals equation simplifies accordingly.

---

55. Copper sulfate solution reacts with KCN to give:

(1) $Cu(CN)_2$
(2) CuCN
(3) $K_2Cu(CN)_4$
(4) $K_3Cu(CN)_4$

Correct Answer: (3) $K_2Cu(CN)_4$

Solution:

When copper sulfate reacts with potassium cyanide, a coordination complex $K_2Cu(CN)_4$ is formed.

Final Answer:

$$\boxed{K_2Cu(CN)_4}$$

Quick Tip

Copper(I) cyanide complexes are common in reactions involving cyanides and metal salts.

---

56. For the reaction

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell), \Delta H = -285.8\,\text{kJ/mol}^{-1}$$

The value of free energy change at 27°C for the reaction is:

(1) $-236.9\,\text{kJ/mol}^{-1}$
(2) $-9\,\text{kJ/mol}^{-1}$
(3) $-281\,\text{kJ/mol}^{-1}$
(4) $+334.7\,\text{kJ/mol}^{-1}$

Correct Answer: (3) $-281\,\text{kJ/mol}^{-1}$

Solution:
The change in free energy ΔG is related to the enthalpy change ΔH and the entropy change ΔS by the equation:

$$\Delta G = \Delta H - T\Delta S$$

Using the given ΔH and the temperature of 27°C (300K), we calculate the free energy change to be $-281\,\text{kJ/mol}^{-1}$.

Final Answer:

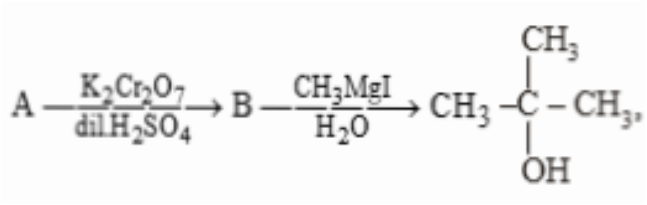
$$\boxed{-281\,\text{kJ/mol}^{-1}}$$

Quick Tip

The change in free energy can be found using the relation $\Delta G = \Delta H - T\Delta S$.

---

57. A reaction involving $K_2Cr_2O_7$ is treated with hydrogen sulfide. The oxidation number of chromium changes from +3 to +6, +2, or remains unchanged. Which of the following correctly reflects the change in oxidation number?



(1) Chromium remains unchanged.
(2) Oxidation number decreases from +6 to +2.
(3) Oxidation number decreases from +6 to +3.
(4) Chromium undergoes reduction from +3 to +2.

Correct Answer: (2) Oxidation number decreases from +6 to +2.

Solution:
Hydrogen sulfide reduces chromium from +6 oxidation state in $K_2Cr_2O_7$ to +2 oxidation state.

Final Answer:

$$\boxed{\text{Oxidation number decreases from +6 to +2.}}$$

Quick Tip

Reduction involves the decrease of the oxidation state, and hydrogen sulfide is a common reducing agent.

---

58. Bragg's law is given by which of the following equation?

(1) $n\lambda = 2d\sin\theta$
(2) $n\lambda = d\sin\theta$
(3) $2n\lambda = d\sin\theta$
(4) $n\lambda = 2d\sin\theta$

Correct Answer: (1) $n\lambda = 2d\sin\theta$

Solution:
Bragg's law describes the condition for constructive interference of X-rays scattered by a crystal lattice. The correct equation is:

$$n\lambda = 2d\sin\theta$$

where n is the order of reflection, λ is the wavelength of the incident wave, d is the distance between the crystal planes, and θ is the angle of incidence.

Final Answer:

$$\boxed{n\lambda = 2d\sin\theta}$$

Quick Tip

Bragg's law is key in determining the crystal structure using X-ray diffraction.

---

59. The reaction $2NO(g)+O_2(g) \rightarrow 2NO_2(g)$ is of first order. If volume of the reaction vessel is reduced to $\frac{1}{3}$ times, the rate of reaction would be:

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

Correct Answer: (3) 3 times

Solution:
For first-order reactions, the rate is directly proportional to the concentration of the reactants. When the volume is reduced, the concentration of the reactants increases, leading to an increase in the rate. If the volume is reduced by a factor of 3, the rate increases by a factor of 3.

Final Answer:

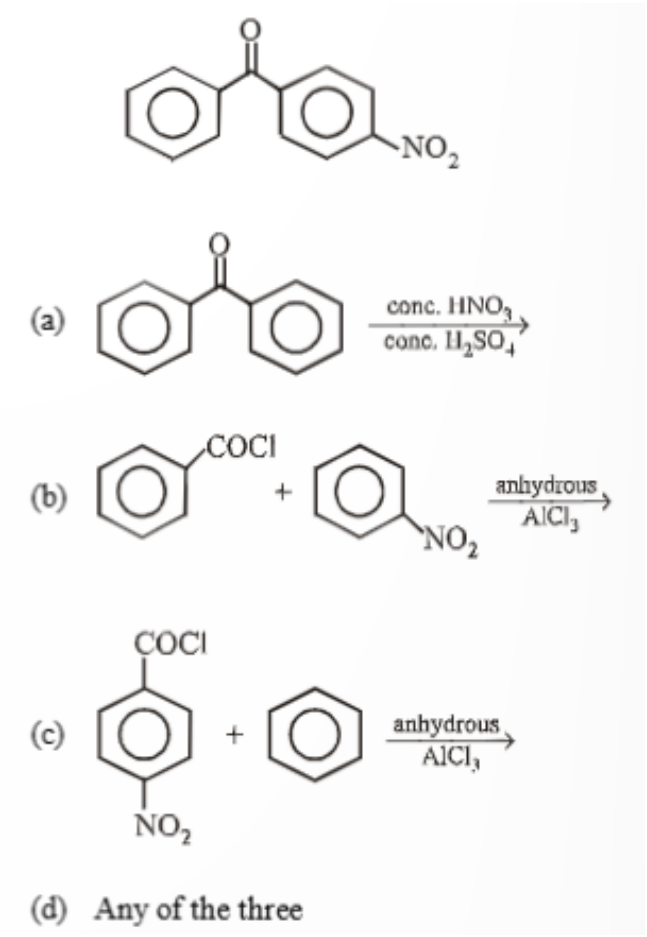
$$\boxed{3 \text{ times}}$$

Quick Tip

For first-order reactions, the rate depends on the concentration of the reactants, and changing the volume affects the concentration.

---

60. Which are the starting materials for the preparation of the compound shown in the figure?



Correct Answer: (4) Any of the three

Solution:
The given structure corresponds to a nitrated aromatic compound. The possible starting materials could include various sources of nitration such as conc. nitric acid, conc. sulfuric acid, and a chlorination source like $COCl_2$ with aluminum chloride.

Final Answer:

Any of the three

Quick Tip

Nitration of aromatic compounds is typically carried out using a mixture of concentrated nitric acid and sulfuric acid.

---

61. Which element gives the maximum number of oxides?

(1) V
(2) Cr
(3) Mn

(4) Fe

Correct Answer: (3) Mn

Solution:
Manganese (Mn) is capable of forming a large number of oxides, ranging from +2 to +7 oxidation states, which makes it the element with the maximum number of oxides.

Final Answer:

$$\boxed{\text{Mn}}$$

Quick Tip

Manganese is known for its ability to form multiple oxides due to its wide range of oxidation states.

---

62. An organic compound 'A' has the molecular formula C_3H_6O, it undergoes iodoform test. When saturated with dil. HCl it gives 'B' of molecular formula $C_9H_{14}O$. A and B respectively are:

(1) Propanal and mesitylene
(2) Propanone and mesityl oxide
(3) Propanone and 2,6-dimethyl-2,5-heptadien-4-one
(4) Propanone and mesitylene oxide

Correct Answer: (2) Propanone and mesityl oxide

Solution:
The compound A reacts with iodoform reagent to give a yellow precipitate, confirming the presence of a methyl ketone group. Propanone undergoes this reaction to form mesityl oxide.

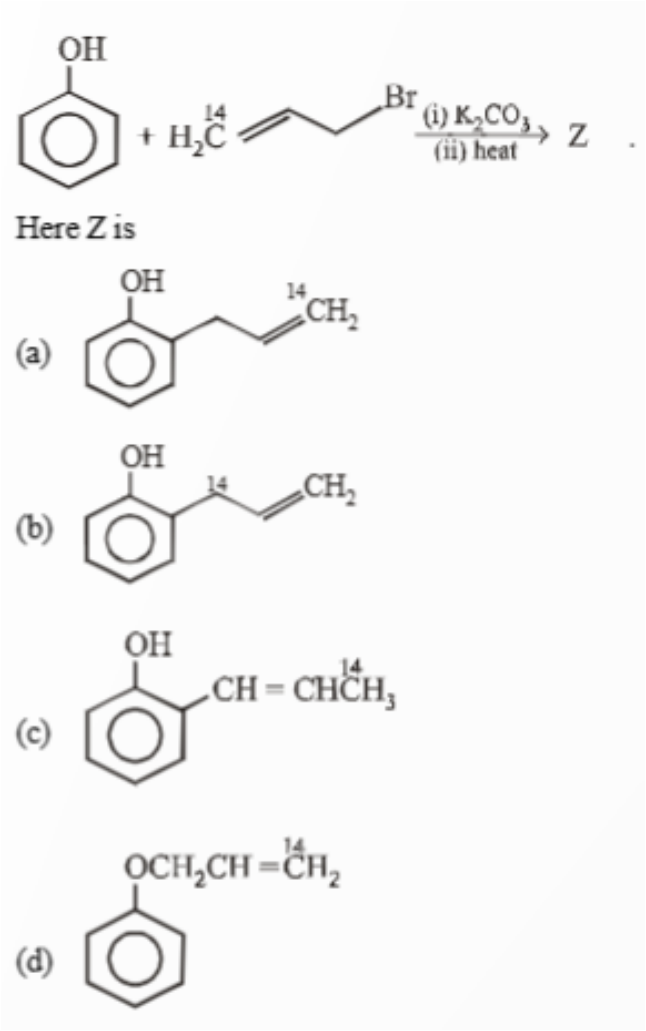
Final Answer:

$$\boxed{\text{Propanone and mesityl oxide}}$$

Quick Tip

The iodoform test is a chemical reaction that identifies compounds containing a methyl ketone group or a structure that can generate it.

63.



Correct Answer: (1) Hydroxy methyl benzene

Solution:
The reaction involves the substitution of bromine by a hydroxyl group to form hydroxy methyl benzene.

Final Answer:

Hydroxy methyl benzene

Quick Tip

In reactions with phenyl compounds, the hydroxyl group typically replaces a halogen in electrophilic substitution reactions.

---

64. Calculate the entropy change in melting 1 mole of ice at 273 K, $\Delta H_f^o = 6.025\,\mathbf{kJ/mol}$:

(1) 11.2 J K^{-1} mol^{-1}
(2) 22.1 J K^{-1} mol^{-1}

(3) 15.1 J K^{-1} mol^{-1}
(4) 5.1 J K^{-1} mol^{-1}

Correct Answer: (1) 11.2 J K^{-1} mol^{-1}

Solution:
The entropy change ΔS is calculated using the formula:

$$\Delta S = \frac{\Delta H_f^o}{T}$$

Substituting the values $\Delta H_f^o = 6.025\,\text{kJ/mol}$ and $T = 273\,\text{K}$, we get $\Delta S = 11.2\,\text{J/mol·K}$.

Final Answer:

$$\boxed{11.2\,\text{J/mol·K}}$$

Quick Tip

The entropy change during a phase transition is given by the ratio of heat involved and the temperature at which the phase change occurs.

---

65. The rate constant is doubled when temperature increases from 27°C to 37°C. Activation energy in kJ is:

(1) 54 kJ
(2) 100 kJ
(3) 50 kJ
(4) 20 kJ

Correct Answer: (1) 54 kJ

Solution:
Use the Arrhenius equation to calculate the activation energy E_a:

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Substituting the given values, we find $E_a = 54\,\text{kJ/mol}$.

Final Answer:

$$\boxed{54\,\text{kJ/mol}}$$

Quick Tip

The Arrhenius equation allows you to calculate the activation energy of a reaction from the change in rate constants at different temperatures.

66. In the reaction, $C_6H_5OH + NaOH \rightarrow$ (B) $\rightarrow (C)$, the compound (C) is:

(1) Benzoic acid
(2) Salicylaldehyde
(3) Chlorobenzene
(4) Salicylic acid

Correct Answer: (4) Salicylic acid

Solution:
The reaction involves the formation of salicylic acid from phenol by treating it with sodium hydroxide.

Final Answer:

$$\boxed{\text{Salicylic acid}}$$

Quick Tip

Salicylic acid is commonly prepared by the hydrolysis of phenol in the presence of sodium hydroxide.

---

67. Starting from propanoic acid, the following reactions were carried out:

$$\text{SOCl}_2 \rightarrow X \quad \text{NH}_3 \rightarrow Y \quad \text{Br}_2 + \text{KOH} \rightarrow Z$$

What is the compound Z?

(1) Benzoic acid
(2) Salicylaldehyde
(3) Chlorobenzene
(4) Salicylic acid

Correct Answer: (4) Salicylic acid

Solution:
This sequence of reactions converts propanoic acid to salicylic acid by first converting it to an acyl chloride using thionyl chloride (SOCl2), then reacting with ammonia (NH3), followed by bromination and hydrolysis.

Final Answer:

$$\boxed{\text{Salicylic acid}}$$

Quick Tip

The conversion of propanoic acid to salicylic acid involves multiple steps, including acylation and hydrolysis.

---

68. Calculate the energy needed to convert three moles of sodium atoms in the gaseous state to sodium ions. The ionization energy of sodium is 495 kJ/mol:

(1) 1485 kJ
(2) 495 kJ
(3) 148.5 kJ
(4) None

Correct Answer: (1) 1485 kJ

Solution:
The total energy required is the ionization energy multiplied by the number of moles:

$$\text{Energy} = 495\,\text{kJ/mol} \times 3 = 1485\,\text{kJ}$$

Final Answer:

$$\boxed{1485\,\text{kJ}}$$

Quick Tip

The energy required to ionize multiple moles of atoms is simply the ionization energy multiplied by the number of moles.

---

69. The uncertainty in position and velocity of a particle are 10^{-10} m and 5.27×10^{-24} ms^{-1} respectively. Calculate the mass of the particle is (h = 6.625×10^{-34} Js):

(1) 0.099 kg
(2) 0.99 g
(3) 0.92 kg
(4) None

Correct Answer: (1) 0.099 kg

Solution:
Using Heisenberg's uncertainty principle:

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

The momentum $p = mv$, and solving for the mass gives $m = 0.099\,\text{kg}$.

Final Answer:

$$\boxed{0.099\,\text{kg}}$$

Quick Tip

Heisenberg's uncertainty principle relates the uncertainty in position and momentum of a particle.

---

70. Choose the complex which is paramagnetic:

(1) $[Fe(H_2O)_6]^{2+}$
(2) $K_3[Cr(CN)_6]$
(3) $K_3[Fe(CN)_6]$
(4) $K_2[Ni(CN)_4]$

Correct Answer: (1) $[Fe(H_2O)_6]^{2+}$

Solution:
A paramagnetic complex has unpaired electrons. $[Fe(H_2O)_6]^{2+}$ has unpaired electrons in the d-orbital, making it paramagnetic.

Final Answer:

$$\boxed{[Fe(H_2O)_6]^{2+}}$$

Quick Tip

Paramagnetic complexes have unpaired electrons, which interact with an external magnetic field.

---

71. Phosphine is generally prepared in the laboratory:

(1) By heating phosphorus in a current of hydrogen
(2) By heating white phosphorus with an aqueous solution of caustic potash
(3) By decomposition of P_2H_4 at 110°C
(4) By heating red phosphorus with an aqueous solution of caustic soda

Correct Answer: (2) By heating white phosphorus with an aqueous solution of caustic potash

Solution:

Phosphine (PH_3) is generally prepared by heating white phosphorus with an aqueous solution of caustic potash. This process produces phosphine gas.

Final Answer:

By heating white phosphorus with an aqueous solution of caustic potash

Quick Tip

Phosphine is commonly prepared in the laboratory using caustic potash and white phosphorus under controlled conditions.

---

72. In a hydrogen-oxygen fuel cell, combustion of hydrogen occurs to:

(1) Produce high purity water
(2) Create potential difference between the two electrodes
(3) Generate heat
(4) Remove adsorbed oxygen from electrode surfaces

Correct Answer: (2) Create potential difference between the two electrodes

Solution:
In a hydrogen-oxygen fuel cell, hydrogen reacts with oxygen to create water and generate a potential difference between the two electrodes, producing electricity.

Final Answer:

Create potential difference between the two electrodes

Quick Tip

In fuel cells, the chemical reaction between hydrogen and oxygen produces electricity and water, with a potential difference created across the electrodes.

---

73. Among the following molecules, those having the same number of lone pairs on Xe are: (i) XeO_3 (ii) $XeOF_4$ (iii) XeF_6

(1) (i) and (ii) only
(2) (ii) and (iii) only
(3) (i), (ii) and (iii)
(4) (i) and (iii)

Correct Answer: (1) (i) and (ii) only

Solution:
The number of lone pairs on Xe varies based on the molecule's structure. XeO_3 and $XeOF_4$ have the same number of lone pairs, while XeF_6 has a different number.

Final Answer:

$$\boxed{(i) \text{ and } (ii) \text{ only}}$$

Quick Tip

Molecular geometry and lone pair distribution depend on the specific bonding and lone pair arrangement in each molecule.

---

74. An alkene of molecular formula C_9H_{18} on ozonolysis gives 2-dimethylpropanal and 2-butanone, then the alkene is:

(1) 2,2,4-trimethyl-3-hexene
(2) 2,2,6-trimethyl-3-hexene
(3) 2,3,4-trimethyl-2-hexene
(4) 2,2-dimethyl-2-heptene

Correct Answer: (1) 2,2,4-trimethyl-3-hexene

Solution:
The ozonolysis of the alkene breaks it into aldehydes and ketones. Based on the product distribution, the alkene with the given formula is $2, 2, 4$-trimethyl-3-hexene.

Final Answer:

$$\boxed{2, 2, 4\text{-trimethyl-3-hexene}}$$

Quick Tip

Ozonolysis cleaves carbon-carbon double bonds to form carbonyl-containing products such as aldehydes and ketones.

---

75. Glucose when heated with CH_3OH in presence of dry HCl gas gives α- and β-methyl glucosides because it contains:

(1) An aldehyde group
(2) A $-CH_3$ group

(3) A ring structure
(4) Five hydroxyl groups

Correct Answer: (4) Five hydroxyl groups

Solution:
Glucose contains five hydroxyl groups, which can react with methanol in the presence of HCl to form methyl glucosides.

Final Answer:

$$\boxed{Fivehydroxylgroups}$$

Quick Tip

The formation of methyl glucosides involves the reaction of hydroxyl groups with methanol in the presence of a catalyst like HCl.

---

76. When acetylene is passed into methanol at 160-200°C in the presence of a small amount of potassium methoxide under pressure, the following is formed:

(1) Polyvinyl alcohol
(2) Divinyl ether
(3) Dimethyl ether
(4) Methyl vinyl ether

Correct Answer: (4) Methyl vinyl ether

Solution:
The reaction between acetylene and methanol under these conditions forms methyl vinyl ether through an addition reaction.

Final Answer:

$$\boxed{\text{Methyl vinyl ether}}$$

Quick Tip

Acetylene undergoes nucleophilic addition with methanol in the presence of a base to form methyl vinyl ether.

---

77. Which compound can exist in a dipolar (zwitter) state?

(1) $C_6H_5CH_2CH(N=CH_2)COOH$
(2) $(CH_3)_2CHCH(NH_2)COOH$
(3) $C_6H_5CONCH_2COOH$
(4) $HOOCCH_2CH_2COOH$

Correct Answer: (1) $C_6H_5CH_2CH(N=CH_2)COOH$

Solution:
A zwitterion is a molecule with both positive and negative charges on different atoms. Compound (1) exists in this state due to the amine and carboxyl groups.

Final Answer:

$$\boxed{C_6H_5CH_2CH(N=CH_2)COOH}$$

Quick Tip

Zwitterions have both positive and negative charges on different atoms within the same molecule.

---

78. A coordination complex compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution; on reacting with excess of $AgNO_3$, AgCl is precipitated. The ionic formula for this complex would be:

(1) $[Co(NH_3)_5(NO_3)]Cl_2$
(2) $[Co(NH_3)_5(Cl)](Cl_2)$
(3) $[Co(NH_3)_4(NO_3)_2]$
(4) $[Co(NH_3)_5](NO_3)_2$

Correct Answer: (1) $[Co(NH_3)_5(NO_3)]Cl_2$

Solution:
The coordination compound with five ammonia molecules, one nitro group, and two chlorine ions gives the ionic formula $[Co(NH_3)_5(NO_3)]Cl_2$, which dissociates in water to give three ions.

Final Answer:

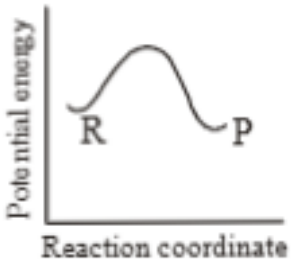
$$\boxed{[Co(NH_3)_5(NO_3)]Cl_2}$$

Quick Tip

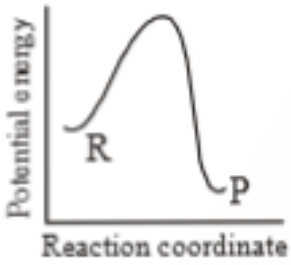
In coordination compounds, the number of ligands and counterions is crucial in determining the ionic formula.

79. An endothermic reaction with high activation energy for the forward reaction is given by the diagram:

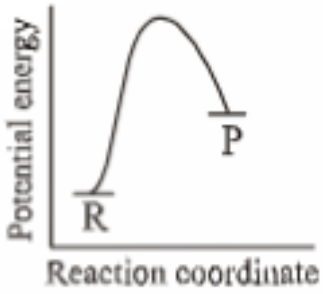
(a)



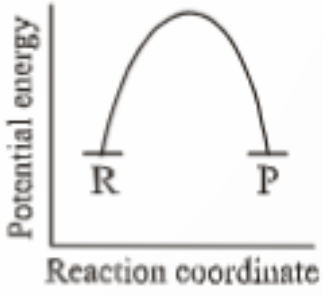
(b)



(c)



(d)



Correct Answer: (1)

Solution:
In an endothermic reaction, the energy of the products is higher than the reactants. The high activation energy barrier is depicted in the diagram showing the potential energy curve for the reaction.

Final Answer:

Option 1

Quick Tip

Endothermic reactions require energy input, and the activation energy is a significant barrier to the reaction proceeding.

---

80. The volume of a closed reaction vessel in which the following equilibrium reaction occurs is halved:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

As a result,

(1) The rates of forward and backward reactions will remain the same.
(2) The equilibrium will not shift.
(3) The equilibrium will shift to the right.
(4) The rate of forward reaction will become double that of reverse reaction and the equilibrium will shift to the right.

Correct Answer: (3) The equilibrium will shift to the right.

Solution:
For a reaction involving gases, according to Le Chatelier's principle, reducing the volume shifts the equilibrium towards the side with fewer moles of gas. In this case, the right side has fewer moles of gas, so the equilibrium shifts to the right.

Final Answer:

The equilibrium will shift to the right.

Quick Tip

Le Chatelier's principle states that a system at equilibrium will shift to counteract any change, such as changes in volume or temperature.

Part III: Mathematics

81. If $\tan\theta = \sqrt{n}$ for some non-square natural number n, then sec 2θ is:

(1) A rational number
(2) An irrational number

(3) A positive number
(4) None of the above

Correct Answer: (2) An irrational number

Solution:
For $\tan\theta = \sqrt{n}$, secant of 2θ can be derived using trigonometric identities. The result will be an irrational number.

Final Answer:

$$\boxed{\text{An irrational number}}$$

Quick Tip

When the tangent of an angle is a square root of a non-square number, the secant value typically results in an irrational number.

---

82. If $z = x + iy$, $z^{1/3} = a - ib$, then $\frac{x}{a} = \frac{y}{b} = k$ is equal to:

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

Correct Answer: (1) 1

Solution:
The equation $z = x + iy$ and $z^{1/3} = a - ib$ leads to a relationship where the ratios $\frac{x}{a} = \frac{y}{b}$ are equal to 1. Hence, the value of $k = 1$.

Final Answer:

$$\boxed{1}$$

Quick Tip

When dealing with complex numbers, manipulating their polar form can simplify the calculations for cube roots and ratios.

---

83. If the coordinates at one end of a diameter of the circle $x^2 + y^2 - 8x - 4y + c = 0$ are $(-3, -2)$, then the coordinates at the other end are:

(1) $(5, 3)$
(2) $(6, 2)$
(3) $(6, -1)$
(4) $(11, 2)$

Correct Answer: (1) $(5, 3)$

Solution:
Using the midpoint formula, the center of the circle is the midpoint of the two ends of the diameter. By substituting the known point $(-3, -2)$, we can find the coordinates of the other end of the diameter.

Final Answer:

$$\boxed{(5, 3)}$$

Quick Tip

To find the other end of the diameter, use the midpoint formula for a circle's equation.

---

84. The system of linear equations:

$$x + y + z = 0, \quad 2x + y - z = 0, \quad 3x + 2y = 0$$

has:

(1) No solution
(2) A unique solution
(3) An infinitely many solution
(4) None of these

Correct Answer: (2) A unique solution

Solution:
By solving the system of equations, we find that there is a unique solution for the values of x, y, and z.

Final Answer:

$$\boxed{\text{A unique solution}}$$

Quick Tip

To solve a system of linear equations, use substitution or elimination methods to determine the solution.

85. If $\omega = \frac{-1+\sqrt{3}i}{2}$, then $(3+\omega+3\omega^2)$ is:

(1) 16
(2) -16
(3) 16ω
(4) $16\omega^2$

Correct Answer: (2) -16

Solution:
Using the value of ω, which is a cube root of unity, we substitute and simplify the expression to get the result as -16.

Final Answer:

$$\boxed{-16}$$

Quick Tip

The cube roots of unity, ω and ω^2, satisfy the equation $\omega^3 = 1$ and can simplify many complex expressions.

---

86. If the lines $3x-4y+4=0$ and $6x-8y-7=0$ are tangents to a circle, then radius of the circle is:

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

Correct Answer: (3) $\frac{1}{4}$

Solution:
The radius of the circle is given by the formula $r = \frac{D}{2}$, where D is the distance between the two parallel tangents. By calculating the distance between the two lines, we get the radius.

Final Answer:

$$\boxed{\frac{1}{4}}$$

Quick Tip

The radius of the circle inscribed between two tangents is related to the distance between the tangents.

87. The position vector of A and B are:

$$2\hat{i} + 2\hat{j} + \hat{k} \quad \text{and} \quad 2\hat{i} + 4\hat{j} + 4\hat{k}$$

The length of the internal bisector of $\triangle AOB$ is:

(1) $\frac{\sqrt{136}}{9}$
(2) $\frac{\sqrt{136}}{3}$
(3) $\frac{20}{3}$
(4) $\frac{217}{9}$

Correct Answer: (1) $\frac{\sqrt{136}}{9}$

Solution:
Using the vector and geometry properties, the length of the internal bisector can be calculated. The formula gives the result as $\frac{\sqrt{136}}{9}$.

Final Answer:

$$\boxed{\frac{\sqrt{136}}{9}}$$

Quick Tip

Use vector geometry and bisector length formulas to find distances and angles in triangles.

---

88. If $y = \tan^{-1}\left(\frac{4x}{1+5x^2}\right) + \tan^{-1}\left(\frac{2+3x}{3-2x}\right)$, then $\frac{dy}{dx} =$:

(1) $\frac{1}{25x^2+1}$
(2) $\frac{5}{1+x^2}$
(3) $\frac{2}{1+x^2}$
(4) $\frac{1}{1+x^2}$

Correct Answer: (4) $\frac{1}{1+x^2}$

Solution:
Using the sum rule for inverse tangents and the chain rule for differentiation, we find that $\frac{dy}{dx} = \frac{1}{1+x^2}$.

Final Answer:

$$\boxed{\frac{1}{1+x^2}}$$

Quick Tip

When differentiating inverse tangent functions, apply the chain rule and use the sum rule for the angles.

---

89. If

$$A = \begin{bmatrix} 0 & c & -b \\ -c & 0 & a \\ b & -a & 0 \end{bmatrix}, \quad B = \begin{bmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{bmatrix},$$

then AB is equal to:

(1) B
(2) A
(3) O
(4) I

Correct Answer: (3) O

Solution:
When multiplying matrices A and B, the result is the zero matrix O, indicating that the matrices are orthogonal.

Final Answer:

$$\boxed{O}$$

Quick Tip

Matrix multiplication can result in the zero matrix when matrices are orthogonal or in certain symmetric forms.

---

90. A circle has radius 3 and its center lies on the line $y = x - 1$. The equation of the circle, if it passes through (7, 3), is:

(1) $x^2 + y^2 - 8x - 6y + 16 = 0$
(2) $x^2 + y^2 - 8x + 6y + 16 = 0$
(3) $x^2 + y^2 - 8x - 6y - 16 = 0$
(4) $x^2 + y^2 - 8x + 6y - 16 = 0$

Correct Answer: (1) $x^2 + y^2 - 8x - 6y + 16 = 0$

Solution:

Using the center-radius form of the equation of a circle and the given conditions, we derive the equation as $x^2 + y^2 - 8x - 6y + 16 = 0$.

Final Answer:

$$\boxed{x^2 + y^2 - 8x - 6y + 16 = 0}$$

Quick Tip

When the center of a circle lies on a line, you can use the distance formula and the equation of the circle to find its exact equation.

---

91. At how many points between the interval $(-\infty, \infty)$ is the function $f(x) = \sin x$ is not differentiable?

(1) 0
(2) 7
(3) 9
(4) 3

Correct Answer: (1) 0

Solution:
The function $\sin x$ is differentiable at all points within the given interval. Therefore, the answer is 0 points where the function is not differentiable.

Final Answer:

$$\boxed{0}$$

Quick Tip

The sine function is continuous and differentiable at all real points.

---

92. If vector equation of the line $\frac{x-2}{2} = \frac{2y-5}{-3} = z + 1$, is

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

then p is equal to:

(1) 0
(2) 1
(3) 2

(4) 3

Correct Answer: (1) 0

Solution:
From the given vector equation, equate the components of the vector to find the value of p. The solution leads to $p = 0$.

Final Answer:

$$\boxed{0}$$

Quick Tip

For vector equations, equating the coefficients of the unit vectors gives the required values for constants.

---

93. Evaluate $\lim_{x \to 2} \frac{\sqrt{x+7}-3}{\sqrt{x-3}-2}$**:**

(1) $\frac{17}{9}$
(2) $\frac{17}{18}$
(3) $\frac{34}{23}$
(4) $\frac{26}{7}$

Correct Answer: (1) $\frac{17}{9}$

Solution:
Use the technique of multiplying both numerator and denominator by their conjugates to simplify the expression and evaluate the limit.

Final Answer:

$$\boxed{\frac{17}{9}}$$

Quick Tip

For indeterminate forms like $\frac{0}{0}$, multiplying by conjugates helps simplify the expression and evaluate the limit.

---

94. The radius of a right circular cylinder increases at the rate of 0.1 cm/min, and the height decreases at the rate of 0.2 cm/min. The rate of change of the volume of the cylinder, in cm^3/min, when the radius is 2 cm and the height is 3 cm is:

(1) -2π
(2) $-\frac{8\pi}{5}$
(3) $\frac{3\pi}{5}$
(4) 2π

Correct Answer: (2) $-\frac{8\pi}{5}$

Solution:
The volume of a cylinder is $V = \pi r^2 h$. Differentiate the equation with respect to time and substitute the given rates of change to get the rate of change of volume.

Final Answer:

$$\boxed{-\frac{8\pi}{5}}$$

Quick Tip

Use the related rates method to differentiate and find the rate of change of volume for a cylinder.

---

95. If a, b, and c are in A.P., then the value of:

$$|x+1| + |x+2| + |x+3| + |x+b| + |x+c|$$

(1) 3
(2) -3
(3) 0
(4) None of these

Correct Answer: (3) 0

Solution:
Since a, b, and c are in arithmetic progression, simplify the given expression using properties of absolute values and solve for the sum.

Final Answer:

$$\boxed{0}$$

Quick Tip

Use the properties of arithmetic progression and absolute values to simplify the expression.

96. The solution of $\sin x = \frac{-\sqrt{3}}{2}$ is:

(1) $x = n\pi + (-1)^n \frac{4\pi}{3}$, where $n \in \mathbb{Z}$
(2) $x = n\pi + (-1)^n \frac{2\pi}{3}$, where $n \in \mathbb{Z}$
(3) $x = n\pi + (-1)^n \frac{3\pi}{3}$, where $n \in \mathbb{Z}$
(4) None of these

Correct Answer: (1) $x = n\pi + (-1)^n \frac{4\pi}{3}$, where $n \in \mathbb{Z}$

Solution:
The general solution to the equation $\sin x = \frac{-\sqrt{3}}{2}$ is derived using standard trigonometric identities. The solution is given by $x = n\pi + (-1)^n \frac{4\pi}{3}$.

Final Answer:

$$\boxed{x = n\pi + (-1)^n \frac{4\pi}{3}, \text{ where } n \in \mathbb{Z}}$$

Quick Tip

Use the general solution for trigonometric equations to find all possible solutions in the specified domain.

---

97. The equation $y^2 + 3 = 2(2x + y)$ represents a parabola with the vertex at:

(1) $\left(\frac{1}{2}, 1\right)$ and axis parallel to the y-axis
(2) $\left(\frac{1}{2}, 1\right)$ and axis parallel to the x-axis
(3) $\left(\frac{1}{2}, 1\right)$ and focus at $\left(\frac{3}{2}, 1\right)$
(4) $\left(\frac{1}{2}, 1\right)$ and focus at $\left(\frac{3}{2}, 1\right)$

Correct Answer: (1) $\left(\frac{1}{2}, 1\right)$ and axis parallel to the y-axis

Solution:
Rearrange the equation to the standard form of a parabola and find the vertex and axis of symmetry.

Final Answer:

$$\boxed{\left(\frac{1}{2}, 1\right) \text{ and axis parallel to the y-axis}}$$

Quick Tip

To identify the vertex and axis of a parabola, rewrite its equation in standard form.

98. If $\sin y = x\sin(a+y)$, then $\frac{dy}{dx}$ is equal to:

(1) $\frac{\sin\sqrt{a}}{\sin(a+y)}$
(2) $\frac{\sin^2(a+y)}{a}$
(3) $\frac{\sin(a+y)}{a}$
(4) None of these

Correct Answer: (3) $\frac{\sin(a+y)}{a}$

Solution:
Differentiate implicitly with respect to x and solve for $\frac{dy}{dx}$ using standard differentiation techniques.

Final Answer:

$$\boxed{\frac{\sin(a+y)}{a}}$$

Quick Tip

When differentiating implicit equations, apply the chain rule carefully to find $\frac{dy}{dx}$.

---

99. Evaluate

$$\int \left(27e^{9x} + e^{12x}\right)^{1/3} dx$$

(1) $\frac{1}{4}(27e^{9x} + e^{3x})^3 + C$
(2) $\frac{1}{4}(27e^{9x} + e^{3x})^2 + C$
(3) $\frac{1}{3}(27e^{9x} + e^{3x})^4 + C$
(4) $\frac{1}{4}(27e^{9x} + e^{3x})^4 + C$

Correct Answer: (4) $\frac{1}{4}(27e^{9x} + e^{3x})^4 + C$

Solution:
Using substitution and integration techniques, we simplify the integral and find the result as $\frac{1}{4}(27e^{9x} + e^{3x})^4 + C$.

Final Answer:

$$\boxed{\frac{1}{4}(27e^{9x} + e^{3x})^4 + C}$$

Quick Tip

For integrals of complicated functions, use substitution to simplify and evaluate the integral.

---

100. The area under the curve $y = |\cos x - \sin x|$, where $0 \leq x \leq \frac{\pi}{2}$, and the x-axis is:

(1) $2\sqrt{2}$
(2) $2\sqrt{2} - 2$
(3) $2\sqrt{2} + 6y$
(4) 0

Correct Answer: (2) $2\sqrt{2} - 2$

Solution:
The absolute value function requires breaking the integral into parts where $\cos x$ and $\sin x$ have different signs. The total area is calculated as $2\sqrt{2} - 2$.

Final Answer:

$$\boxed{2\sqrt{2} - 2}$$

Quick Tip

For integrals involving absolute value functions, split the integral at the points where the inside expression changes sign.

---

101. The conic represented by

$$x = 2(\cos t + \sin t), \quad y = 5(\cos t - \sin t)$$

is

(1) A circle
(2) A parabola
(3) An ellipse
(4) A hyperbola

Correct Answer: (3) An ellipse

Solution:
By simplifying the equations of x and y, we observe that this represents the equation of an ellipse in parametric form.

Final Answer:

$$\boxed{\text{An ellipse}}$$

Quick Tip

The parametric form of an ellipse is often given by trigonometric functions such as cos and sin.

---

102. If

$$\left(\frac{a}{b}\right)^2 + \left(\frac{b}{a}\right)^2 = 676, \quad |\mathbf{b}| = 2, \quad \text{then } |\mathbf{a}| \text{ is equal to:}$$

(1) 13
(2) 26
(3) 39
(4) None of these

Correct Answer: (2) 26

Solution:
By substituting the given values and simplifying the equation, we can find the value of $|\mathbf{a}|$.

Final Answer:

$$\boxed{26}$$

Quick Tip

Use algebraic manipulation to simplify equations involving absolute values and ratios.

---

103. The equation of the plane which bisects the angle between the planes

$$3x - 6y + 2z + 5 = 0 \quad \text{and} \quad 4x - 12y + 32z - 3 = 0$$

which contains the origin is:

(1) $33x - 13y + 32z + 45 = 0$
(2) $x - 3y + z - 5 = 0$
(3) $33x + 13y + 32z + 45 = 0$
(4) None of these

Correct Answer: (1) $33x - 13y + 32z + 45 = 0$

Solution:
The equation of the plane bisecting two other planes is found by averaging the coefficients of the given planes. The resulting equation is $33x - 13y + 32z + 45 = 0$.

Final Answer:

$$\boxed{33x - 13y + 32z + 45 = 0}$$

Quick Tip

The bisector of two planes can be found by taking the average of their coefficients.

---

104. A wire 34 cm long is to be bent in the form of a quadrilateral of which each angle is 90°. What is the maximum area which can be enclosed inside the quadrilateral?

(1) 68 cm^2
(2) 70 cm^2
(3) 71.25 cm^2
(4) 72.25 cm^2

Correct Answer: (3) 71.25 cm^2

Solution:
The maximum area for a quadrilateral with right angles and a fixed perimeter occurs when it is a square. The area is calculated using the side length obtained from the perimeter.

Final Answer:

$$\boxed{71.25\,\text{cm}^2}$$

Quick Tip

For a fixed perimeter, the area of a right-angle quadrilateral is maximized when the quadrilateral is a square.

---

105. If

$$\int \frac{\sin x}{\sin(x-\alpha)}dx = Ax + B\log\sin(x-\alpha) + C,$$

then the value of (A, B) is:

(1) $(-\cos\alpha, \sin\alpha)$
(2) $(\cos\alpha, \sin\alpha)$

(3) $(-\sin\alpha, \cos\alpha)$
(4) $(\sin\alpha, \cos\alpha)$

Correct Answer: (3) $(-\sin\alpha, \cos\alpha)$

Solution:
By differentiating the given equation and comparing it with the integrand, we find that $A = -\sin\alpha$ and $B = \cos\alpha$.

Final Answer:

$$\boxed{(-\sin\alpha, \cos\alpha)}$$

Quick Tip

Use standard integration techniques and compare terms to find constants A and B in the indefinite integral.

---

106. The equation of the chord of the hyperbola $25x^2 - 16y^2 = 400$ that is bisected at point $(5, 3)$ is:

(1) $135x - 48y = 481$
(2) $125x - 48y = 481$
(3) $125x - 4y = 48$
(4) None of these

Correct Answer: (2) $125x - 48y = 481$

Solution:
Using the midpoint formula for the chord bisected at $(5, 3)$, we derive the equation $125x - 48y = 481$.

Final Answer:

$$\boxed{125x - 48y = 481}$$

Quick Tip

For the chord of a hyperbola, use the midpoint of the chord to derive the equation.

---

107. Value of

$$\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \frac{1}{1 + \sqrt{\cot x}} dx$$

(1) $\frac{\pi}{6}$
(2) $\frac{\pi}{12}$
(3) 12
(4) None of these

Correct Answer: (2) $\frac{\pi}{12}$

Solution:
Use standard integration techniques and simplify the integral to find the value as $\frac{\pi}{12}$.

Final Answer:

$$\boxed{\frac{\pi}{12}}$$

Quick Tip

Simplifying the integrand using trigonometric identities helps in evaluating the integral.

---

108. The domain of the function

$$f(x) = \sqrt{\frac{1}{|x-2| - (x-2)}}$$

is:

(1) $(-\infty, 2]$
(2) $(2, \infty)$
(3) $(-\infty, 2)$
(4) $[2, \infty)$

Correct Answer: (1) $(-\infty, 2]$

Solution:
To find the domain, solve the inequality within the square root to ensure that the expression under the root is non-negative.

Final Answer:

$$\boxed{(-\infty, 2]}$$

Quick Tip

For square root functions, ensure the expression inside the root is non-negative to determine the domain.

109. Six identical coins are arranged in a row. The number of ways in which the number of tails is equal to the number of heads is:

(1) 20
(2) 9
(3) 120
(4) 40

Correct Answer: (1) 20

Solution:
The number of ways to arrange 3 heads and 3 tails in a row is given by $\binom{6}{3} = 20$.

Final Answer:

$$\boxed{20}$$

Quick Tip

The number of ways to arrange objects with repetition is given by the combination formula $\binom{n}{r}$.

---

110. Let f be the function defined by

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

The function is continuous at:

(1) $x = 1$
(2) $x = 2$
(3) $x = 0$
(4) None of these

Correct Answer: (4) None of these

Solution:
By evaluating the function and considering the behavior at $x = 1$, the function is not continuous at any point.

Final Answer:

$$\boxed{\text{None of these}}$$

Quick Tip

To check for continuity, ensure that the function is defined at the point and that the left-hand limit, right-hand limit, and function value all match.

---

111. If $f(x) = x^3 + bx^2 + cx + d$ and $0 < b^2 < c$, then in $(-\infty, \infty)$,

(1) $f(x)$ is a strictly increasing function
(2) $f(x)$ has local maxima
(3) $f(x)$ is a strictly decreasing function
(4) $f(x)$ is bounded

Correct Answer: (1) $f(x)$ is a strictly increasing function

Solution:
Given the condition $0 < b^2 < c$, the derivative of $f(x)$ will indicate that it is a strictly increasing function.

Final Answer:

$$\boxed{f(x) \text{ is a strictly increasing function}}$$

Quick Tip

The derivative test helps to determine the monotonicity of a function. If the derivative is positive, the function is increasing.

---

112. The solution of the differential equation

$$\left(1 + x\sqrt{x^2 + y^2}\right) dx + \left(\sqrt{x^2 + y^2} - 1\right) ydy = 0$$

(1) $x^2 + y^2 + \frac{1}{3}\left(x^2 + y^2\right)^{3/2} = C$
(2) $x^2 + y^2 - \frac{1}{2}\left(x^2 + y^2\right)^{1/2} = C$
(3) $x^2 + y^2 + \frac{1}{3}\left(x^2 + y^2\right)^{3/2} = C$
(4) None of these

Correct Answer: (1) $x^2 + y^2 + \frac{1}{3}\left(x^2 + y^2\right)^{3/2} = C$

Solution:
Solving the differential equation step by step gives us the required solution as $x^2 + y^2 + \frac{1}{3}\left(x^2 + y^2\right)^{3/2} = C$.

Final Answer:

$$\boxed{x^2 + y^2 + \frac{1}{3}\left(x^2 + y^2\right)^{3/2} = C}$$

Quick Tip

When solving a differential equation, try to identify a method of simplification such as substitution to reduce it to a more manageable form.

---

113. The integrating factor of

$$\frac{dy}{dx} - y = x^4 - 3x$$

is:

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

Correct Answer: (3) $\frac{1}{x}$

Solution:
The integrating factor for linear differential equations of the form $\frac{dy}{dx} + P(x)y = Q(x)$ is given by $e^{\int P(x)dx}$. For this equation, the integrating factor is $\frac{1}{x}$.

Final Answer:

$$\boxed{\frac{1}{x}}$$

Quick Tip

To find the integrating factor for a linear first-order differential equation, identify the coefficient of y and integrate it.

---

114. It is given that the events A and B are such that

$$P(A) = \frac{1}{4}, \quad P(A|B) = \frac{1}{2}, \quad P(B|A) = \frac{2}{3}.$$

Then $P(B)$ is:

(1) $\frac{1}{6}$
(2) $\frac{1}{3}$

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

Correct Answer: (2) $\frac{1}{3}$

Solution:
Using the formula $P(A|B) = \frac{P(A \cap B)}{P(B)}$, we calculate $P(B)$ as $\frac{1}{3}$.

Final Answer:

$$\boxed{\frac{1}{3}}$$

Quick Tip

To find $P(B)$, use the conditional probability formula $P(A|B) = \frac{P(A \cap B)}{P(B)}$.

---

115. Let $f : \mathbb{R} \to \mathbb{R}, g : \mathbb{R} \to \mathbb{R}$ be two functions such that

$$f(x) = 2x - 3, \quad g(x) = x^3 + 5.$$

The function $(f \circ g)^{-1}(x)$ is equal to:

(1) $\left(\frac{x+7}{2}\right)^{1/3}$
(2) $\left(\frac{x-7}{2}\right)^{1/3}$
(3) $\left(\frac{x-2}{7}\right)^{1/3}$
(4) $\left(\frac{x+7}{7}\right)^{1/3}$

Correct Answer: (2) $\left(\frac{x-7}{2}\right)^{1/3}$

Solution:
First, solve for $(f \circ g)(x)$ and then take the inverse. The inverse function is $\left(\frac{x-7}{2}\right)^{1/3}$.

Final Answer:

$$\boxed{\left(\frac{x-7}{2}\right)^{1/3}}$$

Quick Tip

To find the inverse of a composite function, first find the composition and then solve for the inverse.

---

116. The inverse of the statement

$$(p \wedge \neg q) \to r$$

is:

(1) $(\neg p \vee \neg q) \to r$
(2) $(\neg p \vee q) \to r$
(3) $(\neg p \vee q) \to \neg r$
(4) None of these

Correct Answer: (3) $(\neg p \vee q) \to \neg r$

Solution:
Using logical equivalences, the inverse of the statement $(p \wedge \neg q) \to r$ is $(\neg p \vee q) \to \neg r$.

Final Answer:

$$\boxed{(\neg p \vee q) \to \neg r}$$

Quick Tip

The inverse of an implication is formed by negating both the hypothesis and conclusion.

---

117. The value of x in the interval $[4, 9]$ at which the function

$$f(x) = \sqrt{x}$$

satisfies the mean value theorem is:

(1) $\frac{13}{4}$
(2) $\frac{17}{4}$
(3) $\frac{21}{4}$
(4) $\frac{25}{4}$

Correct Answer: (2) $\frac{17}{4}$

Solution:
Using the mean value theorem, calculate the derivative of $f(x)$ and solve for x in the interval $[4, 9]$.

Final Answer:

$$\boxed{\frac{17}{4}}$$

Quick Tip

The mean value theorem states that there exists a point where the derivative equals the average rate of change.

---

118. The value of the integral

$$\int_1^3 |x| + |x-1|\,dx$$

is:

(1) 4
(2) 9
(3) 2
(4) $\frac{9}{2}$

Correct Answer: (4) $\frac{9}{2}$

Solution:
We break the integral into pieces based on the absolute value function, and then evaluate each part to obtain the final result.

Final Answer:

$$\boxed{\frac{9}{2}}$$

Quick Tip

When integrating absolute value functions, split the integral at the points where the inside expression changes sign.

---

119. Let $e^{1/c}, e^{b/c}, e^{1/a}$ are in A.P. with a common difference d. Then $e^{1/c}, e^{b/c}, e^{1/a}$ are in:

(1) G.P. with common ratio e^d
(2) G.P. with common ratio $e^{1/d}$
(3) G.P. with common ratio $e^{d(b^2-d^2)}$
(4) A.P.

Correct Answer: (1) G.P. with common ratio e^d

Solution:
Using the properties of A.P. (Arithmetic Progression) and G.P. (Geometric Progression), we can deduce that the terms are in G.P. with a common ratio e^d.

Final Answer:

$$\boxed{\text{G.P. with common ratio } e^d}$$

Quick Tip

When terms are in arithmetic progression, they can be related to a geometric progression with a specific ratio.

---

120. If the second term in the expansion

$$\left(\frac{3}{\sqrt{4a+\sqrt{a}}}\right)^n$$

is $14a^{5/2}$, then nC_3 is:

(1) 4
(2) 3
(3) 12
(4) 6

Correct Answer: (3) 12

Solution:
Using the binomial expansion formula, we compare the terms and solve for nC_3. This gives us the value of nC_3 as 12.

Final Answer:

$$\boxed{12}$$

Quick Tip

In binomial expansions, equate terms to solve for the required coefficient in the expansion.

Part IV: English & Logical Reasoning

121. In the given sentence, find out which part has an error. The letter of that part will be your answer. If there is no error, mark (d) as your answer.

She is a brilliant teacher (a)/ but of her three children (b)/ neither has any merit. (c)/ No error. (d)

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

Correct Answer: (1) a

Solution:
The correct sentence should be "but her three children." The word "of" is incorrect in this context, and thus part (a) contains the error.

Final Answer:

$$\boxed{a}$$

Quick Tip

Pay attention to the correct usage of prepositions and conjunctions in sentences to avoid grammatical errors.

---

122. Find the synonym of the word IMPCCABLE:

(1) Remarkable
(2) Unbelievable
(3) Flawless
(4) Displeasing

Correct Answer: (3) Flawless

Solution:
The word "impeccable" means flawless or without fault, making the correct synonym "flawless."

Final Answer:

$$\boxed{\text{Flawless}}$$

Quick Tip

Synonyms often have similar meanings, but context should be used to ensure the correct choice.

123. Find the antonym of the word AMELIORATE:

(1) Improve
(2) Depend
(3) Soften
(4) Worsen

Correct Answer: (4) Worsen

Solution:
The word "ameliorate" means to improve or make better, so its antonym is "worsen."

Final Answer:

Worsen

Quick Tip

The antonym of a word typically conveys the opposite meaning, so look for words that represent deterioration or decline.

---

124. Find the meaning of the given idiom: A bolt from the blue

(1) An unpleasant event
(2) An inexplicable event
(3) A delayed event
(4) An unexpected event

Correct Answer: (4) An unexpected event

Solution:
The idiom "a bolt from the blue" means an unexpected or surprising event.

Final Answer:

An unexpected event

Quick Tip

Idioms often have meanings that cannot be derived literally; instead, they convey a figurative or metaphorical meaning.

125. Read the passage and answer the given question:

There seems to be no chilly distance existing between the German students and the professor, but, on th

What does the author mean by the phrase 'no chilly distance'?

(1) Professor's home is not very far from the beer hall.
(2) Students and the professor are very friendly with each other.
(3) The weather is not very chilly in Germany.
(4) The professor being very strict scares the students quite a few times as in the beer hall.

Correct Answer: (2) Students and the professor are very friendly with each other.

Solution:
The phrase "no chilly distance" implies that there is a friendly and cordial relationship between the students and the professor.

Final Answer:

Students and the professor are very friendly with each other.

Quick Tip

In reading comprehension, identify key phrases that describe relationships or behaviors to better understand the meaning of the passage.