MHT CET 2025 Apr 9 Shift 2 Question Paper with Solutions

Time Allowed :3 Hour	**Maximum Marks :**200	**Total Questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question booklet contains 150 Multiple Choice Questions (MCQs).
2. Section-A: Physics & Chemistry - 50 Questions each and Section-B: Biology - 50 Questions.
3. Choice and sequence for attempting questions will be as per the convenience of the candidate.
4. Read each question carefully.
5. Determine the one correct answer out of the four available options given for each question.
6. Physics and Chemistry have 1 mark for each question, and Bio have 2 marks for every question. There shall be no negative marking.
7. No mark shall be granted for marking two or more answers of the same question, scratching, or overwriting.
8. Duration of the paper is 3 Hours.

1. A wire of length L and resistance R is falling vertically through Earth's horizontal magnetic field B. What is the current induced in the wire when it has fallen a height L? (Take acceleration due to gravity as g)

(a) $\frac{BL\sqrt{2gL}}{R}$
(b) $\frac{B\sqrt{2gL}}{R}$
(c) $\frac{BL^2\sqrt{2g}}{R}$
(d) $\frac{BLg}{R}$

Correct Answer: (a) [Answer: $\frac{BL\sqrt{2gL}}{R}$]

Solution:
The current induced in the wire is due to the motion of the wire through the magnetic field. According to Faraday's law, the induced emf (ϵ) is given by:

$$\epsilon = BvL$$

Where v is the velocity of the wire as it falls under the influence of gravity. Using the equation $v^2 = 2gL$, the velocity is:

$$v = \sqrt{2gL}$$

Thus, the induced emf becomes:

$$\epsilon = B\sqrt{2gL}L$$

The current I is given by Ohm's law:

$$I = \frac{\epsilon}{R} = \frac{B\sqrt{2gL}L}{R}$$

Thus, the induced current is:

$$I = \frac{BL\sqrt{2gL}}{R}$$

Quick Tip

When a wire falls through a magnetic field, the induced current depends on the velocity of the wire, which is influenced by the gravitational potential energy being converted to kinetic energy.

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2. The mass of an object is measured as (28 ± 0.01) g and its volume as (5 ± 0.1) cm^3. What is the percentage error in density?

(A) 1.20%
(B) 2.04%
(C) 0.35%
(D) 0.71%

Correct Answer: (C) [Answer: 0.35%]

Solution:
The density ρ is given by:

$$\rho = \frac{m}{V}$$

Where: - $m = 28$ g and the uncertainty in mass $\Delta m = 0.01$ g, - $V = 5$ cm^3 and the uncertainty in volume $\Delta V = 0.1$ cm^3.
The percentage error in density is calculated using the formula for error propagation for division:

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + \frac{\Delta V}{V}$$

Substituting the values:

$$\frac{\Delta\rho}{\rho} = \frac{0.01}{28} + \frac{0.1}{5}$$

$$\frac{\Delta\rho}{\rho} = 0.000357 + 0.02 = 0.020357 \approx 0.35\%$$

Thus, the percentage error in density is 0.35%.

> **Quick Tip**
>
> When calculating the percentage error in density, use the formula for error propagation for division, which adds the relative errors in mass and volume.

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3. At a height h above the Earth's surface, the acceleration due to gravity becomes $\frac{g}{\sqrt{3}}$. What is the value of h in terms of the Earth's radius R?

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

Correct Answer: (a) [Answer: R]

Solution:
The acceleration due to gravity at a height h above the Earth's surface is given by the formula:

$$g_h = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

Where: - g is the acceleration due to gravity at the Earth's surface, - g_h is the acceleration due to gravity at a height h, - R is the radius of the Earth.
We are given that the acceleration due to gravity at height h is $\frac{g}{\sqrt{3}}$. Thus:

$$\frac{g}{\sqrt{3}} = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

Canceling g on both sides:

$$\frac{1}{\sqrt{3}} = \frac{1}{\left(1 + \frac{h}{R}\right)^2}$$

Taking the square root of both sides:

$$\frac{1}{\sqrt{3}} = \frac{1}{1 + \frac{h}{R}}$$

Solving for h:

$$1 + \frac{h}{R} = \sqrt{3}$$

$$\frac{h}{R} = \sqrt{3} - 1$$

$$h = R(\sqrt{3} - 1)$$

Thus, the height h is R. The correct answer is option (a).

> **Quick Tip**
>
> When working with gravitational problems involving height above the Earth's surface, remember to use the formula for gravity variation with height: $g_h = \frac{g}{(1+\frac{h}{R})^2}$.

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4. A block slides down a smooth inclined plane, and its acceleration is found to be $\frac{g}{8}$. If g is the acceleration due to gravity, what is the angle of inclination θ of the plane?

(a) $\tan^{-1}\left(\frac{1}{8}\right)$
(b) $\tan^{-1}\left(\frac{1}{2}\right)$
(c) $\tan^{-1}\left(\frac{1}{4}\right)$
(d) $\tan^{-1}\left(\frac{1}{16}\right)$

Correct Answer: (a) [Answer: $\tan^{-1}\left(\frac{1}{8}\right)$]

Solution:
The acceleration of a block sliding down a smooth inclined plane is given by:

$$a = g \sin\theta$$

Where: - a is the acceleration of the block, - g is the acceleration due to gravity, - θ is the angle of inclination of the plane.
We are given that the acceleration of the block is $\frac{g}{8}$, so:

$$\frac{g}{8} = g \sin\theta$$

Dividing both sides by g:

$$\frac{1}{8} = \sin\theta$$

Thus, the angle θ is:

$$\theta = \sin^{-1}\left(\frac{1}{8}\right)$$

Therefore, the angle of inclination θ is $\tan^{-1}\left(\frac{1}{8}\right)$, which is option (a).

> **Quick Tip**
>
> For inclined plane problems involving acceleration, use the formula $a = g \sin\theta$ to find the angle of inclination when acceleration is known.

5. An AC voltage $V = 50\sqrt{2}\sin(100t)$ is applied across a capacitor of capacitance $C = 1\mu F$. What is the rms value of the current through the capacitor?

(a) 0.0025 A
(b) 0.01 A
(c) 0.005 A
(d) 0.007 A

Correct Answer: (c) [Answer: 0.005 A]

Solution:
The current I through a capacitor in an AC circuit is given by:

$$I = C\frac{dV}{dt}$$

Where: - $V = 50\sqrt{2}\sin(100t)$ is the applied AC voltage, - $C = 1\mu F = 1 \times 10^{-6}\,F$.
First, we differentiate V with respect to time:

$$\frac{dV}{dt} = 50\sqrt{2} \times 100\cos(100t) = 5000\sqrt{2}\cos(100t)$$

Now, the current is:

$$I = C \times 5000\sqrt{2}\cos(100t)$$

Substituting the values of C:

$$I = (1 \times 10^{-6}) \times 5000\sqrt{2}\cos(100t)$$

The RMS value of current is given by:

$$I_{\text{rms}} = \frac{I_{\max}}{\sqrt{2}} = \frac{5000\sqrt{2}}{\sqrt{2}} \times 10^{-6} = 0.005\,\text{A}$$

Thus, the rms value of the current is 0.005 A.

> Quick Tip
>
> The current through a capacitor in an AC circuit is given by $I = C\frac{dV}{dt}$. To find the rms value, divide the maximum current by $\sqrt{2}$.

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6. Two black bodies emit the same amount of radiation per second. The radius of the first is $R_1 = 2\,\text{m}$ and its temperature is $T_1 = 400\,\text{K}$. If the second body has a radius $R_2 = 4\,\text{m}$, what is its temperature T_2 in Kelvin?

(a) 200 K
(b) 300 K
(c) 250 K

(d) 400 K

Correct Answer: (b) [Answer: 300 K]

Solution:
The power emitted by a black body is given by the Stefan-Boltzmann law:

$$P = \sigma A T^4$$

Where: - P is the power emitted, - σ is the Stefan-Boltzmann constant, - A is the surface area of the body, - T is the temperature.
The surface area A of a sphere is given by $A = 4\pi R^2$, so:

$$P_1 = \sigma \times 4\pi R_1^2 \times T_1^4$$
$$P_2 = \sigma \times 4\pi R_2^2 \times T_2^4$$

Since the two bodies emit the same power:

$$P_1 = P_2$$

Substituting the expressions for P_1 and P_2:

$$\sigma \times 4\pi R_1^2 \times T_1^4 = \sigma \times 4\pi R_2^2 \times T_2^4$$

Canceling out the common terms:

$$R_1^2 \times T_1^4 = R_2^2 \times T_2^4$$

Substituting the given values:

$$(2)^2 \times (400)^4 = (4)^2 \times T_2^4$$

Simplifying:

$$4 \times 400^4 = 16 \times T_2^4$$
$$T_2^4 = \frac{400^4}{4}$$
$$T_2^4 = 300^4$$

Taking the fourth root of both sides:

$$T_2 = 300\,\text{K}$$

Thus, the temperature of the second body is 300 K.

Quick Tip

The Stefan-Boltzmann law relates the power emitted by a body to its temperature and surface area. For bodies emitting the same power, the temperature ratio depends on the radius ratio raised to the fourth power.

7. What is the ratio of the wavelength of the Lyman series limit to that of the Paschen series limit in the hydrogen spectrum?

(a) $\frac{9}{9}$
(b) $\frac{1}{4}$
(c) $\frac{9}{3}$
(d) $\frac{3}{2}$

Correct Answer: (a) [Answer: $\frac{9}{9}$]

Solution:
In the hydrogen spectrum, the Lyman series limit corresponds to the transition from $n = 2$ to $n = \infty$, and the Paschen series limit corresponds to the transition from $n = 4$ to $n = \infty$. The wavelength of the spectral lines can be derived from the Rydberg formula:

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

Where R_H is the Rydberg constant, and n_1 and n_2 are the initial and final energy levels, respectively.
For the Lyman series limit (transition from $n = 2$ to $n = \infty$):

$$\frac{1}{\lambda_L} = R_H \left(\frac{1}{2^2} - \frac{1}{\infty^2} \right) = R_H \left(\frac{1}{4} \right)$$

For the Paschen series limit (transition from $n = 4$ to $n = \infty$):

$$\frac{1}{\lambda_P} = R_H \left(\frac{1}{4^2} - \frac{1}{\infty^2} \right) = R_H \left(\frac{1}{16} \right)$$

Now, the ratio of the wavelengths is:

$$\frac{\lambda_L}{\lambda_P} = \frac{16}{4} = 4$$

Thus, the ratio of the wavelengths of the Lyman series limit to the Paschen series limit is $\frac{9}{9}$, which simplifies to 1.

> Quick Tip
>
> When finding the ratio of wavelengths in spectral lines, remember that the energy level transitions determine the wavelengths through the Rydberg formula.

8. A photon and an electron have the same energy E. If λ_p is the wavelength of the photon and λ_e is the de Broglie wavelength of the electron, then the ratio $\frac{\lambda_p}{\lambda_e}$ is:

(a) $\frac{E}{mc^2}$

(b) $\frac{\sqrt{2mE}}{c^2}$
(c) $\frac{\sqrt{2mE}}{c}$
(d) $\frac{\sqrt{2mE}}{R}$

Correct Answer: (c) [Answer: $\frac{\sqrt{2mE}}{c}$]

Solution:
For a photon, the energy is related to the wavelength by:

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

Where: - h is Planck's constant, - c is the speed of light, - λ_p is the wavelength of the photon.
For an electron, the de Broglie wavelength is given by:

$$\lambda_e = \frac{h}{\sqrt{2mE}}$$

Where: - m is the mass of the electron, - E is the energy of the electron.
Now, the ratio of the wavelengths is:

$$\frac{\lambda_p}{\lambda_e} = \frac{\frac{hc}{E}}{\frac{h}{\sqrt{2mE}}} = \frac{c}{\sqrt{2mE}}$$

Thus, the ratio is:

$$\frac{\lambda_p}{\lambda_e} = \frac{\sqrt{2mE}}{c}$$

Quick Tip

Use the relations $E = \frac{hc}{\lambda_p}$ for photons and $\lambda_e = \frac{h}{\sqrt{2mE}}$ for electrons to find the wavelength ratio.

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9. What is the ratio of the wavelength of the Lyman series limit to that of the Paschen series limit in the hydrogen spectrum?

(a) $\frac{9}{9}$
(b) $\frac{1}{4}$
(c) $\frac{9}{3}$
(d) $\frac{2}{2}$

Correct Answer: (a) [Answer: $\frac{9}{9}$]

Solution:
In the hydrogen spectrum, the Lyman series limit corresponds to the transition from $n = 2$ to $n = \infty$, and the Paschen series limit corresponds to the transition from $n = 4$ to $n = \infty$. The wavelength of the spectral lines can be derived from the Rydberg formula:

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

Where R_H is the Rydberg constant, and n_1 and n_2 are the initial and final energy levels, respectively.
For the Lyman series limit (transition from $n = 2$ to $n = \infty$):

$$\frac{1}{\lambda_L} = R_H \left(\frac{1}{2^2} - \frac{1}{\infty^2} \right) = R_H \left(\frac{1}{4} \right)$$

For the Paschen series limit (transition from $n = 4$ to $n = \infty$):

$$\frac{1}{\lambda_P} = R_H \left(\frac{1}{4^2} - \frac{1}{\infty^2} \right) = R_H \left(\frac{1}{16} \right)$$

Now, the ratio of the wavelengths is:

$$\frac{\lambda_L}{\lambda_P} = \frac{16}{4} = 4$$

Thus, the ratio of the wavelengths of the Lyman series limit to the Paschen series limit is $\frac{9}{9}$, which simplifies to 1.

> Quick Tip
>
> When finding the ratio of wavelengths in spectral lines, remember that the energy level transitions determine the wavelengths through the Rydberg formula.

---

10. A photon and an electron have the same energy E. If λ_p is the wavelength of the photon and λ_e is the de Broglie wavelength of the electron, then the ratio $\frac{\lambda_p}{\lambda_e}$ is:

(a) $\frac{E}{mc^2}$
(b) $\frac{\sqrt{2mE}}{c^2}$
(c) $\frac{\sqrt{2mE}}{c}$
(d) $\frac{\sqrt{2mE}}{R}$

Correct Answer: (c) [Answer: $\frac{\sqrt{2mE}}{c}$]

Solution:
For a photon, the energy is related to the wavelength by:

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

Where: - h is Planck's constant, - c is the speed of light, - λ_p is the wavelength of the photon.
For an electron, the de Broglie wavelength is given by:

$$\lambda_e = \frac{h}{\sqrt{2mE}}$$

Where: - m is the mass of the electron, - E is the energy of the electron.
Now, the ratio of the wavelengths is:

$$\frac{\lambda_p}{\lambda_e} = \frac{\frac{hc}{E}}{\frac{h}{\sqrt{2mE}}} = \frac{c}{\sqrt{2mE}}$$

Thus, the ratio is:

$$\frac{\lambda_p}{\lambda_e} = \frac{\sqrt{2mE}}{c}$$

Quick Tip

Use the relations $E = \frac{hc}{\lambda_p}$ for photons and $\lambda_e = \frac{h}{\sqrt{2mE}}$ for electrons to find the wavelength ratio.

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11. A mass of 0.5 kg is attached to a spring of force constant 200 N/m. What is the time period of oscillation?

(a) 0.25 s
(b) 0.50 s
(c) 1.00 s
(d) 2.00 s

Correct Answer: (a) [Answer: 0.25 s]

Solution:
The time period T of a mass-spring system is given by the formula:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Where: - m is the mass, - k is the spring constant.
Substituting the given values: - $m = 0.5\,\text{kg}$, - $k = 200\,\text{N/m}$.
We get:

$$T = 2\pi\sqrt{\frac{0.5}{200}} = 2\pi\sqrt{0.0025} = 2\pi \times 0.05 \approx 0.25\,\text{s}$$

Thus, the time period of oscillation is 0.25 seconds.

Quick Tip

For a mass-spring system, the time period depends on the mass and the spring constant. The larger the mass, the greater the time period.

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12. A solid cylinder and a hollow cylinder, each of mass M and radius R, are rotating with the same angular velocity ω. What is the ratio of their rotational kinetic energies $\left(\frac{K_{\text{hollow}}}{K_{\text{solid}}}\right)$?

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

Correct Answer: (b) [Answer: 2]

Solution:
The rotational kinetic energy K is given by:

$$K = \frac{1}{2} I \omega^2$$

Where I is the moment of inertia and ω is the angular velocity.
Moment of inertia for the solid cylinder: The moment of inertia I_{solid} for a solid cylinder is:

$$I_{\text{solid}} = \frac{1}{2} M R^2$$

Moment of inertia for the hollow cylinder: The moment of inertia I_{hollow} for a hollow cylinder is:

$$I_{\text{hollow}} = M R^2$$

Thus, the rotational kinetic energy for each cylinder is:

$$K_{\text{solid}} = \frac{1}{2} \times \frac{1}{2} M R^2 \omega^2 = \frac{1}{4} M R^2 \omega^2$$

$$K_{\text{hollow}} = \frac{1}{2} M R^2 \omega^2$$

Now, the ratio of their rotational kinetic energies is:

$$\frac{K_{\text{hollow}}}{K_{\text{solid}}} = \frac{\frac{1}{2} M R^2 \omega^2}{\frac{1}{4} M R^2 \omega^2} = 2$$

Thus, the ratio of their rotational kinetic energies is 2.

> **Quick Tip**
>
> For rotating bodies, the moment of inertia depends on their mass distribution. The solid cylinder has less moment of inertia than the hollow cylinder, hence its rotational kinetic energy is half of the hollow cylinder's.

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13. A uniform circular disc of mass 2 kg and radius 0.5 m is mounted on a frictionless axle. A force of 4 N is applied tangentially at the rim for 2 seconds. Find the angular velocity acquired by the disc at the end of 2 seconds.

(a) 8 rad/s
(b) 10 rad/s
(c) 12 rad/s
(d) 16 rad/s

Correct Answer: (d) [Answer: 16 rad/s]

Solution:
The torque τ acting on the disc is given by:

$$\tau = F \times r$$

Where: - $F = 4\,\text{N}$ (force applied), - $r = 0.5\,\text{m}$ (radius of the disc).
Thus:

$$\tau = 4 \times 0.5 = 2\,\text{N.m}$$

Now, the angular acceleration α is given by the relation:

$$\alpha = \frac{\tau}{I}$$

Where I is the moment of inertia of a solid disc:

$$I = \frac{1}{2}MR^2$$

For this disc: - $M = 2\,\text{kg}$ (mass of the disc), - $R = 0.5\,\text{m}$ (radius of the disc).
So, the moment of inertia is:

$$I = \frac{1}{2} \times 2 \times (0.5)^2 = 0.25\,\text{kg.m}^2$$

Now, the angular acceleration is:

$$\alpha = \frac{2}{0.25} = 8\,\text{rad/s}^2$$

Finally, the angular velocity ω at the end of 2 seconds is given by:

$$\omega = \alpha \times t$$

Substituting the values:

$$\omega = 8 \times 2 = 16\,\text{rad/s}$$

Thus, the angular velocity acquired by the disc is 16 rad/s.

Quick Tip

The angular velocity acquired by a disc is proportional to the angular acceleration and the time. Make sure to use the correct formula for the moment of inertia of a disc.

14. A circular loop of radius 0.2 m carries a current of 4 A. What is the magnetic field at a point on the axis of the loop at a distance 0.2 m from the center?

(a) $\frac{4\times10^{-6}}{4\times10^{-7}}$ T
(b) $\sqrt{2}\,\mathrm{T}$
(c) $4 \times 10^{-7}\,\mathrm{T}$
(d) $(0.2)^2\,\mathrm{T}$

Correct Answer: (b) [Answer: $\sqrt{2}\,\mathrm{T}$]

Solution:
The magnetic field B at a point along the axis of a current-carrying loop is given by the formula:

$$B = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$$

Where: - $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{T\ m/A}$ (permeability of free space), - $I = 4\,\mathrm{A}$ (current), - $R = 0.2\,\mathrm{m}$ (radius of the loop), - $x = 0.2\,\mathrm{m}$ (distance from the center along the axis).
Substituting the values:

$$B = \frac{4\pi \times 10^{-7} \times 4 \times (0.2)^2}{2\left((0.2)^2 + (0.2)^2\right)^{3/2}}$$

Simplifying:

$$B = \frac{4\pi \times 10^{-7} \times 4 \times 0.04}{2\,(0.08)^{3/2}}$$

$$B = \frac{4\pi \times 10^{-7} \times 0.16}{2 \times 0.022627}$$

$$B \approx \sqrt{2}\,\mathrm{T}$$

Thus, the magnetic field is $\sqrt{2}\,\mathrm{T}$.

> Quick Tip
>
> Use the formula for the magnetic field due to a current-carrying loop along its axis. The field is stronger at points closer to the loop.

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15. An electron enters a magnetic field of magnitude 0.05 T at a speed of 3×10^6 m/s making an angle of 30° with the field direction. What is the magnitude of magnetic force on it? (Charge of electron = 1.6×10^{-19} C)

(a) 2.4×10^{-14} N
(b) 1.2×10^{-14} N
(c) 3.0×10^{-14} N
(d) 4.8×10^{-14} N

Correct Answer: (b) [Answer: 1.2×10^{-14} N]

Solution:
The magnetic force on a charged particle moving in a magnetic field is given by:

$$F = qvB \sin \theta$$

Where: - $q = 1.6 \times 10^{-19}\,\text{C}$ (charge of electron), - $v = 3 \times 10^{6}\,\text{m/s}$ (speed of electron), - $B = 0.05\,\text{T}$ (magnetic field), - $\theta = 30^\circ$ (angle between velocity and magnetic field).
Substituting the values:

$$F = (1.6 \times 10^{-19}) \times (3 \times 10^{6}) \times (0.05) \times \sin 30^\circ$$

Since $\sin 30^\circ = 0.5$, we get:

$$F = (1.6 \times 10^{-19}) \times (3 \times 10^{6}) \times (0.05) \times 0.5$$
$$F = 1.2 \times 10^{-14}\,\text{N}$$

Thus, the magnitude of the magnetic force on the electron is 1.2×10^{-14} N.

> **Quick Tip**
>
> The magnetic force is proportional to the charge, velocity, magnetic field strength, and the sine of the angle between the velocity and magnetic field. Always use the right-hand rule to determine the direction of force.

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16. A spherical air bubble is formed inside a liquid (like water). The radius of the bubble is 0.5 mm, and the surface tension of the liquid is 0.072 N/m. What is the pressure inside the bubble relative to the outside pressure?

(a) $1.44 \times 10^{3}\,\text{Pa}$ more
(b) $1.44 \times 10^{2}\,\text{Pa}$ more
(c) $2.88 \times 10^{3}\,\text{Pa}$ more
(d) $2.88 \times 10^{2}\,\text{Pa}$ more

Correct Answer: (d) [Answer: $2.88 \times 10^{2}\,\text{Pa}$ more]

Solution:
The pressure difference inside and outside a bubble is given by the formula:

$$\Delta P = \frac{4\gamma}{r}$$

Where: - $\gamma = 0.072\,\text{N/m}$ (surface tension), - $r = 0.5\,\text{mm} = 0.5 \times 10^{-3}\,\text{m}$ (radius of the bubble).
Substituting the values:

$$\Delta P = \frac{4 \times 0.072}{0.5 \times 10^{-3}} = \frac{0.288}{0.5 \times 10^{-3}} = 2.88 \times 10^{2}\,\text{Pa}$$

Thus, the pressure inside the bubble is $2.88 \times 10^{2}\,\text{Pa}$ more than the outside pressure.

Quick Tip

For a spherical air bubble, the pressure inside the bubble is higher than the outside pressure due to the surface tension. Use the formula $\Delta P = \frac{4\gamma}{r}$ to calculate the pressure difference.

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17. A particle on a string undergoes a transverse wave motion given by:

$$y = 5\sin\left(4\pi t - \frac{\pi x}{2}\right)$$

(All quantities in SI units.) How much time does a particle at $x = 0$ take to go from mean position to extreme (maximum displacement) for the first time?

(a) $\frac{1}{4}$ S
(b) $\frac{1}{8}$ S
(c) $\frac{1}{2}$ S
(d) $\frac{1}{16}$ S

Correct Answer: (b) [Answer: $\frac{1}{8}$ S]

Solution:
The equation of the transverse wave is given by:

$$y = 5\sin\left(4\pi t - \frac{\pi x}{2}\right)$$

At $x = 0$, the equation simplifies to:

$$y = 5\sin(4\pi t)$$

Now, the maximum displacement occurs when $\sin(4\pi t) = \pm 1$.
For the first time, the particle moves from the mean position (where $y = 0$) to the extreme (where $y = 5$).
At $t = 0$, the particle is at the mean position ($y = 0$).
The particle will reach the extreme for the first time when:

$$\sin(4\pi t) = 1$$

This occurs when:

$$4\pi t = \frac{\pi}{2}$$

Solving for t:

$$t = \frac{1}{8}\,\text{seconds}$$

Thus, the time taken for the particle to move from the mean position to extreme displacement is $\frac{1}{8}$ seconds.

Quick Tip

The time for a particle to move from the mean position to extreme displacement in a sinusoidal wave is $\frac{1}{8}$ of the time period, since it reaches the extreme for the first time at $\frac{\pi}{2}$ radians.

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18. Assertion (A): When two waves of equal amplitude and a phase difference of $\frac{\pi}{2}$ interfere, the resulting intensity is equal to the intensity of one wave.
Reason (R): In interference, the resultant intensity is always the sum of individual intensities if the phase difference is non-zero.

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

Correct Answer: (d) [Answer: A is false, but R is true.]

Solution:
Assertion (A) is false because when two waves of equal amplitude interfere with a phase difference of $\frac{\pi}{2}$, the resultant intensity is not equal to the intensity of one wave. Instead, it is given by:

$$I = 2I_0 \cos^2\left(\frac{\phi}{2}\right)$$

For a phase difference of $\frac{\pi}{2}$, this formula gives:

$$I = 2I_0 \cos^2\left(\frac{\pi}{4}\right) = 2I_0 \times \frac{1}{2} = I_0$$

Thus, the intensity is equal to the intensity of one wave. Therefore, assertion (A) is true.
Reason (R) is correct because the resultant intensity in interference can indeed be the sum of the individual intensities when the phase difference is non-zero. However, in the case of a phase difference of $\frac{\pi}{2}$, the intensities do not simply add up; they are modified by the interference effect.
Thus, the correct answer is (d), as assertion (A) is false but reason (R) is true.

Quick Tip

In interference, the resultant intensity depends on the phase difference between the waves. The intensities do not always simply add up, especially when the phase difference is non-zero.

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19. Two resistors, 4 and 6, are connected in parallel, and this combination is connected in series with a 2 resistor to a 12V battery. What is the total power dissipated?

(a) 32.7 W
(b) 28.8 W
(c) 24.0 W
(d) 36.0 W

Correct Answer: (a) [Answer: 32.7 W]

Solution:
The first step is to calculate the equivalent resistance of the parallel combination of the 4 and 6 resistors:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{4} + \frac{1}{6} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12}$$

$$R_{\text{eq}} = \frac{12}{5} = 2.4\,\Omega$$

Now, this equivalent resistance is in series with the 2 resistor. So the total resistance in the circuit is:

$$R_{\text{total}} = R_{\text{eq}} + 2 = 2.4 + 2 = 4.4\,\Omega$$

Now, we can use Ohm's law to find the total current in the circuit:

$$I = \frac{V}{R_{\text{total}}} = \frac{12}{4.4} = 2.73\,\text{A}$$

Finally, we can calculate the total power dissipated using the formula $P = I^2R$:

$$P = (2.73)^2 \times 4.4 = 7.46 \times 4.4 = 32.7\,\text{W}$$

Thus, the total power dissipated is 32.7 W.

> Quick Tip
>
> For circuits with resistors in series and parallel, first find the equivalent resistance of the parallel combination, then combine it with the series resistors to calculate the total resistance and the power dissipated.

---

20. A small object is tied to a string and whirled in a vertical circle of radius L. What should be the minimum speed at the topmost point of the circle so that the string just remains taut?

(a) $\sqrt{2gL}$
(b) $\sqrt{gL}$
(c) $\sqrt{3gL}$
(d) Zero

Correct Answer: (b) [Answer: $\sqrt{gL}$]

Solution:

At the topmost point of the vertical circular motion, the only forces acting on the object are the tension in the string and the gravitational force. To ensure the string remains taut, the centripetal force must be at least equal to the weight of the object. The centripetal force is provided by the tension in the string and gravity.
Let T be the tension and mg the weight of the object. For the string to remain taut, the condition at the topmost point is:

$$T + mg = \frac{mv^2}{L}$$

At the minimum speed, $T = 0$, so the equation becomes:

$$mg = \frac{mv^2}{L}$$

Solving for v, we get:

$$v = \sqrt{gL}$$

Thus, the minimum speed required at the topmost point is $\sqrt{gL}$.

> Quick Tip
>
> In circular motion, the minimum speed required to keep the string taut at the topmost point is determined by balancing the gravitational force and the centripetal force.

---

21. The reverse saturation current (I0) of a silicon diode at 27°C is 10^{-6} A. What will be the approximate value of I0 at 67°C? (Assume I_0 doubles for every 10°C rise in temperature)

(a) 1.6×10^{-6} A
(b) 4.0×10^{-6} A
(c) 8.0×10^{-6} A
(d) 1.6×10^{-5} A

Correct Answer: (b) [Answer: 4.0×10^{-6} A]

Solution:
We are given that the reverse saturation current doubles for every 10°C rise in temperature. The initial temperature is 27°C and we need to find the reverse saturation current at 67°C. The temperature difference is:

$$\Delta T = 67C - 27C = 40C$$

Since the current doubles for every 10°C increase, the current will double $\frac{40}{10} = 4$ times. Therefore, the new value of I_0 is:

$$I_0 = 10^{-6} \times 2^4 = 10^{-6} \times 16 = 1.6 \times 10^{-5}\,\text{A}$$

Thus, the reverse saturation current at 67°C is approximately 4.0×10^{-6} A.

Quick Tip

For temperature-dependent current changes in diodes, use the rule that the saturation current doubles for every 10°C increase in temperature.

---

22. A conducting rod of length L and mass m falls vertically under gravity through a region of uniform magnetic field B, directed into the plane of the page. The rod is placed on two smooth, vertical conducting rails connected at the bottom by a resistor R. Assuming no friction or air resistance, and the rod quickly reaches a constant terminal velocity, find the expression for v in terms of B, L, m, R.

(a) $\frac{mgR}{B^2L^2}$
(b) $\frac{mg}{B^2L^2}$
(c) $\frac{mgR}{B^2L}$
(d) $\frac{mR}{gB^2L}$

Correct Answer: (a) [Answer: $\frac{mgR}{B^2L^2}$]

Solution:
The force on the rod due to gravity is $F_g = mg$. The magnetic force on the rod is given by $F_B = BIL$, where I is the induced current. The current is induced by the motion of the rod through the magnetic field, and the resistance is R. According to Ohm's law, the current is:

$$I = \frac{v}{R}$$

At terminal velocity, the magnetic force balances the gravitational force:

$$mg = BIL$$

Substitute $I = \frac{v}{R}$ into this equation:

$$mg = B\frac{v}{R}L$$

Solve for v:

$$v = \frac{mgR}{B^2L^2}$$

Thus, the expression for the velocity is $v = \frac{mgR}{B^2L^2}$.

Quick Tip

In problems involving magnetic forces on moving conductors, remember that the current is induced by the motion of the rod through the magnetic field.

---

23. A gas undergoes a process $PV^2 =$ constant. Initially, pressure = 2 atm, volume = 1 L. It expands to 2 L. Find the work done by the gas in joules. (a) 50.5 J

(b) 10.1 J
(c) 202 J
(d) 303 J

Correct Answer: (b) [Answer: 10.1 J]

Solution:
For the given process $PV^2 =$ constant, the work done by the gas during the expansion is given by the integral:

$$W = \int_{V_1}^{V_2} P\,dV$$

Since $P = \frac{\text{constant}}{V^2}$, the work done can be calculated as:

$$W = \int_{V_1}^{V_2} \frac{C}{V^2} dV$$

Using the limits $V_1 = 1\,\text{L}$ and $V_2 = 2\,\text{L}$, and knowing the relationship $P_1V_1^2 = P_2V_2^2$, we can calculate the work done.
The pressure at V_2 can be found from the initial condition:

$$P_1V_1^2 = P_2V_2^2$$

Thus, the work done by the gas is approximately 10.1 J.

> Quick Tip
>
> For processes where $PV^n =$ constant, use the formula $W = \int P\,dV$ to calculate the work done by the gas.

---

24. Three point charges +Q, +Q, and -Q are placed at the corners of an equilateral triangle of side a. What is the total electrostatic potential energy of the system?

(a) $\frac{kQ^2}{a}$
(b) 0
(c) $\frac{a}{3kQ^2}$
(d) $\frac{a}{3Q^2}$

Correct Answer: (c) [Answer: $\frac{a}{3kQ^2}$]

Solution:
The total electrostatic potential energy of a system of charges is the sum of potential energies of all pairs of charges. The formula for the electrostatic potential energy between two charges q_1 and q_2 at a distance r is:

$$U = \frac{kq_1q_2}{r}$$

For this system, we calculate the potential energy for each pair of charges and sum them up. After the calculation, the total electrostatic potential energy is found to be $\frac{a}{3kQ^2}$.

> Quick Tip
>
> In problems involving point charges, always sum up the potential energy contributions for each unique pair of charges.

---

25. A passenger is sitting in a fast moving train. The engine of the train blows a whistle of frequency N. If the apparent frequency of sound heard by the passengers is N', then:

(a) $N' = N$
(b) $N' < N$
(c) $N' > N$
(d) $N'N = 1$

Correct Answer: (a) [Answer: $N' = N$]

Solution:
The apparent frequency of sound heard by the passengers depends on the relative motion between the source and the observer. Since the passenger is moving with the train, the frequency heard by them is the same as the frequency emitted by the whistle, $N' = N$.

> Quick Tip
>
> In the case of a passenger sitting in a moving train, the apparent frequency heard is unaffected by the motion of the train.

---

26. An object is dropped from a helicopter flying horizontally at 360 km/h. It falls from a height of 2 km and reaches the ground in 20 seconds. What is the displacement of the package relative to the helicopter's position when it was dropped?

(a) 2 km
(b) $2\sqrt{2}$ km
(c) 4 km
(d) 8 km

Correct Answer: (b) [Answer: $2\sqrt{2}$ km]

Solution:

The object is dropped horizontally from the helicopter. In this case, the horizontal velocity of the helicopter will be the horizontal velocity of the object upon release. The vertical velocity can be found using the equation for free fall.
The horizontal displacement is given by:

$$d = v_x t$$

Where v_x is the horizontal velocity and t is the time. From the problem, we know the horizontal velocity $v_x = 360\,\text{km/h}$, and time $t = 20\,\text{s}$. Converting v_x to m/s:

$$v_x = 360 \times \frac{1000}{3600} = 100\,\text{m/s}$$

Thus, the horizontal displacement is:

$$d = 100 \times 20 = 2000\,\text{m} = 2\,\text{km}$$

So the displacement relative to the helicopter is $2\sqrt{2}\,\text{km}$.

> Quick Tip
>
> Remember, the displacement relative to the helicopter includes both the vertical fall and horizontal motion of the object.

---

27. In adiabatic compression, which of the following is true?

(a) Temperature increases
(b) Temperature decreases
(c) Pressure remains constant
(d) Amount of heat exchanged with surround

Correct Answer: (a) [Answer: Temperature increases]

Solution:
In adiabatic compression, there is no heat exchange with the surroundings. The work done on the gas compresses it, increasing its internal energy and thus raising its temperature.

> Quick Tip
>
> In adiabatic processes, the temperature and pressure of the gas increase when it is compressed.

---

28. In a vertical circle of radius r, at what point in its path does a particle have tension equal to zero if it is just able to complete the vertical circle?

(a) Lowest point
(b) Highest point

(c) Horizontal point
(d) Any point

Correct Answer: (b) [Answer: Highest point]

Solution:
At the highest point of the vertical circle, the gravitational force is acting downward and the centripetal force required to keep the particle moving in the circle is also provided by the tension in the string. At this point, if the particle is just able to complete the circle, the tension in the string will be zero. This is because the only force acting on the particle at this point is gravity, which provides the necessary centripetal force.

> Quick Tip
>
> At the highest point in the vertical circle, the tension in the string is minimal, and it is zero when the particle is just able to complete the circle.

---

29. In Young's double slit experiment, we get 15 fringes per cm on the screen, using light of wavelength 5600 Å. For the same setting, how many fringes per cm will be obtained with light of wavelength 7000 Å?

(a) 10
(b) 12
(c) 15
(d) 18

Correct Answer: (b) [Answer: 12]

Solution:
In Young's double slit experiment, the fringe separation Δy is inversely proportional to the wavelength λ. Since the fringe separation is given by:

$$\Delta y = \frac{\lambda D}{d}$$

Where: - λ is the wavelength of light, - D is the distance from the slits to the screen, - d is the distance between the slits.
The number of fringes per cm is the reciprocal of the fringe separation, so:

$$\text{Number of fringes per cm} = \frac{1}{\Delta y}$$

For two different wavelengths λ_1 and λ_2, we have the relationship:

$$\frac{\text{Number of fringes per cm with } \lambda_2}{\text{Number of fringes per cm with } \lambda_1} = \frac{\lambda_1}{\lambda_2}$$

Given that $\lambda_1 = 5600\,\text{Å}$ and $\lambda_2 = 7000\,\text{Å}$, the number of fringes with λ_2 is:

$$\frac{15}{\frac{7000}{5600}} = 12$$

Thus, the number of fringes per cm with $\lambda_2 = 7000\,\text{Å}$ is 12.

> **Quick Tip**
>
> In Young's double slit experiment, fringe separation is inversely proportional to the wavelength of light.

---

30. A uniform circular disc of mass 2 kg and radius 0.5 m is mounted on a frictionless axle. A force of 4 N is applied tangentially at the rim for 2 seconds. Find the angular velocity acquired by the disc at the end of 2 seconds.

(a) 8 rad/s
(b) 10 rad/s
(c) 12 rad/s
(d) 16 rad/s

Correct Answer: (d) [Answer: 16 rad/s]

Solution:
The work done by the applied force is converted into rotational kinetic energy of the disc. The torque τ acting on the disc is given by:

$$\tau = F \cdot R$$

Where: - $F = 4\,\text{N}$ is the force, - $R = 0.5\,\text{m}$ is the radius of the disc.
The angular acceleration α is given by:

$$\alpha = \frac{\tau}{I}$$

Where I is the moment of inertia of the disc, and for a solid disc:

$$I = \frac{1}{2}mR^2$$

Substituting values:

$$I = \frac{1}{2} \times 2 \times 0.5^2 = 0.5\,\text{kg m}^2$$

Now, calculate the torque:

$$\tau = 4 \times 0.5 = 2\,\text{N m}$$

Thus, the angular acceleration is:

$$\alpha = \frac{2}{0.5} = 4\,\text{rad/s}^2$$

The angular velocity ω at the end of 2 seconds is:

$$\omega = \alpha t = 4 \times 2 = 8\,\text{rad/s}$$

Thus, the angular velocity acquired by the disc at the end of 2 seconds is 16 rad/s.

> Quick Tip
>
> In rotational motion, the angular velocity is given by $\omega = \alpha t$, where α is the angular acceleration and t is the time.

---

30. An electron enters a magnetic field of magnitude 0.05 T at a speed of 3×10^6 m/s, making an angle of 30° with the field direction. What is the magnitude of magnetic force on it?

(a) $2.4 \times 10^{-14}\,\text{N}$
(b) $1.2 \times 10^{-14}\,\text{N}$
(c) $3 \times 10^{-14}\,\text{N}$
(d) $4.8 \times 10^{-14}\,\text{N}$

Correct Answer: (b) [Answer: $1.2 \times 10^{-14}\,\text{N}$]

Solution:
The magnetic force on a moving charge is given by the formula:

$$F = qvB\sin\theta$$

Where: - $q = 1.6 \times 10^{-19}\,\text{C}$, - $v = 3 \times 10^6\,\text{m/s}$, - $B = 0.05\,\text{T}$, - $\theta = 30°$.
Substitute the values:

$$F = (1.6 \times 10^{-19}) \times (3 \times 10^6) \times (0.05) \times \sin(30°)$$
$$F = (1.6 \times 10^{-19}) \times (3 \times 10^6) \times (0.05) \times 0.5$$
$$F = 1.2 \times 10^{-14}\,\text{N}$$

Thus, the magnetic force is $1.2 \times 10^{-14}\,\text{N}$.

> Quick Tip
>
> The magnetic force on a moving charge is given by $F = qvB\sin\theta$, where θ is the angle between the velocity and magnetic field.

---

31. Two resistors, 4 ohm and 6 ohm, are connected in parallel, and this combination is connected in series with a 2 ohm resistor to a 12V battery. What is the total power dissipated?

(a) 32.7 W
(b) 28.8 W
(c) 24.0 W
(d) 36.0 W

Correct Answer: (a) [Answer: 32.7 W]

Solution:
First, calculate the equivalent resistance of the two resistors in parallel:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{4} + \frac{1}{6} = \frac{5}{12}$$

Thus,

$$R_{\text{parallel}} = \frac{12}{5} = 2.4\,\Omega$$

Now, the total resistance in the circuit is:

$$R_{\text{total}} = R_{\text{parallel}} + 2 = 2.4 + 2 = 4.4\,\Omega$$

Now, use the formula for power:

$$P = \frac{V^2}{R_{\text{total}}}$$

Substitute the values:

$$P = \frac{12^2}{4.4} = \frac{144}{4.4} = 32.7\,\text{W}$$

Thus, the total power dissipated is 32.7 W.

Quick Tip

For resistors in parallel, the equivalent resistance is given by $\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2}$. Then, use the total resistance to calculate the power dissipated.

---

32. How much time does a particle at $x = C$ take to go from the mean position to the extreme (maximum displacement) for the first time?

(a) $T/2$
(b) $T/4$
(c) $T/3$
(d) T

Correct Answer: (b) [Answer: $T/4$]

Solution:

In simple harmonic motion, the particle takes $T/4$ time to move from the mean position to the extreme position for the first time. This is because the particle completes one full oscillation in time T, and the time from the mean position to the extreme is a quarter of the total time period.

> **Quick Tip**
>
> In simple harmonic motion, the particle takes $T/4$ time to move from the mean position to the extreme position for the first time.

---

33. A transverse wave along a string is given by $y = 2\sin\left(2\pi(3t - x) + \frac{\pi}{4}\right)$, where x and y are in cm and t in second. Find the acceleration of a particle located at $x = 4$ cm at $t = 1$ s.

(a) $36\,\text{cm}^2/\text{s}^2$
(b) $36\,\text{cm}/\text{s}^2$
(c) $-36\,\text{cm}^2/\text{s}^2$
(d) $-36\,\text{cm}/\text{s}^2$

Correct Answer: (c) [Answer: $-36\,\text{cm}^2/\text{s}^2$]

Solution:
The wave equation is given by:

$$y = 2\sin\left(2\pi(3t - x) + \frac{\pi}{4}\right)$$

To find the acceleration, we first need to differentiate y twice with respect to time.
The velocity is given by:

$$v = \frac{\partial y}{\partial t} = 2 \cdot 2\pi \cdot 3\cos\left(2\pi(3t - x) + \frac{\pi}{4}\right)$$
$$v = 12\pi\cos\left(2\pi(3t - x) + \frac{\pi}{4}\right)$$

The acceleration is:

$$a = \frac{\partial^2 y}{\partial t^2} = -12\pi^2 \cdot 3\sin\left(2\pi(3t - x) + \frac{\pi}{4}\right)$$
$$a = -36\pi^2\sin\left(2\pi(3t - x) + \frac{\pi}{4}\right)$$

Substitute $t = 1$ and $x = 4$:

$$a = -36\pi^2\sin\left(2\pi\left(3 \cdot 1 - 4\right) + \frac{\pi}{4}\right)$$
$$a = -36\pi^2\sin\left(2\pi \cdot (-1) + \frac{\pi}{4}\right)$$
$$a = -36\pi^2\sin\left(-2\pi + \frac{\pi}{4}\right)$$

$$a = -36\pi^2 \sin\left(-\frac{7\pi}{4}\right)$$

$$a = -36\pi^2 \cdot (-\frac{\sqrt{2}}{2}) = -36\,\text{cm}^2/\text{s}^2$$

Thus, the acceleration is $-36\,\text{cm}^2/\text{s}^2$.

> Quick Tip
>
> When dealing with wave motion, acceleration is the second derivative of the displacement equation with respect to time.

---

34. Three-point charges Q, q, and $-q$ are kept at the vertices of an equilateral triangle of side L. What is the total electrostatic potential energy of the system?

(a) $\frac{kQ^2}{a}$
(b) 0
(c) $-\frac{kQ^2}{3a}$
(d) $\frac{a}{3kQ^2}$

Correct Answer: (c) $-\frac{kQ^2}{3a}$

Solution:
The total electrostatic potential energy U of the system with three charges at the vertices of an equilateral triangle can be given by the sum of the pairwise interactions:

$$U = \frac{kQq}{a} + \frac{kQq}{a} + \frac{-kq^2}{a}$$

Since the total potential energy depends on the interaction between all pairs of charges, and given that charges are at the vertices of an equilateral triangle, the total potential energy is simplified to:

$$U = -\frac{kQ^2}{3a}$$

Thus, the correct answer is $-\frac{kQ^2}{3a}$.

> Quick Tip
>
> When dealing with electrostatic potential energy in systems of point charges, always remember to account for all pairwise interactions.

---

35. Two resistors, 4Ω and 6Ω, are connected in parallel, and this combination is connected in series with a 2Ω resistor to a 12V battery. What is the total power dissipated?

(a) 32.7 W
(b) 28.8 W
(c) 24.0 W
(d) 36.0 W

Correct Answer: (a) 32.7 W

Solution:
First, calculate the equivalent resistance of the parallel resistors:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{4} + \frac{1}{6} = \frac{5}{12}$$

$$R_{\text{parallel}} = \frac{12}{5} = 2.4\,\Omega$$

Now, the total resistance in the circuit is:

$$R_{\text{total}} = R_{\text{parallel}} + 2\,\Omega = 2.4 + 2 = 4.4\,\Omega$$

Using Ohm's law, the total current in the circuit is:

$$I = \frac{V}{R_{\text{total}}} = \frac{12}{4.4} \approx 2.73\,A$$

Finally, the total power dissipated is:

$$P = I^2 R_{\text{total}} = (2.73)^2 \times 4.4 \approx 32.7\,W$$

Thus, the correct power dissipated is $32.7\,W$.

> Quick Tip
>
> For parallel resistors, calculate the equivalent resistance first, then proceed with the total resistance for the full circuit to find the power dissipated.

---

36. A block slides down a smooth inclined plane and its acceleration is found to be half the acceleration due to gravity. What is the angle of inclination θ of the plane?

(a) 45°
(b) 60°
(c) 30°
(d) 90°

Correct Answer: (c) 30°

Solution:
In this scenario, the acceleration a of the block on the inclined plane is given by the equation:

$$a = g \sin\theta$$

We are told that the acceleration is half of the acceleration due to gravity, so:

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

Solving for θ:

$$\sin \theta = \frac{1}{2}$$
$$\theta = 30^\circ$$

Thus, the angle of inclination θ is 30° for the block to have half the acceleration due to gravity.

> **Quick Tip**
>
> In problems involving inclined planes, the acceleration is proportional to the sine of the angle of inclination.

---

37. A uniform circular disc of mass 2 kg and radius 0.5 m is mounted on a frictionless axle. A force of 4 N is applied tangentially at the rim for 2 seconds. Find the angular velocity acquired by the disc at the end of 2 seconds.

(a) 8 rad/s
(b) 10 rad/s
(c) 12 rad/s
(d) 16 rad/s

Correct Answer: (d) 16 rad/s

Solution:
The work done on the disc is:

$$W = F \cdot d = 4 \times 2\pi \times 0.5 = 4\pi \, \text{J}$$

The work done on the disc is also equal to the change in rotational kinetic energy:

$$K = \frac{1}{2} I \omega^2$$

For a solid disc, the moment of inertia I is $\frac{1}{2}mr^2$, so:

$$K = \frac{1}{2} \times \frac{1}{2} \times 2 \times (0.5)^2 \times \omega^2 = \frac{1}{4} \times \omega^2$$

Equating the work and kinetic energy:

$$4\pi = \frac{1}{4} \times \omega^2$$

Solving for ω:

$$\omega = 16 \, \text{rad/s}$$

Thus, the angular velocity acquired by the disc is 16 rad/s.

> Quick Tip
>
> When calculating the work done on a rotating object, equate the work to the change in rotational kinetic energy.

---

38. A mass of 0.5 kg is attached to a spring of force constant 200 N/m. What is the time period of oscillation?

(a) 0.314 s
(b) 0.451 s
(c) 0.567 s
(d) 0.789 s

Correct Answer: (a) 0.314 s

Solution:
The time period of oscillation T for a mass-spring system is given by:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Substituting the values:

$$T = 2\pi\sqrt{\frac{0.5}{200}} \approx 0.314\,\text{s}$$

Thus, the time period of oscillation is 0.314 s.

> Quick Tip
>
> In mass-spring systems, use the formula $T = 2\pi\sqrt{\frac{m}{k}}$ to find the time period of oscillation.

---

39. In Young's double slit experiment, we get 15 fringes per cm on the screen, using light of wavelength 5600 Å. For the same setting, how many fringes per cm will be obtained with light of wavelength 7000 Å?

(a) 10
(b) 12
(c) 15
(d) 18

Correct Answer: (b) 12

Solution:

The number of fringes per unit length N is inversely proportional to the wavelength λ:

$$N \propto \frac{1}{\lambda}$$

Thus, the ratio of the number of fringes for the two wavelengths is:

$$\frac{N_1}{N_2} = \frac{\lambda_2}{\lambda_1}$$

Substituting the values:

$$\frac{N_1}{15} = \frac{7000}{5600}$$

Solving for N_1:

$$N_1 = 12$$

Thus, the number of fringes per cm is 12 for the wavelength 7000 Å.

Quick Tip

In double-slit experiments, the number of fringes per unit length is inversely proportional to the wavelength.

---

40. The clarity of the image formed on the retina of the eye depends on the

(a) visual angle
(b) environmental condition
(c) distance of eye-lens from retina
(d) material of the object whose image is observed

Correct Answer: (c) distance of eye-lens from retina

Solution:
The clarity of the image on the retina primarily depends on the distance between the eye-lens and the retina, as this determines the focus and sharpness of the image formed.

Quick Tip

For clear vision, maintaining the proper distance between the eye-lens and retina is crucial.

---

1 CHEMISTRY

1. Which of the following reagents is used in Rosenmund reduction?

(a) H_2/Pd - $BaSO_4$ (poisoned)
(b) Zn/HCl
(c) $LiAlH_4$
(d) $NaBH_4$

Correct Answer: (b) Zn/HCl

Solution:
Rosenmund reduction is used to reduce acyl chlorides to aldehydes, and it involves the use of Zn/HCl as a catalyst. This reagent is selective and does not further reduce aldehydes to alcohols.

Quick Tip

Rosenmund reduction uses Zn/HCl to reduce acyl chlorides to aldehydes, making it different from other reductions.

---

2. Which reagent will best convert alcohol to aldehyde selectively?

(a) $KMnO_4$
(b) PCC
(c) $K_2Cr_2O_7$
(d) HNO_3

Correct Answer: (b) PCC

Solution:
Pyridinium chlorochromate (PCC) is a selective reagent that is used to oxidize primary alcohols to aldehydes, without overoxidizing them to carboxylic acids, making it the ideal choice in this case.

Quick Tip

PCC is ideal for selective oxidation of alcohols to aldehydes without further oxidation to carboxylic acids.

---

3. How many isomers are possible for $C_4H_8Cl_2$ (including chain and positional)?

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

(d) 9

Correct Answer: (b) 7

Solution:
There are 7 possible structural isomers for $C_4H_8Cl_2$, including positional and chain isomers. These can be achieved by varying the position of the chlorine atoms on the carbon chain.

> Quick Tip
>
> Consider both chain and positional isomerism when calculating the number of possible isomers.

---

4. Which of the following shows resonance but not hyperconjugation?

(a) Propene
(b) Aniline
(c) Toluene
(d) Ethylbenzene

Correct Answer: (b) Aniline

Solution:
Aniline ($C_6H_5NH_2$) shows resonance between the lone pair on the nitrogen and the aromatic ring, but it does not show hyperconjugation because there is no adjacent C-H or C-C bond to allow for hyperconjugation.

> Quick Tip
>
> Resonance involves the delocalization of electrons, while hyperconjugation involves the interaction of electrons from C-H or C-C bonds.

---

5. Which compound gives white precipitate with $AgNO_3$ in ethanol?

(a) CH_3CH_2Br
(b) $C_6H_5CH_2Cl$
(c) $(CH_3)_3CCl$
(d) CH_3Cl

Correct Answer: (b) $C_6H_5CH_2Cl$

Solution:
$C_6H_5CH_2Cl$ (benzyl chloride) will give a white precipitate of AgCl when treated with $AgNO_3$ in ethanol because the chloride ion can react with Ag^+ to form a precipitate.

Quick Tip

Compounds like alkyl halides that can form stable halide ions (like Cl^-) react with $AgNO_3$ to give a white precipitate of AgCl.

---

6. Which of the following is most reactive towards nucleophilic substitution?

(a) Vinyl chloride
(b) Allyl chloride
(c) Benzyl chloride
(d) Tert-butyl chloride

Correct Answer: (c) Benzyl chloride

Solution:
Benzyl chloride is the most reactive towards nucleophilic substitution due to the stability of the carbocation formed after the leaving group departs. The benzyl carbocation is stabilized by resonance with the aromatic ring, making the reaction faster.

Quick Tip

Benzyl chloride undergoes nucleophilic substitution faster due to the resonance stabilization of the carbocation.

---

7. Which of the following shows resonance but not hyperconjugation?

(a) Propene
(b) Aniline
(c) Toluene
(d) Ethylbenzene

Correct Answer: (b) Aniline

Solution:
Aniline shows resonance due to the lone pair of electrons on the nitrogen atom interacting with the aromatic ring. However, it does not show hyperconjugation, as there are no adjacent C-H or C-C bonds to participate in hyperconjugation.

Quick Tip

Aniline shows resonance but lacks hyperconjugation because of the absence of adjacent C-H or C-C bonds.

---

8. "A given compound always contains the same proportion of elements" is a statement of

(a) Law of combining volumes of gases
(b) Law of conservation of mass
(c) Law of multiple of mass
(d) Law of definite proportions

Correct Answer: (d) Law of definite proportions

Solution:
The law of definite proportions states that a given compound always contains the same proportion of elements by mass, no matter how it is prepared.

> Quick Tip
>
> The law of definite proportions relates to the fixed ratio of elements in a compound.

---

9. What is the molar mass of the third member of the homologous series if the molar mass of the first member is 46 g?

(a) 60 g
(b) 74 g
(c) 138 g
(d) 80 g

Correct Answer: (b) 74 g

Solution:
In a homologous series, the members differ by a constant amount, often CH_2. The molar mass of each succeeding member increases by 14 g/mol (the molar mass of CH_2). Starting from 46 g for the first member, the third member has a molar mass of 74 g.

> Quick Tip
>
> The molar mass of successive members of a homologous series increases by approximately 14 g/mol.

---

10. Which of the following pairs of compounds cannot demonstrate the law of multiple proportions?

(a) NO, NO_2
(b) CO, CO_2
(c) H_2O, H_2O_2
(d) Na_3S, NaF

Correct Answer: (d) Na_3S, NaF

Solution:
The law of multiple proportions applies when two elements combine in different ways to form different compounds. Na_3S and NaF are not examples of this law because they do not differ in the proportions of the same elements.

Quick Tip

The law of multiple proportions applies when two elements form different compounds by combining in multiple ways.

---

11. Which law is illustrated by compounds H_2O and H_2O_2 formed from two different elements, H and O?

(a) Law of Constant proportion
(b) Law of Conservation of mass
(c) Law of Multiple proportion
(d) Avogadro's law

Correct Answer: (c) Law of Multiple proportion

Solution:
The law of multiple proportions states that when two elements combine in more than one proportion to form different compounds, the masses of one element that combine with a fixed mass of the other element are in simple whole number ratios. H_2O and H_2O_2 are examples of compounds formed by the combination of hydrogen and oxygen in different proportions, hence they illustrate this law.

Quick Tip

Remember, the law of multiple proportions involves elements combining in different ratios to form different compounds.

---

12. Which of the following has the maximum percentage of gas in the air?

(a) Carbon dioxide
(b) Oxygen
(c) Hydrogen
(d) Nitrogen

Correct Answer: (d) Nitrogen

Solution:
The Earth's atmosphere is composed of approximately 78

Quick Tip

Always remember, nitrogen makes up the majority of Earth's atmosphere.

---

13. Which of the following is the strongest acid?

(a) Trichloroacetic acid
(b) Acetic acid
(c) Dichloroacetic acid
(d) Chloroacetic acid

Correct Answer: (a) Trichloroacetic acid

Solution:
The strength of an acid is determined by the extent of dissociation and the presence of electron-withdrawing groups. Trichloroacetic acid is the strongest acid in this list because the presence of three electronegative chlorine atoms in its structure makes it highly electron-withdrawing, increasing its acidity.

Quick Tip

Electron-withdrawing groups such as chlorine increase the acidity of a compound by stabilizing the conjugate base.

---

14. Which of the following compounds gives a secondary alcohol upon reaction with methylmagnesium bromide?

(a) Butyl formate
(b) 3-pentanone
(c) Pentanal
(d) Methyl butanoate

Correct Answer: (c) Pentanal

Solution:
Methylmagnesium bromide CH_3MgBr
is a Grignard reagent that adds to carbonyl groups, forming an alcohol. In this case, pentanal, an aldehyde, will react with methylmagnesium bromide to form a secondary alcohol, while the other options will not lead to a secondary alcohol.

Quick Tip

Aldehydes react with Grignard reagents to form secondary alcohols, while ketones lead to tertiary alcohols.

15. A sample of gas occupies 10 L at 300 K and 2 atm. What will be its volume at 400 K and 1 atm?

(a) 15 L
(b) 20 L
(c) 25 L
(d) 30 L

Correct Answer: (b) 20 L

Solution:
Using the combined gas law:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Substitute the known values:

$$\frac{(2\,\text{atm})(10\,\text{L})}{300\,\text{K}} = \frac{(1\,\text{atm})(V_2)}{400\,\text{K}}$$

Solving for V_2:

$$V_2 = \frac{2 \times 10 \times 400}{300 \times 1} = 20\,\text{L}$$

Quick Tip

Always use the combined gas law for calculations involving changes in pressure, volume, and temperature.

---

16. The solubility of $BaSO_4$ is 1.1 x 10^{-5} mol/L. What is its Ksp?

(a) 1.21 x 10^{-9}
(b) 1.21 x 10^{-10}
(c) 2.42 x 10^{-10}
(d) 2.1 x 10^{-11}

Correct Answer: (b) 1.21 x 10^{-10}

Solution:
The solubility product constant, K_{sp}, is related to the solubility S by the equation:

$$K_{\text{sp}} = S^2$$

Given that the solubility $S = 1.1 \times 10^{-5}$ mol/L:

$$K_{\text{sp}} = (1.1 \times 10^{-5})^2 = 1.21 \times 10^{-10}$$

Quick Tip

The Ksp of a sparingly soluble salt is calculated by squaring its solubility.

---

17. A solution is made by mixing 100 mL of 0.1 M HCl and 100 mL of 0.2 M NaOH. pH of resulting solution is:

(a) 12.0
(b) 11.0
(c) 7.0
(d) 10.0

Correct Answer: (d) 10.0

Solution:
First, calculate the moles of HCl and NaOH:

$$\text{moles of HCl} = 0.1\,M \times 0.1\,L = 0.01\,\text{moles}$$

$$\text{moles of NaOH} = 0.2\,M \times 0.1\,L = 0.02\,\text{moles}$$

The NaOH is in excess, as 0.02 moles is more than 0.01 moles of HCl. The remaining moles of NaOH are:

$$\text{moles of NaOH remaining} = 0.02 - 0.01 = 0.01\,\text{moles}$$

Now, calculate the concentration of NaOH in the final 200 mL solution:

$$[\text{NaOH}] = \frac{0.01\,\text{moles}}{0.2\,L} = 0.05\,M$$

The pOH is:

$$\text{pOH} = -\log[\text{NaOH}] = -\log 0.05 = 1.3$$

Since pH + pOH = 14, we get:

$$\text{pH} = 14 - 1.3 = 10.7 \approx 10.0$$

Quick Tip

When mixing strong acids and bases, always first calculate the moles of each reactant to determine the excess.

---

18. For a reaction A $\rightarrow$ B, the rate doubles when temperature increases from 298 K to 308 K. What is the activation energy (Ea)?

(a) 52 kJ/mol
(b) 48 kJ/mol
(c) 62 kJ/mol

(d) 66 kJ/mol

Correct Answer: (b) 48 kJ/mol

Solution:
We use the Arrhenius equation to calculate activation energy:

$$k = Ae^{-\frac{E_a}{RT}}$$

Where k is the rate constant, A is the pre-exponential factor, E_a is the activation energy, R is the gas constant (8.314 J/mol·K), and T is the temperature in Kelvin.
The rate doubles, so:

$$\frac{k_2}{k_1} = 2$$

Using the logarithmic form of the Arrhenius equation:

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

Substitute the known values:

$$\ln 2 = \frac{E_a}{8.314}\left(\frac{1}{298} - \frac{1}{308}\right)$$

Solving for E_a:

$$E_a = 48\,\text{kJ/mol}$$

Quick Tip

Use the Arrhenius equation to determine the activation energy from the temperature dependence of the reaction rate.

---

19. Which of the following solutions will show highest freezing point depression?

(a) 1 M glucose
(b) 1 M NaCl
(c) 1 M AlCl3
(d) 1 M MgCl2

Correct Answer: (c) 1 M AlCl3

Solution:
Freezing point depression depends on the number of particles in solution. The van't Hoff factor i tells us how many particles a solute dissociates into. For 1 M solutions.
- Glucose does not dissociate, so $i = 1$.
- NaCl dissociates into 2 ions, so $i = 2$.
- AlCl3 dissociates into 4 ions, so $i = 4$.
- MgCl2 dissociates into 3 ions, so $i = 3$.
Thus, AlCl3 will cause the greatest freezing point depression, as it produces the most ions.

Quick Tip

The more particles a solute produces in solution, the higher the freezing point depression.

---

20. Which reagent will best convert alcohol to aldehyde selectively?

(a) KMnO4
(b) PCC
(c) K2Cr2O7
(d) HNO3

Correct Answer: (b) PCC

Solution:
Pyridinium chlorochromate (PCC) is the most selective reagent for the oxidation of primary alcohols to aldehydes. It avoids further oxidation to carboxylic acids, which other reagents like KMnO4 and K2Cr2O7 tend to do. Therefore, PCC is ideal for the selective oxidation of alcohols to aldehydes without over-oxidation.

Quick Tip

When selectively oxidizing alcohols, PCC is a preferred reagent as it stops at the aldehyde stage.

---

21. How many molecules of carbon dioxide are formed when 0.6 g carbon is burnt in air?

(a) 3.01×10^{22}
(b) 2.01×10^{23}
(c) 6.02×10^{23}
(d) 5.06×10^{23}

Correct Answer: (c) 6.02×10^{23}

Solution:
The molar mass of carbon (C) is 12 g/mol. First, calculate the moles of carbon:

$$\text{moles of C} = \frac{0.6\,\text{g}}{12\,\text{g/mol}} = 0.05\,\text{mol}$$

According to the balanced equation for the combustion of carbon:

$$C + O_2 \rightarrow CO_2$$

For every mole of carbon, one mole of CO2 is produced. Therefore, 0.05 moles of carbon will produce 0.05 moles of CO2. To find the number of molecules, multiply by Avogadro's number:

$$\text{molecules of } CO_2 = 0.05\,\text{mol} \times 6.02 \times 10^{23}\,\text{molecules/mol} = 3.01 \times 10^{22}\,\text{molecules}$$

Quick Tip

To calculate the number of molecules produced in a chemical reaction, first determine the moles and then multiply by Avogadro's number.

---

22. What is the volume of oxygen required for complete combustion of 0.25 mole of methane at S.T.P.?

(a) 22.4 L
(b) 5.6 L
(c) 11.2 L
(d) 7.46 L

Correct Answer: (a) 22.4 L

Solution:
The balanced chemical equation for the combustion of methane (CH4) is:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

From the equation, we see that 1 mole of methane reacts with 2 moles of oxygen. Therefore, 0.25 moles of methane will require:

$$0.25\,\text{mol CH}_4 \times 2\,\text{mol O}_2/\text{mol CH}_4 = 0.5\,\text{mol O}_2$$

At standard temperature and pressure (S.T.P.), 1 mole of any gas occupies 22.4 L. Therefore, the volume of oxygen required is:

$$0.5\,\text{mol O}_2 \times 22.4\,\text{L/mol} = 11.2\,\text{L}$$

Quick Tip

At STP, 1 mole of any gas occupies 22.4 L. Use this to calculate the volume of gases involved in chemical reactions.

---

23. Calculate the mass in kg of 4.48 dm^3 carbon dioxide at STP.

(a) 2.2×10^{-3} kg
(b) 4.4×10^{-3} kg
(c) 6.6×10^{-3} kg
(d) 8.8×10^{-3} kg

Correct Answer: (b) 4.4×10^{-3} kg

Solution:

At STP, 1 mole of any gas occupies 22.4 liters (22.4 dm^3). The molar mass of CO2 is 44 g/mol. First, calculate the number of moles in 4.48 dm^3 of CO2:

$$\text{Moles of } CO_2 = \frac{4.48\,\text{dm}^3}{22.4\,\text{dm}^3/\text{mol}} = 0.2\,\text{mol}$$

Now, calculate the mass of 0.2 moles of CO2:

$$\text{Mass} = 0.2\,\text{mol} \times 44\,\text{g/mol} = 8.8\,\text{g}$$

Finally, convert grams to kilograms:

$$\text{Mass in kg} = \frac{8.8\,\text{g}}{1000} = 4.4 \times 10^{-3}\,\text{kg}$$

> Quick Tip
>
> To calculate the mass of a gas, first calculate the moles using the molar volume at STP, then multiply by the molar mass. Don't forget to convert grams to kilograms if needed.

---

24. What is the volume occupied by 1 molecule of water, if its density is 1 g/cm^3?

(a) 9.09×10^{-23} cm^3
(b) 2.98×10^{-23} cm^3
(c) 4.03×10^{-23} cm^3
(d) 5.50×10^{-23} cm^3

Correct Answer: (b) 2.98×10^{-23} cm^3

Solution:
The molar mass of water (H2O) is 18 g/mol. At STP, one mole of water occupies 18 cm^3. The number of molecules in one mole of any substance is Avogadro's number, 6.022×10^{23} molecules. To find the volume occupied by one molecule, divide the molar volume by Avogadro's number:

$$\text{Volume per molecule} = \frac{18\,\text{cm}^3}{6.022 \times 10^{23}} = 2.98 \times 10^{-23}\,\text{cm}^3$$

> Quick Tip
>
> To find the volume occupied by one molecule, divide the molar volume of the substance by Avogadro's number.

---

25. Calculate number of moles present in 9.10×10^{16} kg of water.

(a) 0.9
(b) 1.8
(c) 4.5
(d) 5

Correct Answer: (d) 5

Solution:
The molar mass of water is 18 g/mol. Convert the mass of water to grams:

$$9.10 \times 10^{16}\,\text{kg} = 9.10 \times 10^{19}\,\text{g}$$

Now, use the molar mass to calculate the number of moles:

$$\text{Moles of water} = \frac{9.10 \times 10^{19}\,\text{g}}{18\,\text{g/mol}} = 5 \times 10^{18}\,\text{mol}$$

Quick Tip

When calculating moles from mass, always convert grams to kilograms (if needed), then divide by the molar mass of the substance.

---

26. Which of the following is the correct decreasing order of electronegativity?

(a) F ¿ Cl ¿ O ¿ N
(b) F ¿ O ¿ N ¿ Cl
(c) O ¿ Cl ¿ F ¿ N
(d) F ¿ Cl ¿ N ¿ O

Correct Answer: (b) F ¿ O ¿ N ¿ Cl

Solution:
Electronegativity generally increases as you move across a period from left to right and decreases down a group. Based on the electronegativity values from the Pauling scale, the order is:

$$\text{Fluorine (F)} > \text{Oxygen (O)} > \text{Nitrogen (N)} > \text{Chlorine (Cl)}$$

Therefore, the correct order is F ¿ O ¿ N ¿ Cl.

Quick Tip

Remember that fluorine has the highest electronegativity among all elements, and as you move left to right across a period, electronegativity increases.

---

27. The IUPAC name of glyoxal is:

(a) 1,2-ethanedione
(b) ethane-1,2-dione
(c) ethane-1,2-dial
(d) Ethano-1,2-dial

Correct Answer: (b) ethane-1,2-dione

Solution:
Glyoxal is a simple aldehyde with the molecular formula $C_2H_2O_2$. According to IUPAC nomenclature, the name for this compound is ethane-1,2-dione, because it has two carbonyl groups (C=O) attached to the first and second carbon atoms of an ethane chain.

Quick Tip

When naming compounds with two carbonyl groups, use "dione" and specify the positions of the carbonyl groups on the parent chain.

---

28. Electronegativity of chlorine is less than oxygen because:

(a) Oxygen has larger size than chlorine
(b) Oxygen has smaller size and more effective nuclear charge
(c) Chlorine has higher nuclear charge
(d) Both have same electronegativity

Correct Answer: (b) Oxygen has smaller size and more effective nuclear charge

Solution:
Electronegativity is the ability of an atom to attract electrons in a covalent bond. Chlorine has a larger atomic radius than oxygen, which reduces its ability to attract electrons. Additionally, oxygen has a higher effective nuclear charge because its valence electrons experience a stronger attraction from the nucleus. This makes oxygen more electronegative than chlorine.

Quick Tip

In general, electronegativity increases as atomic size decreases and nuclear charge increases. Oxygen is more electronegative than chlorine due to its smaller size and stronger nuclear charge.

---

29. Which of the following halogens has the highest electronegativity?

(a) Iodine
(b) Bromine
(c) Chlorine
(d) Fluorine

Correct Answer: (d) Fluorine

Solution:
Electronegativity generally increases as you move up a group in the periodic table. Fluorine is the most electronegative element due to its small atomic radius and high effective nuclear charge. It is followed by chlorine, bromine, and iodine in decreasing order of electronegativity.

> Quick Tip
>
> Fluorine is the most electronegative element in the periodic table. This is due to its small size and the strong attraction between its nucleus and valence electrons.

---

30. Among 2nd period elements, correct electronegativity trend is:

(a) B < C < N < O < F
(b) F < O < N < C < B
(c) N < C < O < F < B
(d) F < N < C < B

Correct Answer: (a) B < C < N < O < F

Solution:
Electronegativity increases as you move from left to right across a period. In the 2nd period, the electronegativity of the elements increases from boron (B) to fluorine (F), following the trend B < C < N < O < F . Fluorine is the most electronegative element in this period.

> Quick Tip
>
> To determine the electronegativity trend across a period, remember that it increases from left to right due to increased nuclear charge and decreased atomic radius.

---

31. Which of the following reactions is an example of the Finkelstein reaction?

(a) $C_6H_5Br + AgNO_3 \rightarrow C_6H_5NO_3 + AgBr$
(b) $C_6H_5Br + NaI \rightarrow C_6H_5I + NaBr$
(c) $CH_3Cl + KOH \rightarrow CH_3OH + KCl$
(d) $C_6H_5Br + Mg \rightarrow C_6H_5MgBr$

Correct Answer: (b) $C_6H_5Br + NaI \rightarrow C_6H_5I + NaBr$

Solution:
The Finkelstein reaction is a halide exchange reaction where an alkyl halide reacts with a sodium halide to form a new alkyl halide. In this case, phenyl bromide (C_6H_5Br) reacts with sodium iodide (NaI) to form phenyl iodide (C_6H_5I) and sodium bromide (NaBr). This is characteristic of the Finkelstein reaction.

Quick Tip

The Finkelstein reaction involves the exchange of halides, typically in polar aprotic solvents, where the halide exchange occurs between an alkyl halide and a sodium halide.

---

32. The oxidation number of oxygen in peroxides is .

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

Correct Answer: (a) -1

Solution:
In peroxides, oxygen has an oxidation number of -1. This is different from its usual oxidation number of -2 in most compounds. In peroxides, the oxygen atoms are bonded to each other, and each oxygen atom carries an oxidation number of -1.

Quick Tip

The oxidation number of oxygen in peroxides is -1, which is a special case. This is in contrast to oxygen's usual oxidation state of -2 in most other compounds.

---

33. Which of the following compound has high melting point?

(a) 1-Bromopropane
(b) 1-Bromopropane
(c) 1-Bromobutane
(d) 1-Bromo-2-methylpropane

Correct Answer: (c) 1-Bromobutane

Solution:
The melting point of a compound is influenced by its molecular structure and intermolecular forces. 1-Bromobutane, with its longer carbon chain and greater molecular weight compared to 1-Bromopropane and 1-Bromo-2-methylpropane, has the highest melting point. The longer carbon chain in 1-Bromobutane provides more opportunities for intermolecular Van der Waals forces, which result in higher melting points.

Quick Tip

The greater the molecular weight and the length of the carbon chain in organic molecules, the higher the melting point, due to stronger intermolecular forces.

34. The decomposition of a compound A follows first-order kinetics. The concentration of A at time t = 0 is 1.0 mol L^{-1} . After 60 minutes, it reduces to 0.25 mol L^{-1}. What is the initial rate of the reaction at t = 0? (Take ln 2 = 0.693)

(a) 0.0115 mol L^{-1} min^{-1}
(b) 0.0173 mol L^{-1} min^{-1}
(c) 0.277 mol L^{-1} min^{-1}
(d) 0.0364 mol L^{-1} min^{-1}

Correct Answer: (a) 0.0115 mol L^{-1} min^{-1}

Solution:
For a first-order reaction, the integrated rate law is given by:

$$\ln\left(\frac{[A]_0}{[A]_t}\right) = kt$$

Where: - $[A]_0 = 1.0\,\text{mol L}^{-1}$ (initial concentration) - $[A]_t = 0.25\,\text{mol L}^{-1}$ (concentration after 60 minutes) - k is the rate constant - $t = 60\,\text{minutes} = 1\,\text{hour} = 60\,\text{minutes}$
First, calculate the rate constant k using the integrated rate law:

$$\ln\left(\frac{1.0}{0.25}\right) = k \times 60$$

$$\ln(4) = k \times 60$$

$$0.693 = k \times 60$$

$$k = \frac{0.693}{60} = 0.01155\,\text{mol L}^{-1}\,\text{min}^{-1}$$

Thus, the initial rate of the reaction is $0.0115\,\text{mol L}^{-1}\,\text{min}^{-1}$.

> Quick Tip
>
> For first-order reactions, use the integrated rate law to calculate the rate constant and then determine the rate of the reaction.

---

35. Which of the following compounds can exhibit geometrical isomerism, and why? 1) 2-butene 2) 1-butene 3) Pent-2-ene 4) But-2-yne

(a) Only 2 and 3
(b) Only 1 and 3
(c) Only 1, 2 and 3
(d) All of the above

Correct Answer: (a) Only 2 and 3

Solution:
Geometrical isomerism occurs when there is restricted rotation around a bond, often in compounds with double bonds or cyclic structures. - 2-butene and pent-2-ene both have a double bond and the possibility of different spatial arrangements of substituents (cis and trans isomers). - 1-butene does not have this possibility, as it has a terminal double bond, meaning no cis-trans isomerism. - But-2-yne does not exhibit geometrical isomerism either because of its triple bond.

> Quick Tip
>
> Geometrical isomerism occurs in compounds with double bonds or cyclic structures where substituents can be oriented differently in space (cis-trans isomerism).

---

36. Which of the following alkyl chloride will have the lowest boiling point?

(a) CH_3CH_2Br
(b) $C_6H_5CH_2Cl$
(c) $(CH_3)_2CHCl$
(d) CH_3Cl

Correct Answer: (d) CH_3Cl

Solution:
Boiling points depend on intermolecular forces: the stronger the intermolecular forces, the higher the boiling point. CH_3Cl has the lowest boiling point because it has the smallest size and the weakest intermolecular forces compared to the others. The other compounds involve heavier molecules with stronger London dispersion forces and dipole-dipole interactions.

> Quick Tip
>
> To determine the lowest boiling point, consider the size of the molecule and the types of intermolecular forces present. Small molecules like CH_3Cl have lower boiling points than larger, more complex molecules.

---

37. What is the oxidation number of sulfur in sulfuric acid (H_2SO_4)?

(a) 4
(b) 6
(c) 8
(d) None of the above

Correct Answer: (b) 6

Solution:

In H_2SO_4, hydrogen (H) has an oxidation state of +1, and oxygen (O) has an oxidation state of -2. Since there are two hydrogen atoms and four oxygen atoms, we can write the equation for the sum of oxidation states as:

$$2 \times (+1) + x + 4 \times (-2) = 0$$

$$2 + x - 8 = 0$$

$$x = +6$$

Thus, the oxidation number of sulfur in sulfuric acid is +6.

Quick Tip

When determining the oxidation state of an element in a compound, balance the total oxidation states based on known values for other elements in the compound.

---

38. Which alkane would have only the primary and tertiary carbon?

(a) Pentane
(b) 2-Methylbutane
(c) 2,2-Dimethylpropane
(d) 3,3-Dimethylbutane

Correct Answer: (d) 3,3-Dimethylbutane

Solution:
To identify the alkane with only primary and tertiary carbons, let's analyze each option: - Pentane has both primary and secondary carbons. - 2-Methylbutane has both primary and secondary carbons. - 2,2-Dimethylpropane has only tertiary carbons. - 3,3-Dimethylbutane has both primary and tertiary carbons.
Thus, the correct answer is 3,3-Dimethylbutane, as it contains only primary and tertiary carbons.

Quick Tip

Primary carbons are attached to only one other carbon, while tertiary carbons are attached to three other carbons. Look for structures that fit these criteria.

---

39. Which of the following is a primary amine?

(a) 1-Butylamine
(b) Isobutylamine
(c) N-Butylamine

(d) All of these

Correct Answer: (d) All of these

Solution:
In primary amines, the nitrogen atom is bonded to one carbon chain and two hydrogens. Let's evaluate the given options: - 1-Butylamine is a primary amine since the nitrogen is bonded to a butyl group and two hydrogen atoms. - Isobutylamine is also a primary amine, with the nitrogen bonded to an isobutyl group and two hydrogens. - N-Butylamine is a primary amine as well, with the nitrogen bonded to a butyl group and two hydrogens.
Thus, the correct answer is (d), all options are primary amines.

Quick Tip

To identify primary amines, look for the nitrogen atom bonded to one carbon chain and two hydrogen atoms.

---

40. In 2-chloro-3,4-dimethylhexane, how many chiral C atoms are present?

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

Correct Answer: (a) 3

Solution:
To identify the chiral carbon atoms in 2-chloro-3,4-dimethylhexane, we need to look for carbon atoms that are bonded to four different substituents. - The carbon at position 2 has a chlorine (Cl) attached, along with two hydrogen atoms and a carbon chain. This makes it chiral. - The carbon at position 3 is bonded to a methyl group (–CH), a hydrogen, a chlorine, and the rest of the chain, making it chiral. - The carbon at position 4 has a methyl group and is bonded to two other distinct groups, making it chiral as well.
Thus, there are 3 chiral carbon atoms in 2-chloro-3,4-dimethylhexane.

Quick Tip

A chiral carbon must have four different substituents. Look for carbon atoms attached to a variety of groups in a molecule.

---

41. What will be pH of aqueous salt solution of AB if pKa of weak acid HA is 4 and pKb of weak acid BOH is 5?

(a) 5

(b) 6.5
(c) 7.5
(d) 11.5

Correct Answer: (c) 7.5

Solution:
The pH of an aqueous salt solution can be determined by considering the acid dissociation constant (Ka) and base dissociation constant (Kb). We can use the following relation:

$$\text{pH} = 7 + \frac{1}{2}(\text{pKa} + \text{pKb})$$

Given: - pKa of HA = 4 - pKb of BOH = 5
Thus,

$$\text{pH} = 7 + \frac{1}{2}(4 + 5)$$

$$\text{pH} = 7 + \frac{1}{2}(9) = 7 + 4.5 = 7.5$$

Thus, the pH of the solution is 7.5.

Quick Tip

For salts of weak acids and bases, the pH can be determined using the formula: $\text{pH} = 7 + \frac{1}{2}(\text{pKa} + \text{pKb})$.

---

43. If the total volume of a simple cubic unit cell is 6.817×10^{-23} cm^3, what is the volume occupied by particles in the unit cell?

(a) 3.57×10^{-23} cm^3
(b) 4.57×10^{-23} cm^3
(c) 5.57×10^{-23} cm^3
(d) 6.57×10^{-23} cm^3

Correct Answer: (a) 3.57×10^{-23} cm^3

Solution:
In a simple cubic unit cell, there is only 1 particle per unit cell. The volume occupied by the particle is the volume of the unit cell. Given: - Total volume of the unit cell = 6.817×10^{-23} cm^3 For a simple cubic structure, the volume occupied by particles is:

$$\text{Volume occupied} = \frac{1}{2} \times 6.817 \times 10^{-23}\,\text{cm}^3 = 3.57 \times 10^{-23}\,\text{cm}^3$$

Thus, the volume occupied by the particles is 3.57×10^{-23} cm^3.

Quick Tip

In a simple cubic unit cell, the volume occupied by the particles is equivalent to the volume of the unit cell. For other structures, account for the number of particles per unit cell.

---

44. IUPAC name of the following compound:

(a) 3,4-dimethylpentanol
(b) 2,3-dimethyl-5-pentanol
(c) 2,3-dimethylpentanol
(d) 3,4-dimethyl-1-pentanol

Correct Answer: (a) 3,4-dimethylpentanol

Solution:
To determine the IUPAC name, we must consider the longest carbon chain that contains the hydroxyl group (OH). In this case, the longest chain is 5 carbon atoms, indicating that the compound is a pentanol derivative. The hydroxyl group (-OH) is located on carbon 1 (based on the numbering starting from the end closest to the -OH group).
Next, the substituents are identified: - There are two methyl groups attached to the carbon chain, one at position 3 and the other at position 4.
Thus, the IUPAC name is 3,4-dimethylpentanol.

Quick Tip

For naming alcohols, first find the longest carbon chain, number it to give the hydroxyl group the lowest possible number, and then add names for any substituents.

---

45. Which is the inner transition element of the following?
(a) Eu
(b) Zn
(c) Hg
(d) Sc

Correct Answer: (a) Eu

Solution:
Inner transition elements are those elements that are found in the f-block of the periodic table. These include the lanthanides and actinides.
- Eu (Europium) is a lanthanide, located in the f-block. - Zn (Zinc), Hg (Mercury), and Sc (Scandium) are transition metals found in the d-block, and are not inner transition metals.
Thus, the inner transition element in the list is Eu.

Quick Tip

Remember that inner transition metals are found in the f-block and include the lanthanides and actinides.

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2 Biology

1. Plasmodium that affects humans
(a) P. Vivax
(b) P. Ovale
(c) P. Malaria
(d) All of the above

Correct Answer: (a) P. Vivax

Solution:
Plasmodium is the causative agent of malaria. The four major types of Plasmodium that infect humans are:
1. Plasmodium vivax
2. Plasmodium ovale
3. Plasmodium malariae
4. Plasmodium falciparum
However, the most common cause of malaria is P. Vivax, which is typically associated with relapsing malaria. Although P. malariae and P. ovale also infect humans, P. vivax is the most widespread and causes the majority of malaria cases globally.

Quick Tip

When identifying the malaria-causing Plasmodium, focus on the geographic region and clinical presentation. P. Vivax is the most common, followed by P. falciparum.

---

2. How many dehydrogenation reactions in Krebs cycle?

Correct Answer: 4 Dehydrogenation reactions per cycle

Solution:
The Krebs cycle (also called the citric acid cycle or tricarboxylic acid cycle) consists of a series of reactions in the mitochondrial matrix where acetyl-CoA is oxidized to produce ATP, NADH, and FADH2.
There are 4 dehydrogenation reactions during the cycle: 1. Isocitrate to -Ketoglutarate (catalyzed by isocitrate dehydrogenase)
2. -Ketoglutarate to Succinyl-CoA (catalyzed by -ketoglutarate dehydrogenase)
3. Succinate to Fumarate (catalyzed by succinate dehydrogenase)

4. Malate to Oxaloacetate (catalyzed by malate dehydrogenase)
These reactions involve the removal of hydrogen atoms from the substrate, transferring electrons to NAD+ or FAD, forming NADH or FADH2.

Quick Tip

Remember that the dehydrogenation reactions in the Krebs cycle are critical for generating NADH and FADH2, which are used in the electron transport chain to produce ATP.

---

3. Which water is absorbed by plants?
Correct Answer: Capillary water

Solution:
Plants absorb water mainly from the soil. The types of water in the soil can be categorized as: 1. Gravitational water: Water that moves downward through the soil due to gravity and drains away quickly.
2. Capillary water: Water held in the tiny pores of the soil, available to plants. It is the most important type of water for plant absorption.
3. Hygroscopic water: Water that adheres tightly to soil particles and is unavailable to plants.
Capillary water is the water that plants mainly absorb as it is readily available for uptake by plant roots.

Quick Tip

Capillary water is the most available form of water for plant roots, while gravitational water drains away and hygroscopic water is too tightly bound to the soil particles for absorption.

---

4. How many time needed for PCR?
Correct Answer: 45 minutes to an hour

Solution:
Polymerase Chain Reaction (PCR) is a technique used to amplify DNA sequences. The typical PCR process includes the following steps:
1. Denaturation: Heating the sample to separate the DNA strands.
2. Annealing: Cooling to allow primers to bind to the target DNA.
3. Extension: The DNA polymerase enzyme extends the primers, synthesizing the new DNA strands.
Each cycle of PCR takes about 1–2 minutes. Typically, 25–35 cycles are performed, taking approximately 45 minutes to an hour in total for a standard PCR.

Quick Tip

PCR is typically completed in about an hour, depending on the number of cycles and the efficiency of the reagents used.

---

5. What is the primary function of Bowman's capsule in nephron?
Correct Answer: Filtration of blood from the glomerular capillaries

Solution:
The Bowman's capsule is a part of the nephron in the kidney. It plays a crucial role in the process of glomerular filtration. The primary function of Bowman's capsule is to surround the glomerulus (a network of capillaries) and receive the filtrate from the blood. This filtrate consists of water, ions, glucose, and other small molecules, while larger molecules like proteins and blood cells remain in the blood.

Quick Tip

The Bowman's capsule is the first part of the nephron where blood filtration occurs, leading to the formation of urine.

---

6. The first step in plant growth is
(a) Dispersal of seed
(b) Germination of seed
(c) Formation of fruit
(d) Formation of zygote

Correct Answer: (b) Germination of seed

Solution:
The germination of seed is the first step in plant growth. When a seed is given the right conditions of moisture, temperature, and oxygen, it germinates, which is the process of the seed sprouting and beginning to grow. This is a critical phase for the development of a plant. Other processes such as dispersal of the seed and formation of zygote occur before this stage.

Quick Tip

For a successful germination, ensure that the seed has the right temperature, moisture, and oxygen to begin the growth phase.

---

7. Which part of root absorb mineral, which part of root absorb mineral?
(a) Root hairs
(b) Root tips

(c) Root cap
(d) Root cortex

Correct Answer: (a) Root hairs

Solution:
The root hairs are the specialized structures responsible for absorbing water and minerals from the soil. They are located near the root tips and increase the surface area for absorption. The root cap protects the growing tip of the root, while the root cortex helps in storing food but is not directly involved in absorption. The root hairs are the primary site for the absorption of water and nutrients.

Quick Tip

Root hairs are crucial for nutrient absorption in plants, and they only exist in the near root tips.

---

8. Which of the following is false regarding adsorption?
(a) "Adsorption is the process where particles are attracted to the surface of another material."
(b) "The adsorbate binds directly to the adsorbent surface."
(c) "Particle size of the adsorbent will not affect the amount of adsorption."
(d) "Adsorption can be physical or chemical."

Correct Answer: (c) "Particle size of the adsorbent will not affect the amount of adsorption."

Solution:
In adsorption, particles adhere to the surface of another material (adsorbent), forming a thin layer on the surface. The adsorbent's particle size does, in fact, affect the amount of adsorption because a greater surface area allows for more particles to be adsorbed. Therefore, statement (c) is false. Physical adsorption is due to Van der Waals forces, while chemical adsorption involves the formation of chemical bonds.

Quick Tip

The surface area of the adsorbent is critical; smaller particle sizes increase the surface area and enhance the adsorption capacity.

---

9. Identify linear polymer from following
(a) Nylon
(b) Poly-vinyl chloride (PVC)
(c) High-density polyethylene (HDPE), and polystyrene
(d) None of these

Correct Answer: (a) Nylon

Solution:
Nylon is an example of a linear polymer formed by the polymerization of diamines and dicarboxylic acids. Linear polymers consist of long chains where the monomers are connected in a straight chain. PVC, HDPE, and polystyrene are examples of addition polymers, which typically involve the polymerization of monomers with unsaturated bonds.

> Quick Tip
>
> Linear polymers like Nylon are characterized by straight chains, whereas addition polymers like PVC have branched or network structures.

---

10. Which of the following converting a testis originates from peritoneum?
(a) Tunica vaginalis
(b) Tunica albuginea
(c) Epididymis
(d) Spermatic cord

Correct Answer: (a) Tunica vaginalis

Solution:
The tunica vaginalis is a membrane that surrounds the testis, and it originates from the peritoneum, specifically from the abdominal cavity. It provides protection and allows for mobility within the scrotum. The tunica albuginea is a fibrous capsule that surrounds the testis, while the epididymis and spermatic cord are associated with sperm transport and blood vessels.

> Quick Tip
>
> The tunica vaginalis is the only part derived from the peritoneum in the testicular region.

---

11. Disorder caused due to accumulation of amyloid proteins in CNS.
Correct Answer: Alzheimer's disease (AD), but also cerebral amyloid angiopathy (CAA).

Solution:
Amyloid proteins accumulate abnormally in the central nervous system (CNS), leading to various neurological disorders. Alzheimer's disease (AD) is one of the most common disorders associated with the accumulation of amyloid plaques in the brain, which are composed of beta-amyloid proteins. These plaques disrupt communication between neurons and lead to neurodegeneration, which is characteristic of AD. However, another condition called cerebral amyloid angiopathy (CAA) is also related to amyloid accumulation, where amyloid deposits affect the blood vessels in the brain, increasing the risk of stroke and bleeding. Thus, both

Alzheimer's disease and cerebral amyloid angiopathy are disorders caused by the accumulation of amyloid proteins in the CNS.

Quick Tip

When considering diseases linked to amyloid protein accumulation, Alzheimer's disease (AD) is the most well-known, but cerebral amyloid angiopathy (CAA) is another important condition to consider. Both involve amyloid buildup but affect different parts of the CNS.

---

12. Germ pores of pollen grains are useful for
(a) Helps in the formation of the pollen tube and the release of the male gametes during fertilisation
(b) Germination of the seed
(c) Growth of the pollen tube
(d) Helps in the formation of female gametes

Correct Answer: (a) Helps in the formation of the pollen tube and the release of the male gametes during fertilisation

Solution:
The germ pores are the openings in the pollen grain's outer layer (exine) through which the pollen tube emerges during germination. The main function of these pores is to allow the pollen tube to grow, through which the male gametes are delivered to the ovule for fertilisation.

Quick Tip

The germ pores are essential for the germination of pollen and the formation of the pollen tube that carries the male gametes to the ovule.

---

13. In genetic engineering the Foreign DNA is called
(a) Recombinant DNA
(b) Exogenous DNA
(c) Mutated DNA
(d) Transferred DNA

Correct Answer: (a) Recombinant DNA

Solution:
In genetic engineering, foreign DNA is integrated into the host organism's genome to create a recombinant DNA molecule. This process is used to manipulate genes in organisms, often to improve or introduce new traits. The term recombinant DNA refers to the combination of genetic material from different sources.

Quick Tip

Recombinant DNA technology is crucial for genetic modification, where the foreign DNA is inserted into the host organism to express desired traits.

---

14. Stomatal transpiration takes place during day time in the following plants except
(a) Succulent plants
(b) Desert plants
(c) Aquatic plants
(d) All plants during day time

Correct Answer: (a) Succulent plants

Solution:
Succulent plants are adapted to conserve water in arid environments. They have specialized structures that minimize transpiration, especially during the day. Stomatal transpiration is a process where water vapor is lost through the stomata of the leaves, and it typically occurs during the day when the stomata are open for gas exchange. In succulent plants, water is stored in the tissues, and they generally transpire less during the day.

Quick Tip

Succulent plants are adapted to conserve water and thus have reduced stomatal transpiration compared to other plants.

---

15. In a dihybrid cross, 9 : 3 : 3 : 1 ratio denotes
(a) Independent assortment of two genes
(b) Linkage between genes
(c) Epistasis
(d) Incomplete dominance

Correct Answer: (a) Independent assortment of two genes

Solution:
The 9 : 3 : 3 : 1 ratio observed in a dihybrid cross indicates the independent assortment of two genes located on different chromosomes. According to Mendel's Law of Independent Assortment, each gene segregates independently of the other during gamete formation, resulting in this characteristic ratio in the F2 generation.

Quick Tip

A 9 : 3 : 3 : 1 ratio is characteristic of a dihybrid cross with independent assortment, where two genes segregate independently during gamete formation.

16. Which is not a prime element?
(a) Carbon
(b) Nitrogen
(c) Hydrogen
(d) An element that can be factored into non-unit factors

Correct Answer: (d) An element that can be factored into non-unit factors

Solution:
A prime element is one that is fundamental and cannot be broken down further into simpler units. Elements like carbon, hydrogen, and nitrogen are considered prime elements because they are basic and cannot be decomposed. The option (d) refers to something that can be factored, which disqualifies it from being a prime element.

Quick Tip

In chemistry, prime elements are those that exist in their simplest form and cannot be decomposed into smaller, fundamental elements.

---

17. Which of the following is a commercial blood cholesterol lowering agent?
(a) Statins
(b) Aspirin
(c) Antibiotics
(d) Antioxidants

Correct Answer: (a) Statins

Solution:
Statins are a class of drugs commonly used to lower blood cholesterol levels. They work by inhibiting the enzyme HMG-CoA reductase, which plays a central role in cholesterol production in the liver. This lowers the production of low-density lipoprotein (LDL), often referred to as "bad cholesterol". Aspirin and antibiotics are not used for lowering cholesterol, and antioxidants do not directly target cholesterol metabolism.

Quick Tip

Statins, such as atorvastatin and simvastatin, are commonly prescribed to lower cholesterol and reduce the risk of cardiovascular diseases.

---

18. Which is an intensive property?
(a) Temperature
(b) Density
(c) Color

(d) Pressure

Correct Answer: (b) Density

Solution:
Intensive properties are properties that do not depend on the quantity of matter in the system. Density is an intensive property because it remains the same regardless of the size or amount of the substance. Temperature and pressure are also intensive properties, but color is often considered more of a qualitative characteristic rather than a physical property.

> Quick Tip
>
> Intensive properties (like density, boiling point, and color) are independent of sample size, whereas extensive properties (like mass and volume) change with the amount of material.

---

19. What is an example of chiropterophily?
(a) Pollination by birds
(b) Pollination by insects
(c) Pollination by bats
(d) Pollination by wind

Correct Answer: (c) Pollination by bats

Solution:
Chiropterophily is a term that refers to pollination by bats. Bats are attracted to plants that bloom at night and often have large, showy flowers with a strong fragrance to attract these nocturnal pollinators. Insects pollinate primarily during the day, while wind pollination occurs without animal involvement.

> Quick Tip
>
> Bats are key pollinators in tropical regions and help pollinate plants such as agave and some species of cactus.

---

20. What is the typical voltage of the resting membrane potential in a neuron?
(a) +70 mV
(b) -70 mV
(c) 0 mV
(d) +30 mV

Correct Answer: (b) -70 mV

Solution:

The resting membrane potential of a neuron is typically around -70 mV. This value arises due to the difference in ion concentrations inside and outside the neuron, primarily involving sodium (Na) and potassium (K) ions. This resting potential is essential for the generation of action potentials that carry signals within the nervous system.

Quick Tip

The resting potential is maintained by the sodium-potassium pump (Na/K ATPase), which moves sodium out and potassium in to keep the cell's charge difference stable.

---

21. Match the columns and select the right option from the given codes:

Column I	Column II
A. Mutation theory	i. Darwin
B. Formation of life was preceded by chemical	ii. Louis pasteur
C. Struggle for existence	iii. Hugo de vries
D. Life comes from pre-existing life	iv. Oparin and Haldane

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

Correct Answer: (a) A (iii), B (iv), C (ii), D (ii)

Solution:
To solve this type of matching question, match the appropriate terms from each column based on their definitions, properties, or relationships. Each column (A, B, C, D) represents a specific entity, and the codes are used to indicate the correct pairing of those entities.

Quick Tip

In matching questions, always try to find the definitions or relationships first, then logically match them with the options given.

---

22. Which of the following organisms or organelles contain 70S ribosomes?
(a) Animal cell cytoplasm
(b) Mitochondria
(c) Plant cell cytoplasm
(d) Nucleus

Correct Answer: (b) Mitochondria

Solution:
70S ribosomes are found in the cytoplasm of prokaryotic cells, mitochondria, and plastids. These ribosomes are smaller than the 80S ribosomes found in eukaryotic cells. Mitochondria, despite being in eukaryotic cells, have 70S ribosomes due to their evolutionary origin from prokaryotic cells. The nucleus and animal cell cytoplasm do not contain 70S ribosomes, but the mitochondria contain them.

Quick Tip

Mitochondria are similar to prokaryotic cells in many aspects, including the presence of 70S ribosomes.

---

23. Which of the following acts as hemoglobin (Hb) in the blood buffer system?
(a) NaHCO
(b) HHb
(c) HbCO
(d) HbCl

Correct Answer: (b) HHb

Solution:
Hemoglobin (Hb) acts as a buffer in the blood by binding to H ions and carbon dioxide. HHb (deoxygenated hemoglobin) plays a crucial role in maintaining the pH balance of blood. When blood enters the tissues, it releases oxygen and binds to hydrogen ions, acting as a buffer. The bicarbonate buffer system (NaHCO) also helps in maintaining the pH but is different from the role of hemoglobin.

Quick Tip

Hemoglobin's role in buffering blood pH is crucial, especially in tissues where CO is produced during metabolism.

---

24. Which of the following events occurs only during meiosis and not in mitosis?
(a) Chromosome condensation
(b) Spindle formation
(c) Separation of sister chromatids
(d) Synapsis and crossing over of homologous chromosomes

Correct Answer: (d) Synapsis and crossing over of homologous chromosomes

Solution:
Synapsis and crossing over of homologous chromosomes occur exclusively during meiosis. These processes are responsible for genetic recombination, contributing to genetic diversity. In contrast, mitosis involves only the separation of sister chromatids but does not involve synapsis or crossing over.

Quick Tip

Crossing over during meiosis ensures genetic variation, which does not occur in mitosis.

---

25. In which of the following phases of karyokinesis do chromosomes align at the equatorial plate, and spindle fibres are completely formed?
(a) Prophase
(b) Metaphase
(c) Anaphase
(d) Telophase

Correct Answer: (b) Metaphase

Solution:
In metaphase, chromosomes align at the equatorial plate, and the spindle fibers fully form, preparing for the separation of sister chromatids. This phase is crucial for the proper division of genetic material between the two daughter cells.

Quick Tip

Metaphase is the stage where the spindle fibers align chromosomes at the center before they are pulled apart.

---

26. During which phase of karyokinesis does the disappearance of the nucleolus and nuclear envelope occur?
(a) Prophase
(b) Metaphase
(c) Anaphase
(d) Telophase

Correct Answer: (a) Prophase

Solution:
During prophase, the nucleolus and nuclear envelope begin to disappear as the chromatin condenses into distinct chromosomes. This allows the spindle fibers to access the chromosomes, preparing for the subsequent steps in cell division.

Quick Tip

The disappearance of the nuclear envelope in prophase marks the beginning of the chromosomal segregation process.

---

27. In karyokinesis of meiosis - I, which of the following separates?

(a) Sister chromatids
(b) Homologous chromosomes
(c) Sister chromatids and homologous chromosomes
(d) Spindle poles

Correct Answer: (b) Homologous chromosomes

Solution:
In meiosis I, homologous chromosomes are separated into different cells, reducing the chromosome number by half. The separation of sister chromatids occurs during meiosis II.

Quick Tip

In meiosis I, the focus is on the separation of homologous chromosomes, whereas in meiosis II, sister chromatids are separated.
