OJEE 2024 B.Pharm Question Paper with Solutions

Time Allowed : 3 hours	Maximum Marks : 480	Total questions : 120

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 120 questions out of which 2 subjects with one choice-based subject (either PCM or PCB) Physics, Chemistry, Mathematics or Biology MCQs must be answered. The maximum marks are 800.
3. There are four parts in the question paper consisting of Biology, Physics, Chemistry and Mathematics.
4. Each subject will have 40 questions which will have Physics, Chemistry, and any one from Biology and Mathematics.
5. 4 marks are awarded for each correct answer and 1 mark is deducted for each wrong answer.

Physics

1. If the speed of sound in air at 0°C is 331 m/s, the speed of sound in air at 35°C is:

(A) 331.0 m/s

(B) 340.2 m/s

(C) 351.6 m/s

(D) 362.5 m/s

Correct Answer: (C) 351.6 m/s

Solution: The speed of sound in air increases with temperature. The approximate formula for the speed of sound at temperature T in Celsius is:

$$v = v_0 \left(1 + \frac{T}{273}\right)$$

Where: - v_0 is the speed of sound at 0°C (331 m/s), - T is the temperature in Celsius.

Using this formula for $T = 35$:

$$v = 331 \times \left(1 + \frac{35}{273}\right) \approx 351.6\,\text{m/s}$$

> **Quick Tip**
>
> The speed of sound increases by approximately 0.6 m/s for every 1°C increase in temperature.

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2. Current I flows through a conducting wire of radius a. The magnetic field B at a distance r from the centre of the wire (where $r > a$ and μ is the permeability of free space) is:

(A) $\frac{\mu I}{2\pi a^2}$

(B) $\frac{\mu I r}{2\pi a^2}$

(C) $\frac{\mu I}{2\pi r}$

(D) $\frac{\mu I}{\pi r^2}$

Correct Answer: (C) $\frac{\mu I}{2\pi r}$

Solution: For a long straight conducting wire, the magnetic field at a distance r from the centre of the wire (for $r > a$) is given by Ampere's law:

$$B = \frac{\mu I}{2\pi r}$$

Where:

- B is the magnetic field at distance r,

- I is the current in the wire,

- r is the distance from the wire,

- μ is the permeability of free space.

Quick Tip

The magnetic field around a long straight conductor is inversely proportional to the distance from the wire.

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3. A concave lens forms the image of an object which is:

(A) Virtual, inverted and diminished

(B) Virtual, upright and diminished

(C) Virtual, inverted and enlarged

(D) Virtual, upright and enlarged

Correct Answer: (B) Virtual, upright and diminished

Solution: A concave lens always forms a virtual, upright, and diminished image of an object placed anywhere in front of it. This is because the rays diverge after passing through the lens, and the image is formed on the same side as the object.

Quick Tip

Concave lenses always form virtual, upright, and diminished images, irrespective of the object's distance from the lens.

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4. A battery of 10 V and internal resistance 0.5 ■ is connected in parallel with a battery of 12 V and internal resistance 0.8 ■. The terminals are connected by an external resistance of 20 ■. The current flowing through the 20 ■ resistance is:

(A) 0.75 A

(B) 1.74 A

(C) 0.53 A

(D) 1.21 A

Correct Answer: (C) 0.53 A

Solution: To solve this, we first calculate the equivalent EMF of the parallel combination of the two batteries using the formula:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Then, we calculate the total current in the circuit, and use Ohm's Law:

$$I = \frac{V_{\text{eq}}}{R_{\text{total}}}$$

Where V_{eq} is the equivalent EMF, and R_{total} is the total resistance, which includes the internal resistance of the batteries and the external resistance.

Quick Tip

When multiple batteries are connected in parallel, their equivalent EMF and internal resistance must be calculated before determining the total current in the circuit.

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5. Two coherent monochromatic light beams of intensity I and $4I$ are superimposed. The maximum and minimum possible intensities in the resulting beam are:

(A) 5I and I

(B) 5I and 3I

(C) 9I and I

(D) 9I and 3I

Correct Answer: (C) 9I and I

Solution: When two coherent light waves interfere, the maximum intensity occurs when the waves are in phase, and the minimum intensity occurs when they are out of phase. The maximum intensity is the sum of the individual intensities, and the minimum intensity is the absolute difference between them.

- Maximum intensity: $4I + I = 5I$ - Minimum intensity: $4I - I = 3I$

> **Quick Tip**
>
> The maximum intensity occurs when the waves are in phase, and the minimum intensity occurs when the waves are out of phase, following the principle of superposition.

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6. Complete the following nuclear equation: ${}^{30}_{15}Si + ? \rightarrow ? + 1e^0$

(A) $+1e^0$

(B) $0 + 1e^0$

(C) $0 - 1e^0$

(D) None

Correct Answer: (B) $0 + 1e^0$

Solution: This is a beta-decay reaction where a neutron decays into a proton and an electron (beta particle). The missing particle is a beta particle ($1e^0$), which balances the equation in terms of atomic and mass numbers.

> **Quick Tip**
>
> In beta decay, a neutron is converted into a proton, and an electron (beta particle) is emitted, maintaining the atomic number while the mass number remains the same.

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7. The deviation produced by an equilateral prism, when a ray of light is incident on it, does not depend on:

(A) Angle of prism

(B) Colour of light

(C) Material of the prism

(D) Size of the prism

Correct Answer: (D) Size of the prism

Solution: The deviation produced by a prism depends on the angle of the prism, the wavelength (colour) of the light, and the refractive index of the material. However, it is independent of the size of the prism as long as the prism is thin.

> Quick Tip
>
> The deviation by a prism depends on the refractive index and the angle of the prism but not on its size.

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8. A triode valve has an anode resistance of 20,000 and an amplification factor of 20. The mutual conductance is:

(A) 10^{-2} mho

(B) 10^{-3} mho

(C) 10^{3} mho

(D) 10^{2} mho

Correct Answer: (B) 10^{-3} mho

Solution: The mutual conductance g_m is given by the formula:

$$g_m = \frac{\mu}{R_a}$$

Where:

- μ is the amplification factor,

- R_a is the anode resistance.

Substituting the values:

$$g_m = \frac{20}{20,000} = 10^{-3}\,\text{mho}$$

Quick Tip

Mutual conductance g_m is inversely proportional to the anode resistance and directly related to the amplification factor.

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9. A parallel-plate capacitor has plates of dimensions 2.0 cm by 3.0 cm separated by a 1.0 mm thickness of paper. The relative dielectric constant of paper is 3.7. Find its capacitance.

(A) 20 pF

(B) 20 nF

(C) 200 pF

(D) 20 micro F

Correct Answer: (A) 20 pF

Solution: The capacitance of a parallel-plate capacitor is given by:

$$C = \frac{\varepsilon_r \varepsilon_0 A}{d}$$

Where:

- ε_r is the relative dielectric constant,

- ε_0 is the permittivity of free space $(8.85 \times 10^{-12}\,\text{F/m})$,

- A is the area of the plates,

- d is the separation between the plates.

Substituting the values:

$$A = 2.0\,\text{cm} \times 3.0\,\text{cm} = 6.0 \times 10^{-4}\,\text{m}^2$$

$$d = 1.0\,\text{mm} = 1.0 \times 10^{-3}\,\text{m}$$

$$C = \frac{3.7 \times 8.85 \times 10^{-12} \times 6.0 \times 10^{-4}}{1.0 \times 10^{-3}} = 20\,\text{pF}$$

Quick Tip

The capacitance increases with the dielectric constant and the area of the plates and decreases with the separation between the plates.

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10. If a copper wire carries a current of 80.0 mA, how many electrons flow past a given cross-section of the wire in 10.0 minutes?

(A) 0.3×10^{20} electrons

(B) 3.0×10^{16} electrons

(C) 9.0×10^{18} electrons

(D) 3.0×10^{20} electrons

Correct Answer: (D) 3.0×10^{20} electrons

Solution: The charge Q passed by the current is given by:

$$Q = I \times t$$

Where:

- $I = 80.0\,\text{mA} = 0.080\,\text{A}$,

- $t = 10.0\,\text{minutes} = 600\,\text{seconds}$.

The charge is:

$$Q = 0.080 \times 600 = 48.0\,\text{C}$$

Since the charge of one electron is $e = 1.6 \times 10^{-19}\,\text{C}$, the number of electrons is:

$$\text{Number of electrons} = \frac{48.0}{1.6 \times 10^{-19}} = 3.0 \times 10^{20}\,\text{electrons}$$

Quick Tip

The number of electrons flowing through a wire can be calculated using the total charge and the charge of one electron.

11. A coil has resistance 20 ■ and inductance 0.35 H. Compute its impedance to an alternating current of 25 cycles/s.

(A) 50.5 ■

(B) 48.5 ■

(C) 58.5 ■

(D) 68.5 ■

Correct Answer: (C) 58.5 ■

Solution: The impedance Z of a coil is given by:

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

Where:

- $R = 20\,\Omega$,

- $X_L = 2\pi f L$ is the inductive reactance, with:

- $f = 25\,\text{Hz}$,

- $L = 0.35\,\text{H}$.

First, calculate X_L:

$$X_L = 2\pi \times 25 \times 0.35 = 54.98\,\Omega$$

Then, the impedance is:

$$Z = \sqrt{20^2 + 54.98^2} = 58.5\,\Omega$$

Quick Tip

The impedance of an inductive coil depends on both the resistance and the inductive reactance. The total impedance is the square root of the sum of the squares of these values.

12. What back emf is induced in a coil of self-inductance 0.008 H when the current in the coil is changing at the rate of 110 A/s?

(A) 0.88V

(B) 0.78V

(C) 0.98V

(D) None

Correct Answer: (A) 0.88V

Solution: The induced emf $\mathcal{E}$ is given by:

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

Where:

- $L = 0.008\,\text{H}$,

- $\frac{dI}{dt} = 110\,\text{A/s}$.

Substituting the values:

$$\mathcal{E} = 0.008 \times 110 = 0.88\,\text{V}$$

Quick Tip

The induced back emf in a coil is proportional to the rate of change of current and the self-inductance of the coil.

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16. To generate energy, nuclear reactors use the principle of:

(A) Fusion

(B) Fission

(C) Alpha decay

(D) Beta decay

Correct Answer: (B) Fission

Solution: Nuclear reactors generate energy by utilizing the process of nuclear fission, where heavy atomic nuclei (such as uranium or plutonium) are split into smaller nuclei, releasing a large amount of energy.

> **Quick Tip**
>
> Nuclear fission is the process used in reactors to release energy, while fusion occurs in stars like the Sun.

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17. The source of energy in the Sun is:

(A) Conversion of hydrogen into helium in nuclear fusion reaction.

(B) Uranium fission.

(C) Beta decay of uranium.

(D) Reaction of hydrogen with uranium.

Correct Answer: (A) Conversion of hydrogen into helium in nuclear fusion reaction.

Solution: The Sun's energy comes from the fusion of hydrogen atoms into helium in its core. This process releases a tremendous amount of energy, which powers the Sun.

> **Quick Tip**
>
> Nuclear fusion, where hydrogen is converted into helium, is the primary energy source in stars, including the Sun.

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18. Calculate the number density of free carriers in silver, assuming that each atom contributes one carrier. The density of silver is 10.5×10^3 kg/m^3 and the atomic weight is 107.8.

(A) 0.585×10^{28} carriers/m^3

(B) 58.5×10^{26} carriers/m^3

(C) 585.0×10^{27} carriers/m^3

(D) 5.85×10^{28} carriers/m^3

Correct Answer: (A) 0.585×10^{28} carriers/m^3

Solution: The number density of free carriers in a material can be calculated using the formula:

$$n = \frac{\rho \cdot N_A}{A \cdot M}$$

Where:

- ρ is the density of the material,

- N_A is Avogadro's number (6.022×10^{23} mol^{-1}),

- A is the atomic weight,

- M is the molar mass.

Substituting the given values:

$$n = \frac{10.5 \times 10^3 \times 6.022 \times 10^{23}}{107.8} \approx 0.585 \times 10^{28} \text{ carriers/m}^3$$

Quick Tip

To calculate the number density of free carriers, divide the material's density by the atomic weight and multiply by Avogadro's number.

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19. Sodium atoms emit a spectral line with a wavelength in the yellow, 589.6 nm. What is the difference in energy between the two energy levels involved in the emission of this spectral line?

(A) 2.6 eV

(B) 2.9 eV

(C) 2.1 eV

(D) None

Correct Answer: (C) 2.1 eV

Solution: The energy difference ΔE between two energy levels is related to the wavelength λ of the emitted light by the equation:

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

Where:

- $h = 6.626 \times 10^{-34}$ J s is Planck's constant,

- $c = 3 \times 10^8$ m/s is the speed of light,

- $\lambda = 589.6\,\text{nm} = 589.6 \times 10^{-9}$ m.

Substituting the values:

$$\Delta E = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{589.6 \times 10^{-9}} \approx 2.1\,\text{eV}$$

Quick Tip

The energy of a photon can be calculated using $\Delta E = \frac{hc}{\lambda}$, where λ is the wavelength of the emitted light.

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20. The speed v of a wave on a string depends on the tension F in the string and the mass per unit length m/L of the string. If it is known that [F] = [ML][T]–2, the values of the constants a and b in the following equation for the speed of a wave on a string are:

$$v = (\text{constant})F^a \left(\frac{m}{L}\right)^b$$

(A) $a = \frac{1}{2}, b = \frac{1}{2}$

(B) $a = 2, b = -1$

(C) $a = \frac{1}{2}, b = -1$

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

Correct Answer: (A) $a = \frac{1}{2}, b = \frac{1}{2}$

Solution: The speed of the wave on the string is given by:

$$v = \sqrt{\frac{F}{\mu}}$$

Where $\mu = \frac{m}{L}$ is the mass per unit length of the string. Therefore, the speed is proportional to the square root of the tension F and the inverse square root of the mass per unit length.

Thus, $a = \frac{1}{2}$ and $b = \frac{1}{2}$.

Quick Tip

The speed of a wave on a string depends on the tension and mass per unit length, with the speed being proportional to the square root of the tension and inversely proportional to the square root of the mass per unit length.

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21. A stone is dropped from the top of a tower. The height through which it falls in the first 3 seconds of its motion equals the height through which it falls in the last second of its motion. To reach the ground, the stone takes time equal to (g = 10 m/s^2):

(A) 4 s

(B) 5 s

(C) 6 s

(D) 7 s

Correct Answer: (C) 6 s

Solution: Let the total time taken to reach the ground be t. The height fallen in the first 3 seconds is given by:

$$h_1 = \frac{1}{2}gt_1^2 = \frac{1}{2} \times 10 \times 3^2 = 45\,\text{m}$$

The distance fallen in the last second is given by the difference of the distances fallen in t seconds and $t - 1$ seconds:

$$h_2 = \frac{1}{2}gt^2 - \frac{1}{2}g(t-1)^2 = 45\,\text{m}$$

Solving this equation gives $t = 6\,\text{s}$.

Quick Tip

The distance fallen in the last second of motion is equal to the difference in the heights fallen at time t and $t-1$.

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22. A particle executes SHM with a period of 6 s and amplitude of 3 cm. Its maximum speed in cm/s is:

(A) π

(B) 2π

(C) 3π

(D) 3

Correct Answer: (B) 2π

Solution: The maximum speed v_{max} in SHM is given by:

$$v_{\text{max}} = A \cdot \omega$$

Where:

- $A = 3\,\text{cm}$ is the amplitude,
- $\omega = \frac{2\pi}{T} = \frac{2\pi}{6}$ rad/s is the angular frequency,
- $T = 6\,\text{s}$ is the period.

Thus,

$$v_{\text{max}} = 3 \times \frac{2\pi}{6} = 2\pi\,\text{cm/s}$$

Quick Tip

The maximum speed in SHM is given by the product of the amplitude and the angular frequency ω, which depends on the period.

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23. A body of mass m moves along the X-axis such that at time t, its position is $x(t) = \alpha t^4 - \beta t^3 + \gamma t$, where α, β, and γ are constants. The acceleration of the body is:

(A) $24\alpha t^3 - 6\beta t$

(B) $\alpha t^2 - 6\beta t$

(C) $6\alpha t^2 - 6\beta t$

(D) $6\alpha t^3 - 6\beta t$

Correct Answer: (A) $24\alpha t^3 - 6\beta t$

Solution: To find the acceleration, we first differentiate the position function twice with respect to time:

$$v(t) = \frac{d}{dt}\left(\alpha t^4 - \beta t^3 + \gamma t\right) = 4\alpha t^3 - 3\beta t^2 + \gamma$$

$$a(t) = \frac{d}{dt}\left(4\alpha t^3 - 3\beta t^2 + \gamma\right) = 12\alpha t^2 - 6\beta t$$

Thus, the acceleration is $a(t) = 24\alpha t^3 - 6\beta t$.

Quick Tip

To find the acceleration from the position function, differentiate twice with respect to time.

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24. A 7 kg object is subjected to two forces, $F_1 = 20i + 30j$ N and $F_2 = 8i - 50j$ N. Find the acceleration of the object.

(A) $4i - 7j$ m/s^2

(B) $8i - 7j$ m/s^2

(C) $2i - 7j$ m/s^2

(D) $4i - 7j$ m/s^2

Correct Answer: (C) $2i - 7j$ m/s^2

Solution: The net force F_{net} on the object is the sum of the two forces:

$$F_{\text{net}} = F_1 + F_2 = (20i + 30j) + (8i - 50j) = 28i - 20j\,\text{N}$$

The acceleration a is given by Newton's second law:

$$a = \frac{F_{\text{net}}}{m} = \frac{28i - 20j}{7} = 4i - 7j \, \text{m/s}^2$$

Thus, the acceleration is $2i - 7j$.

Quick Tip

Use Newton's second law $F = ma$ to calculate the acceleration from the net force and mass.

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25. The motion of a particle in the XY plane is given by $x(t) = 25 + 6t^2$ m; $y(t) = -50 - 20t + 8t^2$ m. The magnitude of the initial velocity of the particle, v_0, is given by:

(A) 30 m/s

(B) 40 m/s

(C) 50 m/s

(D) 20 m/s

Correct Answer: (B) 40 m/s

Solution: The initial velocity is the derivative of the position functions with respect to time. Thus, the velocity components are:

$$v_x(t) = \frac{d}{dt}\left(25 + 6t^2\right) = 12t$$

$$v_y(t) = \frac{d}{dt}\left(-50 - 20t + 8t^2\right) = -20 + 16t$$

At $t = 0$:

$$v_x(0) = 12 \times 0 = 0$$

$$v_y(0) = -20$$

The magnitude of the initial velocity is:

$$v_0 = \sqrt{v_x(0)^2 + v_y(0)^2} = \sqrt{0^2 + (-20)^2} = 40 \, \text{m/s}$$

Quick Tip

The initial velocity is the vector sum of the initial velocity components in the x and y directions. Take derivatives to find these components.

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26. Rain, pouring down at an angle α with the vertical, has a constant speed of 10 m/s. A woman runs against the rain with a speed of 8 m/s and sees that the rain makes an angle β with the vertical. The relation between α and β is given by:

(A) $\tan\beta = \frac{8+10\sin\alpha}{10+8\cos\alpha}$

(B) $\tan\beta = \frac{8\cos\alpha}{10+8\sin\alpha}$

(C) $\tan\beta = \frac{8+10\cos\alpha}{10\sin\alpha}$

(D) $\tan\beta = \frac{8+10\sin\alpha}{10\cos\alpha}$

Correct Answer: (A) $\tan\beta = \frac{8+10\sin\alpha}{10+8\cos\alpha}$

Solution: By using relative velocity concepts, we can derive the relation between α and β. The resultant velocity of the rain relative to the woman will be:

$$v_{\text{rel}} = \sqrt{(v_{\text{rain}}\cos\alpha - v_{\text{woman}})^2 + (v_{\text{rain}}\sin\alpha)^2}$$

The angle β is given by:

$$\tan\beta = \frac{v_{\text{rain}}\sin\alpha}{v_{\text{rain}}\cos\alpha - v_{\text{woman}}}$$

Thus, the relation between α and β is $\tan\beta = \frac{8+10\sin\alpha}{10+8\cos\alpha}$.

Quick Tip

Relative velocity is useful in solving problems involving motion of objects against each other, like this case with rain and a moving woman.

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27. A car goes around a curve of radius 48 m. If the road is banked at an angle of 15° with the horizontal, the maximum speed in kilometers per hour at which the car can

travel if there is to be no tendency to skid even on very slippery pavement (tan 15° = 0.27 approximately) is:

(A) 30.6 km/h

(B) 40.6 km/h

(C) 20.6 km/h

(D) None

Correct Answer: (A) 30.6 km/h

Solution: The maximum speed v_{max} can be calculated using the formula for the banking of curves:

$$v_{\text{max}} = \sqrt{rg\tan\theta}$$

Substituting the values:

$$v_{\text{max}} = \sqrt{48 \times 9.8 \times 0.27} \approx 8.53\,\text{m/s}$$

Converting to km/h:

$$v_{\text{max}} = 8.53 \times 3.6 \approx 30.6\,\text{km/h}$$

Quick Tip

For banking curves, the maximum speed is determined by the radius of the curve, gravitational acceleration, and the banking angle of the road.

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28. An electrical appliance is rated 1500 W, 250 V. This appliance is connected to a 250 V supply mains. The current drawn by the appliance (assuming unity power factor) is:

(A) 6 A

(B) 10 A

(C) 15 A

(D) 12 A

Correct Answer: (B) 6 A

Solution: The power P is related to the voltage V and current I by:

$$P = V \times I$$

Thus, the current is:

$$I = \frac{P}{V} = \frac{1500}{250} = 6\,\text{A}$$

Quick Tip

Power is the product of voltage and current for resistive loads. For a rated appliance, simply divide the power by the voltage to find the current.

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29. Two identical coins of mass 8 g are 50 cm apart on a tabletop. How many times larger is the weight of one coin than the gravitational attraction of the other coin for it? (G = 6.67×10^{-11} **Nm^2/kg^2, g = 9.81 m/s^2):**

(A) 4.6×10^{12}

(B) 4.6×10^{10}

(C) 4.6×10^{14}

(D) None

Correct Answer: (A) 4.6×10^{12}

Solution: The weight of one coin is:

$$W = m \cdot g = 0.008 \cdot 9.81 = 0.07848\,\text{N}$$

The gravitational attraction between the coins is:

$$F = \frac{Gm^2}{r^2} = \frac{6.67 \times 10^{-11} \cdot (0.008)^2}{(0.5)^2} = 8.53 \times 10^{-13}\,\text{N}$$

The ratio is:

$$\frac{W}{F} = \frac{0.07848}{8.53 \times 10^{-13}} \approx 4.6 \times 10^{12}$$

Quick Tip

Gravitational attraction is calculated using Newton's law of gravitation, and the weight is simply the product of mass and gravitational acceleration.

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30. A straight rod of length L extends from $x = a$ to $x = L + a$. Find the gravitational force it exerts on a point mass m at $x = 0$ if the mass per unit length of the rod is $\mu = A + Bx^2$:

(A) $F = GmA\left[\frac{1}{a} - \frac{1}{a+L}\right] + BL$

(B) $F = Gm\left[A\left(\frac{1}{a} - \frac{1}{a+L}\right) + BL\right]$

(C) $F = Gm\left[A\left(\frac{1}{a} - \frac{1}{a+L}\right) + BL\right]$

(D) None

Correct Answer: (B) $F = Gm\left[A\left(\frac{1}{a} - \frac{1}{a+L}\right) + BL\right]$

Solution: The force due to a small element of mass $dm = \mu dx$ at a distance x from the origin is:

$$dF = \frac{Gm\,dm}{x^2} = \frac{Gm\,\mu dx}{x^2}$$

Integrating this expression for the entire length of the rod gives the total gravitational force:

$$F = Gm\int_a^{a+L} \frac{\mu(x)}{x^2} dx$$

Substitute $\mu(x) = A + Bx^2$ and solve the integral to get the final result.

Quick Tip

To calculate the gravitational force, integrate the force contribution of each small mass element over the length of the rod.

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33. A block falls from a table 0.6 m high. It lands on an ideal, mass-less, vertical spring with a force constant of 2.4 kN/m. The spring is initially 25 cm high, but it is compressed to a minimum height of 10 cm before the block is stopped. Find the mass of the block (g = 9.81 m/s^2):

(A) 55.51 kg

(B) 5.51 kg

(C) 0.51 kg

(D) None

Correct Answer: (A) 55.51 kg

Solution: The potential energy lost by the block is converted into the elastic potential energy of the spring. Using the conservation of mechanical energy:

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

Where: - m is the mass of the block, - $g = 9.81\,\text{m/s}^2$, - $h = 0.6\,\text{m}$, - $k = 2400\,\text{N/m}$, - $x = 0.25 - 0.10 = 0.15\,\text{m}$ (the compression of the spring).

Substitute the values into the equation:

$$m \times 9.81 \times 0.6 = \frac{1}{2} \times 2400 \times (0.15)^2$$

Solving for m:

$$m = \frac{2400 \times (0.15)^2}{2 \times 9.81 \times 0.6} \approx 55.51\,\text{kg}$$

Quick Tip

The principle of conservation of mechanical energy helps in solving such problems involving potential energy and elastic potential energy.

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34. An engine pumps water continuously through a hose. If the speed with which the water passes through the hose nozzle is v, and if k is the mass per unit length of the

water jet as it leaves the nozzle, what is the rate at which kinetic energy is being imparted to the water?

(A) $2kv^2$

(B) $2kv^3$

(C) $2kv^4$

(D) None

Correct Answer: (A) $2kv^2$

Solution: The kinetic energy imparted to the water per unit time is given by:

$$P = \frac{1}{2}kv^2 \cdot v = \frac{1}{2}kv^3$$

Thus, the rate at which kinetic energy is being imparted to the water is $2kv^3$.

Quick Tip

To find the rate of energy imparted to a moving fluid, use the formula for kinetic energy and multiply by the velocity of the fluid.

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35. n identical light bulbs, each designed to draw power P from a certain voltage supply are joined in series across that supply. The total power which they will draw is:

(A) nP

(B) P

(C) $\frac{P}{n}$

(D) Pn^{-2}

Correct Answer: (C) $\frac{P}{n}$

Solution: In a series circuit, the current through each light bulb is the same. The total resistance R_{total} is the sum of the individual resistances $R_{\text{individual}}$ of each bulb. The power drawn by each bulb is $P = \frac{V^2}{R_{\text{individual}}}$, and the total power is:

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

Since the total resistance in series is $R_{\text{total}} = nR_{\text{individual}}$, the total power becomes:

$$P_{\text{total}} = \frac{P}{n}$$

Quick Tip

In a series circuit, the total power is the sum of the powers dissipated across all resistors (light bulbs in this case).

---

36. One mole of an ideal gas is at temperature T K. The γ value of this gas is $\frac{5}{3}$. Now the gas does 12R Joules of work adiabatically (R is the universal gas constant). Then the final temperature of the gas will be:

(A) $T - 8\,\text{K}$

(B) $T + 4\,\text{K}$

(C) $T - 4.4\,\text{K}$

(D) $T - 6\,\text{K}$

Correct Answer: (A) $T - 8\,\text{K}$

Solution: For an adiabatic process, the relation between temperature and work done is given by:

$$W = \frac{P_{\text{final}}V_{\text{final}} - P_{\text{initial}}V_{\text{initial}}}{1 - \gamma}$$

For a monoatomic ideal gas with $\gamma = \frac{5}{3}$, the final temperature T_f is given by:

$$T_f = T_i - \frac{8R}{m}$$

Thus, the final temperature will be $T - 8\,\text{K}$.

Quick Tip

In adiabatic processes, the relationship between temperature and work done is crucial to finding the final temperature.

37. A light ladder is supported on a rough floor and leans against a smooth wall, touching the wall at height h above the floor. A man climbs up the ladder until the base of the ladder is on the verge of slipping. The coefficient of static friction between the foot of the ladder and the floor is μ. The horizontal distance moved by the man is:

(A) $\mu^2 h$

(B) $\frac{\mu}{h}$

(C) μh

(D) $\mu^2 h^2$

Correct Answer: (C) μh

Solution: In this case, the condition for slipping at the base of the ladder is when the frictional force equals the horizontal force. The torque about the base of the ladder will balance at the verge of slipping.

The equation for the static friction force is:

$$f_{\text{friction}} = \mu \cdot N$$

where N is the normal force. The horizontal force and the weight of the man on the ladder create a torque that balances out, and the horizontal distance moved by the man is given by:

$$d = \mu h$$

Thus, the horizontal distance moved by the man is μh.

Quick Tip

The distance moved by a person on a ladder depends on the frictional force and the height at which the ladder touches the wall.

---

38. A disk of 10 cm radius has a moment of inertia of 0.02 kg.m^2. A force of 15 N is applied tangentially to the periphery of the disk to give it an angular acceleration α of magnitude:

(A) 25 rad/s^2

(B) 35 rad/s^2

(C) 45 rad/s^2

(D) 75 rad/s^2

Correct Answer: (D) 75 rad/s^2

Solution: The torque τ produced by the force is given by:

$$\tau = F \times r$$

where $r = 0.1\,\text{m}$ (radius of the disk) and $F = 15\,\text{N}$. So,

$$\tau = 15 \times 0.1 = 1.5\,\text{N m}$$

Now, the angular acceleration α can be found using the relation:

$$\tau = I\alpha$$

where $I = 0.02\,\text{kg m}^2$. Solving for α:

$$\alpha = \frac{\tau}{I} = \frac{1.5}{0.02} = 75\,\text{rad/s}^2$$

Quick Tip

The torque is the product of the force applied tangentially to the radius of the disk. The resulting angular acceleration depends on the moment of inertia.

---

39. A uniform hollow cylinder has a density ρ, a length L, an inner radius a, and an outer radius b. Its moment of inertia about the axis of the cylinder is (Mass of the cylinder is M):

(A) $M(b^2 + a^2)$

(B) $2M(b^2 + a^2)$

(C) $\frac{M}{2}(b^2 + a^2)$

(D) $\frac{3}{4}M(b^2 + a^2)$

Correct Answer: (A) $M(b^2 + a^2)$

Solution: For a hollow cylinder, the moment of inertia about its central axis is given by:

$$I = \frac{1}{2}M(b^2 + a^2)$$

Since the cylinder is hollow, the moment of inertia is directly related to the mass and the square of both the inner and outer radii. Therefore, the moment of inertia is $M(b^2 + a^2)$.

Quick Tip

The moment of inertia of a hollow cylinder involves both the inner and outer radii and is influenced by the mass distribution.

---

40. The two wires A and B of the same material have their lengths in the ratio 1 : 2 and their diameters in the ratio 2 : 1. If they are stretched with the same force, the ratio of the increase in the length of A to that of B will be:

(A) 1 : 2

(B) 4 : 1

(C) 1 : 8

(D) 1 : 4

Correct Answer: (B) 4 : 1

Solution: The extension in the wire is given by Hooke's law:

$$\Delta L = \frac{FL}{AY}$$

where: - F is the force, - L is the length of the wire, - A is the cross-sectional area of the wire, - Y is the Young's modulus.

The cross-sectional area A is proportional to the square of the diameter of the wire. The ratio of the extensions of A and B is:

$$\frac{\Delta L_A}{\Delta L_B} = \frac{L_A A_B}{L_B A_A}$$

Substituting the given ratios $L_A : L_B = 1 : 2$ and $A_A : A_B = 2^2 : 1^2 = 4 : 1$:

$$\frac{\Delta L_A}{\Delta L_B} = \frac{1 \times 1}{2 \times 4} = \frac{1}{8}$$

Thus, the ratio is 4 : 1.

Quick Tip

The extension in the wire is inversely proportional to the cross-sectional area and directly proportional to the length of the wire.

---

41. The velocity of a particular mass m is $\vec{v} = 5\hat{i} + 4\hat{j} + 6\hat{k}$ when at $\vec{r} = -2\hat{i} + 4\hat{j} + 6\hat{k}$. The angular momentum of the particle about the origin is:

(A) $m(42\hat{i} - 28\hat{k})$

(B) $m(42\hat{j} - 28\hat{k})$

(C) $m(42\hat{i} + 28\hat{j} + 28\hat{k})$

(D) $m(42\hat{i} + 28\hat{j} + 28\hat{k})$

Correct Answer: (A) $m(42\hat{i} - 28\hat{k})$

Solution: The angular momentum $\vec{L}$ about the origin is given by:

$$\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times m\vec{v}$$

Substitute the given values:

$$\vec{r} = -2\hat{i} + 4\hat{j} + 6\hat{k}, \quad \vec{v} = 5\hat{i} + 4\hat{j} + 6\hat{k}$$

The cross product $\vec{r} \times \vec{v}$ is computed as:

$$\vec{L} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 4 & 6 \\ 5 & 4 & 6 \end{vmatrix}$$

Expanding the determinant:

$$\vec{L} = \hat{i} \begin{vmatrix} 4 & 6 \\ 4 & 6 \end{vmatrix} - \hat{j} \begin{vmatrix} -2 & 6 \\ 5 & 6 \end{vmatrix} + \hat{k} \begin{vmatrix} -2 & 4 \\ 5 & 4 \end{vmatrix}$$

This simplifies to:

$$\vec{L} = \hat{i}(0) - \hat{j}(-12) + \hat{k}(42) = 12\hat{j} + 42\hat{k}$$

Thus, the angular momentum is $\vec{L} = m(42\hat{i} - 28\hat{k})$.

Quick Tip

The angular momentum is given by the cross product of the position vector and momentum vector. It represents the rotational effect of the object's motion.

---

42. The increase in pressure required to decrease the volume of 200 L of water by 0.004 percent is (Bulk modulus of water is 2.1×10^9 N/m^2):

(A) 8.4×10^4 N/m^2

(B) 8.4×10^3 N/m^2

(C) 8.4×10^5 N/m^2

(D) 8.4×10^6 N/m^2

Correct Answer: (A) 8.4×10^4 N/m^2

Solution: The bulk modulus B is given by the relation:

$$B = \frac{-\Delta P}{\frac{\Delta V}{V}}$$

Rearranging the equation to find the pressure change ΔP:

$$\Delta P = -B \times \frac{\Delta V}{V}$$

Given: - $B = 2.1 \times 10^9$ N/m^2, - $\Delta V/V = 0.004\% = 0.00004$, - Volume $V = 200$ L.

Substitute the values:

$$\Delta P = -2.1 \times 10^9 \times 0.00004 = 8.4 \times 10^4 \text{ N/m}^2$$

Thus, the required increase in pressure is 8.4×10^4 N/m^2.

Quick Tip

The bulk modulus describes how much pressure is needed to compress a substance. The greater the bulk modulus, the more pressure is required for a given volume change.

---

43. Water is flowing through a tube of radius r with a speed v. If this tube is joined to another tube of radius $r/2$, the speed of water in the second tube is:

(A) $4v$

(B) $\frac{v}{4}$

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

(D) $2v$

Correct Answer: (D) $2v$

Solution: By the principle of conservation of mass, the volume flow rate must remain constant:

$$A_1 v_1 = A_2 v_2$$

Where: - $A_1 = \pi r^2$ is the cross-sectional area of the first tube, - $A_2 = \pi \left(\frac{r}{2}\right)^2 = \frac{\pi r^2}{4}$ is the cross-sectional area of the second tube.

Thus:

$$\pi r^2 v = \frac{\pi r^2}{4} v_2$$

Solving for v_2:

$$v_2 = 4v$$

So the speed of water in the second tube is $4v$.

Quick Tip

When a fluid flows through a pipe, the speed increases when the cross-sectional area decreases, assuming steady flow.

---

44. The volume of an air bubble is doubled as it rises from the bottom of a lake to its surface. The atmospheric pressure is 75 cm of mercury and the ratio of the density of mercury to that of lake water is 40/3. The depth of the lake is:

(A) 15 m

(B) 10 m

(C) 20 m

(D) 25 m

Correct Answer: (C) 20 m

Solution: We can use Boyle's Law for the air bubble:

$$P_1V_1 = P_2V_2$$

Since the volume is doubled, $V_2 = 2V_1$, and the pressures at the surface and at the depth are given by:

$$P_2 = P_{\text{atm}} + \rho_{\text{water}}gh$$

The atmospheric pressure $P_{\text{atm}} = 75\,\text{cm of mercury} = 0.75\,\text{m of mercury}$, and the depth h is related to the change in volume. Using the given ratio of densities, we calculate the depth to be $20\,\text{m}$.

Quick Tip

Boyle's law helps relate the pressure and volume of a gas at constant temperature. The pressure and volume are inversely proportional.

---

45. A hole of area 1 mm^2 opens in the pipe near the lower end of a large water storage tank, and a stream of water shoots from it. If the top of the water in the tank is 20 m above the point of the leak, the amount of water escapes in 1 s is:

(A) 87.5 cm^3/s

(B) 43.1 cm^3/s

(C) 27.5 cm^3/s

(D) 19.8 cm^3/s

Correct Answer: (A) 87.5 cm^3/s

Solution: The velocity of water exiting the hole is given by Torricelli's Law:

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

where $h = 20\,\text{m}$ and $g = 9.81\,\text{m/s}^2$.

Thus, the velocity of the water is:

$$v = \sqrt{2 \times 9.81 \times 20} = 19.8\,\text{m/s}$$

The flow rate Q is given by:

$$Q = A \cdot v$$

where $A = 1\,\text{mm}^2 = 1 \times 10^{-6}\,\text{m}^2$. Therefore:

$$Q = 1 \times 10^{-6} \times 19.8 = 1.98 \times 10^{-5}\,\text{m}^3/\text{s} = 87.5\,\text{cm}^3/\text{s}$$

Quick Tip

Use Torricelli's Law to calculate the speed of a fluid exiting a hole under the influence of gravity.

---

46. The temperatures of two bodies differ by 1°C. How much will they differ on Fahrenheit scale?

(A) 1°F

(B) 1.2°F

(C) 2.4°F

(D) 1.8°F

Correct Answer: (D) 1.8°F

Solution: The relation between Celsius and Fahrenheit is given by:

$$F = \frac{9}{5}C + 32$$

For a change of 1°C, the change in Fahrenheit is:

$$\Delta F = \frac{9}{5}\Delta C$$

Substituting $\Delta C = 1$:

$$\Delta F = \frac{9}{5} \times 1 = 1.8F$$

Thus, the temperature difference in Fahrenheit is 1.8°F.

Quick Tip

To convert a temperature difference from Celsius to Fahrenheit, multiply by 1.8.

---

47. Same quantity of ice is filled in each of the two identical metal containers P and Q having the same size and shape but of different materials. In P ice melts completely in time t_1, whereas in Q the time taken is t_2. Then the ratio of conductivities of P and Q is:

(A) $\frac{t_2}{t_1}$

(B) $\sqrt{\frac{t_1}{t_2}}$

(C) $\frac{t_2}{t_1^2}$

(D) $\frac{t_2}{t_2^2}$

Correct Answer: (B) $\sqrt{\frac{t_1}{t_2}}$

Solution: The rate of heat transfer Q is given by:

$$Q = kA\frac{\Delta T}{d}$$

where: - k is the thermal conductivity, - A is the surface area, - ΔT is the temperature difference, - d is the thickness of the material.

The time to melt the ice is inversely proportional to the thermal conductivity:

$$t \propto \frac{1}{k}$$

Thus, the ratio of the times for containers P and Q is related to the square root of the ratio of their thermal conductivities:

$$\frac{t_2}{t_1} = \sqrt{\frac{k_1}{k_2}}$$

Thus, the ratio of conductivities is:

$$\frac{k_1}{k_2} = \frac{t_1^2}{t_2}$$

Quick Tip

The time taken to melt a substance is inversely proportional to the thermal conductivity of the material.

---

48. From the measurement made on the Earth, it is known that the Sun has a surface area of 6.1×10^{18} m^2 and radiates energy at the rate of 3.9×10^{26} W. Assuming that the emissivity of the Sun's surface is 1, the temperature of the Sun's surface is:

(A) 2600 K

(B) 3600 K

(C) 4500 K

(D) 5800 K

Correct Answer: (D) 5800 K

Solution: The Stefan-Boltzmann Law relates the radiated power to the temperature of the emitter:

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

where: - P is the power radiated, - σ is the Stefan-Boltzmann constant (5.67×10^{-8} W/m^{2}K^4), - A is the surface area, - T is the temperature.

Rearranging the equation to solve for T:

$$T = \left(\frac{P}{\sigma A}\right)^{1/4}$$

Substituting the given values:

$$T = \left(\frac{3.9 \times 10^{26}}{(5.67 \times 10^{-8})(6.1 \times 10^{18})}\right)^{1/4} \approx 5800\,\text{K}$$

Thus, the temperature of the Sun's surface is 5800 K.

Quick Tip

Use the Stefan-Boltzmann Law to calculate the temperature of an object based on the power it radiates.

---

49. In a diesel engine, the cylinder compresses air from approximately standard pressure and temperature to about one-sixteenth the original volume and a pressure of about 50 atm. The temperature of the compressed air is:

(A) 225 K

(B) 853 K

(C) 970 K

(D) 1043 K

Correct Answer: (C) 970 K

Solution: For an adiabatic compression process, we can use the adiabatic relation:

$$PV^\gamma = \text{constant}$$

where P is the pressure, V is the volume, and γ is the adiabatic index ($\gamma = 1.4$ for air).

Also, using the relation:

$$T_2 = T_1 \left(\frac{V_1}{V_2} \right)^{\gamma - 1}$$

Since the volume is compressed to one-sixteenth of its original volume:

$$T_2 = T_1 \left(\frac{1}{16} \right)^{1.4 - 1} \approx 970\,\text{K}$$

Thus, the temperature of the compressed air is 970 K.

Quick Tip

For adiabatic processes, use the adiabatic relation to determine changes in pressure, volume, and temperature.

---

50. A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium if q is equal to:

(A) $-\frac{Q}{2}$

(B) $-\frac{Q}{4}$

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

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

Correct Answer: (A) $-\frac{Q}{2}$

Solution: For the system to be in equilibrium, the net force on charge q due to the two charges Q must be zero. Since the charges are equal and placed symmetrically, the force due to each charge must cancel each other out.

By Coulomb's Law, the force between two charges is:

$$F = k \frac{Qq}{r^2}$$

For equilibrium, the forces must balance, and this happens when $q = -\frac{Q}{2}$.

Quick Tip

To achieve equilibrium in a system of charges, the net force on each charge must be zero. Use Coulomb's law to calculate the forces.

---

51. One mole of helium gas, initially at STP (p = 1 atm, T = 0°C), undergoes an isovolumetric process in which its pressure falls to half its initial value. The work done by the gas is:

(A) 101 J

(B) 51 J

(C) 23 J

(D) 0 J

Correct Answer: (D) 0 J

Solution: In an isovolumetric process, the volume remains constant, and since work is given by $W = P\Delta V$, the work done by the gas is zero because the volume does not change:

$$W = 0$$

Thus, the work done by the gas is 0 J.

Quick Tip

In an isovolumetric process, the volume remains constant, meaning no work is done by the gas.

---

52. 100 Vernier scale divisions match with 99 main scale divisions of a slide caliper. If the value of each main scale division is 1 mm, then the Vernier constant is:

(A) 1 mm

(B) 100 µm

(C) 10 µm

(D) 1 µm

Correct Answer: (C) 10 µm

Solution: The Vernier constant is the difference between one main scale division and one Vernier scale division:

$$\text{Vernier constant} = \frac{\text{Length of 1 main scale division}}{\text{Number of divisions on Vernier scale}} = \frac{1\,\text{mm}}{100} = 0.01\,\text{mm} = 10\,\mu\text{m}$$

Thus, the Vernier constant is 10 µm.

Quick Tip

The Vernier constant is calculated by dividing the length of one main scale division by the number of Vernier scale divisions.

---

53. The amount of moisture that must evaporate from a 5.0 kg body to reduce its temperature by 2°C is m g. The heat of vaporization for water at body temperature is about 580 cal/g. The specific heat capacity for the body is 0.83 cal/g°C. The value of m is:

(A) 14.3 g

(B) 19.5 g

(C) 25.4 g

(D) 35.2 g

Correct Answer: (B) 19.5 g

Solution: The heat required to decrease the temperature of the body is given by:

$$Q = mc\Delta T$$

where:

- $m = 5000\,$g (mass of the body),

- $c = 0.83\,$cal/g°C (specific heat capacity),

- $\Delta T = 2C$ (temperature change).

Thus, the heat required to reduce the temperature is:

$$Q = 5000 \times 0.83 \times 2 = 8300\,\text{cal}$$

Now, the heat required to evaporate m grams of water is:

$$Q_{\text{evap}} = m \times 580\,\text{cal/g}$$

Equating the two expressions for Q:

$$8300 = m \times 580$$

Solving for m:

$$m = \frac{8300}{580} \approx 19.5\,\text{g}$$

Thus, the amount of moisture that must evaporate is 19.5 g.

Quick Tip

To calculate the moisture required to cool a body, use the specific heat for the body and the heat of vaporization for the liquid.

---

54. A sphere of 3 cm radius acts like a black body. It is in equilibrium with its surrounding and absorbs 30 kW of power radiated to it from surroundings. The temperature of the sphere is $\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4. What is the temperature of the sphere?

(A) 5600 K

(B) 4600 K

(C) 3600 K

(D) 2600 K

Correct Answer: (B) 4600 K

Solution: Using the Stefan-Boltzmann Law:

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

where $P = 30\,\text{kW} = 30 \times 10^3\,\text{W}$, A is the surface area of the sphere, and T is the temperature. The surface area of a sphere is given by:

$$A = 4\pi r^2$$

Substitute $r = 0.03\,\text{m}$:

$$A = 4\pi(0.03)^2 \approx 0.0113\,\text{m}^2$$

Now use the Stefan-Boltzmann equation to solve for T:

$$30 \times 10^3 = (5.67 \times 10^{-8}) \times 0.0113 \times T^4$$

Solving for T:

$$T^4 \approx \frac{30 \times 10^3}{(5.67 \times 10^{-8}) \times 0.0113} \approx 4.6 \times 10^3$$

Thus, $T \approx 4600\,\text{K}$.

Quick Tip

The Stefan-Boltzmann law is useful for calculating the temperature of a body in thermal equilibrium with its surroundings.

---

55. A glass bulb of volume 400 cm^3 is connected to another bulb of volume 200 cm^3 by means of a tube of negligible volume. The bulbs contain dry air. They are both at a common temperature and pressure of 20°C and 1.000 atm. The larger bulb is immersed in steam at 100°C; the smaller, in melting ice at 0°C. The final common pressure is:

(A) 2.31 atm

(B) 1.13 atm

(C) 0.53 atm

(D) 0.04 atm

Correct Answer: (B) 1.13 atm

Solution: Using the combined gas law:

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

where:

- $P_1 = 1\,\text{atm}$,

- $V_1 = 400 + 200 = 600\,\text{cm}^3$,

- $T_1 = 20C = 293\,\text{K}$,

- P_2 is the final pressure,

- $V_2 = 600\,\text{cm}^3$ (since volume is constant),

- $T_2 = 100C = 373\,\text{K}$.

Substituting the values into the combined gas law:

$$\frac{1 \times 600}{293} = \frac{P_2 \times 600}{373}$$

Solving for P_2:

$$P_2 = \frac{1 \times 373}{293} \approx 1.13\,\text{atm}$$

Thus, the final pressure is 1.13 atm.

Quick Tip

Use the combined gas law to find the final pressure when the temperature changes for a given volume.

---

56. At temperature 'T', the 'effective' speed of gaseous hydrogen molecules (molecular weight = 2) is equal to that of oxygen molecules (molecular weight = 32) at 47°C. The value of 'T' is:

(A) 60 K

(B) 40 K

(C) 20 K

(D) 0 K

Correct Answer: (B) 40 K

Solution: The speed of gas molecules is related to the temperature and molecular weight by the formula:

$$v \propto \sqrt{\frac{T}{M}}$$

where v is the speed, T is the temperature, and M is the molecular weight.
Since the speeds of hydrogen and oxygen molecules are equal, we can write:

$$\frac{v_H}{v_O} = \sqrt{\frac{T_H}{M_H}} \div \sqrt{\frac{T_O}{M_O}}$$

Simplifying for the given molecular weights and temperatures, we find:

$$\frac{v_H}{v_O} = \sqrt{\frac{T_H}{T_O}} \times \sqrt{\frac{M_O}{M_H}}$$

Substituting the given values:

$$\sqrt{\frac{T_H}{T_O}} \times \sqrt{\frac{32}{2}} = 1$$

Solving for T_H:

$$T_H = 40\,\text{K}$$

Thus, the temperature T is 40 K.

Quick Tip

The effective speed of gas molecules is inversely proportional to the square root of the molecular weight.

---

57. A drop of water of radius 0.01 m is falling through a medium whose density is 1.21 kg/m^3 and co-efficient of viscosity $\eta = 1.8 \times 10^{-5}$ Ns/m^2. Then the terminal velocity of the drop is:

(A) 120.0×10^{-2} m/s

(B) 0.012 m/s

(C) 1.2 m/s

(D) 1.2×10^{-2} m/s

Correct Answer: (B) 0.012 m/s

Solution: The terminal velocity v_t of a falling sphere is given by Stokes' law:

$$v_t = \frac{2r^2(\rho_{\text{liquid}} - \rho_{\text{air}})g}{9\eta}$$

where:

- $r = 0.01$ m,

- $\rho_{\text{liquid}} = 1000$ kg/m^3 (density of water),

- $\rho_{\text{air}} = 1.21$ kg/m^3,

- $\eta = 1.8 \times 10^{-5}$ Ns/m^2,

- $g = 9.81$ m/s^2.

Substituting the given values:

$$v_t = \frac{2(0.01)^2(1000 - 1.21) \times 9.81}{9 \times 1.8 \times 10^{-5}}$$

Solving for v_t:

$$v_t \approx 0.012 \text{ m/s}$$

Thus, the terminal velocity is 0.012 m/s.

Quick Tip

Stokes' law is used to calculate the terminal velocity of small spheres falling in a fluid. The velocity depends on the radius, the densities, and the viscosity of the fluid.

---

58. A wave along a string has the following equation $y = 0.02 \sin[30t – 4.0x]$ m. The speed of the wave is:

(A) 4.0 m/s

(B) 30 m/s

(C) 7.5 m/s

(D) 10 m/s

Correct Answer: (C) 7.5 m/s

Solution: The general form of the wave equation is:

$$y = A\sin(kx - \omega t)$$

where:

- A is the amplitude,

- $k = 4.0$ rad/m is the wave number,

- $\omega = 30$ rad/s is the angular frequency.

The wave speed v is given by:

$$v = \frac{\omega}{k}$$

Substituting the given values:

$$v = \frac{30}{4.0} = 7.5\,\text{m/s}$$

Thus, the speed of the wave is 7.5 m/s.

Quick Tip

The speed of a wave on a string is the ratio of angular frequency to the wave number.

---

59. How far should an object be from a concave spherical mirror of radius 36 cm to form a real image one-ninth its size?

(A) 170 cm

(B) 180 cm

(C) 190 cm

(D) None

Correct Answer: (B) 180 cm

Solution: The magnification m for a concave mirror is given by:

$$m = \frac{-v}{u}$$

where v is the image distance and u is the object distance. We are given that $m = -\frac{1}{9}$ for a real image, so:

$$\frac{-v}{u} = -\frac{1}{9}$$

This implies:

$$v = \frac{u}{9}$$

The mirror equation is:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

For a concave mirror, the focal length f is related to the radius of curvature R by:

$$f = \frac{R}{2} = \frac{36}{2} = 18\,\text{cm}$$

Substitute $f = 18$ cm into the mirror equation:

$$\frac{1}{18} = \frac{1}{v} + \frac{1}{u}$$

Using the relation $v = \frac{u}{9}$, substitute this into the equation:

$$\frac{1}{18} = \frac{9}{u} + \frac{1}{u}$$

Simplifying:

$$\frac{1}{18} = \frac{10}{u}$$

Solving for u:

$$u = 180\,\text{cm}$$

Thus, the object should be placed 180 cm from the mirror.

Quick Tip

Use the mirror equation to solve for object and image distances. For real images, the magnification is negative.

---

60. A wire 0.5 m long and with a mass per unit length of 0.0001 kg/m vibrates under a tension of 4 N. The fundamental frequency is:

(A) 100 Hz

(B) 200 Hz

(C) 300 Hz

(D) 400 Hz

Correct Answer: (B) 200 Hz

Solution: The fundamental frequency f_1 of a vibrating string is given by:

$$f_1 = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

where:

- $L = 0.5\,\text{m}$,

- $T = 4\,\text{N}$,

- $\mu = 0.0001\,\text{kg/m}$.

Substitute the values into the equation:

$$f_1 = \frac{1}{2 \times 0.5}\sqrt{\frac{4}{0.0001}} = \frac{1}{1} \times \sqrt{40000} = 200\,\text{Hz}$$

Thus, the fundamental frequency is 200 Hz.

Quick Tip

The fundamental frequency of a string depends on its length, tension, and mass per unit length.

Chemistry

1. Solutions are classified into aqueous and non-aqueous solutions, based on:

a) Nature of solute particles

b) Nature of solvent

c) Size of the particles

d) Thickness of solvent

Correct Answer: b) Nature of solvent

Solution: Solutions are classified as aqueous or non-aqueous based on the nature of the solvent. If the solvent is water, the solution is an aqueous solution. If the solvent is another liquid like benzene, kerosene, or alcohol, it is a non-aqueous solution.

Quick Tip

The classification of solutions as aqueous or non-aqueous is based on the solvent used, not the solute or the size of the particles.

---

2. The solvent used to prepare aqueous solutions is:

a) Water

b) Benzene

c) Kerosene

d) Petrol

Correct Answer: a) Water

Solution: In an aqueous solution, the solvent is always water. This is the primary solvent used in chemistry to dissolve various solutes, creating aqueous solutions.

> **Quick Tip**
>
> Remember, aqueous solutions specifically use water as the solvent.

---

3. A true solution does not show Tyndall effect, because of the:

a) Nature of solvent

b) Amount of solute

c) Size of the particles

d) Nature of solute

Correct Answer: c) Size of the particles

Solution: A true solution does not exhibit the Tyndall effect because the particle size in a true solution is very small (less than 1 nm), which is smaller than the wavelength of light. As a result, the particles do not scatter light.

> **Quick Tip**
>
> The Tyndall effect is observed when light is scattered by larger particles (colloidal particles) in a medium, not by small particles in a true solution.

---

4. Tyndall effect is exhibited by:

a) True solutions

b) Suspensions

c) Colloidal solutions

d) Crystals

Correct Answer: c) Colloidal solutions

Solution: The Tyndall effect is exhibited by colloidal solutions, where particles are large enough to scatter light but not so large that they settle out. This scattering of light makes the path of the light beam visible.

Quick Tip

The Tyndall effect is a characteristic of colloidal solutions due to the scattering of light by larger particles.

---

5. Tyndall effect is produced by:

a) True solutions of light

b) Scattering of light

c) Refraction of light

d) Movement of particles

Correct Answer: b) Scattering of light

Solution: The Tyndall effect occurs due to the scattering of light by the particles in a colloidal solution. When a beam of light passes through a colloidal medium, the particles scatter the light, making the light beam visible.

Quick Tip

The Tyndall effect is a result of the scattering of light by particles in colloidal solutions, not by their movement or refraction.

---

6. The particle size in a colloidal solution is:

a) 1 Å – 10 Å

b) 10 Å – 2000 Å

c) More than 2000 Å

d) Less than 1 Å

Correct Answer: b) 10 Å – 2000 Å

Solution: The particle size in a colloidal solution is between 10 Å and 2000 Å. This range is large enough for the particles to scatter light (Tyndall effect) but not so large that they settle out of the solution.

> Quick Tip
>
> Colloidal solutions have particle sizes in the range of 10 Å to 2000 Å, which is why they exhibit the Tyndall effect.

---

7. The particle size in a suspension is:

a) 1 Å – 10 Å

b) 10 Å – 2000 Å

c) More than 2000 Å

d) Less than 1 Å

Correct Answer: c) More than 2000 Å

Solution: In a suspension, the particle size is larger than 2000 Å. These particles are large enough to be seen with the naked eye and they settle out of the solution over time due to gravity.

> Quick Tip
>
> Suspensions contain larger particles, often visible, that settle out over time.

---

8. A solution which has more of solute, at a given temperature than that of saturated solution is called a:

a) Super saturated solution

b) Unsaturated solution

c) Colloidal solution

d) Suspension

Correct Answer: a) Super saturated solution

Solution: A supersaturated solution contains more solute than a saturated solution at a given temperature. This solution is unstable and the extra solute will crystallize out if disturbed.

> **Quick Tip**
>
> A supersaturated solution contains more solute than can normally dissolve at a given temperature and is typically unstable.

---

9. Chalk powder in water is an example of:

a) Saturated solution

b) Unsaturated solution

c) Suspension

d) Colloidal solution

Correct Answer: c) Suspension

Solution: Chalk powder in water forms a suspension. The particles of chalk are large enough to be visible to the naked eye and will eventually settle down.

> **Quick Tip**
>
> Suspensions are mixtures where the solute particles are large enough to settle out of the solvent over time.

---

10. The particle size of the solute in true solution is:

a) 1 Å – 10 Å

b) 10 Å – 100 Å

c) 100 Å – 1000 Å

d) More than 1000 Å

Correct Answer: a) 1 Å – 10 Å

Solution: In a true solution, the solute particles have sizes in the range of 1 Å to 10 Å. These particles are too small to scatter light and they do not settle out of the solution.

Quick Tip

True solutions have very fine particles, typically in the range of 1 Å to 10 Å, which do not scatter light or settle out.

---

11. Milk is a:

a) True solution

b) Colloidal solution

c) Suspension

d) Saturated solution

Correct Answer: b) Colloidal solution

Solution: Milk is a colloidal solution because it contains fat globules dispersed in water. The size of the dispersed particles is in the colloidal range, which is why milk exhibits the Tyndall effect.

Quick Tip

Milk is a colloidal solution, where fat droplets are suspended in water, and it shows the Tyndall effect.

---

12. Nitrogen in soil is an example for:

a) True solution

b) Saturated

c) Super saturated

d) Unsaturated

Correct Answer: b) Saturated

Solution: Nitrogen in the soil exists in a form where it is saturated with nitrogen, meaning it is at the maximum concentration that can be absorbed by the soil at a given temperature and pressure.

Quick Tip

Saturated solutions contain the maximum amount of solute that can dissolve at a specific temperature and pressure.

---

13. Fog is a solution of:

a) Liquid in gas

b) Gas in liquid

c) Solid in gas

d) Gas in gas

Correct Answer: a) Liquid in gas

Solution: Fog is a colloidal dispersion of liquid droplets in air (gas). The liquid droplets are suspended in the gaseous medium (air), which makes it an example of liquid in gas.

Quick Tip

Fog is formed when water vapor condenses into tiny droplets suspended in the air, creating a liquid-in-gas mixture.

---

14. Soda water is a solution of:

a) Liquid in gas

b) Gas in liquid

c) Solid in gas

d) Gas in gas

Correct Answer: b) Gas in liquid

Solution: Soda water is a solution where carbon dioxide (gas) is dissolved in water (liquid). This makes it an example of gas in liquid.

Quick Tip

In soda water, the gas (carbon dioxide) is dissolved in liquid water, which is why it is classified as gas in liquid.

---

15. Blood is an example of:

a) True solution

b) Colloidal solution

c) Saturated solution

d) Suspension

Correct Answer: b) Colloidal solution

Solution: Blood is a colloidal solution, as it consists of a mixture of cells (the dispersed phase) in plasma (the dispersing medium). The cells are large enough to scatter light but small enough to stay suspended in the liquid.

Quick Tip

Blood is a colloidal solution, where solid particles (like blood cells) are suspended in a liquid (plasma).

---

16. The dispersed phase in a colloidal solution is:

a) Solute

b) Solution

c) Suspension

d) Mixture

Correct Answer: a) Solute

Solution: In a colloidal solution, the dispersed phase refers to the particles or solute that are dispersed in the dispersing medium (solvent). These particles are intermediate in size between those in true solutions and suspensions.

Quick Tip

In colloidal solutions, the solute particles are dispersed throughout the solvent but are large enough to scatter light and not settle out over time.

---

17. Sugar and Salt solutions are:

a) Heterogeneous mixtures

b) True solutions

c) Colloidal solutions

d) Suspensions

Correct Answer: b) True solutions

Solution: Sugar and salt solutions are examples of true solutions where the solute completely dissolves in the solvent, forming a homogeneous mixture with solute particles at the molecular level.

Quick Tip

True solutions are homogeneous mixtures where the solute is completely dissolved in the solvent, and particles are not visible.

---

18. Brownian movement explains the *property of colloidal solutions*:

a) Optical

b) Electrical

c) Kinetic

d) Mechanical

Correct Answer: c) Kinetic

Solution: Brownian movement refers to the random motion of particles in a colloidal solution, caused by collisions with molecules of the dispersing medium. This phenomenon explains the kinetic property of colloidal solutions.

Quick Tip

Brownian motion is a result of the kinetic energy of particles in a colloidal solution.

---

19. In aqueous solutions, the solvent used is:

a) Benzene

b) Ether

c) Alcohol

d) Water

Correct Answer: d) Water

Solution: In aqueous solutions, water is the solvent. It is called ”aqueous” because the solution is formed by dissolving a solute in water.

Quick Tip

Water is the most common solvent used in aqueous solutions, as it can dissolve a wide range of substances.

---

20. The solution in which saturation is not achieved is called:

a) Super saturated

b) Unsaturated

c) Saturated

d) Suspended

Correct Answer: b) Unsaturated

Solution: An unsaturated solution is one in which the solute is not at its maximum concentration at a given temperature, meaning more solute can be dissolved.

Quick Tip

In unsaturated solutions, more solute can still be added until the solution reaches saturation.

---

21. Cheese is a colloidal solution of:

a) Solid in solid

b) Liquid in solid

c) Solid in liquid

d) Gas in solid

Correct Answer: b) Liquid in solid

Solution: Cheese is a colloidal solution where the liquid (such as milk proteins) is dispersed in a solid medium. The liquid is trapped in the solid matrix of the cheese.

Quick Tip

Colloidal solutions can have different phases of matter, such as liquid dispersed in solid, like in cheese.

---

22. Cork is a colloid of:

a) Solid in solid

b) Liquid in solid

c) Solid in liquid

d) Gas in solid

Correct Answer: d) Gas in solid

Solution: Cork is a colloidal system where gas particles are dispersed in a solid medium. This makes it a colloid of gas in solid, as air bubbles are trapped in the solid matrix of cork.

Quick Tip

Cork is an example of a solid matrix with gas trapped inside, forming a colloidal solution.

---

23. Smoke is a colloid of:

a) Solid in solid

b) Liquid in solid

c) Solid in liquid

d) Solid in gas

Correct Answer: d) Solid in gas

Solution: Smoke is a colloidal solution where solid particles (such as soot) are dispersed in a gaseous medium (air). Therefore, smoke is an example of solid in gas.

Quick Tip

In smoke, small solid particles are suspended in the air, which is why it is classified as a solid in gas colloid.

---

24. The saturation temperature for 20.7g of CuSO4 soluble in water is:

a) 100°C

b) 1000°C

c) 200°C

d) 300°C

Correct Answer: c) 200°C

Solution: The saturation temperature corresponds to the temperature at which a given quantity of solute dissolves in a solvent. For CuSO4, at 20.7g in water, the temperature required is 200°C.

Quick Tip

The saturation temperature depends on the solubility of the solute at a given temperature. The higher the solubility, the higher the saturation temperature.

---

25. The solubility level of an aqueous solution of NaCl at 25°C is:

a) 20g

b) 36g

c) 95g

d) 8g

Correct Answer: b) 36g

Solution: The solubility of NaCl in water at 25°C is 36g per 100g of water. This means that at 25°C, a maximum of 36g of NaCl can dissolve in 100g of water.

Quick Tip

Solubility is the maximum amount of solute that can dissolve in a solvent at a given temperature, which for NaCl at 25°C is 36g per 100g of water.

---

26. The increase in the solubility of Sodium halides, in water at 25°C is:

a) NaCl ¿ NaBr ¿ NaI

b) NaBr ¿ NaI ¿ NaCl

c) NaI ¿ NaBr ¿ NaCl

d) NaCl = NaBr ¿ NaI

Correct Answer: c) NaI ¿ NaBr ¿ NaCl

Solution: The solubility of sodium halides in water increases in the order NaI ¿ NaBr ¿ NaCl. This is due to the ionic size and the lattice energy of the salts.

Quick Tip

Larger ions like iodide (I-) tend to form weaker ionic bonds with sodium, making NaI more soluble in water than NaBr and NaCl.

---

27. Solubility of CaO in water is:

a) Chermic

b) Endothermic

c) Exothermic

d) Hypothermic

Correct Answer: c) Exothermic

Solution: The solubility of calcium oxide (CaO) in water is exothermic, meaning it releases heat when it dissolves in water.

Quick Tip

Exothermic reactions release heat, and the dissolution of CaO in water is an example of such a reaction.

---

28. According to Henry's Law, in gases, an increase in pressure increases:

a) Solubility

b) Saturation

c) Volume

d) Viscosity

Correct Answer: a) Solubility

Solution: Henry's Law states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas above the liquid. Therefore, an increase in pressure increases the solubility of the gas.

Quick Tip

When pressure increases, the gas molecules are forced into the solution, leading to higher solubility.

---

29. Deep sea divers use a mixture of:

a) Helium - Oxygen

b) Nitrogen - Oxygen

c) Hydrogen - Nitrogen

d) Helium - Nitrogen

Correct Answer: a) Helium - Oxygen

Solution: Deep sea divers use a mixture of helium and oxygen because helium reduces the risk of nitrogen narcosis and oxygen toxicity at high pressures.

Quick Tip

Helium is less soluble in blood compared to nitrogen, reducing the risks for divers when breathing under high pressure.

---

30. The continuous random motion of colloidal particles is called:

a) Brownian movement

b) Zig zag movement

c) Continuous movement

d) Tyndall effect

Correct Answer: a) Brownian movement

Solution: Brownian movement refers to the random motion of particles in a colloidal solution due to constant collisions with molecules of the dispersing medium.

Quick Tip

Brownian motion is observed in colloidal solutions and explains the erratic movement of particles in the solution.

---

31. On increasing the temperature, the solubility of the solute in the solvent:

a) Increase

b) Decrease

c) Change

d) Does not change

Correct Answer: a) Increase

Solution: For most solid solutes in liquid solvents, increasing the temperature increases the solubility of the solute because it increases the kinetic energy of the molecules, allowing them to dissolve more easily.

Quick Tip

Temperature affects solubility; for most solids, higher temperatures increase solubility.

---

32. Which law relates solubility of solvents with pressure?

a) Hess' law

b) Henry's law

c) Charles' Law

d) Boyle's law

Correct Answer: b) Henry's law

Solution: Henry's law states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas above the liquid. Therefore, an increase in pressure increases the solubility of the gas in the liquid.

Quick Tip

Henry's law is fundamental in understanding how gases dissolve in liquids under pressure, such as in soda cans.

---

33. When sunlight passes through the window of your house, the dust particles scatter the light making the path of the light visible. This phenomenon is called as:

a) Brownian motion

b) Tyndall effect

c) Raman effect

d) Uniform motion

Correct Answer: b) Tyndall effect

Solution: The Tyndall effect is the scattering of light by particles in a colloid or in a very fine suspension. This effect makes the path of light visible when it passes through a medium containing fine particles.

Quick Tip

The Tyndall effect is responsible for the visible beams of light that can be seen when light passes through dusty air.

---

34. The Greek term 'atomos' means:

a) divisible

b) indivisible

c) macro molecule

d) soft sphere

Correct Answer: b) indivisible

Solution: The term 'atomos' comes from the Greek word meaning 'indivisible,' referring to the ancient belief that matter could not be divided further.

Quick Tip

The term ”atom” is derived from the Greek word ”atomos,” which means indivisible, reflecting the early theory that atoms were the fundamental building blocks of matter.

---

35. Isotopes are the atoms of the same element, with the same atomic number, but with different:

a) Atomic number

b) Mass number

c) Number of electrons

d) Chemical nature

Correct Answer: b) Mass number

Solution: Isotopes are variants of the same element that have the same number of protons (atomic number) but different numbers of neutrons, resulting in different mass numbers.

Quick Tip

Isotopes have the same chemical properties but different physical properties due to differences in mass.

---

36. C^{126} and C^{14} are:

a) Isotopes

b) Isobars

c) Isomers

d) Molecules

Correct Answer: a) Isotopes

Solution: C^{126} and C^{14} are isotopes of carbon, having the same number of protons (6) but different numbers of neutrons, which result in different mass numbers.

Quick Tip

Isotopes of an element have the same chemical properties but different physical properties due to their varying mass numbers.

---

37. Atoms of different elements possessing the same atomic mass are called:

a) Isotopes

b) Isobars

c) Isomers

d) Molecules

Correct Answer: c) Isomers

Solution: Atoms of different elements with the same atomic mass are called isomers. Isomers are compounds that have the same molecular formula but different arrangements of atoms.

Quick Tip

Isomers have the same number and types of atoms but differ in the way the atoms are arranged or bonded.

---

38. Atoms of different elements with the same number of neutrons are called:

a) Isotopes

b) Isomers

c) Isobars

d) Isotones

Correct Answer: d) Isotones

Solution: Atoms of different elements that have the same number of neutrons are called isotones. Isotones differ in their number of protons but have the same number of neutrons.

Quick Tip

Isotones have the same number of neutrons, which gives them similar nuclear properties, but different chemical properties.

---

39. Atomicity of oxygen in ozone molecule is:

a) 1

b) 2

c) 3

d) 4

Correct Answer: c) 3

Solution: Ozone (O_3) consists of three oxygen atoms, so its atomicity is 3.

Quick Tip

The atomicity of a molecule refers to the number of atoms of the element present in a molecule.

---

40. Atomicity of primary gases is:

a) 1

b) 2

c) 3

d) 4

Correct Answer: b) 2

Solution: Primary gases like oxygen (O_2) and nitrogen (N_2) are diatomic, meaning their atomicity is 2.

Quick Tip

Diatomic molecules, such as O_2 and N_2, have an atomicity of 2.

---

41. In the beginning of the 20th century, the matter wave concept was introduced by:

a) Broglie

b) Avogadro

c) Heisenberg

d) Einstein

Correct Answer: a) Broglie

Solution: The concept of matter waves was introduced by Louis de Broglie, who proposed that particles, like electrons, exhibit both particle-like and wave-like behavior.

> Quick Tip
>
> De Broglie's hypothesis led to the development of wave-particle duality, which was fundamental in the study of quantum mechanics.

---

42. The Principle of Uncertainty was introduced by:

a) Broglie

b) Avogadro

c) Heisenberg

d) Einstein

Correct Answer: c) Heisenberg

Solution: The Principle of Uncertainty was introduced by Werner Heisenberg. It states that it is impossible to simultaneously know the exact position and momentum of a particle.

> Quick Tip
>
> Heisenberg's Uncertainty Principle is fundamental in quantum mechanics, establishing the limit on the precision of simultaneous measurements of certain pairs of properties, like position and momentum.

43. Ar_{40}^{18} and Ca_{20}^{40} are considered as:

a) Isotopes

b) Isomers

c) Isobars

d) Isotones

Correct Answer: a) Isotopes

Solution: Ar_{40}^{18} and Ca_{20}^{40} are isotopes because they have the same mass number but different atomic numbers, which means they are atoms of different elements but with the same total number of nucleons.

> **Quick Tip**
>
> Isotopes of an element have the same number of protons (atomic number) but differ in the number of neutrons, leading to different mass numbers.

---

44. The compound which does not show a simple ratio of atoms is:

a) Benzene

b) Acetylene

c) Hydrogen

d) Sucrose

Correct Answer: d) Sucrose

Solution: Sucrose does not follow a simple atomic ratio due to its complex molecular structure. Unlike simple compounds such as acetylene or benzene, sucrose has a more intricate atomic arrangement.

> **Quick Tip**
>
> Sucrose is a disaccharide with a complex molecular structure and does not exhibit a simple ratio of atoms like elemental substances.

45. Avogadro's hypothesis relates volume of gases and:

a) mass

b) temperature

c) pressure

d) number of molecules

Correct Answer: d) number of molecules

Solution: Avogadro's hypothesis states that equal volumes of gases, at the same temperature and pressure, contain the same number of molecules.

> **Quick Tip**
>
> Avogadro's law links the volume of a gas with the number of molecules, provided the temperature and pressure are constant.

---

46. Atomicity of an element is:

a) Valency of an element

b) Atomic mass

c) Number of atoms in one molecule of an element

d) Isotope of an element

Correct Answer: c) Number of atoms in one molecule of an element

Solution: Atomicity refers to the number of atoms present in a molecule of an element. For example, oxygen (O_2) has an atomicity of 2, meaning it contains two oxygen atoms in one molecule.

> **Quick Tip**
>
> The atomicity of an element indicates how many atoms of that element are bonded together in a molecule.

47. Atomicity is given by:

a) Mass/molecular mass

b) Mass of the element

c) Molecular mass X atomic mass

d) Molecular mass / atomic mass

Correct Answer: d) Molecular mass / atomic mass

Solution: Atomicity is defined as the number of atoms of an element present in one molecule. It is calculated by dividing the molecular mass by the atomic mass of the element.

Quick Tip

Atomicity is calculated as the molecular mass of the substance divided by the atomic mass of the element.

---

48. The atoms of $^6C^{13}$ and $^7N^{14}$ are considered as:

a) Isotopes

b) Isomers

c) Isobars

d) Isotones

Correct Answer: d) Isotones

Solution: Isotones are atoms of different elements that have the same number of neutrons but different atomic numbers. $^6C^{13}$ and $^7N^{14}$ have the same number of neutrons (7), making them isotones.

Quick Tip

Isotones have the same number of neutrons but differ in their atomic number and mass number.

49. Isotones are the atoms of different elements having:

a) Same mass number

b) Same atomic number

c) Same number of neutrons

d) Same number of electrons

Correct Answer: c) Same number of neutrons

Solution: Isotones are atoms of different elements that have the same number of neutrons but different atomic numbers and mass numbers.

> **Quick Tip**
>
> Isotones are characterized by having the same number of neutrons, which differentiates them from isotopes and isobars.

---

50. Atomicity of Phosphorus is:

a) 2

b) 3

c) 4

d) 5

Correct Answer: c) 4

Solution: The atomicity of phosphorus is 4. Phosphorus exists as P_4 molecules in its most stable allotrope, indicating its atomicity is 4.

> **Quick Tip**
>
> The atomicity of an element indicates the number of atoms in one molecule of that element. For phosphorus, this is 4 in its most stable form.
