JEECUP Sample Paper

Physics (Group A) - Paper 1

Duration: 37 Minutes | **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions from the Physics section of the JEECUP Group A syllabus.
- Each correct answer carries **+4 marks**. There is **no negative marking** - attempt every question.
- Only **one** option is correct. Maximum marks: **100**. Total duration: **37 minutes** (Physics-only).
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Physics: 25 Questions

Q1. A body is thrown vertically upwards with an initial velocity of $20\,\mathrm{m\,s^{-1}}$. Taking $g = 10\,\mathrm{m\,s^{-2}}$, the maximum height reached is:

(A) $10\,\mathrm{m}$

(B) $20\,\mathrm{m}$

(C) $30\,\mathrm{m}$

(D) $40\,\mathrm{m}$

Q2. A force of $10\,\mathrm{N}$ acts on a body of mass $2\,\mathrm{kg}$ for $5\,\mathrm{s}$. The change in momentum produced is:

(A) $20\,\mathrm{kg\,m\,s^{-1}}$

(B) $50\,\mathrm{kg\,m\,s^{-1}}$

(C) $25\,\mathrm{kg\,m\,s^{-1}}$

(D) $10\,\mathrm{kg\,m\,s^{-1}}$

Q3. Two cars start from the same point and travel in perpendicular directions at $30\,\mathrm{km/h}$ and $40\,\mathrm{km/h}$. After 1 hour, the distance between them is:

(A) $50\,\mathrm{km}$

(B) $70\,\mathrm{km}$

(C) $10\,\mathrm{km}$

(D) $35\,\mathrm{km}$

Q4. A man of mass $60\,\mathrm{kg}$ stands in a lift accelerating downward at $2\,\mathrm{m\,s^{-2}}$. His apparent weight is ($g = 10\,\mathrm{m\,s^{-2}}$):

(A) $600\,\mathrm{N}$

(B) $720\,\mathrm{N}$

(C) $480\,\mathrm{N}$

(D) $120\,\mathrm{N}$

Q5. The work done in moving a $5\,\mathrm{kg}$ object up a smooth incline of length $4\,\mathrm{m}$ and height $2\,\mathrm{m}$ is ($g = 10\,\mathrm{m\,s^{-2}}$):

(A) $100\,\mathrm{J}$

(B) $200\,\mathrm{J}$

(C) $50\,\mathrm{J}$

(D) $400\,\mathrm{J}$

Q6. An object of mass $1\,\mathrm{kg}$ moving with velocity $4\,\mathrm{m\,s^{-1}}$ collides with a stationary object of mass $3\,\mathrm{kg}$ and they stick together. The common velocity after collision is:

(A) $1\,\mathrm{m\,s^{-1}}$

(B) $2\,\mathrm{m\,s^{-1}}$

(C) $3\,\mathrm{m\,s^{-1}}$

(D) $4\,\mathrm{m\,s^{-1}}$

Q7. The escape velocity from Earth's surface is approximately ($R = 6400\,\mathrm{km}$, $g = 9.8\,\mathrm{m\,s^{-2}}$):

(A) $7.9\,\mathrm{km\,s^{-1}}$

(B) $11.2\,\mathrm{km\,s^{-1}}$

(C) $5.6\,\mathrm{km\,s^{-1}}$

(D) $22.4\,\mathrm{km\,s^{-1}}$

Q8. A simple pendulum has a time period of $2\,\mathrm{s}$ on Earth. On a planet where g is one-fourth that of Earth, the new time period is:

(A) $1\,\mathrm{s}$

(B) $2\,\mathrm{s}$

(C) $4\,\mathrm{s}$

(D) $8\,\mathrm{s}$

Q9. The amount of heat required to raise the temperature of $200\,\mathrm{g}$ of water by $25°\mathrm{C}$ is (specific heat of water $= 4.2\,\mathrm{J\,g^{-1}\,K^{-1}}$):

(A) $21000\,\mathrm{J}$

(B) $4200\,\mathrm{J}$

(C) $2100\,\mathrm{J}$

(D) $1050\,\mathrm{J}$

Q10. The SI unit of thermal conductivity is:

(A) $\mathrm{W\,m^{-1}\,K^{-1}}$

(B) $\mathrm{J\,K^{-1}}$

(C) $\mathrm{W\,m^{-2}\,K^{-1}}$

(D) $\mathrm{J\,m\,K}$

Q11. An ideal gas at temperature $300\,\mathrm{K}$ has pressure P_0. If it is heated to $600\,\mathrm{K}$ at constant volume, the new pressure is:

(A) $P_0/2$

(B) P_0

(C) $2P_0$

(D) $4P_0$

Q12. A convex lens of focal length $20\,\mathrm{cm}$ forms an image of an object placed at $30\,\mathrm{cm}$ from the lens. The image distance is:

(A) $12\,\mathrm{cm}$

(B) $60\,\mathrm{cm}$

(C) $-60\,\mathrm{cm}$

(D) $50\,\mathrm{cm}$

Q13. The refractive index of glass with respect to air is 1.5. The speed of light in glass is (speed of light in vacuum $= 3 \times 10^8\,\mathrm{m\,s^{-1}}$):

(A) $2 \times 10^8\,\mathrm{m\,s^{-1}}$

(B) $4.5 \times 10^8\,\mathrm{m\,s^{-1}}$

(C) $1.5 \times 10^8\,\mathrm{m\,s^{-1}}$

(D) $3 \times 10^8\,\mathrm{m\,s^{-1}}$

Q14. A concave mirror has a focal length of $15\,\mathrm{cm}$. The radius of curvature is:

(A) $7.5\,\mathrm{cm}$

(B) $15\,\mathrm{cm}$

(C) $30\,\mathrm{cm}$

(D) $45\,\mathrm{cm}$

Q15. Light of wavelength $600\,\mathrm{nm}$ in air enters a medium of refractive index 1.5. Its wavelength in the medium is:

(A) $900\,\mathrm{nm}$

(B) $400\,\mathrm{nm}$

(C) $600\,\mathrm{nm}$

(D) $300\,\mathrm{nm}$

Q16. Two resistors of $4\,\Omega$ and $6\,\Omega$ are connected in parallel. Their equivalent resistance is:

(A) $10\,\Omega$

(B) $2.4\,\Omega$

(C) $24\,\Omega$

(D) $1.5\,\Omega$

Q17. A current of $2\,\text{A}$ flows through a wire of resistance $5\,\Omega$ for $10\,\text{s}$. The heat developed is:

(A) $100\,\text{J}$

(B) $200\,\text{J}$

(C) $50\,\text{J}$

(D) $400\,\text{J}$

Q18. The magnetic field at the centre of a circular coil of radius r carrying current I is given by:

(A) $\frac{\mu_0 I}{2\pi r}$

(B) $\frac{\mu_0 I}{2r}$

(C) $\frac{\mu_0 I}{4\pi r}$

(D) $\frac{\mu_0 I r}{2}$

Q19. A transformer steps up voltage from $220\,\text{V}$ to $11000\,\text{V}$. The turn ratio (secondary to primary) is:

(A) $5 : 1$

(B) $50 : 1$

(C) $1 : 50$

(D) $25 : 1$

Q20. The work function of a metal is $2.0\,\mathrm{eV}$. The threshold frequency is ($h = 6.6 \times 10^{-34}\,\mathrm{J\,s}$, $1\,\mathrm{eV} = 1.6 \times 10^{-19}\,\mathrm{J}$):

(A) $4.85 \times 10^{14}\,\mathrm{Hz}$

(B) $2.42 \times 10^{14}\,\mathrm{Hz}$

(C) $9.7 \times 10^{14}\,\mathrm{Hz}$

(D) $1.21 \times 10^{14}\,\mathrm{Hz}$

Q21. The half-life of a radioactive substance is $20\,\mathrm{minutes}$. The fraction of the original sample remaining after 1 hour is:

(A) $1/2$

(B) $1/4$

(C) $1/8$

(D) $1/16$

Q22. A wave has frequency $500\,\mathrm{Hz}$ and wavelength $0.6\,\mathrm{m}$. Its speed is:

(A) $300\,\mathrm{m\,s^{-1}}$

(B) $833\,\mathrm{m\,s^{-1}}$

(C) $250\,\mathrm{m\,s^{-1}}$

(D) $0.0012\,\mathrm{m\,s^{-1}}$

Q23. A capacitor of $4\,\mu\mathrm{F}$ is charged to $100\,\mathrm{V}$. The energy stored is:

(A) $0.02\,\mathrm{J}$

(B) $0.04\,\mathrm{J}$

(C) $0.2\,\mathrm{J}$

(D) $0.4\,\text{J}$

Q24. A diode acts primarily as a:

(A) Amplifier

(B) Oscillator

(C) Rectifier

(D) Transformer

Q25. The dimensional formula for impulse is:

(A) $[MLT^{-1}]$

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

(C) $[ML^2T^{-2}]$

(D) $[ML^{-1}T^{-2}]$

Solutions

Q1. Maximum height in vertical motion.

Solution

Concept. A body thrown straight up decelerates uniformly under gravity. At the highest point, the instantaneous velocity is zero. The third equation of motion in the vertical direction is $v^2 = u^2 - 2gh$.

Given. Initial velocity $u = 20\,\mathrm{m\,s^{-1}}$; final velocity at the top $v = 0$; $g = 10\,\mathrm{m\,s^{-2}}$.

Step 1. Write the equation of motion: $v^2 = u^2 - 2gh$.

Step 2. Substitute the known values: $0 = (20)^2 - 2(10)h$.

Step 3. Simplify: $0 = 400 - 20h$, so $20h = 400$.

Step 4. Solve for h: $h = 400/20 = 20\,\mathrm{m}$.

Sanity check. Using energy conservation: $\frac{1}{2}mu^2 = mgh$ gives $h = u^2/(2g) = 400/20 = 20\,\mathrm{m}$, matching the kinematic result.

Answer: (B)

← Go back to Q1

Q2. Change in momentum from a constant force.

Solution

Concept. Newton's second law in impulse form states that the change in linear momentum equals the impulse delivered: $\Delta p = F\,\Delta t$. The mass of the body does NOT appear in this expression once force and time are specified, because F already accounts for inertia.

Given. Force $F = 10\,\mathrm{N}$; time of action $\Delta t = 5\,\mathrm{s}$; mass $m = 2\,\mathrm{kg}$ (not required for Δp).

Step 1. Write the impulse-momentum theorem: $\Delta p = F\,\Delta t$.

Step 2. Substitute: $\Delta p = 10 \times 5$.

Step 3. Compute: $\Delta p = 50\,\mathrm{kg\,m\,s^{-1}}$.

Common trap. Many students multiply by the mass and report 100 or divide by it and report 25. Both errors come from confusing impulse (Ft) with acceleration (F/m). Memorise: *change in momentum equals impulse*.

Answer: (B)

← Go back to Q2

Q3. Separation of two cars moving along perpendicular directions.

Solution

Concept. Two motions along perpendicular axes are independent. The resultant displacement between the two cars at any instant is the vector sum, whose magnitude follows from the Pythagorean theorem: $d = \sqrt{d_1^2 + d_2^2}$.

Given. Speed of car A, $v_1 = 30\,\text{km/h}$; speed of car B (perpendicular direction), $v_2 = 40\,\text{km/h}$; elapsed time $t = 1\,\text{h}$.

Step 1. Distance covered by car A in 1 hour: $d_1 = v_1 t = 30 \times 1 = 30\,\text{km}$.

Step 2. Distance covered by car B in 1 hour: $d_2 = v_2 t = 40 \times 1 = 40\,\text{km}$.

Step 3. Apply Pythagoras: $d = \sqrt{d_1^2 + d_2^2} = \sqrt{30^2 + 40^2}$.

Step 4. Compute: $d = \sqrt{900 + 1600} = \sqrt{2500} = 50\,\text{km}$.

Answer: (A)

← Go back to Q3

Q4. Apparent weight in an accelerating lift.

Solution

Concept. The apparent weight read by a weighing scale equals the normal reaction N from the lift floor. When the lift accelerates downward at a, applying Newton's second law to the person gives $mg - N = ma$, so $N = m(g - a)$.

Given. Mass $m = 60\,\text{kg}$; lift acceleration $a = 2\,\text{m}\,\text{s}^{-2}$ (downward); $g = 10\,\text{m}\,\text{s}^{-2}$.

Step 1. Free-body diagram: gravity mg acts downward, normal N acts upward.

Step 2. Net downward force $= ma$ (downward acceleration). So $mg - N = ma$, i.e. $N = m(g - a)$.

Step 3. Substitute: $N = 60(10 - 2) = 60 \times 8$.

Step 4. Compute: $N = 480\,\text{N}$. This is the apparent weight - less than the actual $600\,\text{N}$ because the lift "falls away" under the person slightly.

Answer: (C)

← Go back to Q4

Q5. Work done against gravity on a smooth incline.

Solution

Concept. On a frictionless (smooth) incline, the only force doing work as the object is moved up is gravity. The work done against gravity depends only on the change in height, not on the path length. So $W = mgh$, regardless of the incline length.

Given. Mass $m = 5\,\text{kg}$; vertical rise $h = 2\,\text{m}$; incline length $L = 4\,\text{m}$ (irrelevant when smooth); $g = 10\,\text{m}\,\text{s}^{-2}$.

Step 1. Identify the relevant work: against gravity, $W_g = mgh$.

Step 2. Substitute: $W_g = 5 \times 10 \times 2$.

Step 3. Compute: $W_g = 100\,\mathrm{J}$.

Tip. If the incline had friction μ, you would add $\mu mg \cos\theta \cdot L$ to this. With smooth surface, the path length $4\,\mathrm{m}$ is a distractor.

Answer: (A)

← Go back to Q5

Q6. Perfectly inelastic collision.

Solution

Concept. When two bodies stick together, linear momentum is conserved (no external horizontal force), although kinetic energy is NOT conserved (some becomes heat / deformation energy). Conservation gives $m_1u_1 + m_2u_2 = (m_1 + m_2)v$.

Given. $m_1 = 1\,\mathrm{kg}$, $u_1 = 4\,\mathrm{m\,s^{-1}}$; $m_2 = 3\,\mathrm{kg}$, $u_2 = 0$ (stationary).

Step 1. Write conservation of momentum: $m_1u_1 + m_2u_2 = (m_1 + m_2)v$.

Step 2. Substitute: $(1)(4) + (3)(0) = (1 + 3)v$.

Step 3. Simplify: $4 = 4v$.

Step 4. Solve: $v = 1\,\mathrm{m\,s^{-1}}$.

Reality check. KE before $= 0.5 \times 1 \times 16 = 8\,\mathrm{J}$; KE after $= 0.5 \times 4 \times 1 = 2\,\mathrm{J}$. $6\,\mathrm{J}$ was lost to deformation - consistent with an inelastic collision.

Answer: (A)

← Go back to Q6

Q7. Escape velocity from Earth's surface.

Solution

Concept. A projectile escapes Earth's gravity when its kinetic energy equals (or exceeds) the magnitude of its gravitational potential energy at the surface: $\frac{1}{2}mv_e^2 = GMm/R$. Using $g = GM/R^2$, this simplifies to the familiar $v_e = \sqrt{2gR}$.

Given. $R = 6400\,\mathrm{km} = 6.4 \times 10^6\,\mathrm{m}$; $g = 9.8\,\mathrm{m\,s^{-2}}$.

Step 1. Write the formula: $v_e = \sqrt{2gR}$.

Step 2. Substitute: $v_e = \sqrt{2 \times 9.8 \times 6.4 \times 10^6}$.

Step 3. Compute inside the root: $2 \times 9.8 = 19.6$; $19.6 \times 6.4 = 125.44$; so $v_e = \sqrt{1.2544 \times 10^8}$.

Step 4. Take the square root: $v_e \approx 1.12 \times 10^4\,\mathrm{m\,s^{-1}} = 11.2\,\mathrm{km\,s^{-1}}$.

Answer: (B)

← Go back to Q7

Q8. Pendulum on a planet with reduced gravity.

Solution

Concept. For a simple pendulum, $T = 2\pi\sqrt{L/g}$. The length L of the pendulum stays the same when you carry it to another planet; only g changes. So $T \propto 1/\sqrt{g}$.

Given. Earth period $T_E = 2\,\mathrm{s}$; planet gravity $g_p = g_E/4$.

Step 1. Take the ratio of the two periods: $\frac{T_p}{T_E} = \sqrt{\frac{g_E}{g_p}}$.

Step 2. Substitute $g_p = g_E/4$: $\frac{T_p}{T_E} = \sqrt{\frac{g_E}{g_E/4}} = \sqrt{4} = 2$.

Step 3. Therefore $T_p = 2 \times T_E = 2 \times 2 = 4\,\mathrm{s}$.

Answer: (C)

← Go back to Q8

Q9. Heat required to warm water.

Solution

Concept. The heat absorbed by a substance to raise its temperature (without phase change) is given by $Q = mc\Delta T$, where c is the specific heat capacity. For water, $c = 4.2\,\mathrm{J\,g^{-1}\,K^{-1}}$.

Given. Mass $m = 200\,\mathrm{g}$; temperature rise $\Delta T = 25\,\mathrm{K}$ (or °C, since the size of a Kelvin equals the size of a Celsius degree); $c = 4.2\,\mathrm{J\,g^{-1}\,K^{-1}}$.

Step 1. Write the formula: $Q = mc\Delta T$.

Step 2. Substitute: $Q = 200 \times 4.2 \times 25$.

Step 3. Compute: $200 \times 4.2 = 840$; $840 \times 25 = 21000\,\mathrm{J}$.

Answer: (A)

← Go back to Q9

Q10. SI unit of thermal conductivity.

Solution

Concept. Fourier's law of heat conduction is $\frac{Q}{t} = kA\frac{\Delta T}{L}$. Solving for k gives $k = \frac{Q \cdot L}{t \cdot A \cdot \Delta T}$.

Step 1. The dimensions are: $\frac{[J][m]}{[s][m^2][K]} = \frac{J}{s \cdot m \cdot K}$.

Step 2. Recognising $J/s = W$, this is $W\,m^{-1}\,K^{-1}$.

Note. Don't confuse this with the unit of *convective* heat-transfer coefficient ($W\,m^{-2}\,K^{-1}$, where the area appears but not the length).

Answer: (A)

← Go back to Q10

Q11. Isochoric process for an ideal gas (Gay-Lussac's law).

Solution

Concept. For a fixed mass of ideal gas at constant volume, $\frac{P}{T} = \text{constant}$, where T is in kelvin. This is a direct consequence of $PV = nRT$ when V is held fixed.

Given. Initial state $T_1 = 300\,K$, $P_1 = P_0$. Final state $T_2 = 600\,K$ at constant V.

Step 1. Apply $\frac{P_1}{T_1} = \frac{P_2}{T_2}$: $\frac{P_0}{300} = \frac{P_2}{600}$.

Step 2. Solve for P_2: $P_2 = P_0 \times \frac{600}{300} = 2P_0$.

Answer: (C)

← Go back to Q11

Q12. Lens formula for a real object.

Solution

Concept. The Cartesian-sign-convention lens formula is $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, where distances measured against the incident-light direction are negative and those along it positive. For a convex lens, f is positive.

Given. Object distance $u = -30\,cm$ (object on the incoming side, sign negative); focal length $f = +20\,cm$ (convex lens, positive).

Step 1. Apply the lens formula: $\frac{1}{v} - \frac{1}{-30} = \frac{1}{20}$.

Step 2. Rearrange: $\frac{1}{v} = \frac{1}{20} - \frac{1}{30}$.

Step 3. Common denominator 60: $\frac{1}{v} = \frac{3-2}{60} = \frac{1}{60}$.

Step 4. Therefore $v = +60\,cm$. The positive sign means a real image, formed on the far side of the lens.

Answer: (B)

← Go back to Q12

Q13. Speed of light in a denser medium.

Solution

Concept. Refractive index n is defined as the ratio of the speed of light in vacuum (or air) to that in the medium: $n = c/v$. Higher n means light slows down more.

Given. $n_{\text{glass}} = 1.5$; $c = 3 \times 10^8\,\text{m}\,\text{s}^{-1}$.

Step 1. Rearrange: $v = c/n$.

Step 2. Substitute: $v = 3 \times 10^8/1.5$.

Step 3. Compute: $v = 2 \times 10^8\,\text{m}\,\text{s}^{-1}$.

Tip. Frequency is unchanged across a boundary; only λ and v shrink in a denser medium.

Answer: (A)

← Go back to Q13

Q14. Relation between focal length and radius of curvature of a spherical mirror.

Solution

Concept. For any spherical mirror (concave or convex), the focal point lies midway between the pole and the centre of curvature, so $f = R/2$, or equivalently $R = 2f$.

Given. $f = 15\,\text{cm}$.

Step 1. Apply $R = 2f$.

Step 2. Substitute: $R = 2 \times 15 = 30\,\text{cm}$.

Answer: (C)

← Go back to Q14

Q15. Wavelength of light in a denser medium.

Solution

Concept. When light passes from one medium to another, the frequency f stays constant (it is set by the source). But $v = f\lambda$, and v decreases by the factor n in a denser medium - so λ decreases by the same factor: $\lambda_{\text{medium}} = \lambda_{\text{air}}/n$.

Given. $\lambda_{\text{air}} = 600\,\text{nm}$; $n = 1.5$.

Step 1. Apply the formula: $\lambda_{\text{medium}} = 600/1.5$.

Step 2. Compute: $\lambda_{\text{medium}} = 400\,\text{nm}$.

Answer: (B)

← Go back to Q15

Q16. Equivalent resistance in parallel.

Solution

Concept. For resistors in parallel, the reciprocals add: $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2}$. The equivalent resistance is always SMALLER than the smallest individual resistor.

Given. $R_1 = 4\,\Omega$, $R_2 = 6\,\Omega$.

Step 1. Apply the parallel rule: $\frac{1}{R_{\text{eq}}} = \frac{1}{4} + \frac{1}{6}$.

Step 2. Use LCM 12: $\frac{1}{R_{\text{eq}}} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12}$.

Step 3. Invert: $R_{\text{eq}} = \frac{12}{5} = 2.4\,\Omega$.

Sanity check. The result is less than $4\,\Omega$ (the smaller of the two), as required.

Answer: (B)

← Go back to Q16

Q17. Joule heating in a resistor.

Solution

Concept. The energy dissipated as heat when current I flows through resistance R for time t is $H = I^2Rt$ (Joule's law of heating). Equivalent forms: $H = VIt = V^2t/R$.

Given. $I = 2\,\text{A}$; $R = 5\,\Omega$; $t = 10\,\text{s}$.

Step 1. Apply $H = I^2Rt$.

Step 2. Substitute: $H = (2)^2 \times 5 \times 10$.

Step 3. Compute: $H = 4 \times 5 \times 10 = 200\,\text{J}$.

Answer: (B)

← Go back to Q17

Q18. Magnetic field at the centre of a circular loop.

Solution

Concept. By the Biot-Savart law, each current element of the loop contributes the same magnitude of field at the centre, and they all point in the same direction (perpendicular to the loop plane). Integrating around a single loop gives $B = \frac{\mu_0 I}{2r}$.

Step 1. Compare with the four options - the correct formula is $\frac{\mu_0 I}{2r}$.

Caution. Don't confuse with the field of a long straight wire at distance r, which has an extra π: $B = \frac{\mu_0 I}{2\pi r}$.

Answer: (B)

← Go back to Q18

Q19. Turn ratio of an ideal step-up transformer.

Solution

Concept. For an ideal transformer, $\frac{V_s}{V_p} = \frac{N_s}{N_p}$, where the subscripts refer to the secondary and primary coils. A "step-up" transformer has more turns on the secondary side ($N_s > N_p$).

Given. $V_p = 220\,\text{V}$; $V_s = 11000\,\text{V}$.

Step 1. Apply: $\frac{N_s}{N_p} = \frac{V_s}{V_p}$.

Step 2. Substitute: $\frac{N_s}{N_p} = \frac{11000}{220}$.

Step 3. Compute: $\frac{N_s}{N_p} = 50$, i.e. $N_s : N_p = 50 : 1$.

Answer: (B)

← Go back to Q19

Q20. Threshold frequency from work function.

Solution

Concept. The threshold (or cut-off) frequency is the lowest frequency of light that can liberate electrons from the metal surface. At this frequency, all the photon energy goes into freeing the electron - none into kinetic energy: $\phi = h\nu_0$.

Given. Work function $\phi = 2.0\,\text{eV}$; $h = 6.6 \times 10^{-34}\,\text{J s}$; $1\,\text{eV} = 1.6 \times 10^{-19}\,\text{J}$.

Step 1. Convert ϕ to joules: $\phi = 2.0 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}\,\text{J}$.

Step 2. Apply $\nu_0 = \phi/h$.

Step 3. Substitute: $\nu_0 = 3.2 \times 10^{-19}/6.6 \times 10^{-34}$.

Step 4. Compute: $\nu_0 = 0.485 \times 10^{15} = 4.85 \times 10^{14}\,\text{Hz}$. This falls in the visible/near-UV range.

Answer: (A)

← Go back to Q20

Q21. Fraction remaining after multiple half-lives.

Solution

Concept. Radioactive decay follows $N(t) = N_0(1/2)^n$, where $n = t/T_{1/2}$ is the number of half-lives elapsed. Each half-life halves the population, independent of how many atoms remain.

Given. Half-life $T_{1/2} = 20\,\text{min}$; elapsed time $t = 60\,\text{min}$.

Step 1. Count half-lives: $n = 60/20 = 3$.

Step 2. Compute remaining fraction: $(1/2)^3 = 1/8$.

Sanity check. After 1 half-life ($20\,\text{min}$): $1/2$. After 2: $1/4$. After 3 ($60\,\text{min}$): $1/8$. Consistent.

Answer: (C)

← Go back to Q21

Q22. Wave speed from frequency and wavelength.

Solution

Concept. Every periodic wave satisfies $v = f\lambda$, where f is the frequency (Hz) and λ is the wavelength (metres). The product gives the phase velocity of the wave in metres per second.

Given. $f = 500\,\text{Hz}$; $\lambda = 0.6\,\text{m}$.

Step 1. Apply: $v = f\lambda$.

Step 2. Substitute: $v = 500 \times 0.6$.

Step 3. Compute: $v = 300\,\text{m}\,\text{s}^{-1}$. (This is close to the speed of sound in air at room temperature, suggesting the wave is likely a sound wave.)

Answer: (A)

← Go back to Q22

Q23. Energy stored in a charged capacitor.

Solution

Concept. A capacitor charged to voltage V across capacitance C stores electrostatic potential energy $U = \frac{1}{2}CV^2$. Equivalent forms: $U = \frac{1}{2}QV = \frac{Q^2}{2C}$.

Given. $C = 4\,\mu\text{F} = 4 \times 10^{-6}\,\text{F}$; $V = 100\,\text{V}$.

Step 1. Apply: $U = \frac{1}{2}CV^2$.

Step 2. Substitute: $U = 0.5 \times 4 \times 10^{-6} \times (100)^2$.

Step 3. Compute step by step: $(100)^2 = 10^4$; $0.5 \times 4 \times 10^{-6} = 2 \times 10^{-6}$; $2 \times 10^{-6} \times 10^4 = 2 \times 10^{-2}$.

Step 4. Therefore $U = 0.02\,\text{J}$.

Answer: (A)

← Go back to Q23

Q24. Primary role of a diode.

Solution

Concept. A semiconductor p-n junction diode conducts current freely in one direction (forward bias) and blocks it almost completely in the other (reverse bias). This unidirectional conduction is exactly what converts alternating current (AC) into pulsating direct current (DC) - the process of *rectification*.

Step 1. Of the listed roles, an amplifier needs a transistor, an oscillator needs a tank circuit + active element, a transformer needs coupled coils. None of these is the diode's primary function.

Step 2. The diode's primary application is as a *rectifier* (half-wave, full-wave, or bridge configurations).

Answer: (C)

← Go back to Q24

Q25. Dimensional formula of impulse.

Solution

Concept. Impulse $= F \cdot \Delta t$ = change in momentum $= m \cdot v$. So the dimensions of impulse match those of linear momentum.

Step 1. Mass has dimension $[M]$; velocity has dimension $[LT^{-1}]$.

Step 2. Therefore impulse has dimension $[M] \cdot [LT^{-1}] = [MLT^{-1}]$.

Cross-check via force. $F = [MLT^{-2}]$; multiply by time $[T]$ gives $[MLT^{-1}]$. Consistent.

Answer: (A)

← Go back to Q25

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	A	4	C	5	A
6	A	7	B	8	C	9	A	10	A
11	C	12	B	13	A	14	C	15	B
16	B	17	B	18	B	19	B	20	A
21	C	22	A	23	A	24	C	25	A