JEECUP Sample Paper

Physics (Group A) - Paper 5

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 stone thrown horizontally from a cliff falls $80\,\mathrm{m}$ in time t. With $g = 10\,\mathrm{m\,s^{-2}}$, t is:

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

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

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

(D) $16\,\mathrm{s}$

Q2. A car of mass $1000\,\mathrm{kg}$ accelerates from 0 to $20\,\mathrm{m\,s^{-1}}$ in $5\,\mathrm{s}$. The average power developed is:

(A) $20\,\mathrm{kW}$

(B) $40\,\mathrm{kW}$

(C) $100\,\mathrm{kW}$

(D) $200\,\mathrm{kW}$

Q3. A projectile is launched at 45° with speed $20\,\mathrm{m\,s^{-1}}$. The range on a level ground ($g = 10\,\mathrm{m\,s^{-2}}$) is:

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

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

(C) $80\,\mathrm{m}$

(D) $200\,\mathrm{m}$

Q4. Action and reaction forces:

(A) Act on the same body

(B) Are unequal

(C) Act on different bodies and therefore never cancel each other on a single object

(D) Always cancel

Q5. A body slides down a smooth incline of height $5\,\mathrm{m}$. Its speed at the bottom (starting from rest, $g = 10\,\mathrm{m\,s^{-2}}$) is:

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

(B) $5\,\mathrm{m\,s^{-1}}$

(C) $7.07\,\mathrm{m\,s^{-1}}$

(D) $14.14\,\mathrm{m\,s^{-1}}$

Q6. A bullet of mass $20\,\mathrm{g}$ moving at $400\,\mathrm{m/s}$ embeds in a block of mass $4\,\mathrm{kg}$ at rest. The common velocity after embedding is approximately:

(A) $0.5\,\mathrm{m\,s^{-1}}$

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

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

(D) $5\,\mathrm{m\,s^{-1}}$

Q7. A geostationary satellite orbits Earth with a period of:

(A) 1 hour

(B) 24 hours

(C) 1 week

(D) 1 month

Q8. For a fluid at rest, the pressure at a point depends only on:

(A) Depth below the free surface

(B) Container shape

(C) Container volume

(D) Wall material

Q9. A bar with thermal conductivity $200\,\mathrm{W\,m^{-1}\,K^{-1}}$, length $1\,\mathrm{m}$, area $10^{-3}\,\mathrm{m^2}$ has temperature difference $50\,\mathrm{K}$ across its ends. Steady-state heat flow rate is:

(A) $5\,\mathrm{W}$

(B) $10\,\mathrm{W}$

(C) $20\,\mathrm{W}$

(D) $200\,\mathrm{W}$

Q10. The temperature on the Kelvin scale corresponding to $-23°C$ is:

(A) $0\,K$

(B) $250\,K$

(C) $300\,K$

(D) $-23\,K$

Q11. Avogadro's number is approximately:

(A) 6.022×10^{23}

(B) 6.022×10^{22}

(C) 9.1×10^{-31}

(D) 1.6×10^{-19}

Q12. A real image of an object can be formed by:

(A) Convex mirror

(B) Concave lens

(C) Concave mirror (with object beyond F)

(D) Plane mirror

Q13. A ray passes from glass ($n = 1.5$) into air. The angle of incidence in glass at which total internal reflection just occurs is:

(A) $\sin^{-1}(1/1.5) \approx 41.8°$

(B) $30°$

(C) $45°$

(D) 60°

Q14. A simple microscope (magnifier) using a convex lens of focal length $5\,\text{cm}$ produces an approximate magnification (image at near point, $D = 25\,\text{cm}$):

(A) 5

(B) 6

(C) 25

(D) 30

Q15. A rainbow forms due to:

(A) Diffraction by water droplets

(B) Refraction + internal reflection + dispersion inside water droplets

(C) Polarisation

(D) Scattering only

Q16. Three resistors of $2\,\Omega$, $4\,\Omega$, and $6\,\Omega$ are in series. The equivalent resistance is:

(A) $1\,\Omega$

(B) $4\,\Omega$

(C) $12\,\Omega$

(D) $48\,\Omega$

Q17. A heater connected to $220\,\text{V}$ has resistance $44\,\Omega$. The power dissipated is:

(A) $5\,\mathrm{W}$

(B) $50\,\mathrm{W}$

(C) $1100\,\mathrm{W}$

(D) $4840\,\mathrm{W}$

Q18. The earth's magnetic field at a place has horizontal component $0.3\,\mathrm{G}$ and vertical component $0.4\,\mathrm{G}$. The resultant field intensity is:

(A) $0.1\,\mathrm{G}$

(B) $0.5\,\mathrm{G}$

(C) $0.7\,\mathrm{G}$

(D) $1.0\,\mathrm{G}$

Q19. The self-inductance of a coil is the property due to which:

(A) Resistance increases with current

(B) An EMF is induced when the current through the coil changes

(C) Capacitance increases

(D) Energy is dissipated as heat

Q20. A photon of wavelength λ has momentum:

(A) hc/λ

(B) h/λ

(C) $h\lambda$

(D) $hc\lambda$

Q21. If the mass defect for a nucleus is Δm, the binding energy is:

(A) $\Delta m \cdot c$

(B) $\Delta m \cdot c^2$

(C) $\Delta m / c^2$

(D) $c^2 / \Delta m$

Q22. The angular frequency ω of a wave is related to time period T by:

(A) $\omega = 1/T$

(B) $\omega = 2\pi T$

(C) $\omega = 2\pi / T$

(D) $\omega = T^2$

Q23. The dielectric constant of vacuum is:

(A) 0

(B) 1

(C) > 1

(D) ∞

Q24. A truth table with two inputs has how many possible input combinations:

(A) 2

(B) 4

(C) 8

(D) 16

Q25. The dimensions of frequency are:

(A) $[T]$

(B) $[T^{-1}]$

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

(D) $[LT^{-1}]$

Solutions

Q1. Horizontal projectile vertical drop.

Solution

Concept. In projectile motion, the horizontal and vertical motions are INDEPENDENT. The vertical motion is just free-fall from rest, so $h = \frac{1}{2}gt^2$. The horizontal speed of the stone has no bearing on its falling time.

Given. $h = 80\,\text{m}$; $g = 10\,\text{m}\,\text{s}^{-2}$; initial vertical velocity $= 0$.

Step 1. Apply $h = \frac{1}{2}gt^2$: $80 = \frac{1}{2} \times 10 \times t^2$.

Step 2. Simplify: $80 = 5t^2$, so $t^2 = 16$.

Step 3. Take square root: $t = 4\,\text{s}$.

Answer: (B)

← Go back to Q1

Q2. Average power developed during acceleration.

Solution

Concept. Average power equals the work done divided by the time taken. The work done equals the change in kinetic energy: $W = \Delta K = \frac{1}{2}mv^2 - 0 = \frac{1}{2}mv^2$.

Given. $m = 1000\,\text{kg}$; $v = 20\,\text{m}\,\text{s}^{-1}$; $t = 5\,\text{s}$; starting from rest.

Step 1. Compute ΔK: $\Delta K = 0.5 \times 1000 \times (20)^2 = 0.5 \times 1000 \times 400 = 200000\,\text{J}$.

Step 2. Compute average power: $P_{\text{avg}} = \Delta K/t = 200000/5 = 40000\,\text{W} = 40\,\text{kW}$.

Answer: (B)

← Go back to Q2

Q3. Range of a projectile at $45°$.

Solution

Concept. For a projectile launched at angle θ with initial speed u, on level ground, $R = \dfrac{u^2 \sin 2\theta}{g}$. The maximum range occurs at $\theta = 45°$, where $\sin 2\theta = \sin 90° = 1$, giving $R = u^2/g$.

Given. $u = 20\,\text{m}\,\text{s}^{-1}$; $\theta = 45°$; $g = 10\,\text{m}\,\text{s}^{-2}$.

Step 1. Apply $R = u^2/g$ (since $\sin 90° = 1$).

Step 2. Substitute: $R = (20)^2/10 = 400/10 = 40\,\text{m}$.

Answer: (B)

← Go back to Q3

Q4. Newton's third law - action and reaction.

Solution

Concept. Newton's third law: for every action there is an equal and opposite reaction. The crucial detail: the action and the reaction act on DIFFERENT bodies. They are equal in magnitude and opposite in direction, but because they act on different objects, they do NOT cancel each other when you analyse the motion of a single body.

Step 1. The pair $\{F_{AB}, F_{BA}\}$ acts on bodies A and B respectively - never on a single body.

Step 2. Their magnitudes ARE equal (so "unequal" is wrong) - but only on a single body do internal forces cancel. The third-law pair never resides on a single body.

Step 3. Option C captures this correctly: "act on different bodies and therefore never cancel each other on a single object".

Answer: (C)

← Go back to Q4

Q5. Speed at the bottom of a smooth incline.

Solution

Concept. On a frictionless surface, mechanical energy is conserved: all the lost gravitational PE becomes KE. $mgh = \frac{1}{2}mv^2$ gives $v = \sqrt{2gh}$. Note that mass cancels - it does not appear in the final answer.

Given. $h = 5\,\mathrm{m}$; $g = 10\,\mathrm{m\,s^{-2}}$; starts from rest.

Step 1. Apply $v = \sqrt{2gh}$.

Step 2. Substitute: $v = \sqrt{2 \times 10 \times 5} = \sqrt{100}$.

Step 3. Compute: $v = 10\,\mathrm{m\,s^{-1}}$.

Answer: (A)

← Go back to Q5

Q6. Bullet embedding in a stationary block (perfectly inelastic).

Solution

Concept. The bullet and block stick together - this is perfectly inelastic. Linear momentum is conserved (no external horizontal force during the brief collision): $m_1u_1 + m_2u_2 = (m_1 + m_2)v$.

Given. Bullet: $m_1 = 20\,\text{g} = 0.020\,\text{kg}$, $u_1 = 400\,\text{m/s}$. Block: $m_2 = 4\,\text{kg}$, $u_2 = 0$.

Step 1. Apply momentum conservation: $(0.020)(400) + (4)(0) = (0.020 + 4)v$.

Step 2. Compute LHS: $0.020 \times 400 = 8\,\text{kg}\,\text{m}\,\text{s}^{-1}$.

Step 3. Compute total mass: $0.020 + 4 = 4.020\,\text{kg}$.

Step 4. Solve: $v = 8/4.020 \approx 1.99 \approx 2\,\text{m}\,\text{s}^{-1}$.

Answer: (C)

← Go back to Q6

Q7. Geostationary satellite period.

Solution

Concept. A geostationary satellite appears stationary above a fixed point on Earth's equator. For that to happen, its orbital period must equal Earth's rotational period - 24 hours (more precisely, one sidereal day $\approx 23\,\text{h}\,56\,\text{min}$). The orbital radius works out to about $42000\,\text{km}$ from Earth's centre.

Step 1. Of the listed options, only $24\,\text{hours}$ matches.

Answer: (B)

← Go back to Q7

Q8. Hydrostatic pressure - dependence.

Solution

Concept. For a static incompressible fluid open to the atmosphere, the pressure at any point depends on the depth h below the free surface, the fluid density ρ, and gravity g - via $P = P_{\text{atm}} + \rho g h$. The container shape does NOT matter (hydrostatic paradox - a thin tube or wide bucket of the same depth gives the same pressure at the bottom).

Step 1. Of the listed options, only depth is the correct dependence.

Answer: (A)

← Go back to Q8

Q9. Steady-state heat conduction.

Solution

Concept. Fourier's law in one dimension: $\dfrac{dQ}{dt} = \dfrac{kA\Delta T}{L}$, where k is thermal conductivity, A is cross-sectional area, ΔT is the temperature difference across the bar, and L is the length.

Given. $k = 200\,\mathrm{W\,m^{-1}\,K^{-1}}$; $L = 1\,\mathrm{m}$; $A = 10^{-3}\,\mathrm{m^2}$; $\Delta T = 50\,\mathrm{K}$.

Step 1. Substitute: $dQ/dt = 200 \times 10^{-3} \times 50/1$.

Step 2. Compute: $200 \times 10^{-3} = 0.2$; $0.2 \times 50 = 10$; divided by $1 = 10\,\mathrm{W}$.

Answer: (B)

← Go back to Q9

Q10. Celsius-to-Kelvin conversion.

Solution

Concept. The Kelvin and Celsius scales have the same size of degree; their zero points differ by 273.15 (rounded 273): $T(\mathrm{K}) = T(^\circ\mathrm{C}) + 273$. Kelvin cannot be negative since $0\,\mathrm{K}$ is absolute zero.

Given. $T(^\circ\mathrm{C}) = -23$.

Step 1. Apply: $T(\mathrm{K}) = -23 + 273$.

Step 2. Compute: $T = 250\,\mathrm{K}$.

Answer: (B)

← Go back to Q10

Q11. Avogadro's number.

Solution

Concept. Avogadro's number N_A is the number of constituent particles (atoms, molecules, ions, ...) in exactly one mole of a substance. The SI 2019 redefinition fixes it exactly at $N_A = 6.02214076 \times 10^{23}$.

Step 1. Round to two significant figures: 6.022×10^{23} is the canonical textbook value.

Step 2. The other options are different physical constants (6.022×10^{22} is one-tenth of N_A; $9.1 \times 10^{-31}\,\mathrm{kg}$ is the electron mass; $1.6 \times 10^{-19}\,\mathrm{C}$ is the elementary charge).

Answer: (A)

← Go back to Q11

Q12. Which optical element forms a real image?

Solution

Concept. A REAL image is one where light actually converges, so it can be captured on a screen. (a) Convex mirrors and concave lenses are DIVERGING - they always form virtual images. (b) Plane mirrors form virtual images at the same distance behind. (c) Concave mirrors and convex lenses can form real images, but only when the object is beyond the focal point.

Step 1. Of the options, only "Concave mirror with object beyond F" gives a real image.

Answer: (C)

← Go back to Q12

Q13. Critical angle for glass-to-air.

Solution

Concept. When light goes from a denser medium (glass, $n = 1.5$) to a less-dense one (air, $n = 1$), it bends AWAY from the normal. At a particular incidence angle - the critical angle - the refracted ray grazes the boundary. Snell's law: $n_{\text{glass}} \sin\theta_c = 1 \cdot \sin 90^\circ = 1$, so $\sin\theta_c = 1/n_{\text{glass}}$.

Given. $n_{\text{glass}} = 1.5$.

Step 1. Compute $\sin\theta_c = 1/1.5 \approx 0.667$.

Step 2. Take inverse sine: $\theta_c = \sin^{-1}(0.667) \approx 41.8^\circ$.

Note. For angles of incidence GREATER than θ_c, total internal reflection happens - useful in fibre optics and prism binoculars.

Answer: (A)

← Go back to Q13

Q14. Magnification of a simple microscope (magnifier).

Solution

Concept. For a simple magnifier with image at the near point (most-magnified setting), the angular magnification is $m = 1 + D/f$, where $D = 25\,\text{cm}$ is the near-point distance and f is the focal length of the convex lens (in cm, same units as D).

Given. $f = 5\,\text{cm}$; $D = 25\,\text{cm}$.

Step 1. Substitute: $m = 1 + 25/5$.

Step 2. Compute: $m = 1 + 5 = 6$. (If the image is at infinity instead, $m = D/f = 5$ - slightly less, but easier on the eye.)

Answer: (B)

← Go back to Q14

Q15. How a rainbow forms.

Solution

Concept. Sunlight entering a spherical water droplet undergoes (1) refraction on entry, (2) internal reflection off the back surface, and (3) refraction again on exit. Because refractive index varies with wavelength (dispersion), the different colours emerge at slightly different angles, fanning out into the familiar arc of colours. The primary bow forms at around 42° from the antisolar point.

Step 1. So the rainbow involves refraction + internal reflection + dispersion - all three.

Step 2. Diffraction and scattering produce other atmospheric phenomena (coronae, blue sky) but not the rainbow's arc.

Answer: (B)

← Go back to Q15

Q16. Series resistance.

Solution

Concept. Resistors in series simply add: $R_{\text{eq}} = R_1 + R_2 + R_3 + \dots$.

Given. $R_1 = 2\,\Omega$, $R_2 = 4\,\Omega$, $R_3 = 6\,\Omega$.

Step 1. Add: $R_{\text{eq}} = 2 + 4 + 6 = 12\,\Omega$.

Answer: (C)

← Go back to Q16

Q17. Power dissipated from voltage and resistance.

Solution

Concept. For a resistive load, $P = VI = V^2/R = I^2R$. With V and R given, use $P = V^2/R$.

Given. $V = 220\,\text{V}$; $R = 44\,\Omega$.

Step 1. Compute V^2: $(220)^2 = 48400$.

Step 2. Divide by R: $P = 48400/44 = 1100\,\text{W}$.

Reality check. This is a typical kitchen heater wattage - the numbers make sense.

Answer: (C)

← Go back to Q17

Q18. Resultant of perpendicular field components.

Solution

Concept. The Earth's magnetic field at a point can be decomposed into horizontal (B_H) and vertical (B_V) components, which are mutually perpendicular. The total field magnitude is $B = \sqrt{B_H^2 + B_V^2}$.

Given. $B_H = 0.3\,\text{G}$; $B_V = 0.4\,\text{G}$.

Step 1. Apply: $B = \sqrt{(0.3)^2 + (0.4)^2}$.

Step 2. Compute: $B = \sqrt{0.09 + 0.16} = \sqrt{0.25} = 0.5\,\text{G}$. (Again the 3-4-5 triangle.)

Answer: (B)

← Go back to Q18

Q19. Definition of self-inductance.

Solution

Concept. Self-inductance L is the property of a coil whereby a CHANGE in the current through it produces an induced EMF opposing the change: $\varepsilon = -L\,dI/dt$. The unit is the henry (H). For a constant current, no EMF is induced - the effect is purely about *change*.

Step 1. Of the listed options, only "an EMF is induced when the current through the coil changes" captures this.

Answer: (B)

← Go back to Q19

Q20. Photon momentum.

Solution

Concept. Photons are massless particles carrying momentum $p = h/\lambda$ (equivalently $E = pc$ for a photon, where $E = h\nu = hc/\lambda$). This is the basis of radiation pressure and the de Broglie wavelength relation.

Step 1. Of the listed options, h/λ matches.

Answer: (B)

← Go back to Q20

Q21. Binding energy from mass defect.

Solution

Concept. Inside a nucleus, the bound nucleons have less total mass than the same nucleons would have free - the missing mass Δm has gone into the energy that binds them. By Einstein's mass-energy equivalence: $E = \Delta m \cdot c^2$.

Step 1. Pick the option matching $\Delta m \cdot c^2$.

Numerical note. For typical nuclei, Δm is a fraction of a percent of the total mass, but c^2 is so huge that the resulting binding energies are millions of electron-volts (MeV) per nucleon.

Answer: (B)

← Go back to Q21

Q22. Angular frequency and period.

Solution

Concept. Angular frequency $\omega = 2\pi f = 2\pi/T$, where f is ordinary frequency and T is the period. Angular frequency counts radians per second, where one full cycle is 2π radians.

Step 1. Compare with options: $\omega = 2\pi/T$ is option C.

Answer: (C)

← Go back to Q22

Q23. Dielectric constant of vacuum.

Solution

Concept. Dielectric constant (relative permittivity) $\kappa = \varepsilon/\varepsilon_0$, where ε_0 is the permittivity of free space (vacuum). For vacuum itself: $\varepsilon = \varepsilon_0$, so $\kappa = 1$.

Step 1. All other media have $\kappa > 1$. Vacuum is the baseline reference.

Answer: (B)

← Go back to Q23

Q24. Size of a 2-input truth table.

Solution

Concept. For n binary inputs, the number of distinct input combinations is 2^n (each input independently is 0 or 1).

Step 1. For $n = 2$: $2^2 = 4$ rows. (The four rows are 00, 01, 10, 11.)

Answer: (B)

← Go back to Q24

Q25. Dimensions of frequency.

Solution

Concept. Frequency is $1/T$ (cycles per second). Its dimension is the reciprocal of time: $[T^{-1}]$.

Step 1. Cross-check: SI unit of frequency is the hertz (Hz), which equals s^{-1}. Matches $[T^{-1}]$.

Answer: (B)

← Go back to Q25

Answer Key

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