JEECUP Sample Paper

Physics (Group A) - Paper 2

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 particle moves with uniform acceleration. Its initial velocity is $5\,\mathrm{m\,s^{-1}}$ and after $4\,\mathrm{s}$ its velocity becomes $13\,\mathrm{m\,s^{-1}}$. The acceleration is:

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

(B) $3\,\mathrm{m\,s^{-2}}$

(C) $4\,\mathrm{m\,s^{-2}}$

(D) $8\,\mathrm{m\,s^{-2}}$

Q2. A ball is dropped from a height of $80\,\mathrm{m}$. Time to reach the ground ($g = 10\,\mathrm{m\,s^{-2}}$) is:

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

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

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

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

Q3. The magnitude of the resultant of two forces $3\,\mathrm{N}$ and $4\,\mathrm{N}$ acting at right angles is:

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

(B) $5\,\mathrm{N}$

(C) $7\,\mathrm{N}$

(D) $12\,\mathrm{N}$

Q4. A body of mass $4\,\mathrm{kg}$ moving at $5\,\mathrm{m\,s^{-1}}$ has kinetic energy:

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

(B) $25\,\mathrm{J}$

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

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

Q5. A pump lifts $200\,\mathrm{kg}$ of water through $10\,\mathrm{m}$ in $40\,\mathrm{s}$. The power output is ($g = 10\,\mathrm{m\,s^{-2}}$):

(A) $500\,\mathrm{W}$

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

(C) $1000\,\mathrm{W}$

(D) $2000\,\mathrm{W}$

Q6. The coefficient of friction between a body and a horizontal surface is 0.2. If the body weighs $10\,\mathrm{N}$, the limiting frictional force is:

(A) 1 N

(B) 2 N

(C) 5 N

(D) 10 N

Q7. The gravitational potential energy of a body of mass m at height h above Earth's surface (small h) is:

(A) $-mgh$

(B) mgh

(C) $\frac{1}{2}mgh^2$

(D) mh/g

Q8. A body executes SHM with amplitude $5\,\mathrm{cm}$ and period $2\,\mathrm{s}$. Its maximum velocity is:

(A) 5π cm/s

(B) 10π cm/s

(C) 20π cm/s

(D) π cm/s

Q9. If 1 calorie = 4.18 J, then 200 cal in joules is approximately:

(A) 836 J

(B) 418 J

(C) 200 J

(D) 1000 J

Q10. For two rods A and B of equal length and cross-section, connected in series, with thermal conductivities k and $2k$, the effective thermal conductivity of the combination is:

(A) k

(B) $1.5k$

(C) $\frac{4k}{3}$

(D) $3k$

Q11. For an ideal gas undergoing isothermal expansion, the change in internal energy is:

(A) Positive

(B) Negative

(C) Zero

(D) Depends on volume

Q12. An object is placed at the focus of a convex lens. The image formed is:

(A) Real, inverted, same size

(B) Virtual, erect, at infinity

(C) Real, inverted, larger

(D) Real, formed at infinity

Q13. A ray of light strikes a plane mirror at an angle of 40° with the mirror. The angle of reflection (measured from the normal) is:

(A) 40°

(B) 50°

(C) 80°

(D) 90°

Q14. The critical angle for a medium of refractive index $\sqrt{2}$ relative to air is:

(A) 30°

(B) 45°

(C) 60°

(D) 90°

Q15. The power of a lens of focal length $50\,\text{cm}$ is:

(A) $0.02\,\text{D}$

(B) $0.5\,\text{D}$

(C) $2\,\text{D}$

(D) $50\,\text{D}$

Q16. Three resistors of $6\,\Omega$ each are connected in series across a $9\,\text{V}$ battery. The current through each is:

(A) $0.5\,\text{A}$

(B) $1\,\text{A}$

(C) $1.5\,\text{A}$

(D) $2\,\text{A}$

Q17. The drift velocity of free electrons in a metal under an electric field is typically of the order:

(A) $10^{-4}\,\mathrm{m\,s^{-1}}$

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

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

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

Q18. A current-carrying conductor of length $0.5\,\mathrm{m}$ in a magnetic field of $0.4\,\mathrm{T}$ experiences a force of $0.2\,\mathrm{N}$ when perpendicular to the field. The current is:

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

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

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

(D) $4\,\mathrm{A}$

Q19. Lenz's law is a consequence of:

(A) Conservation of charge

(B) Conservation of energy

(C) Conservation of momentum

(D) Conservation of mass

Q20. The energy of a photon of wavelength $6600\,\text{Å}$ is approximately ($h = 6.6 \times 10^{-34}\,\mathrm{J\,s}$, $c = 3 \times 10^{8}\,\mathrm{m\,s^{-1}}$):

(A) $1.88\,\mathrm{eV}$

(B) $3.0\,\mathrm{eV}$

(C) $0.5\,\mathrm{eV}$

(D) $4.5\,\mathrm{eV}$

Q21. Atomic number Z identifies the number of:

(A) Neutrons

(B) Protons

(C) Nucleons

(D) Electrons in any state

Q22. A stationary wave is formed by two waves moving in opposite directions. The distance between two consecutive nodes is:

(A) $\lambda/4$

(B) $\lambda/2$

(C) λ

(D) 2λ

Q23. The capacitance of a parallel-plate capacitor depends on:

(A) Voltage applied

(B) Charge stored

(C) Plate area and separation

(D) Current through it

Q24. A logic gate with output HIGH only when both inputs are HIGH is:

(A) OR gate

(B) AND gate

(C) NOT gate

(D) NOR gate

Q25. The dimensions of pressure are:

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

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

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

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

Solutions

Q1. Acceleration from change in velocity.

Solution

Concept. Under uniform acceleration, the first kinematic equation $v = u + at$ tells us how velocity evolves linearly in time. Rearranging gives $a = (v - u)/t$.

Given. Initial velocity $u = 5\,\mathrm{m\,s^{-1}}$; final velocity $v = 13\,\mathrm{m\,s^{-1}}$; time interval $t = 4\,\mathrm{s}$.

Step 1. Apply $a = (v - u)/t$.

Step 2. Substitute: $a = (13 - 5)/4$.

Step 3. Compute: $a = 8/4 = 2\,\mathrm{m\,s^{-2}}$.

Answer: (A)

← Go back to Q1

Q2. Free fall from rest.

Solution

Concept. An object dropped (released with $u = 0$) under gravity falls a distance $h = \frac{1}{2}gt^2$ in time t. This is the second equation of motion applied to vertical fall.

Given. Drop height $h = 80\,\mathrm{m}$; initial velocity $u = 0$; $g = 10\,\mathrm{m\,s^{-2}}$.

Step 1. Apply $h = \frac{1}{2}gt^2$.

Step 2. Substitute: $80 = 0.5 \times 10 \times t^2 = 5t^2$.

Step 3. Solve: $t^2 = 80/5 = 16$, so $t = 4\,\mathrm{s}$.

Answer: (B)

← Go back to Q2

Q3. Resultant of two perpendicular forces.

Solution

Concept. When two forces act at right angles, their resultant is the diagonal of the rectangle they span. By the parallelogram law (which reduces to Pythagoras for 90°), $|\vec{R}| = \sqrt{F_1^2 + F_2^2}$.

Given. $F_1 = 3\,\mathrm{N}$; $F_2 = 4\,\mathrm{N}$; angle between them $= 90^\circ$.

Step 1. Apply $R = \sqrt{F_1^2 + F_2^2}$.

Step 2. Substitute: $R = \sqrt{9 + 16}$.

Step 3. Compute: $R = \sqrt{25} = 5\,\mathrm{N}$. (The classic 3-4-5 right triangle.)

Answer: (B)

← Go back to Q3

Q4. Kinetic energy of a moving body.

Solution

Concept. The translational kinetic energy of a body is $K = \frac{1}{2}mv^2$. Note the v^2 dependence - doubling the speed quadruples the KE.

Given. Mass $m = 4\,\text{kg}$; speed $v = 5\,\text{m}\,\text{s}^{-1}$.

Step 1. Apply $K = \frac{1}{2}mv^2$.

Step 2. Substitute: $K = 0.5 \times 4 \times (5)^2$.

Step 3. Compute the square first: $(5)^2 = 25$. Then $0.5 \times 4 = 2$. So $K = 2 \times 25 = 50\,\text{J}$.

Answer: (C)

← Go back to Q4

Q5. Power output of a water pump.

Solution

Concept. Power is the rate at which work is done. The pump does work against gravity to lift the water; this work equals mgh. The average power is therefore $P = mgh/t$.

Given. Mass lifted $m = 200\,\text{kg}$; height $h = 10\,\text{m}$; time $t = 40\,\text{s}$; $g = 10\,\text{m}\,\text{s}^{-2}$.

Step 1. Compute work done: $W = mgh = 200 \times 10 \times 10 = 20000\,\text{J}$.

Step 2. Compute power: $P = W/t = 20000/40$.

Step 3. Result: $P = 500\,\text{W}$. (Half a kilowatt - a fairly modest pump.)

Answer: (A)

← Go back to Q5

Q6. Limiting frictional force on a horizontal surface.

Solution

Concept. The maximum (limiting) static frictional force just before the body starts to slip is $f_s = \mu_s N$, where N is the normal reaction. On a horizontal surface with no extra vertical forces, N equals the weight of the body: $N = W = mg$.

Given. Coefficient of friction $\mu = 0.2$; weight of body $W = 10\,\text{N}$, so $N = 10\,\text{N}$.

Step 1. Apply $f = \mu N$.

Step 2. Substitute: $f = 0.2 \times 10$.

Step 3. Compute: $f = 2\,\mathrm{N}$.

Answer: (B)

← Go back to Q6

Q7. Gravitational PE near Earth's surface.

Solution

Concept. For heights h very small compared to Earth's radius ($R \approx 6400\,\mathrm{km}$), the gravitational field is essentially uniform, and the change in gravitational potential energy on rising a height h above the surface (taking the surface as zero) is simply $U = mgh$.

Step 1. Check sign convention. The standard near-surface convention measures U from the surface upward as positive (a body at height h has more PE than one at the surface).

Step 2. The negative-sign option ($-mgh$) applies only when you take infinity as the reference and write the full $-GMm/r$ formula; that is not the near-surface convention used in option B.

Step 3. Therefore the correct expression at small height is $U = mgh$.

Answer: (B)

← Go back to Q7

Q8. Maximum velocity in simple harmonic motion.

Solution

Concept. In SHM, the displacement is $x(t) = A\cos(\omega t)$, so velocity is $\dot{x}(t) = -A\omega\sin(\omega t)$. The magnitude peaks at $|v|_{\max} = A\omega$, achieved at the equilibrium point. The angular frequency is $\omega = 2\pi/T$.

Given. Amplitude $A = 5\,\mathrm{cm}$; period $T = 2\,\mathrm{s}$.

Step 1. Compute angular frequency: $\omega = 2\pi/T = 2\pi/2 = \pi\,\mathrm{rad\,s^{-1}}$.

Step 2. Apply $v_{\max} = A\omega$.

Step 3. Substitute: $v_{\max} = 5 \times \pi = 5\pi\,\mathrm{cm\,s^{-1}}$.

Answer: (A)

← Go back to Q8

Q9. Unit conversion: calories to joules.

Solution

Concept. The calorie (cal) and the joule (J) are two units of energy. The exact conversion: $1\,\text{cal} = 4.18\,\text{J}$. To convert any energy from calories to joules, multiply by 4.18.

Given. Energy in calories $= 200\,\text{cal}$.

Step 1. Multiply by the conversion factor: $E = 200 \times 4.18\,\text{J}$.

Step 2. Compute: $200 \times 4.18 = 836$.

Step 3. Therefore $200\,\text{cal} = 836\,\text{J}$.

Answer: (A)

← Go back to Q9

Q10. Effective thermal conductivity of two rods in series.

Solution

Concept. When two rods of equal length and area are connected end-to-end (in series), the same heat current flows through both, but the temperature drops add. The combined system behaves like a single rod of length $2L$ with effective conductivity $k_{\text{eff}} = \dfrac{2k_1k_2}{k_1 + k_2}$ (harmonic mean).

Given. $k_1 = k$, $k_2 = 2k$.

Step 1. Apply the series formula: $k_{\text{eff}} = \dfrac{2 \cdot k \cdot 2k}{k + 2k}$.

Step 2. Simplify the numerator: $2 \cdot k \cdot 2k = 4k^2$.

Step 3. Simplify the denominator: $k + 2k = 3k$.

Step 4. Combine: $k_{\text{eff}} = 4k^2/3k = 4k/3$.

Answer: (C)

← Go back to Q10

Q11. Isothermal process - change in internal energy.

Solution

Concept. For an ideal gas, the internal energy depends only on temperature: $U = U(T)$. (This is because the gas molecules have no intermolecular potential energy, only kinetic energy, which is set by T.) In an isothermal process, T is constant by definition, so U is constant, meaning $\Delta U = 0$.

Step 1. Identify the constraint: isothermal $\Rightarrow T =$ constant.

Step 2. For ideal gas: $U = U(T)$, so T constant $\Rightarrow U$ constant $\Rightarrow \Delta U = 0$.

Implication. By the first law, $Q = W$ in an isothermal expansion - all the heat absorbed becomes work done by the gas.

Answer: (C)

← Go back to Q11

Q12. Image of an object at the focus of a convex lens.

Solution

Concept. Use the lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$. With $u = -f$ (object at the focal point on the incoming side) and a convex lens ($f > 0$):

Step 1. Set $u = -f$: $\frac{1}{v} - \frac{1}{-f} = \frac{1}{f}$, i.e. $\frac{1}{v} + \frac{1}{f} = \frac{1}{f}$.

Step 2. Simplify: $\frac{1}{v} = 0$, which means $v \to \infty$.

Step 3. Geometrically: rays diverging from the focus emerge parallel to the principal axis. They never converge to a finite point - the "image" forms at infinity.

Answer: (D)

← Go back to Q12

Q13. Reflection angle convention.

Solution

Concept. By the laws of reflection, the angle of incidence equals the angle of reflection, both measured from the *normal* (the perpendicular to the mirror surface), not from the mirror surface itself.

Given. The ray makes $40°$ with the mirror surface.

Step 1. Convert to angle from the normal: $\theta_i = 90° - 40° = 50°$.

Step 2. By the law of reflection: $\theta_r = \theta_i = 50°$ (also measured from the normal).

Common error. If you forget to convert, you'll pick $40°$ - tempting but wrong. The phrase "angle of reflection" always refers to the angle from the normal.

Answer: (B)

← Go back to Q13

Q14. Critical angle for total internal reflection.

Solution

Concept. When light travels from a denser medium (refractive index n) into a less-dense medium (here, air with $n = 1$), it bends away from the normal. At the critical angle θ_c the refracted ray grazes the boundary at $90°$. From Snell's law: $n \sin\theta_c = 1 \cdot \sin 90° = 1$, so $\sin\theta_c = 1/n$.

Given. Refractive index $n = \sqrt{2}$.

Step 1. Compute $\sin\theta_c = 1/\sqrt{2}$.

Step 2. Recognise $\sin 45^\circ = 1/\sqrt{2}$, so $\theta_c = 45^\circ$.

Answer: (B)

← Go back to Q14

Q15. Power of a lens.

Solution

Concept. The "power" P of a lens (in diopters, D) is the reciprocal of its focal length *expressed in metres*: $P = 1/f(\text{m})$. A more powerful lens (in this technical sense) has a shorter focal length and bends light more strongly.

Given. $f = 50\,\text{cm} = 0.5\,\text{m}$.

Step 1. Apply $P = 1/f$.

Step 2. Substitute: $P = 1/0.5$.

Step 3. Compute: $P = 2\,\text{D}$.

Pitfall. If you forget to convert from cm to m, you'll compute $1/50 = 0.02\,\text{D}$ - the wrong-units trap.

Answer: (C)

← Go back to Q15

Q16. Current through series resistors.

Solution

Concept. Three resistors in series add: $R_{\text{eq}} = R_1 + R_2 + R_3$. The same current flows through each (no branching). By Ohm's law: $I = V/R_{\text{eq}}$.

Given. $R_1 = R_2 = R_3 = 6\,\Omega$; battery voltage $V = 9\,\text{V}$.

Step 1. Series equivalent: $R_{\text{eq}} = 6 + 6 + 6 = 18\,\Omega$.

Step 2. Apply Ohm: $I = V/R_{\text{eq}} = 9/18$.

Step 3. Compute: $I = 0.5\,\text{A}$. Same through every resistor.

Answer: (A)

← Go back to Q16

Q17. Order of drift velocity in metals.

Solution

Concept. Free electrons in a metal under a typical applied field drift very slowly along the field. The drift velocity is $v_d = I/(nAe)$. For typical copper wires carrying everyday currents ($\sim 1\,\text{A}$ in $\sim 1\,\text{mm}^2$), this works out to about $0.1\,\text{mm/s}$ - i.e., $\sim 10^{-4}\,\text{m}\,\text{s}^{-1}$.

Step 1. Compare with the options: only $10^{-4}\,\text{m}\,\text{s}^{-1}$ matches this order of magnitude.

Common surprise. The thermal speed of free electrons is $\sim 10^{6}\,\text{m}\,\text{s}^{-1}$ - 10 billion times faster than the drift. Drift is a tiny systematic bias on top of huge random motion.

Answer: (A)

← Go back to Q17

Q18. Force on a current-carrying conductor in a magnetic field.

Solution

Concept. The force on a straight conductor of length L carrying current I in a magnetic field B is $F = BIL\sin\theta$, where θ is the angle between current and field. With $\theta = 90°$, $\sin\theta = 1$, so $F = BIL$.

Given. $F = 0.2\,\text{N}$; $B = 0.4\,\text{T}$; $L = 0.5\,\text{m}$; $\theta = 90°$.

Step 1. Rearrange: $I = F/(BL)$.

Step 2. Substitute: $I = 0.2/(0.4 \times 0.5)$.

Step 3. Compute denominator: $0.4 \times 0.5 = 0.2$. So $I = 0.2/0.2 = 1\,\text{A}$.

Answer: (A)

← Go back to Q18

Q19. Origin of Lenz's law.

Solution

Concept. Lenz's law: the induced EMF opposes the change in magnetic flux that produced it. If induced currents *aided* the change, energy could be created from nothing - the induced current would itself create more flux, inducing more current, in a runaway feedback loop. To prevent this, the induced current must always be in the direction that resists the change.

Step 1. The "opposes the change" sign is therefore a direct consequence of the conservation of energy.

Step 2. Of the listed options, conservation of energy is the only one with this implication.

Answer: (B)

← Go back to Q19

Q20. Photon energy from wavelength.

Solution

Concept. A photon's energy is $E = h\nu = hc/\lambda$. Plug in SI units and divide by 1.6×10^{-19} to get eV.

Given. $\lambda = 6600\,\text{Å} = 6.6 \times 10^{-7}\,\text{m}$; $h = 6.6 \times 10^{-34}\,\text{J s}$; $c = 3 \times 10^{8}\,\text{m s}^{-1}$.

Step 1. Compute $hc = 6.6 \times 10^{-34} \times 3 \times 10^{8} = 19.8 \times 10^{-26}$.

Step 2. Divide by λ: $E = 19.8 \times 10^{-26}/6.6 \times 10^{-7} = 3 \times 10^{-19}\,\text{J}$.

Step 3. Convert to eV: $E = 3 \times 10^{-19}/1.6 \times 10^{-19} = 1.875\,\text{eV} \approx 1.88\,\text{eV}$.

Reality check. $6600\,\text{Å}$ is red light; visible photons are around $1.6\text{-}3.2\,\text{eV}$, so $1.88\,\text{eV}$ for red is sensible.

Answer: (A)

← Go back to Q20

Q21. Definition of atomic number.

Solution

Concept. The atomic number Z of an element is the number of *protons* in the nucleus of any of its atoms. It is what defines the chemical identity of the element. Atomic mass number A counts protons + neutrons, and the number of electrons equals Z only for a neutral atom.

Step 1. Compare options: protons (B) is the universal, definitive answer; neutrons and nucleons are different counts; "electrons in any state" is ambiguous (an ion has different electron counts).

Answer: (B)

← Go back to Q21

Q22. Node spacing on a stationary wave.

Solution

Concept. On a stationary (standing) wave, points where the medium does not oscillate are called *nodes*. Nodes occur at the points where the two superposed travelling waves are exactly $180°$ out of phase. The pattern of nodes repeats every half-wavelength.

Step 1. Therefore the distance between two adjacent nodes is $\lambda/2$.

Step 2. The distance between a node and the nearest antinode is half of that: $\lambda/4$.

Answer: (B)

← Go back to Q22

Q23. What determines parallel-plate capacitance.

Solution

Concept. For a parallel-plate capacitor in vacuum, $C = \varepsilon_0 A/d$, where A is the plate area and d is the gap. Inserting a dielectric of constant κ multiplies this by κ.

Step 1. Notice what is NOT in the formula: the applied voltage V, the charge stored Q, and the current I.

Step 2. Capacitance is a *geometric* property - it depends on the construction of the capacitor (area, gap, dielectric), not on what's been put on it.

Step 3. Therefore the correct answer is "Plate area and separation".

Answer: (C)

← Go back to Q23

Q24. Logic gate with HIGH output only when both inputs are HIGH.

Solution

Concept. The AND gate truth table: output is 1 only when ALL inputs are 1; output is 0 in every other input combination. Symbolically: $Y = A \cdot B$.

Step 1. Compare with the options. OR gives 1 when ANY input is 1. NOT is a single-input inverter. NOR is the OR's complement (output 1 only when both are 0).

Step 2. Only the AND gate matches the described behaviour.

Answer: (B)

← Go back to Q24

Q25. Dimensions of pressure.

Solution

Concept. Pressure is defined as force per unit area: $P = F/A$. Dimensionally, $[F] = [MLT^{-2}]$ and $[A] = [L^2]$.

Step 1. Divide: $[P] = [MLT^{-2}]/[L^2] = [ML^{-1}T^{-2}]$.

Cross-check. The SI unit of pressure is the pascal: $1\,\text{Pa} = 1\,\text{N/m}^2 = 1\,\text{kg}\cdot\text{m}^{-1}\cdot\text{s}^{-2}$, which matches $[ML^{-1}T^{-2}]$.

Answer: (B)

← Go back to Q25

Answer Key

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