

JEECUP Sample Paper

Physics (Group A) - Paper 4

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 car accelerates uniformly from rest to 20 m s^{-1} in 10 s. The distance covered is:

- (A) 100 m
- (B) 200 m
- (C) 50 m
- (D) 400 m

Q2. A body moving with velocity v has kinetic energy K . If its velocity is doubled, the new kinetic energy is:

- (A) K
- (B) $2K$
- (C) $4K$



(D) $8K$

Q3. A particle moves in a circle of radius 2 m with constant angular velocity $\pi \text{ rad s}^{-1}$. Its linear speed is:

(A) $\pi \text{ m s}^{-1}$

(B) $2\pi \text{ m s}^{-1}$

(C) $4\pi \text{ m s}^{-1}$

(D) 0

Q4. A rocket exhausts 10 kg of gas per second at 200 m/s relative to itself. The thrust developed is:

(A) 200 N

(B) 1000 N

(C) 2000 N

(D) 20000 N

Q5. If the momentum of a body is doubled, its kinetic energy becomes:

(A) Same

(B) Doubled

(C) Tripled

(D) Four times

Q6. A wheel rotates at 120 rpm. Its angular speed in rad s^{-1} is:

(A) π



- (B) 2π
- (C) 4π
- (D) 8π

Q7. A satellite orbits Earth at low altitude. Its orbital speed is approximately:

- (A) 3.1 km/s
- (B) 7.9 km/s
- (C) 11.2 km/s
- (D) 25 km/s

Q8. The pressure exerted by a liquid column of height h , density ρ , on its base is:

- (A) $h\rho g$
- (B) $h\rho/g$
- (C) hg/ρ
- (D) ρg only

Q9. Water has a maximum density at:

- (A) 0°C
- (B) 4°C
- (C) 25°C
- (D) 100°C

Q10. The mode of heat transfer that does NOT require a material medium is:



- (A) Conduction
- (B) Convection
- (C) Radiation
- (D) All require a medium

Q11. The first law of thermodynamics is essentially a statement of:

- (A) Conservation of momentum
- (B) Conservation of energy
- (C) Conservation of mass
- (D) None of these

Q12. An image formed by a plane mirror is:

- (A) Real, inverted
- (B) Virtual, erect, same size
- (C) Real, magnified
- (D) Virtual, inverted

Q13. A convex lens has focal length f . If it is immersed in a liquid whose refractive index is GREATER than that of the lens material, the lens:

- (A) Has a shorter focal length
- (B) Has a longer focal length
- (C) Behaves as a diverging lens
- (D) Has no change in focal length



- Q14.** The least distance of distinct vision for a normal human eye is:
- (A) 10 cm
 - (B) 25 cm
 - (C) 50 cm
 - (D) 1 m
- Q15.** A polariser-analyser pair has its axes parallel. The fraction of intensity transmitted (of the polarised incident light) is:
- (A) 0
 - (B) $1/2$
 - (C) 1
 - (D) $1/4$
- Q16.** A battery of EMF 12 V and internal resistance $1\ \Omega$ is connected to an external resistance of $5\ \Omega$. The current is:
- (A) 2 A
 - (B) 5 A
 - (C) 1 A
 - (D) 12 A
- Q17.** The energy used by a 100 W bulb in 5 hours is:
- (A) 0.5 kWh
 - (B) 5 kWh
 - (C) 50 kWh



(D) 500 kWh

Q18. A moving charge experiences a force in a magnetic field only if it moves:

(A) Parallel to the field

(B) Anti-parallel to the field

(C) At any non-zero angle to the field

(D) Only perpendicular

Q19. Eddy currents are minimised in transformer cores by:

(A) Using a solid block of iron

(B) Laminating the core

(C) Using copper instead of iron

(D) Increasing the frequency

Q20. A photoelectric experiment shows the stopping potential depends on:

(A) Intensity of light only

(B) Frequency of light only

(C) Both intensity and frequency

(D) Neither

Q21. Nuclear fusion in the Sun primarily converts:

(A) Helium to hydrogen

(B) Hydrogen to helium



- (C) Carbon to nitrogen
- (D) Oxygen to carbon

Q22. A spring-mass system oscillates with frequency f . If the mass is quadrupled, the new frequency is:

- (A) f
- (B) $f/2$
- (C) $f/4$
- (D) $2f$

Q23. Two capacitors of $3\ \mu\text{F}$ and $6\ \mu\text{F}$ are connected in series. The equivalent capacitance is:

- (A) $9\ \mu\text{F}$
- (B) $2\ \mu\text{F}$
- (C) $18\ \mu\text{F}$
- (D) $0.5\ \mu\text{F}$

Q24. A NAND gate is called universal because:

- (A) It is the fastest gate
- (B) It needs the least power
- (C) Any Boolean function can be built using only NAND gates
- (D) It is reversible

Q25. The dimensions of work (or energy) are:

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



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

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

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



Solutions

Q1. Distance under uniform acceleration from rest.

Solution

Concept. Under constant acceleration, the distance covered when starting from rest and ending at velocity v over time t equals the average velocity times time: $s = \frac{u+v}{2} \cdot t$. (Alternative form: $s = \frac{1}{2}at^2$ once you know a .)

Given. $u = 0$; $v = 20 \text{ m s}^{-1}$; $t = 10 \text{ s}$.

Step 1. Compute average velocity: $\bar{v} = (0 + 20)/2 = 10 \text{ m s}^{-1}$.

Step 2. Compute distance: $s = \bar{v} \cdot t = 10 \times 10 = 100 \text{ m}$.

Cross-check via acceleration. $a = (v - u)/t = 20/10 = 2 \text{ m s}^{-2}$. Then $s = \frac{1}{2}at^2 = 0.5 \times 2 \times 100 = 100 \text{ m}$. Matches.

Answer: (A)

[← Go back to Q1](#)

Q2. Kinetic energy scaling with velocity.

Solution

Concept. $K = \frac{1}{2}mv^2$. KE depends on the SQUARE of speed - so doubling v quadruples K .

Step 1. Original: $K_1 = \frac{1}{2}mv^2$.

Step 2. After doubling v : $K_2 = \frac{1}{2}m(2v)^2 = \frac{1}{2}m \cdot 4v^2 = 4 \cdot \frac{1}{2}mv^2 = 4K_1$.

Step 3. So $K_2 = 4K_1$.

Practical implication. A car at twice the speed needs four times the braking distance. This is why speed limits matter on highways.

Answer: (C)

[← Go back to Q2](#)

Q3. Linear speed from angular velocity.

Solution

Concept. For circular motion, linear speed v and angular velocity ω are related by $v = \omega r$. The dimension check: $[\omega] = \text{rad s}^{-1}$ (rad is dimensionless), and $[r] = \text{m}$, so $[v] = \text{m s}^{-1}$ as required.

Given. $\omega = \pi \text{ rad s}^{-1}$; $r = 2 \text{ m}$.

Step 1. Apply $v = \omega r$.



Step 2. Substitute: $v = \pi \times 2$.

Step 3. Compute: $v = 2\pi \text{ m s}^{-1}$.

Answer: (B)

[← Go back to Q3](#)

Q4. Rocket thrust.

Solution

Concept. A rocket expels mass backward at exhaust speed u relative to itself. The thrust (forward force) is the rate of change of momentum of the expelled gas: $F = u \cdot (dm/dt)$.

Given. Mass flow rate $dm/dt = 10 \text{ kg/s}$; exhaust speed $u = 200 \text{ m/s}$.

Step 1. Apply $F = u \cdot (dm/dt)$.

Step 2. Substitute: $F = 200 \times 10$.

Step 3. Compute: $F = 2000 \text{ N}$.

Answer: (C)

[← Go back to Q4](#)

Q5. KE in terms of momentum.

Solution

Concept. For a particle of mass m , momentum $p = mv$ and kinetic energy $K = \frac{1}{2}mv^2$.

Substituting $v = p/m$: $K = \frac{1}{2}m(p/m)^2 = \frac{p^2}{2m}$. So $K \propto p^2$.

Step 1. Original: $K_1 = p^2/(2m)$.

Step 2. After doubling momentum: $K_2 = (2p)^2/(2m) = 4p^2/(2m) = 4K_1$.

Step 3. So K becomes four times the original.

Answer: (D)

[← Go back to Q5](#)

Q6. Conversion from rpm to rad/s.

Solution

Concept. 1 revolution = 2π radians; 1 minute = 60 s. So $\omega(\text{rad/s}) = N(\text{rpm}) \cdot 2\pi/60$.

Given. $N = 120 \text{ rpm}$.

Step 1. Substitute: $\omega = 120 \times 2\pi/60$.

Step 2. Simplify: $120/60 = 2$, so $\omega = 2 \times 2\pi = 4\pi \text{ rad s}^{-1}$.



Answer: (C)[← Go back to Q6](#)**Q7.** First-cosmic / orbital speed near Earth's surface.**Solution**

Concept. For a circular orbit at height h above Earth, $v_0 = \sqrt{gR^2/(R+h)}$. For low Earth orbit, $h \ll R$, so $v_0 \approx \sqrt{gR}$.

Given. $g = 9.8 \text{ m s}^{-2}$; $R \approx 6.4 \times 10^6 \text{ m}$.

Step 1. Apply $v_0 = \sqrt{gR}$.

Step 2. Compute the product: $gR = 9.8 \times 6.4 \times 10^6 = 62.72 \times 10^6 \approx 6.27 \times 10^7$.

Step 3. Take the square root: $v_0 \approx 7.9 \times 10^3 \text{ m s}^{-1} = 7.9 \text{ km/s}$.

Useful comparison. Escape speed $= \sqrt{2} \times v_0 \approx 11.2 \text{ km/s}$.

Answer: (B)[← Go back to Q7](#)**Q8.** Hydrostatic pressure at the base of a liquid column.**Solution**

Concept. For a static liquid open to the atmosphere, the gauge pressure at depth h below the free surface is $P = \rho gh$ - linear in depth, density, and gravitational acceleration.

Step 1. Pick the option matching ρgh (order of factors doesn't matter).

Step 2. Dimensional sanity: $[\rho gh] = [\text{kg/m}^3][\text{m/s}^2][\text{m}] = [\text{kg}/(\text{m} \cdot \text{s}^2)] = [\text{Pa}]$. Correct unit.

Answer: (A)[← Go back to Q8](#)**Q9.** Anomalous expansion of water.**Solution**

Concept. Unlike most liquids, water contracts as it warms from 0°C to about 4°C and only then begins to expand. So density is maximum at 4°C - water is heaviest per unit volume at that temperature.

Step 1. This is why ice floats: at 0°C , water is less dense than the slightly warmer water below.

Step 2. It's also why deep lakes don't freeze solid - the 4°C layer settles at the bottom,



keeping aquatic life alive through winter.

Answer: (B)

[← Go back to Q9](#)

Q10. Heat transfer through vacuum.

Solution

Concept. Three modes of heat transfer: (1) conduction - via lattice/electron interactions in solids, needs a medium; (2) convection - via bulk fluid motion, needs a fluid; (3) radiation - via electromagnetic waves, needs NO medium.

Step 1. Sunlight reaching Earth across 1.5×10^{11} m of near-vacuum proves that radiation transfers energy without any material medium.

Step 2. Therefore the answer is "Radiation".

Answer: (C)

[← Go back to Q10](#)

Q11. First law of thermodynamics.

Solution

Concept. The first law states $\Delta Q = \Delta U + \Delta W$: heat absorbed by a system equals change in internal energy plus work done by the system. This bookkeeping equation tracks ALL energy flows in and out - it is the conservation of energy applied to thermal systems.

Step 1. Of the listed options, conservation of energy is the only match.

Historical note. The first law was formulated in the mid-19th century by Joule, Mayer, and Helmholtz to unify mechanical work and heat as forms of the same conserved quantity.

Answer: (B)

[← Go back to Q11](#)

Q12. Image formed by a plane mirror.

Solution

Concept. A plane mirror reflects every incoming ray such that the angle of incidence equals the angle of reflection. Tracing the rays back, the eye sees an image that is: (i) virtual - it is behind the mirror, where rays only *appear* to converge; (ii) erect - same orientation top-to-bottom; (iii) same size - the magnification is exactly +1; (iv) laterally



inverted - left and right are swapped.

Step 1. Of the options, "Virtual, erect, same size" is the canonical description.

Answer: (B)

[← Go back to Q12](#)

Q13. Lens in a denser liquid medium.

Solution

Concept. The lens-maker's formula: $\frac{1}{f} = (n_{\text{lens}}/n_{\text{medium}} - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$. The factor in parentheses, $(n_{\text{lens}}/n_{\text{medium}} - 1)$, decides the SIGN of f .

Step 1. In air, $n_{\text{medium}} = 1 < n_{\text{lens}}$, so the factor is positive - the convex lens converges.

Step 2. If $n_{\text{medium}} > n_{\text{lens}}$, the factor becomes *negative* - the same convex shape now has $f < 0$, behaving as a DIVERGING lens.

Step 3. Intuitive picture: a convex air-bubble in water diverges light (acts like a concave lens) because the medium outside is denser than the "lens" inside.

Answer: (C)

[← Go back to Q13](#)

Q14. Least distance of distinct vision.

Solution

Concept. For a healthy young human eye, the closest distance at which an object can be focused clearly without strain is about 25 cm - the "near point" or least distance of distinct vision, conventionally denoted D . It is the reference distance for calculating magnification of microscopes / magnifiers.

Step 1. Older adults' near points drift outward (presbyopia) - but 25 cm is the standard textbook value.

Answer: (B)

[← Go back to Q14](#)

Q15. Malus's law - parallel polariser-analyser.



Solution

Concept. If light of intensity I_0 (already polarised) passes through an analyser whose transmission axis makes angle θ with the light's polarisation, the transmitted intensity is $I = I_0 \cos^2 \theta$ (Malus's law).

Given. Polariser and analyser axes are parallel: $\theta = 0$.

Step 1. Compute $\cos^2 0 = 1$.

Step 2. So $I = I_0 \times 1 = I_0$ - the ENTIRE polarised input intensity is transmitted. Fraction = 1.

Note. If the question had said "unpolarised light passes through the polariser, then through the analyser at angle $\theta = 0$ ", the answer would be $1/2$ (half is lost at the polariser).

Answer: (C)

[← Go back to Q15](#)

Q16. Current in a battery + external resistor.**Solution**

Concept. A real battery has internal resistance r in series with its EMF E . The total circuit resistance is $R + r$. By Ohm's law: $I = E/(R + r)$.

Given. $E = 12 \text{ V}$; $r = 1 \Omega$; $R = 5 \Omega$.

Step 1. Total resistance = $R + r = 5 + 1 = 6 \Omega$.

Step 2. Apply Ohm: $I = 12/6 = 2 \text{ A}$.

Answer: (A)

[← Go back to Q16](#)

Q17. Electrical energy in kWh.**Solution**

Concept. Electrical energy used = $P \times t$. When P is in kilowatts and t is in hours, the result is in kilowatt-hours (kWh) - the unit on your electricity bill.

Given. $P = 100 \text{ W} = 0.1 \text{ kW}$; $t = 5 \text{ hours}$.

Step 1. Apply $E = Pt$.

Step 2. Substitute: $E = 0.1 \times 5 = 0.5 \text{ kWh}$.

Answer: (A)

[← Go back to Q17](#)



Q18. Force on a moving charge in a magnetic field.**Solution**

Concept. The Lorentz force on a charge is $\vec{F} = q\vec{v} \times \vec{B}$. The cross product gives magnitude $|\vec{F}| = qvB \sin \theta$, where θ is the angle between \vec{v} and \vec{B} . So:

Step 1. $\theta = 0$ (parallel) or $\theta = 180^\circ$ (anti-parallel): $\sin \theta = 0$, force is zero.

Step 2. $\theta = 90^\circ$ (perpendicular): $\sin \theta = 1$, force is maximum.

Step 3. Any other angle: $\sin \theta \neq 0$, force is non-zero.

Conclusion. The charge experiences a non-zero force whenever it moves at ANY non-zero angle to the field - i.e., option C is the most general correct statement.

Answer: (C)

[← Go back to Q18](#)

Q19. Reducing eddy losses in transformer cores.**Solution**

Concept. When the changing magnetic flux in a transformer core induces circular currents (eddy currents) in the conducting iron, these dissipate energy as heat. To minimise them, the core is built from thin laminations (sheets) electrically insulated from each other.

Step 1. A solid iron block would allow large eddy loops. Laminations break those loops into many small ones, each with very small EMF and thus tiny eddy current.

Step 2. Using copper would increase eddy currents (copper is a better conductor). Increasing frequency makes losses WORSE, not better.

Answer: (B)

[← Go back to Q19](#)

Q20. Photoelectric stopping potential.**Solution**

Concept. Einstein's photoelectric equation: $eV_s = h\nu - \phi$, where V_s is the stopping potential, ν is the frequency of incident light, and ϕ is the work function. This says V_s depends ONLY on ν (and the metal's ϕ), NOT on the intensity.

Step 1. Intensity changes the NUMBER of photoelectrons emitted (and hence the photocurrent), but not their maximum kinetic energy.

Step 2. So V_s depends only on frequency.

Historical note. This is the very point that won Einstein his Nobel Prize - it overthrew



the classical wave picture of light.

Answer: (B)

[← Go back to Q20](#)

Q21. Solar fusion.

Solution

Concept. The Sun powers itself via the proton-proton (p-p) chain: four hydrogen nuclei (protons) fuse, in a multi-step reaction, to form one helium-4 nucleus, two positrons, two neutrinos, and a lot of energy (about 26.7 MeV per cycle). Net: $4\text{}^1_1\text{H} \rightarrow \text{}^4_2\text{He} + 2e^+ + 2\nu_e + \gamma$.

Step 1. So the primary fusion process in the Sun is hydrogen \rightarrow helium.

Aside. In more massive stars, the CNO cycle (carbon-nitrogen-oxygen) catalyses the same net hydrogen-to-helium conversion at much higher temperatures.

Answer: (B)

[← Go back to Q21](#)

Q22. Spring-mass frequency vs mass.

Solution

Concept. For a spring-mass oscillator, the natural frequency is $f = \frac{1}{2\pi} \sqrt{k/m}$. So $f \propto 1/\sqrt{m}$ - heavier mass means LOWER frequency.

Step 1. Take the ratio: $\frac{f_2}{f_1} = \sqrt{m_1/m_2}$.

Step 2. Substitute $m_2 = 4m_1$: $\frac{f_2}{f_1} = \sqrt{1/4} = 1/2$.

Step 3. So $f_2 = f/2$.

Answer: (B)

[← Go back to Q22](#)

Q23. Capacitors in series.

Solution

Concept. For two capacitors in series, charges on each are equal but voltages add - the reciprocals of capacitances add: $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$.

Given. $C_1 = 3\ \mu\text{F}$; $C_2 = 6\ \mu\text{F}$.



Step 1. Compute $1/C_{\text{eq}} = 1/3 + 1/6$.

Step 2. Common denominator 6: $1/C_{\text{eq}} = 2/6 + 1/6 = 3/6 = 1/2$.

Step 3. Therefore $C_{\text{eq}} = 2 \mu\text{F}$.

Sanity check. Series capacitance is always LESS than the smallest individual capacitance. $2 < 3$ - confirmed.

Answer: (B)

[← Go back to Q23](#)

Q24. Universality of the NAND gate.

Solution

Concept. A "universal" logic gate is one from which any Boolean function (any truth table) can be implemented using only that one type of gate. NAND is universal: NOT = NAND with both inputs tied; AND = NAND followed by NAND-as-NOT; OR = NAND of (NAND-as-NOT of A) and (NAND-as-NOT of B); and so on for XOR, ADD, multiplexers, etc.

Step 1. NOR is also universal, but the question's options match the universality property only with "any Boolean function can be built using NAND gates" (option C).

Step 2. The other options (fastest, lowest power, reversible) are not the reason for NAND's universality.

Answer: (C)

[← Go back to Q24](#)

Q25. Dimensions of work / energy.

Solution

Concept. Work is force times displacement: $W = F \cdot d$. Dimensionally, $[F] = [MLT^{-2}]$ and $[d] = [L]$, so $[W] = [ML^2T^{-2}]$. The same dimensions apply to energy (kinetic, potential, electrical, etc.) and to heat.

Step 1. Compare with options: $[ML^2T^{-2}]$ is option C.

Unit verification. The SI unit is the joule: $1 \text{ J} = 1 \text{ N} \cdot \text{m} = 1 \text{ kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$ - matches $[ML^2T^{-2}]$ exactly.

Answer: (C)

[← Go back to Q25](#)



Answer Key

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

