SRMJEEE Physics Sample Paper – 4

Duration: 41 Minutes **Maximum Marks: 35**

Instructions

- This paper contains **35** Multiple Choice Questions (Single Correct Answer), modelled on the Physics section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

Q1. In an experiment to determine a resistance using $R = V/I$, the voltage is measured as $V = (10.0 \pm 0.2)$ V and the current as $I = (2.0 \pm 0.1)$ A. The maximum percentage error in the computed value of R is:

(A) 5%

(B) 7%

(C) 3%

(D) 2%

Q2. The dimensional formula of the universal gravitational constant G (from $F = Gm_1m_2/r^2$) is:

(A) $[\mathrm{M^{-1}L^2T^{-2}}]$

(B) $[\mathrm{ML^3T^{-2}}]$

(C) $[\mathrm{M^{-1}L^3T^{-2}}]$

(D) $[M^{-1}L^{3}T^{-1}]$

Q3. A constant force of 20 N acts on a body for 0.5 s. The impulse delivered to the body, equal to its change in momentum, is:

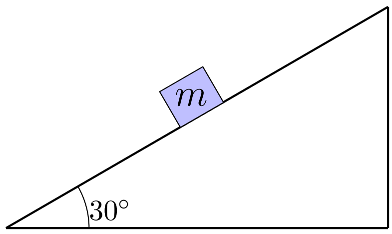
(A) 10 kg m s^{-1}

(B) 40 kg m s^{-1}

(C) 20 kg m s^{-1}

(D) 5 kg m s^{-1}

Q4. A block placed on a rough inclined plane is on the verge of sliding when the inclination is raised to 30°, as shown. The coefficient of static friction between the block and the incline is:



(A) $\sqrt{3}$

(B) 0.5

(C) 1

(D) $\frac{1}{\sqrt{3}}$

Q5. A particle starts from rest and moves with a uniform acceleration of 4 m s^{-2}. The distance it covers during the 3rd second of its motion is:

(A) 12 m

(B) 18 m

(C) 10 m

(D) 6 m

Q6. A spring of force constant 200 N m^{-1} is compressed by 0.1 m. The elastic potential energy stored in the spring is:

(A) 1 J

(B) 2 J

(C) 20 J

(D) 0.5 J

Q7. A bullet of mass 20 g moving with a speed of 400 m s^{-1} embeds itself in a wooden block of mass 1.98 kg resting on a frictionless surface. The common speed of the bullet-plus-block immediately after impact is:

(A) 8 m s^{-1}

(B) 4 m s^{-1}

(C) 2 m s^{-1}

(D) 40 m s^{-1}

Q8. Two point masses 4 kg and 9 kg are separated by a distance of 6 m. The gravitational potential energy of this two-mass system is $\big(G = 6.67 \times 10^{-11}$ N m^{2}kg

(A) $+4.0 \times 10^{-10}$ J

(B) -2.4×10^{-9} J

(C) $+4.0 \times 10^{-11}$ J

(D) -4.0×10^{-10} J

Q9. The orbital period of a geostationary satellite, as seen from a point fixed on the Earth's surface, is:

(A) 1 hour

(B) 12 hours

(C) 24 hours

(D) 48 hours

Q10. Two wires of the same material and same cross-sectional area, of lengths L and $2L$, are joined end to end and a load W is hung from the free end.

If the shorter wire alone would stretch by ℓ under this load, the total elongation of the combination is:

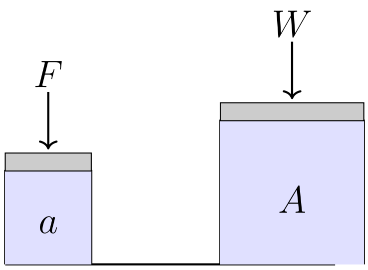
(A) 3ℓ

(B) ℓ

(C) 2ℓ

(D) $\frac{3\ell}{2}$

Q11. In the hydraulic lift shown, a force of 50 N is applied on the small piston of area $5\ \text{cm}^2$. The maximum load that can be lifted on the large piston of area $50\ \text{cm}^2$ is:



(A) 250 N

(B) 500 N

(C) 50 N

(D) 5000 N

Q12. Two fixed charges $+q$ and $+4q$ are placed a distance d apart. A third charge is placed on the line joining them so that it is in equilibrium. Its distance from the charge $+q$ is:

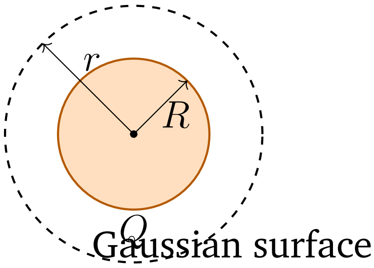
(A) $\frac{d}{2}$

(B) $\frac{2d}{3}$

(C) $\frac{d}{3}$

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

Q13. A solid sphere of radius R carries a uniformly distributed total charge Q. Using Gauss's law with the spherical Gaussian surface shown, the electric field at a point *outside* the sphere (distance $r > R$ from the centre) is $\left(k = \dfrac{1}{4\pi\varepsilon_0}\right)$:



(A) zero

(B) $\dfrac{kQr}{R^3}$

(C) $\dfrac{kQ}{R^2}$

(D) $\dfrac{kQ}{r^2}$

Q14. A parallel-plate capacitor with air between the plates has capacitance $C = \varepsilon_0 A/d$. Keeping the charge isolated and the area fixed, if the separation between the plates is doubled, the capacitance becomes:

(A) $\dfrac{C}{2}$

(B) $2C$

(C) $4C$

(D) C

Q15. An electron initially at rest is accelerated through a potential difference of 500 V. The kinetic energy gained by the electron is:

(A) 250 eV

(B) 500 eV

(C) 1000 eV

(D) 50 eV

Q16. Two identical cells, each of emf 1.5 V, are connected in series. The net emf of the combination is:

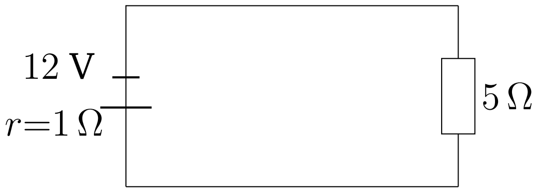
(A) 1.5 V

(B) 0.75 V

(C) 4.5 V

(D) 3.0 V

Q17. A battery of emf 12 V and internal resistance $1\ \Omega$ drives a current through an external resistor of $5\ \Omega$, as shown. The terminal voltage across the battery is:



(A) 12 V

(B) 2 V

(C) 10 V

(D) 6 V

Q18. A resistor of $10\ \Omega$ has a potential difference of 20 V maintained across it. The power dissipated as heat in the resistor is:

(A) 40 W

(B) 20 W

(C) 200 W

(D) 4 W

Q19. A particle of charge q and mass m moves in a uniform magnetic field B perpendicular to its velocity. Its cyclotron (revolution) frequency is:

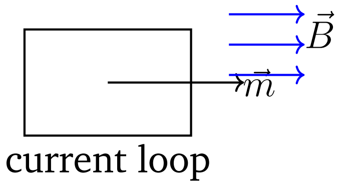
(A) $\frac{2\pi m}{qB}$

(B) $\dfrac{qB}{2\pi m}$

(C) $\dfrac{qB}{m}$

(D) $\dfrac{2\pi qB}{m}$

Q20. A flat rectangular coil of 50 turns and area 4×10^{-3} m^2 carries a current of 2 A. Its plane makes an angle such that the normal to the coil is at 90° to a uniform magnetic field $B = 0.5$ T, as shown. The torque on the coil is:



(A) 0.1 N m

(B) 0.4 N m

(C) 0.2 N m

(D) zero

Q21. The magnetic field at a point on the axis of a short bar magnet of magnetic dipole moment M, at a distance r from its centre (with r much larger than the magnet's length), is:

(A) $\dfrac{\mu_0}{4\pi}\dfrac{M}{r^3}$

(B) $\dfrac{\mu_0}{4\pi}\dfrac{M}{r^2}$

(C) $\dfrac{\mu_0}{4\pi}\dfrac{3M}{r^2}$

(D) $\dfrac{\mu_0}{4\pi}\dfrac{2M}{r^3}$

Q22. A material that is weakly repelled by an external magnetic field and has a small negative susceptibility (slightly less than zero) is classified as:

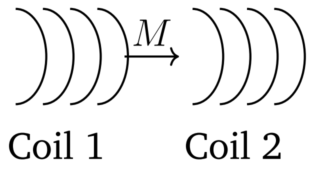
(A) paramagnetic

(B) diamagnetic

(C) ferromagnetic

(D) ferrimagnetic

Q23. Two coupled coils are placed close together as shown. When the current in the primary coil changes at the rate of 4 A s^{-1}, an emf of 8 mV is induced in the secondary coil. The mutual inductance between the coils is:



(A) 2 mH

(B) 32 mH

(C) 0.5 mH

(D) 4 mH

Q24. A series LC circuit has $L = 2$ H and $C = 8$ μF. The angular frequency at which the circuit resonates is:

(A) 125 rad s^{-1}

(B) 500 rad s^{-1}

(C) 250 rad s^{-1}

(D) 1000 rad s^{-1}

Q25. The energy carried by an electromagnetic wave is shared between its electric and magnetic fields. The ratio of the average energy density of the electric field to that of the magnetic field in the wave is:

(A) $c : 1$

(B) $2 : 1$

(C) $1 : c$

(D) $1:1$

Q26. Two thin lenses of focal lengths $+20$ cm and -30 cm are placed in contact coaxially. The power of the combination is:

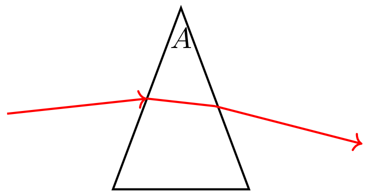
(A) $+5$ D

(B) $+\frac{5}{3}$ D

(C) $-\frac{5}{3}$ D

(D) $+1$ D

Q27. A thin prism of refracting angle $A = 6^\circ$ is made of glass of refractive index $n = 1.5$. The angle of deviation produced by the prism for a small-angle incidence is $\delta = (n-1)A$, equal to:



thin prism

(A) 3°

(B) 6°

(C) 9°

(D) 1.5°

Q28. In a Young's double-slit experiment, a thin transparent sheet of refractive index n and thickness t is placed over one of the slits. The optical path difference introduced by the sheet, which shifts the fringe pattern towards that slit, is:

(A) nt

(B) $\frac{t}{n}$

(C) $(n-1)t$

(D) $(n+1)t$

Q29. In single-slit diffraction, monochromatic light of wavelength λ passes through a slit of width a. The angular position θ of the first minimum is given by:

(A) $a\sin\theta = \frac{\lambda}{2}$

(B) $a\sin\theta = 2\lambda$

(C) $a\cos\theta = \lambda$

(D) $a\sin\theta = \lambda$

Q30. A photon has a wavelength of 620 nm. Taking $hc = 1240$ eV nm, the energy of this photon is:

(A) 1.0 eV

(B) 2.0 eV

(C) 0.5 eV

(D) 4.0 eV

Q31. According to the Bohr model of the hydrogen atom, the speed v_n of the electron in the n-th allowed orbit is proportional to:

(A) $\frac{1}{n}$

(B) n

(C) n^2

(D) $\frac{1}{n^2}$

Q32. A radioactive sample is left for a time equal to two of its half-lives. The fraction of the original nuclei that has *decayed* in this time is:

(A) $\frac{1}{4}$

(B) $\frac{1}{2}$

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

(D) $\frac{1}{8}$

Q33. The radius of a nucleus is given by $R = R_0 A^{1/3}$, where A is the mass number. The density of nuclear matter therefore:

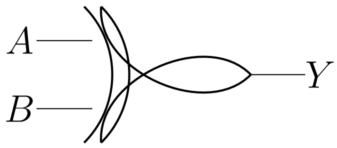
(A) increases with A

(B) is proportional to $A^{1/3}$

(C) decreases as $1/A$

(D) is independent of A

Q34. For the two-input XOR gate shown, the output Y when the inputs are $A = 1$ and $B = 1$ is:



(A) 1

(B) 0

(C) undefined

(D) the same as input A

Q35. In a bipolar junction transistor operating in the active region, the emitter current I_e, base current I_b and collector current I_c are related by:

(A) $I_e = I_b + I_c$

(B) $I_b = I_e + I_c$

(C) $I_c = I_e + I_b$

(D) $I_e = I_c - I_b$

Detailed Solutions

Q1.

Solution

Concept — Combination of errors in a quotient: For $R = V/I$, fractional errors add: $\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$.

Step 1 — Percentage error in V: $\frac{0.2}{10.0} \times 100 = 2\%$.

Step 2 — Percentage error in I: $\frac{0.1}{2.0} \times 100 = 5\%$.

Step 3 — Add them: $\frac{\Delta R}{R} \times 100 = 2\% + 5\% = 7\%$.

Why other options are wrong:

- (A) 5% keeps only the current error.
- (C) 3% subtracts the two errors instead of adding.
- (D) 2% keeps only the voltage error.

Final Answer: Maximum error in R is $7\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Dimensions from Newton's law of gravitation: $F = \frac{Gm_1m_2}{r^2} \Rightarrow G = \frac{Fr^2}{m_1m_2}$.

Step 1 — Substitute the dimensions: $[F] = [\text{MLT}^{-2}]$, $[r^2] = [\text{L}^2]$, $[m_1m_2] = [\text{M}^2]$.

$$[G] = \frac{[\text{MLT}^{-2}][\text{L}^2]}{[\text{M}^2]} = [\text{M}^{-1}\text{L}^3\text{T}^{-2}].$$

Why other options are wrong:

- (A) $[\text{M}^{-1}\text{L}^2\text{T}^{-2}]$ drops one power of length.
- (B) has $[\text{M}^{+1}]$, the wrong sign on mass.
- (D) has T^{-1} instead of T^{-2}.

Final Answer: $[G] = [\text{M}^{-1}\text{L}^3\text{T}^{-2}] \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Impulse-momentum theorem: Impulse $J = F\,t = \Delta p$.

Step 1 — Substitute: $J = 20\text{ N} \times 0.5\text{ s} = 10\text{ N s} = 10\text{ kg m s}^{-1}$.

Step 2 — Interpretation: This 10 kg m s^{-1} is exactly the change in the body's momentum, regardless of its mass.

Why other options are wrong:

- (B) 40 multiplies by 2 s; (D) 5 uses half the force.
- (C) 20 forgets the time factor altogether.

Final Answer: $J = 10\text{ kg m s}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Angle of repose: A block just begins to slide when the incline angle equals the angle of repose θ, where $\mu_s = \tan\theta$.

Step 1 — Apply at $\theta = 30^\circ$:

$$\mu_s = \tan 30^\circ = \frac{1}{\sqrt{3}}.$$

Step 2 — Reasoning: At the verge of sliding, $mg\sin\theta = \mu_s\,mg\cos\theta$, so $\mu_s = \tan\theta$, independent of the mass.

Why other options are wrong:

- (A) $\sqrt{3} = \tan 60^\circ$, the reciprocal angle.
- (B) $0.5 = \sin 30^\circ$, not $\tan 30^\circ$.
- (C) $1 = \tan 45^\circ$.

Final Answer: $\mu_s = \dfrac{1}{\sqrt{3}} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Distance in the n-th second: $s_n = u + \frac{a}{2}(2n-1)$.

Step 1 — Substitute $u = 0$, $a = 4$, $n = 3$:

$$s_3 = 0 + \frac{4}{2}(2\times 3 - 1) = 2\times 5 = 10 \text{ m}.$$

Why other options are wrong:

- (A) 12 uses $(2n) = 6$ instead of $(2n-1) = 5$.
- (B) 18 is the *total* distance in 3 s ($\frac{1}{2}at^2 = 18$ m), not the distance in the 3rd second.
- (D) 6 is the distance in the 2nd second.

Final Answer: $s_3 = 10$ m $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Elastic potential energy of a spring: $U = \frac{1}{2}kx^2$.

Step 1 — Substitute $k = 200$ N m^{-1}, $x = 0.1$ m:

$$U = \frac{1}{2}(200)(0.1)^2 = \frac{1}{2}(200)(0.01) = 1 \text{ J}.$$

Step 2 — Note: The energy depends on x^2, so the sign of the displacement (compression or extension) does not matter.

Why other options are wrong:

- (B) 2 forgets the factor $\frac{1}{2}$.
- (C) 20 uses x instead of x^2.
- (D) 0.5 halves the correct answer.

Final Answer: $U = 1$ J $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Perfectly inelastic collision: The bullet embeds in the block, so momentum is conserved and they move together: $m_b u = (m_b + M)v$.

Step 1 — Total mass after impact: $m_b + M = 0.020 + 1.98 = 2.0$ kg.

Step 2 — Apply momentum conservation:

$$v = \frac{m_b u}{m_b + M} = \frac{0.020 \times 400}{2.0} = \frac{8.0}{2.0} = 4 \text{ m s}^{-1}.$$

Why other options are wrong:

- (A) 8 forgets to divide by the total mass.
- (C) 2 uses double the combined mass; (D) 40 misplaces a power of ten.

Final Answer: $v = 4 \text{ m s}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Gravitational potential energy of two masses: $U = -\dfrac{Gm_1m_2}{r}$ (negative, as the force is attractive).

Step 1 — Substitute $m_1 = 4$**,** $m_2 = 9$**,** $r = 6$**:**

$$U = -\frac{(6.67 \times 10^{-11})(4)(9)}{6} = -\frac{(6.67 \times 10^{-11})(36)}{6}.$$

Step 2 — Simplify: $\dfrac{36}{6} = 6$, so $U = -6 \times 6.67 \times 10^{-11} = -4.0 \times 10^{-10}$ J.

Why other options are wrong:

- (A) has the wrong (positive) sign.
- (B) -2.4×10^{-9} forgets to divide by r.
- (C) misplaces a power of ten.

Final Answer: $U = -4.0 \times 10^{-10} \text{ J} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Geostationary satellite: A geostationary satellite stays fixed above a point on the equator, so its orbital period exactly matches the Earth's rotation period.

Step 1 — Match the rotation: The Earth completes one rotation in 24 hours, so the satellite's period is 24 hours.

Step 2 — Consequence: This synchronism keeps the satellite over the same ground point, which is why it appears stationary in the sky.

Why other options are wrong:

- (A) 1 hour and (B) 12 hours would not keep it fixed over one point.
- (D) 48 hours is twice the rotation period.

Final Answer: Period $= 24$ hours $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Series wires share the same load: Each wire elongates by $\Delta\ell = \dfrac{WL}{AY}$, and the total is the sum.

Step 1 — Shorter wire (length L): given $\ell = \dfrac{WL}{AY}$.

Step 2 — Longer wire (length $2L$, same A, same W, same material):

$$\Delta\ell_2 = \frac{W(2L)}{AY} = 2\ell.$$

Step 3 — Add: total $= \ell + 2\ell = 3\ell$.

Why other options are wrong:

- (B) ℓ ignores the longer wire's stretch.
- (C) 2ℓ counts only the longer wire; (D) $3\ell/2$ wrongly averages the lengths.

Final Answer: Total elongation $= 3\ell \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Pascal's law in a hydraulic lift: Pressure is transmitted equally, so $\frac{F}{a} = \frac{W}{A} \Rightarrow W = F\frac{A}{a}$.

Step 1 — Area ratio: $\frac{A}{a} = \frac{50}{5} = 10$.

Step 2 — Force multiplication:

$$W = F \times \frac{A}{a} = 50 \times 10 = 500 \text{ N}.$$

Why other options are wrong:

- (A) 250 uses an area ratio of 5.
- (C) 50 ignores the area ratio entirely.
- (D) 5000 squares the area ratio.

Final Answer: $W = 500 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Equilibrium of a third charge: The third charge feels zero net force where the magnitudes of the two Coulomb forces are equal. For a point between two like charges this lies nearer the smaller charge.

Step 1 — Let the distance from $+q$ be x; from $+4q$ it is $(d-x)$:

$$\frac{kq}{x^2} = \frac{k(4q)}{(d-x)^2}.$$

Step 2 — Take square roots: $\frac{1}{x} = \frac{2}{d-x} \Rightarrow d - x = 2x \Rightarrow x = \frac{d}{3}$.

Why other options are wrong:

- (A) $d/2$ would balance equal charges, not q and $4q$.
- (B) $2d/3$ is the distance from $+4q$, not from $+q$.
- (D) $d/4$ does not satisfy the force balance.

Final Answer: $x = \frac{d}{3}$ from $+q \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Gauss's law for a charged sphere: The flux through a Gaussian sphere of radius r encloses the full charge Q when $r > R$, so $E(4\pi r^2) = \frac{Q}{\varepsilon_0}$.

Step 1 — Solve for E outside ($r > R$):

$$E = \frac{Q}{4\pi\varepsilon_0 r^2} = \frac{kQ}{r^2}.$$

Step 2 — Note: Outside the sphere the field is identical to that of a point charge Q at the centre; inside ($r < R$) the field instead grows as kQr/R^3.

Why other options are wrong:

- (A) zero is the field at the centre, not outside.
- (B) kQr/R^3 is the *inside* field.
- (C) kQ/R^2 is only the value exactly at the surface ($r = R$).

Final Answer: $E = \frac{kQ}{r^2} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept — Parallel-plate capacitance: $C = \frac{\varepsilon_0 A}{d}$, so $C \propto \frac{1}{d}$.

Step 1 — Double the separation: $d \to 2d \Rightarrow C' = \frac{\varepsilon_0 A}{2d} = \frac{C}{2}$.

Why other options are wrong:

- (B) $2C$ would need the separation *halved*.
- (C) $4C$ has the dependence inverted and squared.
- (D) C ignores the change in d.

Final Answer: $C' = \frac{C}{2} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Energy gained by an accelerated charge: A charge q falling through a potential difference V gains kinetic energy $K = qV$. For an electron through V volts, $K = V$ electron-volts.

Step 1 — Apply: $K = eV = e \times 500$ V $= 500$ eV.

Step 2 — In joules: 500 eV $= 500 \times 1.6 \times 10^{-19} = 8 \times 10^{-17}$ J, but 500 eV is the cleanest form.

Why other options are wrong:

- (A) 250 halves the value with no basis.
- (C) 1000 doubles it; (D) 50 misplaces a power of ten.

Final Answer: $K = 500$ eV $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Cells in series: EMFs of identical cells in series add: $\varepsilon_{\text{net}} = \varepsilon_1 + \varepsilon_2$. (In parallel the net emf would stay 1.5 V.)

Step 1 — Add the two emfs: $\varepsilon_{\text{net}} = 1.5 + 1.5 = 3.0$ V.

Why other options are wrong:

- (A) 1.5 V is the *parallel* combination's emf, not series.
- (B) 0.75 V halves a single cell's emf.
- (C) 4.5 V would need three cells in series.

Final Answer: $\varepsilon_{\text{net}} = 3.0$ V $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Terminal voltage of a real battery: $V = \varepsilon - Ir$, where the current is $I = \dfrac{\varepsilon}{R+r}$.

Step 1 — Find the current:

$$I = \frac{\varepsilon}{R+r} = \frac{12}{5+1} = \frac{12}{6} = 2 \text{ A}.$$

Step 2 — Terminal voltage: $V = \varepsilon - Ir = 12 - (2)(1) = 10$ V. (Equivalently $V = IR = 2 \times 5 = 10$ V.)

Why other options are wrong:

- (A) 12 V ignores the internal-resistance drop.
- (B) 2 V is the drop Ir across r, not the terminal voltage.
- (D) 6 V uses the wrong current.

Final Answer: $V = 10 \text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — Power dissipated in a resistor: $P = \dfrac{V^2}{R}$.

Step 1 — Substitute $V = 20$ V, $R = 10\ \Omega$:

$$P = \frac{(20)^2}{10} = \frac{400}{10} = 40 \text{ W}.$$

Why other options are wrong:

- (B) 20 uses V instead of V^2.
- (C) 200 multiplies V^2 by R wrongly; (D) 4 misplaces a power of ten.

Final Answer: $P = 40 \text{ W} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Cyclotron frequency: For circular motion in a magnetic field, $qvB = \frac{mv^2}{r}$ gives $r = \frac{mv}{qB}$, and the frequency is $f = \frac{v}{2\pi r}$.

Step 1 — Substitute r:

$$f = \frac{v}{2\pi} \cdot \frac{qB}{mv} = \frac{qB}{2\pi m}.$$

Step 2 — Key feature: The frequency is independent of the speed v and the radius r — the basis of cyclotron operation.

Why other options are wrong:

- (A) $\frac{2\pi m}{qB}$ is the period T, the reciprocal of f.
- (C) $\frac{qB}{m}$ is the angular frequency ω, not f.
- (D) misplaces the 2π.

Final Answer: $f = \frac{qB}{2\pi m} \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Torque on a current loop: $\tau = NIAB \sin\theta$, where θ is the angle between the magnetic moment $\vec{m}$ (the normal) and $\vec{B}$.

Step 1 — Identify θ: The normal is at $90°$ to $\vec{B}$ (the plane of the coil contains $\vec{B}$), so $\sin\theta = \sin 90° = 1$ — the torque is maximum.

Step 2 — Substitute:

$$\tau = NIAB = 50 \times 2 \times (4 \times 10^{-3}) \times 0.5 = 0.2 \text{ N m}.$$

Why other options are wrong:

- (A) 0.1 drops a factor of 2.
- (B) 0.4 doubles the area; (D) zero would require the normal parallel to $\vec{B}$.

Final Answer: $\tau = 0.2 \text{ N m} \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Axial field of a short bar magnet (dipole): On the axis, $B_{\text{axial}} = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$.

Step 1 — Read off the dependence: The field falls as $1/r^3$ and carries the factor of 2 characteristic of the axial (end-on) position.

Step 2 — Contrast: On the equatorial (broadside) line the field is $\frac{\mu_0}{4\pi}\frac{M}{r^3}$, half the axial value.

Why other options are wrong:

- (A) $\frac{\mu_0}{4\pi}\frac{M}{r^3}$ is the equatorial field.
- (B),(C) use $1/r^2$, the dependence for a monopole, not a dipole.

Final Answer: $B = \frac{\mu_0}{4\pi}\frac{2M}{r^3} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Magnetic classification: Diamagnetic materials have no permanent dipoles; an applied field induces opposing moments, so they are weakly repelled and have a small *negative* susceptibility ($\chi < 0$).

Step 1 — Match the clues: "weakly repelled" and "negative susceptibility" point uniquely to diamagnetism.

Why other options are wrong:

- (A) paramagnetic materials are weakly *attracted* (χ small positive).
- (C) ferromagnetic materials are strongly attracted (χ large positive).
- (D) ferrimagnetic materials also have net positive susceptibility.

Final Answer: The material is diamagnetic $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Mutual inductance: The emf induced in the secondary is $\varepsilon = M\dfrac{dI}{dt}$, so $M = \dfrac{\varepsilon}{dI/dt}$.

Step 1 — Substitute $\varepsilon = 8$ mV $= 8 \times 10^{-3}$ V, $dI/dt = 4$ A s^{-1}:

$$M = \frac{8 \times 10^{-3}}{4} = 2 \times 10^{-3}\ \text{H} = 2\ \text{mH}.$$

Why other options are wrong:

- (B) 32 mH multiplies instead of dividing.
- (C) 0.5 mH inverts the ratio; (D) 4 mH doubles the result.

Final Answer: $M = 2\ \text{mH} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept — Resonance of an LC circuit: $\omega_0 = \dfrac{1}{\sqrt{LC}}$.

Step 1 — Compute LC: $LC = 2 \times 8 \times 10^{-6} = 16 \times 10^{-6} = 1.6 \times 10^{-5}$.

Step 2 — Take the root: $\sqrt{LC} = \sqrt{16 \times 10^{-6}} = 4 \times 10^{-3}$, so

$$\omega_0 = \frac{1}{4 \times 10^{-3}} = 250\ \text{rad s}^{-1}.$$

Why other options are wrong:

- (A) 125 halves the result; (B) 500 doubles it.
- (D) 1000 drops the square root.

Final Answer: $\omega_0 = 250\ \text{rad s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Energy density in an EM wave: In a plane electromagnetic wave the electric and magnetic fields are related by $E = cB$, and their average energy densities are exactly equal: $u_E = u_B$.

Step 1 — Show the equality: $u_E = \frac{1}{2}\varepsilon_0 E^2$ and $u_B = \dfrac{B^2}{2\mu_0}$. Using $E = cB$ and $c^2 = 1/(\mu_0\varepsilon_0)$ gives $u_E = u_B$.

Step 2 — Ratio: $u_E : u_B = 1 : 1$; the energy is shared equally.

Why other options are wrong:

- (A),(C) bring in a factor of c, which cancels for energy densities.
- (B) $2 : 1$ has no basis; the split is even.

Final Answer: $u_E : u_B = 1 : 1 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q25

Q26.

Solution

Concept — Lenses in contact: Powers add: $P = P_1 + P_2$, with $P = \dfrac{1}{f}$ (in metres).

Step 1 — Individual powers: $P_1 = \dfrac{1}{0.20} = +5$ D, $P_2 = \dfrac{1}{-0.30} = -\dfrac{10}{3}$ D.

Step 2 — Add:

$$P = 5 - \frac{10}{3} = \frac{15 - 10}{3} = \frac{5}{3} \approx +1.67 \text{ D}.$$

Why other options are wrong:

- (A) $+5$ D keeps only the convex lens.
- (C) $-5/3$ D has the wrong overall sign.
- (D) $+1$ D comes from a wrong focal-length sum.

Final Answer: $P = +\dfrac{5}{3}\text{ D} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Deviation by a thin (small-angle) prism: $\delta = (n-1)A$.

Step 1 — Substitute $n = 1.5$, $A = 6°$**:**

$$\delta = (1.5-1)\times 6° = 0.5\times 6° = 3°.$$

Why other options are wrong:

- (B) $6°$ uses $n = 2$.
- (C) $9°$ uses $n = 2.5$; (D) $1.5°$ uses $n = 1.25$.

Final Answer: $\delta = 3° \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept — Extra optical path from a thin slab: A sheet of thickness t and index n replaces a path t of air (path t) with a path of optical length nt, introducing an *extra* path $nt - t = (n-1)t$.

Step 1 — Apply: Optical path difference introduced $= (n-1)t$. This shifts the central fringe towards the covered slit.

Step 2 — Fringe shift: The number of fringes shifted is $\frac{(n-1)t}{\lambda}$.

Why other options are wrong:

- (A) nt is the total optical path through the slab, not the *extra* path.
- (B) t/n inverts the index; (D) $(n+1)t$ adds instead of subtracting the air path.

Final Answer: Extra path $= (n-1)t \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept — Single-slit diffraction minima: Dark fringes occur where $a \sin\theta = m\lambda$, with $m = 1, 2, 3, \ldots$

Step 1 — First minimum ($m = 1$):

$$a \sin\theta = \lambda.$$

Step 2 — Note: This condition is for the *minimum*; the central maximum lies between the first minima on either side.

Why other options are wrong:

- (A) $a \sin\theta = \lambda/2$ is a maximum-like half-wave condition, not the first minimum.
- (B) $a \sin\theta = 2\lambda$ is the *second* minimum.
- (C) uses $\cos\theta$ instead of $\sin\theta$.

Final Answer: $a \sin\theta = \lambda \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q29

Q30.

Solution

Concept — Photon energy: $E = \dfrac{hc}{\lambda}$.

Step 1 — Substitute $hc = 1240$ eV nm, $\lambda = 620$ nm:

$$E = \frac{1240}{620} = 2.0 \text{ eV}.$$

Step 2 — Momentum (for reference): $p = \dfrac{h}{\lambda} = \dfrac{E}{c}$, consistent with the same photon.

Why other options are wrong:

- (A) 1.0 eV uses $\lambda = 1240$ nm.
- (C) 0.5 eV doubles the wavelength again; (D) 4.0 eV halves it.

Final Answer: $E = 2.0 \text{ eV} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Electron speed in the Bohr model: $v_n = \dfrac{e^2}{2\varepsilon_0 h} \cdot \dfrac{1}{n}$, i.e. $v_n \propto \dfrac{1}{n}$.

Step 1 — Read off the dependence: The orbital speed decreases as the principal quantum number rises; for hydrogen $v_1 \approx 2.2 \times 10^6$ m s^{-1} and $v_n = v_1/n$.

Why other options are wrong:

- (B) n and (C) n^2 would mean the electron speeds up in outer orbits, which it does not.
- (D) $1/n^2$ is the dependence of the orbital *energy magnitude*, not the speed.

Final Answer: $v_n \propto \dfrac{1}{n} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q31

Q32.

Solution

Concept — Radioactive decay law: After n half-lives the remaining fraction is $\left(\frac{1}{2}\right)^n$; the decayed fraction is $1 - \left(\frac{1}{2}\right)^n$.

Step 1 — Two half-lives ($n = 2$), remaining: $\left(\frac{1}{2}\right)^2 = \dfrac{1}{4}$.

Step 2 — Fraction decayed: $1 - \dfrac{1}{4} = \dfrac{3}{4}$.

Why other options are wrong:

- (A) $1/4$ is the fraction *remaining*, not decayed.
- (B) $1/2$ is the decayed fraction after one half-life.
- (D) $1/8$ is the fraction remaining after three half-lives.

Final Answer: Fraction decayed $= \dfrac{3}{4} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q32

Q33.

Solution

Concept — Nuclear density: With $R = R_0 A^{1/3}$, the volume is $V = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi R_0^3 A$, proportional to A. Mass is also proportional to A, so density $= \frac{\text{mass}}{\text{volume}}$ has the A cancel.

Step 1 — Form the density:

$$\rho = \frac{A\, m_n}{\frac{4}{3}\pi R_0^3 A} = \frac{m_n}{\frac{4}{3}\pi R_0^3},$$

which contains no A.

Step 2 — Conclusion: Nuclear density is essentially the same ($\sim 2.3 \times 10^{17}$ kg m^{-3}) for all nuclei.

Why other options are wrong:

- (A),(B) the A in numerator and denominator cancel, so density neither grows with A nor scales as $A^{1/3}$.
- (C) it does not fall as $1/A$.

Final Answer: Nuclear density is independent of $A \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q33

Q34.

Solution

Concept — XOR (exclusive-OR) gate: The output is 1 only when the inputs *differ*; for equal inputs $Y = 0$. Truth: $Y = A \oplus B$.

Step 1 — Apply $A = 1$, $B = 1$: The inputs are equal, so $Y = 1 \oplus 1 = 0$.

Step 2 — Cross-check: XOR gives 0 for $(0, 0)$ and $(1, 1)$, and 1 for $(0, 1)$ and $(1, 0)$.

Why other options are wrong:

- (A) 1 would be the OR output for $(1, 1)$, not XOR.
- (C),(D) a logic gate gives a definite 0 or 1 fixed by the inputs.

Final Answer: $Y = 0 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Transistor currents: By charge conservation at the transistor, the emitter current equals the sum of the base and collector currents: $I_e = I_b + I_c$.

Step 1 — Physical picture: Carriers entering the emitter split between a small base current and a large collector current, so I_e is the largest of the three.

Step 2 — Typical magnitudes: Since I_b is small, $I_c \approx I_e$, and $I_c = \beta I_b$ with $\beta \gg 1$.

Why other options are wrong:

- (B),(C) make I_b or I_c the largest current, contradicting the carrier split.
- (D) $I_e = I_c - I_b$ has the wrong sign on I_b.

Final Answer: $I_e = I_b + I_c \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q35

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	A	4	D	5	C
6	A	7	B	8	D	9	C	10	A
11	B	12	C	13	D	14	A	15	B
16	D	17	C	18	A	19	B	20	C
21	D	22	B	23	A	24	C	25	D
26	B	27	A	28	C	29	D	30	B
31	A	32	C	33	D	34	B	35	A