SRMJEEE Physics Sample Paper – 8

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. The radius of a sphere is measured with a percentage error of 2%. The maximum percentage error in the calculated volume of the sphere is:

(A) 2%

(B) 4%

(C) 6%

(D) 8%

Q2. Which of the following physical quantities has the same dimensional formula as that of angular velocity?

(A) Frequency

(B) Velocity

(C) Acceleration

(D) Linear momentum

Q3. A body of mass 5 kg is to be given an acceleration of 2 m s^{-2} along a horizontal surface. A constant frictional force of 6 N opposes the motion. The horizontal force that must be applied is:

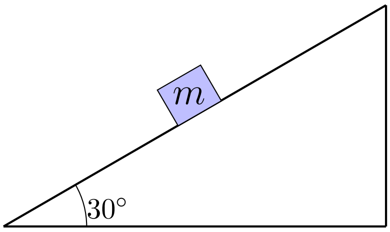
(A) 10 N

(B) 16 N

(C) 4 N

(D) 6 N

Q4. A block rests on a rough inclined plane that makes an angle of 30° with the horizontal, as shown. The minimum coefficient of static friction that will keep the block from sliding down is:



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

(B) $\sqrt{3}$

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

(D) 1

Q5. A body is dropped from rest from a height of 20 m. The speed with which it strikes the ground is $(g = 10 \text{ m s}^{-2})$:

(A) 10 m s^{-1}

(B) 40 m s^{-1}

(C) 14 m s^{-1}

(D) 20 m s^{-1}

Q6. A force acting on a body varies with displacement such that, on a force–displacement graph, the area enclosed between the curve and the displacement axis consists of a rectangle of 20 N$\times 2$ m followed by a triangle of base 2 m and height 20 N. The total work done by the force is:

(A) 40 J

(B) 60 J

(C) 20 J

(D) 80 J

Q7. A very heavy body moving with speed v makes a head-on elastic collision with a light stationary body. Immediately after the collision, the light body moves with a speed of approximately:

(A) v

(B) zero

(C) $v/2$

(D) $2v$

Q8. Owing to the Earth's rotation, the acceleration due to gravity at the poles compared with that at the equator is:

(A) smaller at the poles

(B) the same everywhere

(C) greater at the poles

(D) zero at the poles

Q9. For a satellite revolving in a circular orbit around the Earth, the ratio of its kinetic energy to its (gravitational) potential energy is:

(A) $-\frac{1}{2}$

(B) -2

(C) $+\frac{1}{2}$

(D) -1

Q10. Two wires of the same material carry the same load. The first has length L and radius r; the second has length $2L$ and radius $2r$. The ratio of the elongation of the first wire to that of the second is:

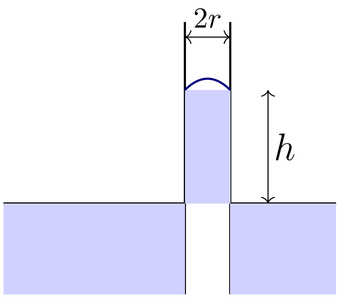
(A) $1 : 1$

(B) $2 : 1$

(C) $1 : 2$

(D) $4 : 1$

Q11. A liquid of density ρ and surface tension T wets the wall of a capillary tube of radius r, rising to a height h with contact angle θ, as shown. The height of the capillary rise is given by:



(A) $\dfrac{T\cos\theta}{\rho g r}$

(B) $\dfrac{T\cos\theta}{2\rho g r}$

(C) $\dfrac{2T\cos\theta}{\rho g r}$

(D) $\dfrac{4T\cos\theta}{\rho g r}$

Q12. Four equal point charges $+q$ are placed at the four corners of a square of side a. The magnitude of the net electrostatic force on any one of the charges due to the other three is $\left(k = \dfrac{1}{4\pi\varepsilon_0}\right)$:

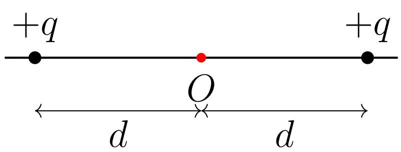
(A) $\dfrac{kq^2}{a^2}$

(B) $\dfrac{2kq^2}{a^2}$

(C) $\dfrac{3kq^2}{a^2}$

(D) $\dfrac{kq^2}{a^2}\left(\sqrt{2}+\dfrac{1}{2}\right)$

Q13. Two equal positive point charges $+q$ are placed a distance $2d$ apart, as shown. The electric field at the midpoint O of the line joining them is:



(A) zero

(B) $\dfrac{kq}{d^2}$

(C) $\dfrac{2kq}{d^2}$

(D) $\dfrac{kq}{2d^2}$

Q14. A capacitor is charged by a battery and then disconnected, after which the charge on it is Q and its energy is U. A dielectric slab of constant $K = 2$ is now inserted, completely filling the gap. The new energy stored in the capacitor is:

(A) $2U$

(B) $\dfrac{U}{2}$

(C) $4U$

(D) U

Q15. An electric dipole of moment p is placed in a uniform electric field E so that the dipole moment makes an angle of 60° with the field. The potential energy of the dipole is:

(A) $-pE$

(B) $+\dfrac{pE}{2}$

(C) $-\frac{pE}{2}$

(D) zero

Q16. Two resistors of $4\ \Omega$ and $2\ \Omega$ are joined in series, and this combination is connected in parallel with a third resistor of $3\ \Omega$. The equivalent resistance of the network is:

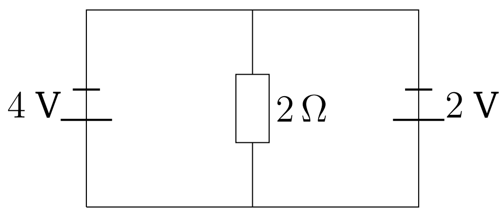
(A) $9\ \Omega$

(B) $3\ \Omega$

(C) $\frac{6}{5}\ \Omega$

(D) $2\ \Omega$

Q17. In the circuit shown, two ideal cells of emf 4 V and 2 V drive current through a common $2\ \Omega$ resistor in the middle branch. Using Kirchhoff's laws, the current through the central $2\ \Omega$ resistor is:



(A) 3 A

(B) 1 A

(C) 2 A

(D) 6 A

Q18. A current of 6 A flows uniformly through a conductor of cross-sectional area $2 \times 10^{-6}\ \text{m}^2$. The magnitude of the current density in the conductor is:

(A) $1.5 \times 10^{6}\ \text{A m}^{-2}$

(B) $3 \times 10^{6}\ \text{A m}^{-2}$

(C) $12 \times 10^{-6}\ \text{A m}^{-2}$

(D) 3×10^{-6} A m^{-2}

Q19. A charged particle enters a region of uniform magnetic field with some velocity. As it moves through the field, its kinetic energy:

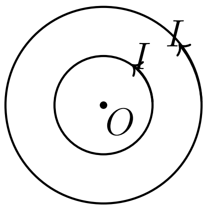
(A) continuously increases

(B) continuously decreases

(C) remains constant

(D) first increases, then decreases

Q20. Two concentric circular loops of radii r and $2r$ carry equal currents I in the *same* sense, as shown. The net magnetic field at their common centre O is:



(A) $\dfrac{\mu_0 I}{2r}$

(B) $\dfrac{\mu_0 I}{4r}$

(C) $\dfrac{\mu_0 I}{r}$

(D) $\dfrac{3\mu_0 I}{4r}$

Q21. A long straight wire carries a steady current of 10 A. The magnitude of the magnetic field at a perpendicular distance of 0.05 m from the wire is $\left(\mu_0 = 4\pi \times 10^{-7}\ \text{T m A}^{-1}\right)$:

(A) 4×10^{-5} T

(B) 2×10^{-5} T

(C) 1×10^{-5} T

(D) 8×10^{-5} T

Q22. A galvanometer of resistance $50\ \Omega$ shows full-scale deflection for a current of 1 mA. To convert it into a voltmeter reading up to 5 V, the series resistance required is:

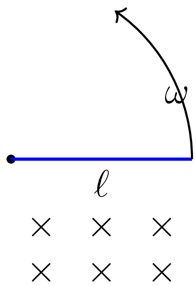
(A) $5050\ \Omega$

(B) $4950\ \Omega$

(C) $5000\ \Omega$

(D) $50\ \Omega$

Q23. A conducting rod of length $\ell = 1$ m rotates about one end in a plane perpendicular to a uniform magnetic field $B = 0.5$ T with an angular speed $\omega = 20$ rad s^{-1}, as shown. The emf induced between the ends of the rod is:



$\vec{B}$ (into page)

(A) 20 V

(B) 10 V

(C) 5 V

(D) 2.5 V

Q24. A sinusoidal alternating current has a peak value $I_0 = \pi$ A. Its average value over a half-cycle is:

(A) π A

(B) $\frac{\pi}{2}$ A

(C) $\frac{\pi}{\sqrt{2}}$ A

(D) 2 A

Q25. For a plane electromagnetic wave travelling in vacuum, which of the following statements is correct?

(A) $E = cB$, and the energy is shared equally between the electric and magnetic fields

(B) $B = cE$, and most of the energy is carried by the magnetic field

(C) $E = cB$, but all the energy resides in the electric field

(D) E and B oscillate 90° out of phase

Q26. A lens forms an image of an object such that the object distance is $u = -20$ cm and the image distance is $v = -40$ cm (both on the same side). The linear magnification produced by the lens is:

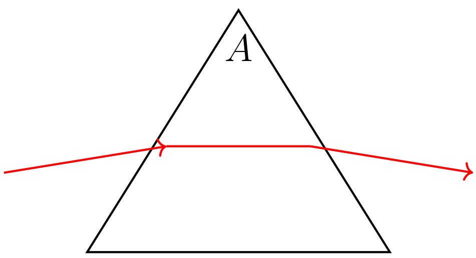
(A) -2

(B) $+2$

(C) $+\frac{1}{2}$

(D) $-\frac{1}{2}$

Q27. A ray of light passes through an equilateral glass prism ($A = 60^\circ$) at minimum deviation, with the angle of minimum deviation $\delta_m = 60^\circ$, as shown. The refractive index of the prism material is:



equilateral prism

(A) 1.33

(B) $\sqrt{2}$

(C) $\sqrt{3}$

(D) 1.5

Q28. In Young's double-slit experiment, the slit separation is $d = 0.5$ mm, the screen is at $D = 1$ m, and the wavelength is $\lambda = 500$ nm. The distance of the 3rd bright fringe from the central maximum is:

(A) 1 mm

(B) 2 mm

(C) 0.5 mm

(D) 3 mm

Q29. Light is incident on the surface of a transparent medium of refractive index $\sqrt{3}$. The angle of incidence at which the reflected light is completely plane polarised (Brewster's angle) is:

(A) 30°

(B) 60°

(C) 45°

(D) 90°

Q30. An electron is accelerated from rest through a potential difference of V volts. Its de Broglie wavelength (in nanometres) is given approximately by:

(A) $\dfrac{1.227}{\sqrt{V}}$ nm

(B) $\dfrac{1.227}{V}$ nm

(C) $1.227\sqrt{V}$ nm

(D) $\dfrac{12.27}{\sqrt{V}}$ nm

Q31. According to Bohr's model of the hydrogen atom, the angular momentum of the electron in the n-th allowed orbit is:

(A) $\dfrac{nh}{4\pi}$

(B) $\dfrac{n^2h}{2\pi}$

(C) $\dfrac{h}{2\pi n}$

(D) $\dfrac{nh}{2\pi}$

Q32. The half-life of a radioactive nucleus is 6.93 s. Its decay constant is approximately:

(A) 0.693 s^{-1}

(B) 6.93 s^{-1}

(C) 0.1 s^{-1}

(D) 0.01 s^{-1}

Q33. In a nuclear fusion reaction, the total mass of the reacting nuclei exceeds the mass of the products by $\Delta m = 0.02$ u. The energy released in the reaction is approximately $(1 \text{ u} \rightarrow 931 \text{ MeV})$:

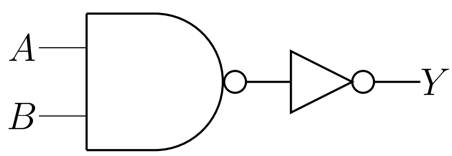
(A) 9.31 MeV

(B) 18.6 MeV

(C) 931 MeV

(D) 0.93 MeV

Q34. In the circuit shown, a NAND gate is followed by a NOT gate. For the inputs $A = 1$ and $B = 1$, the final output Y is:



(A) 1

(B) 0

(C) undefined

(D) the inverse of A

Q35. A full-wave rectifier is fed from an a.c. mains supply of frequency 50 Hz. The fundamental (ripple) frequency of the rectified output is:

(A) 25 Hz

(B) 50 Hz

(C) 100 Hz

(D) 200 Hz

Detailed Solutions

Q1.

Solution

Concept — Error in a power law: For $V \propto r^n$, the fractional error multiplies by the exponent: $\dfrac{\Delta V}{V} = n\,\dfrac{\Delta r}{r}$.

Step 1 — Volume of a sphere: $V = \frac{4}{3}\pi r^3$, so $V \propto r^3$ and the exponent is 3.

Step 2 — Scale the percentage error:

$$\frac{\Delta V}{V} = 3\,\frac{\Delta r}{r} = 3 \times 2\% = 6\%.$$

Why other options are wrong:

- (A) 2% forgets the cube; (B) 4% uses a factor of 2 (area, not volume).
- (D) 8% uses a factor of 4, which no power of r gives.

Final Answer: Error in V is $6\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Dimensions of angular velocity: $\omega = \dfrac{\Delta\theta}{\Delta t}$; angle is dimensionless, so ω has dimensions $[\mathrm{T}^{-1}]$.

Step 1 — Compare with frequency: Frequency $\nu = \dfrac{1}{T}$ also has dimensions $[\mathrm{T}^{-1}]$, identical to angular velocity (indeed $\omega = 2\pi\nu$).

Step 2 — Eliminate the rest: Velocity $[\mathrm{LT}^{-1}]$, acceleration $[\mathrm{LT}^{-2}]$, linear momentum $[\mathrm{MLT}^{-1}]$ — none match $[\mathrm{T}^{-1}]$.

Final Answer: Frequency shares the dimensions of $\omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Newton's second law with friction: The applied force must both overcome friction and supply the net accelerating force: $F = ma + f$.

Step 1 — Net force needed for the acceleration: $ma = 5 \times 2 = 10$ N.

Step 2 — Add the friction: $F = ma + f = 10 + 6 = 16$ N.

Why other options are wrong:

- (A) 10 N is only ma, ignoring friction.
- (C) 4 N subtracts instead of adding; (D) 6 N is the friction alone.

Final Answer: $F = 16 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Block on the verge of sliding: For a block about to slip down a rough incline, the limiting friction balances the gravity component along the plane: $\mu_{\text{min}} = \tan\theta$.

Step 1 — Balance the forces: Along the incline $mg\sin\theta = \mu N = \mu\, mg\cos\theta$, so $\mu = \dfrac{\sin\theta}{\cos\theta} = \tan\theta$.

Step 2 — Substitute $\theta = 30^\circ$: $\mu_{\text{min}} = \tan 30^\circ = \dfrac{1}{\sqrt{3}}$.

Why other options are wrong:

- (B) $\sqrt{3} = \tan 60^\circ$ uses the complementary angle.
- (C) $\frac{1}{2} = \sin 30^\circ$ and (D) $1 = \tan 45^\circ$ are not $\tan 30^\circ$.

Final Answer: $\mu_{\text{min}} = \dfrac{1}{\sqrt{3}} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept — Free fall from rest: Using $v^2 = u^2 + 2gh$ with $u = 0$ gives $v = \sqrt{2gh}$.

Step 1 — Substitute:

$$v = \sqrt{2 \times 10 \times 20} = \sqrt{400} = 20 \text{ m s}^{-1}.$$

Why other options are wrong:

- (A) 10 forgets the factor of $2gh$ (uses $\sqrt{gh}/\sqrt{2}$-type error).
- (B) 40 doubles the speed; (C) $14 \approx \sqrt{200}$ uses $h = 10$ m.

Final Answer: $v = 20 \text{ m s}^{-1} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Work as area under the F–x graph: The work done by a variable force equals the total area between the force curve and the displacement axis.

Step 1 — Area of the rectangle: $W_1 = 20 \text{ N} \times 2 \text{ m} = 40 \text{ J}$.

Step 2 — Area of the triangle: $W_2 = \frac{1}{2} \times 2 \text{ m} \times 20 \text{ N} = 20 \text{ J}$.

Step 3 — Total work: $W = W_1 + W_2 = 40 + 20 = 60 \text{ J}$.

Why other options are wrong:

- (A) 40 J counts only the rectangle.
- (C) 20 J counts only the triangle; (D) 80 J treats the triangle as a full rectangle.

Final Answer: $W = 60 \text{ J} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Elastic collision, heavy on light: For a head-on elastic collision, the velocity of the struck (initially stationary) body is $v_2' = \frac{2m_1}{m_1 + m_2} v$.

Step 1 — Take the limit $m_1 \gg m_2$:

$$v_2' = \frac{2m_1}{m_1 + m_2} v \xrightarrow{m_1 \gg m_2} 2v.$$

Step 2 — Physical picture: A massive body barely slows down and effectively "kicks" the light body forward to nearly twice its own speed.

Why other options are wrong:

- (A) v and (C) $v/2$ underestimate the kick.
- (B) zero would leave the light body at rest, impossible after being struck.

Final Answer: Light body moves with $\approx 2v \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Effect of rotation on g: The apparent gravity is $g' = g - \omega^2 R \cos^2 \lambda$, where λ is the latitude. The rotational term is largest at the equator and zero at the poles.

Step 1 — At the poles ($\lambda = 90°$): $\cos \lambda = 0$, so no reduction; g is at its maximum.

Step 2 — At the equator ($\lambda = 0$): the full term $\omega^2 R$ is subtracted, so g is least there. Hence g is greater at the poles.

Why other options are wrong:

- (A) reverses the comparison; (B) ignores rotation (and the Earth's oblateness).
- (D) g is largest, not zero, at the poles.

Final Answer: g is greater at the poles $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — Energies of an orbiting satellite: For a circular orbit of radius r,

$$\text{PE} = -\frac{GMm}{r}, \qquad \text{KE} = +\frac{GMm}{2r}.$$

Step 1 — Form the ratio:

$$\frac{\text{KE}}{\text{PE}} = \frac{+\frac{GMm}{2r}}{-\frac{GMm}{r}} = -\frac{1}{2}.$$

Step 2 — Note the sign: The kinetic energy is positive and half the magnitude of the (negative) potential energy, giving the total energy $E = -\frac{GMm}{2r}$.

Why other options are wrong:

- (B) -2 inverts the ratio; (C) $+\frac{1}{2}$ drops the sign of the PE.
- (D) -1 would need $|\text{KE}| = |\text{PE}|$, which is not the case.

Final Answer: $\frac{\text{KE}}{\text{PE}} = -\frac{1}{2} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Elongation of a wire: $\Delta\ell = \frac{WL}{AY} = \frac{WL}{\pi r^2 Y}$, with W, Y the same for both wires.

Step 1 — Write each elongation:

$$\ell_1 \propto \frac{L}{r^2}, \qquad \ell_2 \propto \frac{2L}{(2r)^2} = \frac{2L}{4r^2} = \frac{L}{2r^2}.$$

Step 2 — Take the ratio:

$$\frac{\ell_1}{\ell_2} = \frac{L/r^2}{L/2r^2} = 2.$$

So the ratio is $2:1$.

Why other options are wrong:

- (A) $1:1$ would need the area factor to cancel the length, but r is squared.

- (C),(D) invert or mis-square the radius ratio.

Final Answer: $\ell_1 : \ell_2 = 2 : 1 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Capillary rise: Balancing the upward surface-tension force around the circumference against the weight of the raised liquid column gives Jurin's law.

Step 1 — Equate the forces: Upward force $= T\cos\theta\,(2\pi r)$; weight of column $= (\pi r^2 h)\rho g$.

$$T\cos\theta\,(2\pi r) = \pi r^2 h\,\rho g.$$

Step 2 — Solve for h:

$$h = \frac{2T\cos\theta}{\rho g r}.$$

Why other options are wrong:

- (A) drops the factor of 2 from the circumference.
- (B) halves it; (D) double-counts the factor of 2.

Final Answer: $h = \dfrac{2T\cos\theta}{\rho g r} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Vector sum of Coulomb forces: On a corner charge, the two adjacent charges (distance a) and the diagonal charge (distance $a\sqrt{2}$) all repel; the two adjacent forces add as perpendicular vectors.

Step 1 — Forces from the two adjacent charges: Each has magnitude $F_0 = \dfrac{kq^2}{a^2}$, mutually perpendicular, so their resultant is $\sqrt{2}\,F_0$, directed along the diagonal.

Step 2 — Force from the diagonal charge: Distance $a\sqrt{2}$, so $F_d = \dfrac{kq^2}{(a\sqrt{2})^2} = \dfrac{kq^2}{2a^2} = \dfrac{F_0}{2}$, also along the diagonal (same direction).

Step 3 — Add along the diagonal: Both contributions point along the same diagonal, so they add directly:

$$F_{\text{net}} = \sqrt{2}\,F_0 + \frac{F_0}{2} = \frac{kq^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right).$$

Why other options are wrong:

- (A),(B),(C) ignore either the diagonal charge or the perpendicular vector addition of the two adjacent forces.
- Only (D) keeps both the $\sqrt{2}$ from the adjacent pair and the $\frac{1}{2}$ from the diagonal charge.

Final Answer: $F_{\text{net}} = \frac{kq^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right) \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Superposition of fields: The net field is the vector sum of the fields due to each charge.

Step 1 — Fields at the midpoint: Each $+q$ is a distance d from O and produces a field $\frac{kq}{d^2}$ pointing *away* from that charge — i.e. toward O from each side, so the two field vectors point in *opposite* directions.

Step 2 — Add the vectors: Equal magnitudes, opposite directions $\Rightarrow$ they cancel exactly:

$$E_{\text{net}} = \frac{kq}{d^2} - \frac{kq}{d^2} = 0.$$

Why other options are wrong:

- (B),(C) forget that the two fields oppose each other at the midpoint.
- (D) is a partial cancellation that has no physical basis here.

Final Answer: $E_{\text{net}} = 0$ at the midpoint $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Disconnected capacitor (charge fixed): With the battery removed, Q stays constant. Inserting a dielectric raises C to $C' = KC$, and the energy is $U = \frac{Q^2}{2C}$.

Step 1 — New energy at constant Q:

$$U' = \frac{Q^2}{2C'} = \frac{Q^2}{2(KC)} = \frac{1}{K}\frac{Q^2}{2C} = \frac{U}{K}.$$

Step 2 — Substitute $K = 2$: $U' = \frac{U}{2}$.

Why other options are wrong:

- (A) $2U$ and (C) $4U$ apply to constant *voltage* (battery connected), where $U' = KU$.
- (D) U ignores the dielectric.

Final Answer: $U' = \frac{U}{2} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Potential energy of a dipole: $U = -pE\cos\theta$, where θ is the angle between $\vec{p}$ and $\vec{E}$.

Step 1 — Substitute $\theta = 60°$:

$$U = -pE\cos 60° = -pE \times \tfrac{1}{2} = -\frac{pE}{2}.$$

Why other options are wrong:

- (A) $-pE$ is the value at $\theta = 0$ (aligned, minimum energy).
- (B) $+\frac{pE}{2}$ has the wrong sign; (D) zero corresponds to $\theta = 90°$.

Final Answer: $U = -\frac{pE}{2} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Series then parallel: First add the series pair, then combine that with the third in parallel.

Step 1 — Series pair: $R_s = 4 + 2 = 6\ \Omega$.

Step 2 — Parallel with $3\ \Omega$:

$$R_{\text{eq}} = \frac{R_s \times 3}{R_s + 3} = \frac{6 \times 3}{6 + 3} = \frac{18}{9} = 2\ \Omega.$$

Why other options are wrong:

- (A) $9\ \Omega$ adds all three in series.
- (B) $3\ \Omega$ is the third resistor alone; (C) $\frac{6}{5}\ \Omega$ puts all three in parallel.

Final Answer: $R_{\text{eq}} = 2\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Kirchhoff's laws with the superposition idea: Both ideal cells connect across the ends of the same central $2\ \Omega$ resistor and are oriented so that each one drives current through it in the same sense. Each ideal cell (zero internal resistance) then maintains its own emf across that resistor.

Step 1 — Current driven by each cell: By Ohm's law on the central branch, the 4 V cell drives $\frac{4}{2} = 2$ A and the 2 V cell drives $\frac{2}{2} = 1$ A, both in the same direction.

Step 2 — Superpose the two contributions:

$$I = \frac{4}{2} + \frac{2}{2} = 2 + 1 = 3\ \text{A}.$$

Why other options are wrong:

- (B) 1 A keeps only the 2 V cell's contribution.
- (C) 2 A keeps only the 4 V cell's; (D) 6 A uses $R = 1\ \Omega$.

Final Answer: $I = 3$ A through the central $2\ \Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Current density: $J = \dfrac{I}{A}$, the current per unit cross-sectional area.

Step 1 — Substitute:

$$J = \frac{6}{2 \times 10^{-6}} = 3 \times 10^{6} \text{ A m}^{-2}.$$

Why other options are wrong:

- (A) 1.5×10^6 uses $A = 4 \times 10^{-6}$.
- (C),(D) keep the 10^{-6} in the numerator, inverting the area dependence.

Final Answer: $J = 3 \times 10^6 \text{ A m}^{-2} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Magnetic force does no work: The magnetic force $\vec{F} = q\,\vec{v} \times \vec{B}$ is always perpendicular to $\vec{v}$, so $\vec{F} \cdot \vec{v} = 0$ and the work done is zero.

Step 1 — Work–energy theorem: Since $W = 0$, the kinetic energy (and hence the speed) cannot change.

Step 2 — Effect on motion: The field only changes the *direction* of $\vec{v}$ (curving the path into a circle or helix), never its magnitude, so KE stays constant.

Why other options are wrong:

- (A),(B),(D) all require energy to be added or removed, which a magnetic force cannot do.

Final Answer: Kinetic energy remains constant $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Field at the centre of a circular loop: $B = \frac{\mu_0 I}{2R}$; for currents in the same sense, the fields add.

Step 1 — Field from each loop:

$$B_1 = \frac{\mu_0 I}{2r}, \qquad B_2 = \frac{\mu_0 I}{2(2r)} = \frac{\mu_0 I}{4r}.$$

Step 2 — Add (same direction):

$$B = B_1 + B_2 = \frac{\mu_0 I}{2r} + \frac{\mu_0 I}{4r} = \frac{2\mu_0 I + \mu_0 I}{4r} = \frac{3\mu_0 I}{4r}.$$

Why other options are wrong:

- (A),(B) give only one loop's contribution.
- (C) $\frac{\mu_0 I}{r}$ over-counts the smaller loop's field.

Final Answer: $B = \frac{3\mu_0 I}{4r} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Field of a long straight wire: $B = \frac{\mu_0 I}{2\pi r}$.

Step 1 — Substitute:

$$B = \frac{(4\pi \times 10^{-7})(10)}{2\pi(0.05)} = \frac{(2 \times 10^{-7})(10)}{0.05} = \frac{2 \times 10^{-6}}{0.05} = 4 \times 10^{-5}\ \text{T}.$$

Why other options are wrong:

- (B) 2×10^{-5} uses $r = 0.1$ m; (C) 1×10^{-5} also uses the wrong distance.
- (D) 8×10^{-5} drops the 2π to π.

Final Answer: $B = 4 \times 10^{-5}\ \text{T} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Galvanometer to voltmeter: A high resistance R is placed in *series* so that the desired full-scale voltage drives the full-scale current: $V = I_g(R + G)$, hence $R = \dfrac{V}{I_g} - G$.

Step 1 — Substitute ($V = 5$ V, $I_g = 1$ mA $= 10^{-3}$ A, $G = 50\ \Omega$):

$$R = \frac{5}{10^{-3}} - 50 = 5000 - 50 = 4950\ \Omega.$$

Why other options are wrong:

- (A) $5050\ \Omega$ wrongly *adds* G instead of subtracting it.
- (C) $5000\ \Omega$ forgets to subtract G altogether; (D) $50\ \Omega$ is the galvanometer resistance itself.

Final Answer: $R = 4950\ \Omega$ in series $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — emf of a rotating rod: A rod rotating about one end in a perpendicular field develops $\varepsilon = \frac{1}{2}B\omega\ell^2$ (the linear speed varies from 0 at the pivot to $\omega\ell$ at the tip, averaging $\frac{1}{2}\omega\ell$).

Step 1 — Substitute:

$$\varepsilon = \tfrac{1}{2}B\omega\ell^2 = \tfrac{1}{2} \times 0.5 \times 20 \times (1)^2 = \tfrac{1}{2} \times 10 = 5\ \text{V}.$$

Why other options are wrong:

- (A) 20 and (B) 10 forget the factor of $\frac{1}{2}$ (using $B\omega\ell^2$ or similar).
- (D) 2.5 inserts an extra factor of $\frac{1}{2}$.

Final Answer: $\varepsilon = 5$ V $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Average of a sinusoid over a half-cycle: $I_{\text{avg}} = \dfrac{2I_0}{\pi}$.

Step 1 — Substitute $I_0 = \pi$ A:

$$I_{\text{avg}} = \frac{2 \times \pi}{\pi} = 2 \text{ A}.$$

Why other options are wrong:

- (A) π is the peak value, not the half-cycle average.
- (B) $\frac{\pi}{2}$ would need $I_{\text{avg}} = I_0/2$; (C) $\frac{\pi}{\sqrt{2}}$ is the rms value.

Final Answer: $I_{\text{avg}} = 2 \text{ A} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Electromagnetic wave relations: In a plane EM wave the field amplitudes obey $\dfrac{E_0}{B_0} = c$, i.e. $E = cB$, and the wave carries equal energy in its electric and magnetic fields ($u_E = u_B$).

Step 1 — Field ratio: From Maxwell's equations the magnitudes satisfy $E = cB$ at every instant; $\vec{E}$, $\vec{B}$ and the propagation direction form a right-handed set, oscillating *in phase*.

Step 2 — Energy sharing: The energy densities $u_E = \frac{1}{2}\varepsilon_0 E^2$ and $u_B = \dfrac{B^2}{2\mu_0}$ are equal, so each field carries half the total energy.

Why other options are wrong:

- (B) reverses the relation to $B = cE$ and mis-states the energy split.
- (C) wrongly puts all energy in $\vec{E}$; (D) E and B are in phase, not 90° apart.

Final Answer: $E = cB$ with energy shared equally $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Linear magnification of a lens: $m = \dfrac{v}{u}$ (with the sign convention).

Step 1 — Substitute $v = -40$ cm, $u = -20$ cm:

$$m = \frac{v}{u} = \frac{-40}{-20} = +2.$$

Step 2 — Interpret: $m = +2$ means an erect image twice the object's size (a virtual, magnified image, as from a magnifying glass).

Why other options are wrong:

- (A) -2 has the wrong sign (would be a real inverted image).
- (C),(D) use $|m| = \frac{1}{2}$, inverting the v/u ratio.

Final Answer: $m = +2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Prism at minimum deviation: $n = \dfrac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$.

Step 1 — Insert $A = 60°$, $\delta_m = 60°$:

$$n = \frac{\sin\left(\frac{60°+60°}{2}\right)}{\sin\left(\frac{60°}{2}\right)} = \frac{\sin 60°}{\sin 30°} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}.$$

Step 2 — Numerical value: $\sqrt{3} \approx 1.73$.

Why other options are wrong:

- (A) 1.33 is water; (D) 1.5 is ordinary crown glass — neither satisfies this δ_m.
- (B) $\sqrt{2}$ corresponds to $\delta_m = 30°$, not $60°$.

Final Answer: $n = \sqrt{3} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Position of a bright fringe in YDSE: $y_n = \dfrac{n\lambda D}{d}$.

Step 1 — Substitute $n = 3$, $\lambda = 500 \times 10^{-9}$ **m,** $D = 1$ **m,** $d = 0.5 \times 10^{-3}$ **m:**

$$y_3 = \frac{3 \times (500 \times 10^{-9}) \times 1}{0.5 \times 10^{-3}} = \frac{1500 \times 10^{-9}}{0.5 \times 10^{-3}} = 3 \times 10^{-3}\text{ m} = 3\text{ mm}.$$

Why other options are wrong:

- (A) 1 mm is the fringe width $\beta = \frac{\lambda D}{d}$ (the $n = 1$ position).
- (B) 2 mm is the 2nd-order position; (C) 0.5 mm has a wrong power of ten.

Final Answer: $y_3 = 3\text{ mm} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Brewster's law: The polarising angle satisfies $\tan\theta_B = n$.

Step 1 — Substitute $n = \sqrt{3}$:

$$\tan\theta_B = \sqrt{3} \;\Rightarrow\; \theta_B = 60^\circ.$$

Why other options are wrong:

- (A) 30° gives $\tan 30^\circ = \frac{1}{\sqrt{3}}$, i.e. $n = \frac{1}{\sqrt{3}}$ (< 1, impossible here).
- (C) 45° gives $n = 1$; (D) 90° is grazing incidence, not Brewster's angle.

Final Answer: $\theta_B = 60^\circ \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — de Broglie wavelength of an accelerated electron: Combining $\lambda = \frac{h}{p}$ with $p = \sqrt{2meV}$ gives the standard result $\lambda = \frac{12.27}{\sqrt{V}}$ Å $= \frac{1.227}{\sqrt{V}}$ nm.

Step 1 — Derivation: $eV = \frac{p^2}{2m} \Rightarrow p = \sqrt{2meV}$, so

$$\lambda = \frac{h}{\sqrt{2meV}} = \frac{1.227}{\sqrt{V}}\ \text{nm} \quad (V \text{ in volts}).$$

Step 2 — Note the dependence: $\lambda \propto V^{-1/2}$ — raising the accelerating voltage shortens the wavelength.

Why other options are wrong:

- (B) $\frac{1.227}{V}$ uses the wrong power of V; (C) makes λ grow with V.
- (D) $\frac{12.27}{\sqrt{V}}$ mixes up the Å and nm forms (it is the value in Å, which is $\frac{1.227}{\sqrt{V}}$ nm).

Final Answer: $\lambda = \frac{1.227}{\sqrt{V}}$ nm $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q30

Q31.

Solution

Concept — Bohr's quantisation of angular momentum: The electron's angular momentum is quantised in units of $\frac{h}{2\pi}$: $L_n = n\frac{h}{2\pi} = n\hbar$.

Step 1 — Write the postulate: $mvr_n = \frac{nh}{2\pi}$, the central assumption of Bohr's model.

Step 2 — Read off the n-dependence: L_n is directly proportional to n, equal to $n\hbar$.

Why other options are wrong:

- (A) $\frac{nh}{4\pi}$ halves the correct quantum; (B) $\frac{n^2h}{2\pi}$ uses the wrong power of n.
- (C) $\frac{h}{2\pi n}$ makes L *decrease* with n, which is wrong.

Final Answer: $L_n = \frac{nh}{2\pi} \Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q31

Q32.

Solution

Concept — Decay constant and half-life: $\lambda = \dfrac{0.693}{T_{1/2}}$.

Step 1 — Substitute $T_{1/2} = 6.93$ **s:**

$$\lambda = \frac{0.693}{6.93} = 0.1 \text{ s}^{-1}.$$

Why other options are wrong:

- (A) 0.693 s^{-1} corresponds to $T_{1/2} = 1$ s.
- (B) 6.93 s^{-1} takes $\lambda = T_{1/2}$; (D) 0.01 is off by a factor of ten.

Final Answer: $\lambda = 0.1 \text{ s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q32

Q33.

Solution

Concept — Mass–energy equivalence: The energy released equals the mass defect times 931 MeV per u: $E = \Delta m \times 931$ MeV.

Step 1 — Substitute $\Delta m = 0.02$ **u:**

$$E = 0.02 \times 931 = 18.62 \approx 18.6 \text{ MeV}.$$

Why other options are wrong:

- (A) 9.31 uses $\Delta m = 0.01$ u.
- (C) 931 uses $\Delta m = 1$ u; (D) 0.93 uses $\Delta m = 0.001$ u.

Final Answer: $E \approx 18.6 \text{ MeV} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — NAND followed by NOT = AND: A NAND gives $\overline{A \cdot B}$; passing that through a NOT inverts it again, returning $\overline{\overline{A \cdot B}} = A \cdot B$ (a plain AND).

Step 1 — NAND output for $A = B = 1$: $\overline{1 \cdot 1} = \overline{1} = 0$.

Step 2 — Pass through the NOT gate: $Y = \overline{0} = 1$. (Equivalently, the AND of 1 and 1 is 1.)

Why other options are wrong:

- (B) 0 is the NAND output alone, ignoring the second inverter.
- (C),(D) a defined logic network gives a fixed 0 or 1; here it is 1.

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

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Ripple frequency of a full-wave rectifier: A full-wave rectifier inverts the negative half-cycles, producing two output humps per input cycle, so the ripple frequency is twice the input: $f_{\text{out}} = 2f$.

Step 1 — Substitute $f = 50$ Hz:

$$f_{\text{out}} = 2 \times 50 = 100 \text{ Hz}.$$

Step 2 — Contrast with half-wave: A half-wave rectifier passes only one hump per cycle, so its ripple frequency would be 50 Hz.

Why other options are wrong:

- (A) 25 Hz halves the input; (B) 50 Hz is the half-wave (or input) value.
- (D) 200 Hz quadruples the input, which no simple rectifier produces.

Final Answer: $f_{\text{out}} = 100 \text{ Hz} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Answer Key

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