SRMJEEE Physics Sample Paper – 7

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 measure Young's modulus $Y = \dfrac{FL}{A\,\Delta L}$, the measured percentage errors are: in the force F it is 1%, in the length L it is 1%, in the cross-sectional area A it is 3%, and in the elongation ΔL it is 4%. The maximum percentage error in Y is:

(A) 4%

(B) 9%

(C) 7%

(D) 11%

Q2. The dimensional formula of the magnetic field B (in terms of mass M, length L, time T and electric current A) is:

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

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

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

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

Q3. A gun of mass 4 kg fires a bullet of mass 20 g with a muzzle velocity of 400 m s^{-1}. The recoil velocity of the gun is:

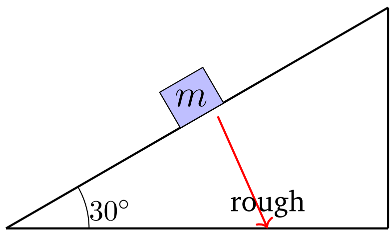
(A) 2 m s^{-1}

(B) 4 m s^{-1}

(C) 8 m s^{-1}

(D) 1 m s^{-1}

Q4. A block is released from rest on a *rough* inclined plane of inclination 30°. The coefficient of kinetic friction between the block and the incline is $\mu = \dfrac{1}{2\sqrt{3}}$. Taking $g = 10$ m s^{-2}, the acceleration of the block down the incline is:



(A) 5 m s^{-2}

(B) 1.5 m s^{-2}

(C) 4 m s^{-2}

(D) 2.5 m s^{-2}

Q5. A projectile is launched from level ground with a speed of 20 m s^{-1} at an angle of 30° above the horizontal. The total time of flight is $(g = 10$ m s$^{-2})$:

(A) 1 s

(B) 4 s

(C) 2 s

(D) 0.5 s

Q6. A motor raises a load of mass 50 kg vertically upward at a constant speed of 4 m s^{-1}. The power delivered by the motor is $\left(g = 10 \text{ m s}^{-2}\right)$:

(A) 1000 W

(B) 2000 W

(C) 500 W

(D) 200 W

Q7. A body of mass m moving with speed v collides head-on and sticks to a stationary body of mass $3m$ (a perfectly inelastic collision). The fraction of the initial kinetic energy that is lost in the collision is:

(A) $3/4$

(B) $1/4$

(C) $1/2$

(D) $1/3$

Q8. At a small height h ($h \ll R$, where R is the radius of the Earth) above the surface, the fractional decrease in the acceleration due to gravity, $\dfrac{\Delta g}{g}$, is approximately:

(A) $\dfrac{h}{R}$

(B) $\dfrac{h}{2R}$

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

(D) $\dfrac{2h}{R}$

Q9. For a satellite in a circular orbit close to the Earth's surface, the escape velocity v_e from the surface is related to the orbital velocity v_o by:

(A) $v_e = v_o$

(B) $v_e = \sqrt{2}\, v_o$

(C) $v_e = 2\, v_o$

(D) $v_e = \dfrac{v_o}{\sqrt{2}}$

Q10. A wire of length L and radius r elongates by ℓ under a load F. A second wire of the *same material* and the *same length* L, but with radius $r/2$, carries a load $2F$. Its elongation is:

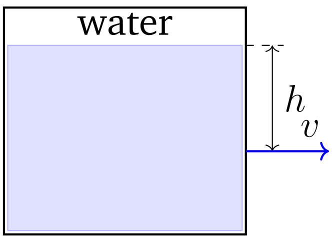
(A) 2ℓ

(B) 4ℓ

(C) 8ℓ

(D) ℓ

Q11. A large tank is filled with water. A small hole is made in its side wall at a depth $h = 0.8$ m below the free surface of the water, as shown. The speed of efflux of water through the hole is $\left(g = 10 \text{ m s}^{-2}\right)$:



(A) 2 m s^{-1}

(B) 8 m s^{-1}

(C) 16 m s^{-1}

(D) 4 m s^{-1}

Q12. Two identical conducting spheres carry charges $+5q$ and $+q$. When held a distance r apart they repel with a force F. They are now touched together and again separated to the same distance r. The new force of repulsion between them is:

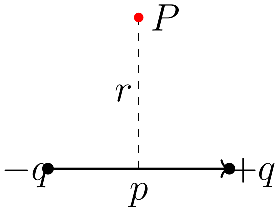
(A) $\dfrac{9F}{5}$

(B) $\frac{5F}{9}$

(C) F

(D) $\frac{F}{5}$

Q13. An electric dipole of dipole moment p is placed in vacuum. The magnitude of the electric field at a point on its equatorial (perpendicular-bisector) line at a distance r ($r \gg$ dipole length) from the centre is $\left(k = \frac{1}{4\pi\varepsilon_0}\right)$:



(A) $\frac{2kp}{r^3}$

(B) zero

(C) $\frac{kp}{r^3}$

(D) $\frac{kp}{r^2}$

Q14. A parallel-plate capacitor (with air between the plates) has capacitance C. If *both* the area of each plate and the separation between the plates are doubled, the new capacitance is:

(A) $4C$

(B) C

(C) $2C$

(D) $C/2$

Q15. A charge of 3 C is moved from a point at potential $V_1 = 20$ V to a point at potential $V_2 = 8$ V. The work done by the external agent (equal to $q(V_1 - V_2)$ here, taking the work done on the charge) is:

(A) 36 J

(B) 24 J

(C) 60 J

(D) 4 J

Q16. n identical resistors, each of resistance R, are first all connected in series and then all connected in parallel. The ratio of the maximum equivalent resistance (series) to the minimum equivalent resistance (parallel) is:

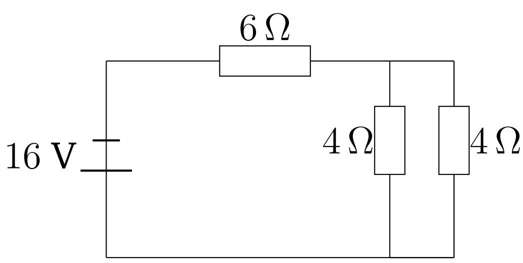
(A) n

(B) $1/n^2$

(C) $1/n$

(D) n^2

Q17. In the circuit shown, two resistors of $4\ \Omega$ and $4\ \Omega$ are in parallel, and this combination is in series with a $6\ \Omega$ resistor across an ideal cell of emf 16 V. The current drawn from the cell is:



(A) 1 A

(B) 2 A

(C) 4 A

(D) 8 A

Q18. A uniform wire of resistance R is folded back exactly at its midpoint so that the two halves lie side by side, forming a wire of half the original length and double the cross-sectional area. The resistance of the folded wire is:

(A) $2R$

(B) $R/2$

(C) $R/4$

(D) $4R$

Q19. A charge $q = 2$ C moves with speed $v = 3$ m s^{-1} at an angle of 30° to a uniform magnetic field $B = 4$ T. The magnitude of the magnetic force on the charge is:

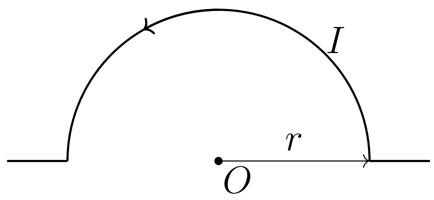
(A) 12 N

(B) 24 N

(C) 6 N

(D) 20.8 N

Q20. A wire carrying a steady current $I = 4$ A is bent into a *semicircular* arc of radius $r = 0.2$ m, as shown. The magnitude of the magnetic field at the centre O of the arc is $\left(\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}\right)$:



(A) $4\pi \times 10^{-6}$ T

(B) $\pi \times 10^{-6}$ T

(C) $8\pi \times 10^{-6}$ T

(D) $2\pi \times 10^{-6}$ T

Q21. Two very long straight wires lie along the x-axis and the y-axis and cross (insulated from each other) at the origin. Each carries the same current $I = 10$ A. The magnitude of the magnetic field at the point $(0, 0, d)$ on the z-axis, with $d = 0.1$ m, is $\left(\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}\right)$:

(A) 2×10^{-5} T

(B) $2\sqrt{2} \times 10^{-5}$ T

(C) 4×10^{-5} T

(D) $\sqrt{2} \times 10^{-5}$ T

Q22. A galvanometer of resistance $G = 99\ \Omega$ gives a full-scale deflection for a current $I_g = 1$ mA. To convert it into an ammeter reading up to $I = 100$ mA, the shunt resistance to be connected in parallel is:

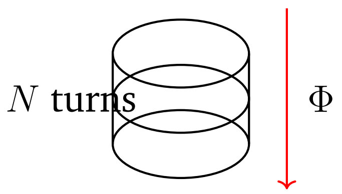
(A) $99\ \Omega$

(B) $0.5\ \Omega$

(C) $1\ \Omega$

(D) $9.9\ \Omega$

Q23. The magnetic flux through each turn of a coil of $N = 200$ turns changes uniformly from 0.04 Wb to 0.01 Wb in a time of 0.6 s, as suggested below. The magnitude of the emf induced in the coil is:



(A) 10 V

(B) 5 V

(C) 20 V

(D) 1 V

Q24. The voltage of the AC mains supply is quoted as 220 V (rms). The peak value V_0 of this voltage is approximately:

(A) 220 V

(B) 156 V

(C) 440 V

(D) 311 V

Q25. Electromagnetic waves travel in vacuum with a speed $c = \dfrac{1}{\sqrt{\mu_0 \varepsilon_0}}$. The order of magnitude of this speed is:

(A) 3×10^6 m s^{-1}

(B) 3×10^{10} m s^{-1}

(C) 3×10^8 m s^{-1}

(D) 1.5×10^8 m s^{-1}

Q26. An object is placed 30 cm in front of a concave mirror of focal length 20 cm. The distance of the image from the mirror is:

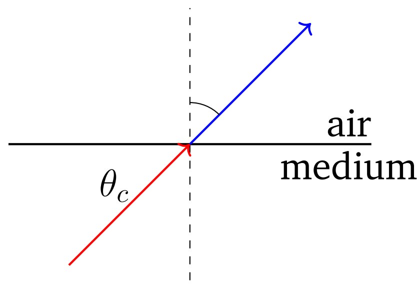
(A) 12 cm

(B) 60 cm

(C) 20 cm

(D) 30 cm

Q27. Light travels inside a transparent medium of refractive index $n = \sqrt{2}$ and meets the boundary with air ($n = 1$), as shown. The critical angle for total internal reflection at this boundary is:



(A) 45°

(B) 30°

(C) 60°

(D) 90°

Q28. In Young's double-slit experiment, light of wavelength $\lambda = 600$ nm illuminates two slits separated by $d = 0.3$ mm, and the fringes are observed on a screen $D = 1.5$ m away. The fringe width is:

(A) 1.5 mm

(B) 6 mm

(C) 0.3 mm

(D) 3 mm

Q29. Unpolarised light of intensity I_0 passes through two ideal polaroids whose transmission axes make an angle of 60° with each other. The intensity of the light emerging from the second polaroid is:

(A) $\frac{I_0}{2}$

(B) $\frac{I_0}{8}$

(C) $\frac{I_0}{4}$

(D) $\frac{3I_0}{8}$

Q30. Light of wavelength $\lambda = 400$ nm is incident on a metal of work function $\phi = 1.9$ eV. The stopping potential for the emitted photoelectrons is approximately $(hc = 1240$ eV nm$)$:

(A) 3.1 V

(B) 1.9 V

(C) 1.2 V

(D) 0.6 V

Q31. In the hydrogen atom (ground-state energy -13.6 eV), the energy of the photon emitted in the transition from $n = 3$ to $n = 2$ is approximately:

(A) 1.89 eV

(B) 3.40 eV

(C) 10.2 eV

(D) 12.1 eV

Q32. The half-life of a radioactive sample is 4 years. The time taken for its activity to fall to $\frac{1}{16}$ of the initial value is:

(A) 8 years

(B) 4 years

(C) 64 years

(D) 16 years

Q33. A certain nucleus has a mass defect of $\Delta m = 0.2$ u. Taking $1\ \text{u}\,c^2 = 931$ MeV, the binding energy of the nucleus is approximately:

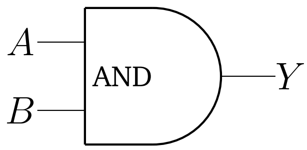
(A) 93.1 MeV

(B) 186 MeV

(C) 9.31 MeV

(D) 466 MeV

Q34. For the logic gate shown (a two-input AND gate), the output Y when both inputs are $A = 1$ and $B = 1$ is:



(A) 1

(B) 0

(C) undefined

(D) the complement of A

Q35. When a p–n junction diode is reverse biased, the width of the depletion region and the current through the diode behave as:

(A) the width decreases and a large current flows

(B) the width is unchanged and a large current flows

(C) the width decreases and only a negligible current flows

(D) the width increases and only a negligible (reverse saturation) current flows

Detailed Solutions

Q1.

Solution

Concept — Combination of errors: For $Z = \frac{x\,y}{u\,w}$ (all to the first power), the fractional errors add: $\frac{\Delta Z}{Z} = \frac{\Delta x}{x} + \frac{\Delta y}{y} + \frac{\Delta u}{u} + \frac{\Delta w}{w}$.

Step 1 — Identify the powers in $Y = \frac{FL}{A\,\Delta L}$: each of F, L, A, ΔL appears to the first power.

Step 2 — Add the percentage errors:

$$\frac{\Delta Y}{Y} = \frac{\Delta F}{F} + \frac{\Delta L}{L} + \frac{\Delta A}{A} + \frac{\Delta(\Delta L)}{\Delta L} = 1\% + 1\% + 3\% + 4\% = 9\%.$$

Why other options are wrong:

- (A) 4% counts only the largest single error.
- (C) 7% drops one of the contributions.
- (D) 11% over-counts (e.g. doubling a term).

Final Answer: Maximum error in Y is $9\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Dimensions of B: From the magnetic force $F = qvB$, we have $B = \frac{F}{qv}$.

Step 1 — Substitute the dimensions: $[F] = [\text{M L T}^{-2}]$, $[q] = [\text{A T}]$, $[v] = [\text{L T}^{-1}]$.

$$[B] = \frac{[\text{M L T}^{-2}]}{[\text{A T}][\text{L T}^{-1}]} = \frac{[\text{M L T}^{-2}]}{[\text{A L T}^{0}]} = [\text{M T}^{-2}\text{A}^{-1}].$$

Step 2 — Note the SI unit: 1 tesla $= 1\ \text{kg}\,\text{s}^{-2}\text{A}^{-1}$, consistent with $[\text{M T}^{-2}\text{A}^{-1}]$.

Why other options are wrong:

- (A) $[\text{M L T}^{-2}\text{A}^{-1}]$ keeps an extra factor of length (this is the dimension of force per unit current per unit length).

- (B) carries an $[\mathrm{L\,T^{-1}}]$ that does not belong; (D) carries an L^2 that does not belong.

Final Answer: $[B] = [\mathrm{M\,T^{-2}A^{-1}}] \Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Conservation of momentum: The gun-bullet system starts at rest, so the total momentum stays zero: $m_g V_g + m_b v_b = 0$.

Step 1 — Solve for the recoil speed:

$$|V_g| = \frac{m_b v_b}{m_g} = \frac{0.020 \times 400}{4} = \frac{8}{4} = 2\ \mathrm{m\,s^{-1}}.$$

Step 2 — Direction: The gun recoils opposite to the bullet.

Why other options are wrong:

- (B) 4 forgets to convert 20 g to 0.02 kg or uses the wrong mass.
- (C),(D) come from arithmetic slips in the mass ratio.

Final Answer: Recoil velocity $= 2\ \mathrm{m\,s^{-1}} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Motion on a rough incline: The net acceleration down the plane is $a = g(\sin\theta - \mu\cos\theta)$.

Step 1 — Insert $\theta = 30^\circ$, $\mu = \dfrac{1}{2\sqrt{3}}$: $\sin 30^\circ = \frac{1}{2}$, $\cos 30^\circ = \frac{\sqrt{3}}{2}$, so

$$\mu\cos\theta = \frac{1}{2\sqrt{3}} \cdot \frac{\sqrt{3}}{2} = \frac{1}{4}.$$

Step 2 — Compute a:

$$a = 10\left(\tfrac{1}{2} - \tfrac{1}{4}\right) = 10 \times \tfrac{1}{4} = 2.5\ \mathrm{m\,s^{-2}}.$$

Why other options are wrong:

- (A) 5 m s^{-2} is the frictionless value $g\sin\theta$, ignoring friction.
- (B),(C) use an incorrect value of $\mu\cos\theta$.

Final Answer: $a = 2.5$ m s^{-2} $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Time of flight of a projectile: $T = \dfrac{2u\sin\theta}{g}$.

Step 1 — Substitute $u = 20$ m s^{-1}, $\theta = 30°$:

$$T = \frac{2\times 20\times \sin 30°}{10} = \frac{2\times 20\times 0.5}{10} = \frac{20}{10} = 2 \text{ s}.$$

Why other options are wrong:

- (A) 1 s is the time to reach the maximum height (half of T).
- (B) 4 s would need $\sin\theta = 1$ ($\theta = 90°$); (D) 0.5 is far too small.

Final Answer: $T = 2$ s $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Power at constant speed: To raise a load at constant speed the motor's force equals the weight mg, so $P = Fv = mgv$.

Step 1 — Substitute:

$$P = mgv = 50\times 10\times 4 = 2000 \text{ W}.$$

Why other options are wrong:

- (A) 1000 uses $v = 2$ m s^{-1} or drops a factor of 2.
- (C),(D) drop a factor of g or v.

Final Answer: $P = 2000$ W $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Perfectly inelastic collision: The bodies stick together. Momentum is conserved; the fraction of KE lost depends on the mass ratio.

Step 1 — Common velocity after collision:

$$mv = (m + 3m)V \Rightarrow V = \frac{v}{4}.$$

Step 2 — Compare kinetic energies:

$$K_i = \tfrac{1}{2}mv^2, \qquad K_f = \tfrac{1}{2}(4m)\left(\frac{v}{4}\right)^2 = \tfrac{1}{2}(4m)\frac{v^2}{16} = \tfrac{1}{2}mv^2 \cdot \frac{1}{4} = \frac{K_i}{4}.$$

Step 3 — Fraction lost:

$$\frac{K_i - K_f}{K_i} = 1 - \frac{1}{4} = \frac{3}{4}.$$

Why other options are wrong:

- (B) $1/4$ is the fraction *retained*, not lost.
- (C),(D) use the wrong mass ratio.

Final Answer: Fraction of KE lost $= 3/4 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Variation of g with small height: $g' = g\left(1 + \frac{h}{R}\right)^{-2} \approx g\left(1 - \frac{2h}{R}\right)$ for $h \ll R$ (binomial approximation).

Step 1 — Find the change: $\Delta g = g - g' = g \cdot \frac{2h}{R}$.

Step 2 — Fractional decrease:

$$\frac{\Delta g}{g} = \frac{2h}{R}.$$

Why other options are wrong:

- (A) h/R drops the factor of 2 from the $(\cdot)^{-2}$ expansion.
- (B) $h/2R$ inverts the factor; (C) h^2/R^2 is a higher-order term, negligible here.

Final Answer: $\frac{\Delta g}{g} = \frac{2h}{R} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Escape vs orbital velocity: For a body near the Earth's surface, $v_o = \sqrt{\frac{GM}{R}}$ and $v_e = \sqrt{\frac{2GM}{R}}$.

Step 1 — Take the ratio:

$$\frac{v_e}{v_o} = \sqrt{\frac{2GM/R}{GM/R}} = \sqrt{2}.$$

Step 2 — Hence: $v_e = \sqrt{2}\, v_o$. (Numerically, $v_o \approx 7.9$ km s^{-1} and $v_e \approx 11.2$ km s^{-1}, and $11.2/7.9 \approx \sqrt{2}$.)

Why other options are wrong:

- (A) treats the two speeds as equal.
- (C) $2v_o$ over-states the factor; (D) inverts the relation.

Final Answer: $v_e = \sqrt{2}\, v_o \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Elongation of a wire: $\Delta\ell = \frac{FL}{AY} = \frac{FL}{\pi r^2 Y}$, so $\Delta\ell \propto \frac{F}{r^2}$ (for fixed L and material).

Step 1 — Original wire: $\ell = \frac{FL}{\pi r^2 Y}$.

Step 2 — New wire ($F \to 2F$, $r \to r/2$, same L):

$$\Delta\ell' = \frac{(2F)L}{\pi(r/2)^2Y} = \frac{2F\,L}{\pi(r^2/4)Y} = \frac{8FL}{\pi r^2Y} = 8\ell.$$

Why other options are wrong:

- (A) 2ℓ counts only the load change.
- (B) 4ℓ counts only the radius change.
- (D) ℓ ignores both changes.

Final Answer: Elongation $= 8\ell \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Torricelli's law: The speed of efflux from a hole at depth h below the free surface is $v = \sqrt{2gh}$ (Bernoulli's theorem applied between the surface and the hole).

Step 1 — Substitute $h = 0.8$ m, $g = 10$ m s^{-2}:

$$v = \sqrt{2 \times 10 \times 0.8} = \sqrt{16} = 4 \text{ m s}^{-1}.$$

Why other options are wrong:

- (A) 2 takes $\sqrt{gh}$ without the factor 2.
- (B) 8 uses $2gh$ without the square root; (C) 16 is the value of $2gh$ itself.

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

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Sharing of charge on contact: Two identical conducting spheres that touch share the total charge equally; then apply Coulomb's law.

Step 1 — Initial force: $F = \dfrac{k(5q)(q)}{r^2} = \dfrac{5kq^2}{r^2}$.

Step 2 — After contact: total charge $= 5q + q = 6q$, so each sphere carries $3q$. New force:

$$F' = \frac{k(3q)(3q)}{r^2} = \frac{9kq^2}{r^2}.$$

Step 3 — Take the ratio:

$$\frac{F'}{F} = \frac{9kq^2/r^2}{5kq^2/r^2} = \frac{9}{5} \Rightarrow F' = \frac{9F}{5}.$$

Why other options are wrong:

- (B) $5F/9$ inverts the ratio.
- (C) F assumes no change; (D) $F/5$ uses only one sphere's charge.

Final Answer: $F' = \dfrac{9F}{5} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Field on the equatorial line of a dipole: For $r \gg$ dipole length, the equatorial field is $E_{\text{eq}} = \dfrac{kp}{r^3}$, directed antiparallel to $\vec{p}$.

Step 1 — Recall the two standard results: axial field $E_{\text{axial}} = \dfrac{2kp}{r^3}$; equatorial field $E_{\text{eq}} = \dfrac{kp}{r^3}$ — exactly half the axial value.

Step 2 — Select the equatorial expression: the point P lies on the perpendicular bisector, so $E = \dfrac{kp}{r^3}$.

Why other options are wrong:

- (A) $2kp/r^3$ is the *axial* field.
- (B) zero is wrong — the two half-fields add along the axis, they do not cancel.

- (D) kp/r^2 has the wrong power of r (that is a point-charge dependence).

Final Answer: $E = \dfrac{kp}{r^3} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

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

Step 1 — Double both A and d:

$$C' = \frac{\varepsilon_0(2A)}{(2d)} = \frac{\varepsilon_0 A}{d} = C.$$

The two factors of 2 cancel.

Why other options are wrong:

- (A) $4C$ would need only the area to change.
- (C) $2C$ changes one quantity only; (D) $C/2$ changes the separation only.

Final Answer: $C' = C$ (unchanged) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Work and potential difference: The work done in moving a charge q from a point at potential V_1 to one at V_2 is $W = q(V_1 - V_2)$ (the work done *on* the charge by the agent against the field equals this for the convention adopted here).

Step 1 — Substitute $q = 3$ C, $V_1 = 20$ V, $V_2 = 8$ V:

$$W = 3 \times (20 - 8) = 3 \times 12 = 36 \text{ J}.$$

Why other options are wrong:

- (B) 24 uses a charge of 2 C.
- (C) 60 uses V_1 alone (3×20); (D) 4 divides instead of multiplying.

Final Answer: $W = 36$ J $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept — Series vs parallel of identical resistors: For n equal resistors R: series gives $R_s = nR$ (maximum); parallel gives $R_p = \frac{R}{n}$ (minimum).

Step 1 — Form the ratio:

$$\frac{R_s}{R_p} = \frac{nR}{R/n} = n \times n = n^2.$$

Why other options are wrong:

- (A) n uses only the series factor.
- (B) $1/n^2$ inverts the ratio; (C) $1/n$ inverts the series factor.

Final Answer: $\frac{R_{\text{max}}}{R_{\text{min}}} = n^2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Mixed series-parallel network: First combine the parallel pair, add the series resistor, then apply Ohm's law.

Step 1 — Parallel pair ($4\ \Omega \parallel 4\ \Omega$):

$$R_{\parallel} = \frac{4 \times 4}{4 + 4} = \frac{16}{8} = 2\ \Omega.$$

Step 2 — Add the series $6\ \Omega$: $R_{\text{eq}} = 6 + 2 = 8\ \Omega$.

Step 3 — Current from the cell:

$$I = \frac{V}{R_{\text{eq}}} = \frac{16}{8} = 2\ \text{A}.$$

Why other options are wrong:

- (A) 1 A uses $R_{\text{eq}} = 16\ \Omega$ (treats the pair as series).
- (C) 4 A ignores the $6\ \Omega$; (D) 8 A uses $R_{\text{eq}} = 2\ \Omega$.

Final Answer: $I = 2\text{ A} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Resistance on folding: $R = \frac{\rho L}{A}$. Folding the wire at its midpoint halves the length and doubles the cross-section.

Step 1 — Apply both changes: $L \to L/2$ and $A \to 2A$, so

$$R' = \frac{\rho(L/2)}{2A} = \frac{\rho L}{4A} = \frac{R}{4}.$$

Step 2 — Equivalent view: The two halves are two equal resistors $R/2$ in parallel, giving $\frac{(R/2)}{2} = \frac{R}{4}$ ✓.

Why other options are wrong:

- (A) $2R$ and (D) $4R$ increase the resistance, but folding lowers it.
- (B) $R/2$ accounts for the length only, not the doubled area.

Final Answer: $R' = \frac{R}{4} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Magnetic Lorentz force: $F = qvB\sin\theta$.

Step 1 — Substitute $q = 2$ C, $v = 3$ m s^{-1}, $B = 4$ T, $\theta = 30°$:

$$F = 2 \times 3 \times 4 \times \sin 30° = 24 \times \tfrac{1}{2} = 12\text{ N}.$$

Why other options are wrong:

- (B) 24 forgets the $\sin 30°$ factor.
- (C) 6 uses $\sin\theta = \frac{1}{4}$; (D) 20.8 wrongly uses $\sin 60°$ or $\cos 30°$.

Final Answer: $F = 12\text{ N} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Field at the centre of a semicircular arc: A full loop gives $B = \frac{\mu_0 I}{2r}$; a semicircle (half the loop) gives exactly half, $B = \frac{\mu_0 I}{4r}$. (The straight lead wires pass through the centre and contribute nothing.)

Step 1 — Substitute $I = 4$ A, $r = 0.2$ m:

$$B = \frac{\mu_0 I}{4r} = \frac{(4\pi \times 10^{-7})(4)}{4(0.2)} = \frac{16\pi \times 10^{-7}}{0.8} = 20\pi \times 10^{-7} = 2\pi \times 10^{-6}\ \text{T}.$$

Why other options are wrong:

- (A) $4\pi \times 10^{-6}$ uses the *full-loop* formula $\mu_0 I/2r$.
- (B) $\pi \times 10^{-6}$ halves the arc contribution once too often.
- (C) $8\pi \times 10^{-6}$ drops the factor r in the denominator.

Final Answer: $B = 2\pi \times 10^{-6}$ T $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Superposition of two perpendicular wires: Each long straight wire produces $B = \frac{\mu_0 I}{2\pi d}$ at perpendicular distance d. At the point $(0, 0, d)$ on the z-axis, both wires are at distance d, and their field vectors are mutually perpendicular, so they add as $\sqrt{B_1^2 + B_2^2}$.

Step 1 — Field of one wire:

$$B_1 = \frac{\mu_0 I}{2\pi d} = \frac{(4\pi \times 10^{-7})(10)}{2\pi(0.1)} = \frac{(2 \times 10^{-7})(10)}{0.1} = 2 \times 10^{-5}\ \text{T}.$$

Step 2 — Resultant of two equal perpendicular fields:

$$B = \sqrt{B_1^2 + B_1^2} = \sqrt{2}\, B_1 = 2\sqrt{2} \times 10^{-5}\ \text{T}.$$

Why other options are wrong:

- (A) 2×10^{-5} is just one wire's field.
- (C) 4×10^{-5} adds the magnitudes algebraically (ignores the right angle).

- (D) $\sqrt{2}\times10^{-5}$ halves one wire's field first.

Final Answer: $B = 2\sqrt{2}\times10^{-5}\ \text{T} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q21

Q22.

Solution

Concept — Shunting an ammeter: A shunt S in parallel with the galvanometer carries the excess current $(I - I_g)$ while the galvanometer takes I_g; the voltage across both is equal: $I_gG = (I - I_g)S$.

Step 1 — Solve for S:

$$S = \frac{I_gG}{I - I_g} = \frac{(1\ \text{mA})(99\ \Omega)}{(100-1)\ \text{mA}} = \frac{99}{99} = 1\ \Omega.$$

Why other options are wrong:

- (A) $99\ \Omega$ is the galvanometer resistance, not the shunt.
- (B) 0.5 and (D) 9.9 come from using the wrong current difference.

Final Answer: $S = 1\ \Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Faraday's law for a coil: $|\varepsilon| = N\dfrac{|\Delta\Phi|}{\Delta t}$.

Step 1 — Change of flux: $|\Delta\Phi| = |0.01 - 0.04| = 0.03$ Wb.

Step 2 — Substitute $N = 200$, $\Delta t = 0.6$ s:

$$|\varepsilon| = 200 \times \frac{0.03}{0.6} = 200 \times 0.05 = 10\ \text{V}.$$

Why other options are wrong:

- (B) 5 uses $N = 100$ or doubles Δt.
- (C) 20 uses $\Delta t = 0.3$ s; (D) 1 omits the factor N partly.

Final Answer: $|\varepsilon| = 10\ \text{V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept — Peak vs rms voltage: For a sinusoidal supply, $V_0 = \sqrt{2}\,V_{\text{rms}}$.

Step 1 — Substitute $V_{\text{rms}} = 220$ V:

$$V_0 = \sqrt{2} \times 220 = 1.414 \times 220 \approx 311 \text{ V}.$$

Why other options are wrong:

- (A) 220 is the rms value itself.
- (B) 156 divides by $\sqrt{2}$ instead of multiplying.
- (C) 440 multiplies by 2 instead of $\sqrt{2}$.

Final Answer: $V_0 \approx 311 \text{ V} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Speed of light in vacuum: $c = \dfrac{1}{\sqrt{\mu_0 \varepsilon_0}}$.

Step 1 — Plug in the constants: $\mu_0 = 4\pi \times 10^{-7}$, $\varepsilon_0 = 8.85 \times 10^{-12}$ (SI),

$$\mu_0\varepsilon_0 \approx 1.11 \times 10^{-17}, \qquad c = \frac{1}{\sqrt{1.11 \times 10^{-17}}} \approx 3 \times 10^8 \text{ m s}^{-1}.$$

Why other options are wrong:

- (A) 3×10^6 and (B) 3×10^{10} misplace the power of ten.
- (D) 1.5×10^8 is roughly the speed of light *in glass*, not vacuum.

Final Answer: $c \approx 3 \times 10^8 \text{ m s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q25

Q26.

Solution

Concept — Mirror formula: $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$. For a concave mirror $f=-20$ cm; real object $u=-30$ cm.

Step 1 — Solve for v:

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-20}-\frac{1}{-30}=-\frac{1}{20}+\frac{1}{30}=\frac{-3+2}{60}=-\frac{1}{60}.$$

Step 2 — Image distance: $v=-60$ cm, i.e. 60 cm in front of the mirror (real image).

Why other options are wrong:

- (A) 12 comes from adding the reciprocals with wrong signs.
- (C) 20 is the focal length; (D) 30 just repeats the object distance.

Final Answer: $|v|=60$ cm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Critical angle: At the critical angle, $\sin\theta_c=\frac{n_{\text{rarer}}}{n_{\text{denser}}}=\frac{1}{n}$ (light going from the denser medium to air).

Step 1 — Substitute $n=\sqrt{2}$:

$$\sin\theta_c=\frac{1}{\sqrt{2}}\Rightarrow\theta_c=45^\circ.$$

Step 2 — Meaning: Rays striking the boundary at more than 45° undergo total internal reflection.

Why other options are wrong:

- (B) 30° gives $\sin\theta_c=0.5$, i.e. $n=2$.
- (C) 60° gives $n=2/\sqrt{3}$; (D) 90° would mean $n=1$ (no refraction interface).

Final Answer: $\theta_c=45^\circ\Rightarrow\boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept — Fringe width in YDSE: $\beta = \dfrac{\lambda D}{d}$.

Step 1 — Convert and substitute: $\lambda = 600$ nm $= 6 \times 10^{-7}$ m, $D = 1.5$ m, $d = 0.3$ mm $= 3 \times 10^{-4}$ m.

$$\beta = \frac{(6 \times 10^{-7})(1.5)}{3 \times 10^{-4}} = \frac{9 \times 10^{-7}}{3 \times 10^{-4}} = 3 \times 10^{-3} \text{ m} = 3 \text{ mm}.$$

Why other options are wrong:

- (A) 1.5 uses $\lambda = 300$ nm or $D = 0.75$ m.
- (B) 6 doubles the result; (C) 0.3 misplaces a power of ten.

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

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Polaroid pair (Malus's law): The first polaroid transmits half the unpolarised intensity; the second applies $I = I_1 \cos^2\theta$.

Step 1 — After the first polaroid: $I_1 = \dfrac{I_0}{2}$.

Step 2 — After the second (axes at $60°$):

$$I = I_1 \cos^2 60° = \frac{I_0}{2}\left(\frac{1}{2}\right)^2 = \frac{I_0}{2} \cdot \frac{1}{4} = \frac{I_0}{8}.$$

Why other options are wrong:

- (A) $I_0/2$ stops after the first polaroid.
- (C) $I_0/4$ uses $\theta = 45°$; (D) $3I_0/8$ would use $\cos^2 30°$.

Final Answer: $I = \dfrac{I_0}{8} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Einstein's photoelectric equation: $eV_s = \frac{hc}{\lambda} - \phi$, where V_s is the stopping potential.

Step 1 — Photon energy: $E = \frac{hc}{\lambda} = \frac{1240}{400} = 3.1$ eV.

Step 2 — Stopping potential: $eV_s = 3.1 - 1.9 = 1.2$ eV $\Rightarrow V_s = 1.2$ V.

Why other options are wrong:

- (A) 3.1 is the photon energy, not the stopping potential.
- (B) 1.9 is the work function; (D) 0.6 halves the correct value.

Final Answer: $V_s \approx 1.2$ V $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept — Hydrogen energy levels: $E_n = -\frac{13.6}{n^2}$ eV; the emitted photon energy is $E = E_{\text{higher}} - E_{\text{lower}}$ in magnitude.

Step 1 — Energies of the levels: $E_2 = -\frac{13.6}{4} = -3.40$ eV, $E_3 = -\frac{13.6}{9} = -1.51$ eV.

Step 2 — Transition $3 \to 2$**:**

$$E = E_3 - E_2 = -1.51 - (-3.40) = 1.89 \text{ eV}.$$

Why other options are wrong:

- (B) 3.40 is $|E_2|$ alone.
- (C) 10.2 is the $2 \to 1$ transition; (D) 12.1 is the $3 \to 1$ transition.

Final Answer: $E \approx 1.89$ eV (H_α line) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q31

Q32.

Solution

Concept — Decay in half-lives: Activity falls by a factor $\frac{1}{2}$ every half-life; after n half-lives it is $\left(\frac{1}{2}\right)^n$ of the initial value.

Step 1 — Find n for a factor $\frac{1}{16}$: $\left(\frac{1}{2}\right)^n = \dfrac{1}{16} = \left(\frac{1}{2}\right)^4 \Rightarrow n = 4.$

Step 2 — Convert to time: $t = n\,T_{1/2} = 4 \times 4 = 16$ years.

Why other options are wrong:

- (A) 8 years is only 2 half-lives (factor $\frac{1}{4}$).
- (B) 4 is one half-life; (C) 64 multiplies instead of using $n = 4$.

Final Answer: $t = 16$ years $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Mass–energy equivalence: The binding energy equals the mass defect times c^2: $E_B = \Delta m\, c^2$, using $1\ \text{u}\, c^2 = 931$ MeV.

Step 1 — Substitute $\Delta m = 0.2$ u:

$$E_B = 0.2 \times 931 = 186.2 \approx 186\ \text{MeV}.$$

Why other options are wrong:

- (A) 93.1 uses $\Delta m = 0.1$ u.
- (C) 9.31 misplaces a power of ten; (D) 466 uses $\Delta m = 0.5$ u.

Final Answer: $E_B \approx 186$ MeV $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — AND gate: The output of a two-input AND gate is $Y = A \cdot B$; it is 1 only when *both* inputs are 1.

Step 1 — Apply the truth table: with $A = 1$ and $B = 1$,

$$Y = 1 \cdot 1 = 1.$$

Why other options are wrong:

- (B) 0 would be the output of a NAND gate (AND with a bubble) for these inputs.
- (C),(D) a logic gate gives a definite value fixed by its truth table, here 1.

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

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Reverse-biased p–n junction: In reverse bias the external field aids the built-in barrier field, pulling majority carriers away from the junction.

Step 1 — Effect on the depletion layer: More immobile ions are exposed, so the depletion region *widens* and the barrier potential increases.

Step 2 — Current: Only a very small reverse saturation current flows (due to minority carriers); it is essentially negligible until breakdown.

Why other options are wrong:

- (A),(B) a large current flowing is the *forward*-bias behaviour.
- (C) the width increases, it does not decrease, under reverse bias.

Final Answer: Width increases; only negligible current flows $\Rightarrow \boxed{D}$

Answer: (D) 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	B	7	A	8	D	9	B	10	C
11	D	12	A	13	C	14	B	15	A
16	D	17	B	18	C	19	A	20	D
21	B	22	C	23	A	24	D	25	C
26	B	27	A	28	D	29	B	30	C
31	A	32	D	33	B	34	A	35	D