SRMJEEE Physics Sample Paper – 10

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. While measuring the diameter of a wire with a screw gauge of pitch 1 mm and 100 divisions on the circular scale, the instrument shows a *positive* zero error of 5 circular-scale divisions. The actual reading is main scale 2 mm and circular scale 35 divisions. The corrected diameter of the wire is:

(A) 2.40 mm

(B) 2.30 mm

(C) 2.35 mm

(D) 2.05 mm

Q2. Which of the following pairs of physical quantities has the *same* dimensional formula?

(A) Pressure and energy density

(B) Force and momentum

(C) Power and energy

(D) Work and force

Q3. Water from a horizontal pipe of cross-sectional area 5×10^{-4} m^2 strikes a wall normally with a speed of 20 m s^{-1} and does not rebound. Taking the density of water as 10^3 kg m^{-3}, the force exerted on the wall is:

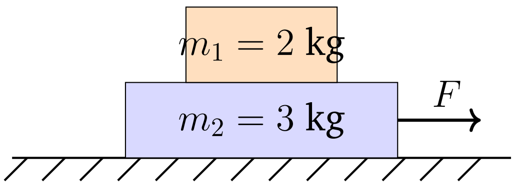
(A) 100 N

(B) 50 N

(C) 200 N

(D) 400 N

Q4. A block of mass $m_1 = 2$ kg rests on top of a block of mass $m_2 = 3$ kg, which lies on a frictionless floor, as shown. The coefficient of friction between the two blocks is $\mu = 0.4$. A horizontal force F is applied to the *lower* block. Taking $g = 10$ m s^{-2}, the maximum value of F for which the upper block does *not* slip on the lower block is:



(A) 8 N

(B) 12 N

(C) 24 N

(D) 20 N

Q5. A car covers the first half of a straight journey at 30 km h^{-1} and the second half (of equal distance) at 60 km h^{-1}. The average speed for the whole journey is:

(A) 40 km h^{-1}

(B) 45 km h^{-1}

(C) 50 km h^{-1}

(D) 35 km h^{-1}

Q6. A child of mass m starts from rest and slides down a smooth (frictionless) slide of vertical height 5 m. Taking $g = 10$ m s^{-2}, the speed of the child at the bottom of the slide is:

(A) 5 m s^{-1}

(B) 10 m s^{-1}

(C) 50 m s^{-1}

(D) 100 m s^{-1}

Q7. A man of mass 60 kg standing on a stationary boat of mass 120 kg floating on still water jumps off horizontally with a speed of 4 m s^{-1} relative to the water. Neglecting water resistance, the recoil speed of the boat is:

(A) 4 m s^{-1}

(B) 1 m s^{-1}

(C) 2 m s^{-1}

(D) 8 m s^{-1}

Q8. Two planets have mean densities in the ratio $\rho_1 : \rho_2 = 1 : 2$ and radii in the ratio $R_1 : R_2 = 2 : 1$. Using $g = \frac{4}{3}\pi G\rho R$, the ratio of the accelerations due to gravity on their surfaces $g_1 : g_2$ is:

(A) $2 : 1$

(B) $1 : 4$

(C) $4 : 1$

(D) $1 : 1$

Q9. Two planets revolve around the Sun in circular orbits of radii r and $4r$ respectively. The ratio of the orbital period of the inner planet to that of the outer planet is:

(A) $1 : 8$

(B) $1 : 4$

(C) $1 : 2$

(D) $1 : 16$

Q10. A steel wire of cross-sectional area 2×10^{-6} m^2 and Young's modulus 2×10^{11} N m^{-2} is to be stretched to a strain of 0.001. The force that must be applied to the wire is:

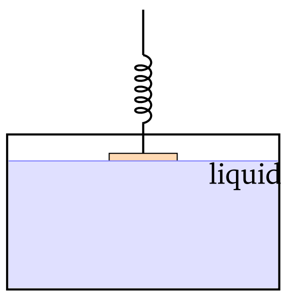
(A) 200 N

(B) 400 N

(C) 800 N

(D) 100 N

Q11. A solid block weighs 5 N in air. When it is fully immersed in a liquid while hanging from a spring balance, as shown, the balance reads 3.5 N. The buoyant force (upthrust) exerted by the liquid on the block is:



(A) 5 N

(B) 3.5 N

(C) 1.5 N

(D) 8.5 N

Q12. A body acquires a positive charge of $1.6\ \mu$C. Taking the magnitude of the electronic charge as 1.6×10^{-19} C, the number of electrons that must be removed from the body is:

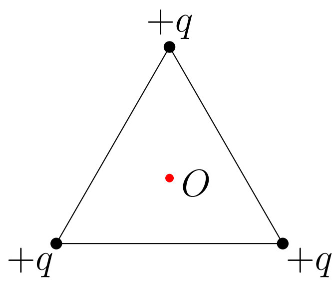
(A) 1×10^{12}

(B) 1.6×10^{13}

(C) 1×10^{19}

(D) 1×10^{13}

Q13. Three equal positive point charges $+q$ are fixed at the vertices of an equilateral triangle, as shown. The net electric field produced by them at the centroid O of the triangle is:



(A) zero

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

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

(D) $\dfrac{\sqrt{3}\,kq}{a^2}$

Q14. A capacitor of capacitance $5\ \mu$F is connected across a battery of 20 V. The charge stored on the capacitor is:

(A) $4\ \mu$C

(B) $100\ \mu$C

(C) $25\ \mu$C

(D) $0.25\ \mu$C

Q15. An external agent moves a charge of 4 C from a point at potential 2 V to a point at potential 7 V. The work done by the agent is:

(A) 28 J

(B) 8 J

(C) 20 J

(D) 36 J

Q16. Three identical cells, each of emf 2 V and internal resistance $0.5\ \Omega$, are connected in series across an external resistor of $1.5\ \Omega$. The current in the circuit is:

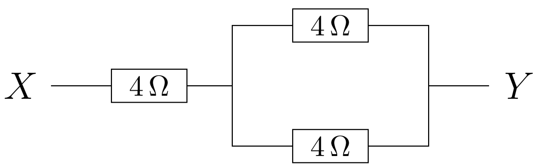
(A) 4 A

(B) 1 A

(C) 1.5 A

(D) 2 A

Q17. In the network shown, three resistors of $4\ \Omega$, $4\ \Omega$ and $4\ \Omega$ are connected between terminals X and Y: two of them are in parallel and the third is in series with that combination. The equivalent resistance across X and Y is:



(A) $6\ \Omega$

(B) $12\ \Omega$

(C) $2\ \Omega$

(D) $8\ \Omega$

Q18. A wire of length 2 m and uniform cross-sectional area $1 \times 10^{-6}\ m^2$ is made of a material of resistivity $5 \times 10^{-7}\ \Omega\,m$. The resistance of the wire is:

(A) $0.5\ \Omega$

(B) $1\ \Omega$

(C) $2\ \Omega$

(D) $0.25\ \Omega$

Q19. A straight wire of length 0.5 m carrying a current of 4 A is placed in a uniform magnetic field of 0.2 T, with the wire making an angle of 30° with the field. The magnitude of the force on the wire is:

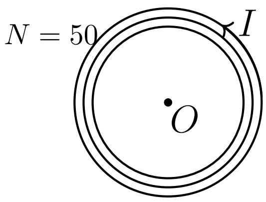
(A) 0.4 N

(B) 0.8 N

(C) 0.2 N

(D) 0.1 N

Q20. A flat circular coil of 50 turns and radius 0.1 m carries a current of 1 A, as shown. The magnitude of the magnetic field at the centre O of the coil is $\left(\mu_0 = 4\pi \times 10^{-7}\ \text{T m A}^{-1}\right)$:



(A) $2\pi \times 10^{-4}$ T

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

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

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

Q21. At a certain place the horizontal component of the Earth's magnetic field is B_H and the vertical component is $B_V = \sqrt{3}\,B_H$. The angle of dip δ at that place is:

(A) 60°

(B) 30°

(C) 45°

(D) 90°

Q22. The magnetic field B inside a magnetised material is related to the magnetic intensity H and the intensity of magnetisation M by:

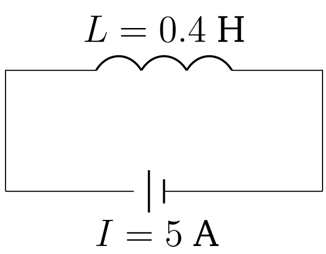
(A) $B = \mu_0 HM$

(B) $B = \mu_0(H + M)$

(C) $B = \mu_0(H - M)$

(D) $B = \dfrac{\mu_0 H}{M}$

Q23. An inductor of inductance 0.4 H carries a steady current of 5 A in the circuit shown. The energy stored in the magnetic field of the inductor is:



(A) 2 J

(B) 10 J

(C) 5 J

(D) 1 J

Q24. A pure capacitor of capacitance $C = \dfrac{10^{-3}}{\pi}$ F is connected to a 50 Hz AC source of rms voltage 20 V. The rms current drawn from the source is:

(A) 0.5 A

(B) 1 A

(C) 4 A

(D) 2 A

Q25. Arrange the following electromagnetic radiations in order of *increasing* wavelength: X-rays, visible light, microwaves, ultraviolet rays.

(A) X-rays $<$ ultraviolet $<$ visible $<$ microwaves

(B) microwaves < visible < ultraviolet < X-rays

(C) visible < X-rays < ultraviolet < microwaves

(D) ultraviolet < X-rays < visible < microwaves

Q26. An object is placed at the centre of curvature of a concave mirror of focal length 15 cm. The magnification produced by the mirror is:

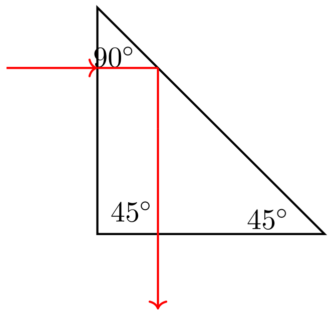
(A) $+1$

(B) -1

(C) -2

(D) -0.5

Q27. A right-angled isosceles glass prism (angles $45°$–$45°$–$90°$, refractive index 1.5) is used in a periscope, as shown. A ray of light enters one face normally, strikes the hypotenuse, and is then turned through $90°$. The phenomenon responsible for this turning is:



(A) dispersion

(B) diffraction

(C) total internal reflection

(D) polarisation

Q28. In an interference pattern, two waves of the same frequency meet at a point with a path difference of $\frac{\lambda}{2}$. The corresponding phase difference between them, and the nature of interference at that point, are:

(A) $\frac{\pi}{2}$, constructive

(B) 2π, constructive

(C) π, constructive

(D) π, destructive

Q29. Plane-polarised light of intensity I_0 is incident on a polaroid. For the transmitted intensity to be exactly $\frac{I_0}{2}$, the angle between the plane of polarisation of the incident light and the transmission axis of the polaroid must be:

(A) $45°$

(B) $60°$

(C) $30°$

(D) $90°$

Q30. The work function of a metal is 3.3×10^{-19} J. Taking Planck's constant $h = 6.6 \times 10^{-34}$ J s, the threshold frequency of the metal is:

(A) 2×10^{14} Hz

(B) 5×10^{14} Hz

(C) 2×10^{15} Hz

(D) 5×10^{15} Hz

Q31. For the hydrogen spectrum, taking the Rydberg constant $R = 1.1 \times 10^7$ m^{-1}, the shortest wavelength (the series limit) of the Lyman series corresponds to a transition from $n = \infty$ to $n = 1$ and is approximately:

(A) 364 nm

(B) 122 nm

(C) 91 nm

(D) 656 nm

Q32. A radioactive sample contains 2×10^{20} nuclei, each with a decay constant of $\lambda = 1 \times 10^{-6}$ s^{-1}. The initial activity of the sample is:

(A) 2×10^{26} decays s^{-1}

(B) 1×10^{14} decays s^{-1}

(C) 2×10^{12} decays s^{-1}

(D) 2×10^{14} decays s^{-1}

Q33. The binding energy per nucleon is about 7.6 MeV for a nucleus P (mass number ≈ 56) and about 7.1 MeV for a nucleus Q (mass number ≈ 12). Which statement is correct?

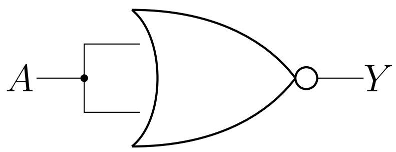
(A) P is more stable than Q

(B) Q is more stable than P

(C) both are equally stable

(D) stability cannot be compared from these data

Q34. In the circuit shown, both inputs of a NOR gate are joined together and fed with the same signal A, so the gate behaves as a NOT gate. When $A = 1$, the output Y is:



(A) 1

(B) 0

(C) equal to A

(D) undefined

Q35. In an extrinsic semiconductor, the majority charge carriers in an n-type material and in a p-type material are, respectively:

(A) holes and electrons

(B) electrons and electrons

(C) electrons and holes

(D) holes and holes

Detailed Solutions

Q1.

Solution

Concept — Screw gauge with zero error: Least count $= \dfrac{\text{pitch}}{\text{circular divisions}}$. The corrected reading is the observed reading *minus* a positive zero error.

Step 1 — Least count: $\text{LC} = \dfrac{1 \text{ mm}}{100} = 0.01$ mm.

Step 2 — Observed reading: $2 \text{ mm} + 35 \times 0.01 \text{ mm} = 2.00 + 0.35 = 2.35$ mm.

Step 3 — Correct for the positive zero error: Zero error $= +5 \times 0.01 = +0.05$ mm, which must be *subtracted*:

$$\text{diameter} = 2.35 - 0.05 = 2.30 \text{ mm}.$$

Why other options are wrong:

- (A) 2.40 *adds* the zero error instead of subtracting it.
- (C) 2.35 is the uncorrected observed reading.
- (D) 2.05 subtracts the full circular reading wrongly.

Final Answer: Corrected diameter $= 2.30$ mm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Comparing dimensions: Two quantities match only if their dimensional formulae are identical.

Step 1 — Pressure: $P = \dfrac{\text{force}}{\text{area}} = \dfrac{[\text{MLT}^{-2}]}{[\text{L}^2]} = [\text{ML}^{-1}\text{T}^{-2}]$.

Step 2 — Energy density: $u = \dfrac{\text{energy}}{\text{volume}} = \dfrac{[\text{ML}^2\text{T}^{-2}]}{[\text{L}^3]} = [\text{ML}^{-1}\text{T}^{-2}]$ — identical to pressure.

Why other options are wrong:

- (B) force $[\text{MLT}^{-2}]$ vs momentum $[\text{MLT}^{-1}]$ — differ by a factor of time.
- (C) power $[\text{ML}^2\text{T}^{-3}]$ vs energy $[\text{ML}^2\text{T}^{-2}]$ — differ.
- (D) work $[\text{ML}^2\text{T}^{-2}]$ vs force $[\text{MLT}^{-2}]$ — differ.

Final Answer: Pressure and energy density match ⇒ $\boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Force of a fluid jet: For a jet striking a wall normally and not rebounding, the force equals the rate of change of momentum, $F = \frac{dm}{dt}v = (\rho A v)\,v = \rho A v^2$.

Step 1 — Substitute the values:

$$F = \rho A v^2 = 10^3 \times (5 \times 10^{-4}) \times (20)^2.$$

Step 2 — Evaluate:

$$F = 10^3 \times 5 \times 10^{-4} \times 400 = 0.5 \times 400 = 200 \text{ N}.$$

Why other options are wrong:

- (A) 100 uses v instead of v^2 (one power of speed dropped).
- (B) 50 also misses a power of v and a factor.
- (D) 400 assumes the jet rebounds elastically (doubling the momentum change), which is not the case here.

Final Answer: $F = 200$ N ⇒ $\boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Two stacked blocks, force on the lower one: The only horizontal force on the *upper* block is friction from the lower block. The upper block does not slip as long as the friction it needs, $m_1 a$, does not exceed the maximum static friction $\mu m_1 g$. So the limiting common acceleration is $a_{\max} = \mu g$.

Step 1 — Maximum common acceleration:

$$a_{\max} = \mu g = 0.4 \times 10 = 4 \text{ m s}^{-2}.$$

Step 2 — Force on the whole system: Both blocks (total mass $m_1 + m_2 = 5$ kg) accelerate together on a frictionless floor:

$$F_{\max} = (m_1 + m_2)\, a_{\max} = 5 \times 4 = 20 \text{ N}.$$

Why other options are wrong:

- (A) 8 N uses only m_1; (B) 12 N uses only m_2.
- (C) 24 N uses μg with the wrong total mass / extra factor.

Final Answer: $F_{\max} = 20 \text{ N} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q4**

Q5.

Solution

Concept — Average speed for equal distances: When equal distances are covered at speeds v_1 and v_2, the average speed is the *harmonic* mean $\bar{v} = \dfrac{2v_1v_2}{v_1 + v_2}$.

Step 1 — Substitute:

$$\bar{v} = \frac{2 \times 30 \times 60}{30 + 60} = \frac{3600}{90} = 40 \text{ km h}^{-1}.$$

Step 2 — Note: The average speed is *not* the arithmetic mean 45 km h^{-1}, because more time is spent on the slower half.

Why other options are wrong:

- (B) 45 is the arithmetic mean, valid only for equal *times*.
- (C),(D) do not follow from the harmonic-mean formula.

Final Answer: $\bar{v} = 40 \text{ km h}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q5**

Q6.

Solution

Concept — Conservation of mechanical energy: On a frictionless slide, the loss of potential energy equals the gain in kinetic energy: $mgh = \frac{1}{2}mv^2$, so $v = \sqrt{2gh}$ (independent of mass and of the shape of the slide).

Step 1 — Substitute:

$$v = \sqrt{2 \times 10 \times 5} = \sqrt{100} = 10 \text{ m s}^{-1}.$$

Why other options are wrong:

- (A) 5 uses $v = \sqrt{gh}$, missing the factor 2.
- (C) $50 = 2gh$ is the value of v^2, not v.
- (D) 100 is $2gh$ without the square root.

Final Answer: $v = 10 \text{ m s}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Conservation of momentum (recoil): The man and boat start at rest, so the total momentum stays zero. The forward momentum of the man is balanced by the backward momentum of the boat.

Step 1 — Momentum balance: $m_{\text{man}}v_{\text{man}} = m_{\text{boat}}v_{\text{boat}}$.

$$60 \times 4 = 120 \times v_{\text{boat}}.$$

Step 2 — Solve:

$$v_{\text{boat}} = \frac{240}{120} = 2 \text{ m s}^{-1}.$$

Why other options are wrong:

- (A) 4 ignores the mass ratio (assumes equal masses).
- (B) 1 uses the wrong mass ratio; (D) 8 inverts the ratio.

Final Answer: $v_{\text{boat}} = 2 \text{ m s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Surface gravity in terms of density: $g = \frac{4}{3}\pi G\rho R$, so $g \propto \rho R$ (for fixed G).

Step 1 — Form the ratio:

$$\frac{g_1}{g_2} = \frac{\rho_1 R_1}{\rho_2 R_2} = \frac{1 \times 2}{2 \times 1} = \frac{2}{2} = 1.$$

Step 2 — Interpret: The larger radius of planet 1 exactly compensates for its smaller density, so $g_1 : g_2 = 1 : 1$.

Why other options are wrong:

- (A) $2 : 1$ keeps only the radius ratio; (B) $1 : 4$ squares one factor.
- (C) $4 : 1$ mishandles both ratios.

Final Answer: $g_1 : g_2 = 1 : 1 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Kepler's third law: $T^2 \propto r^3$, so $\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2}$.

Step 1 — Substitute $r_1 = r$, $r_2 = 4r$**:**

$$\frac{T_1}{T_2} = \left(\frac{r}{4r}\right)^{3/2} = \left(\frac{1}{4}\right)^{3/2} = \frac{1}{(4)^{3/2}} = \frac{1}{8}.$$

Step 2 — Result: $T_1 : T_2 = 1 : 8$ (the inner planet is faster).

Why other options are wrong:

- (B) $1 : 4$ uses $T \propto r$; (C) $1 : 2$ uses $T \propto r^{1/2}$.
- (D) $1 : 16$ uses $T \propto r^2$.

Final Answer: $T_1 : T_2 = 1 : 8 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Young's modulus and strain: $Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\text{strain}}$, so $F = Y \times A \times$ strain.

Step 1 — Substitute the values:

$$F = (2 \times 10^{11}) \times (2 \times 10^{-6}) \times (0.001).$$

Step 2 — Evaluate:

$$F = 2 \times 10^{11} \times 2 \times 10^{-6} \times 10^{-3} = 4 \times 10^2 = 400 \text{ N}.$$

Why other options are wrong:

- (A) 200 drops a factor of 2; (D) 100 drops a factor of 4.
- (C) 800 doubles the strain.

Final Answer: $F = 400 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Archimedes' principle: The apparent loss of weight of a body fully immersed in a liquid equals the buoyant force (upthrust) the liquid exerts: $F_B = W_{\text{air}} - W_{\text{apparent}}$.

Step 1 — Read the balances: $W_{\text{air}} = 5$ N, $W_{\text{apparent}} = 3.5$ N.

Step 2 — Upthrust:

$$F_B = 5 - 3.5 = 1.5 \text{ N}.$$

Why other options are wrong:

- (A) 5 is the full weight in air, not the upthrust.
- (B) 3.5 is the apparent weight in the liquid.
- (D) 8.5 wrongly *adds* the two readings.

Final Answer: $F_B = 1.5 \text{ N} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Quantisation of charge: A charge q corresponds to n electronic charges, $q = ne$, so $n = \frac{q}{e}$.

Step 1 — Substitute ($q = 1.6\ \mu$C $= 1.6 \times 10^{-6}$ C):

$$n = \frac{1.6 \times 10^{-6}}{1.6 \times 10^{-19}}.$$

Step 2 — Evaluate:

$$n = 10^{-6-(-19)} = 10^{13}.$$

Why other options are wrong:

- (A) 10^{12} misplaces a power of ten.
- (B) 1.6×10^{13} forgets to cancel the 1.6 factors.
- (C) 10^{19} inverts the exponent.

Final Answer: $n = 1 \times 10^{13} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Field at the centroid by symmetry: The three equal charges sit at the vertices of an equilateral triangle, all equidistant from the centroid. By symmetry their field vectors at the centroid are equal in magnitude and point at 120° to one another.

Step 1 — Vector sum of three equal vectors at 120°: Three equal vectors separated by 120° add to *zero*.

Step 2 — Conclusion: The net electric field at the centroid is zero. (The potential there, being a scalar, is not zero — but the field is.)

Why other options are wrong:

- (B),(C),(D) all assume the fields add rather than cancel; symmetry forces a complete cancellation.

Final Answer: Net field $= 0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Charge on a capacitor: $Q = CV$.

Step 1 — Substitute:

$$Q = (5\ \mu\text{F}) \times (20\ \text{V}) = 100\ \mu\text{C}.$$

Why other options are wrong:

- (A) $4\ \mu$C *divides* C by V.
- (C) $25\ \mu$C uses $V = 5$; (D) $0.25\ \mu$C inverts the relation.

Final Answer: $Q = 100\ \mu\text{C} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Work to move a charge through a potential difference: $W = q\,\Delta V = q(V_{\text{final}} - V_{\text{initial}})$.

Step 1 — Potential difference: $\Delta V = 7 - 2 = 5$ V.

Step 2 — Work done:

$$W = q\,\Delta V = 4 \times 5 = 20\ \text{J}.$$

Why other options are wrong:

- (A) 28 uses $V = 7$ alone; (D) 36 adds the potentials $(7 + 2)$.
- (B) 8 uses $V = 2$ alone.

Final Answer: $W = 20\ \text{J} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Cells in series: The emfs add and the internal resistances add, then $I = \dfrac{\sum \varepsilon}{R + \sum r}$.

Step 1 — Total emf and total internal resistance:

$$\sum \varepsilon = 3 \times 2 = 6\ \text{V}, \qquad \sum r = 3 \times 0.5 = 1.5\ \Omega.$$

Step 2 — Current:

$$I = \frac{6}{1.5 + 1.5} = \frac{6}{3} = 2\ \text{A}.$$

Why other options are wrong:

- (A) 4 ignores the internal resistances $(6/1.5)$.
- (B) 1 uses a single cell; (C) 1.5 misadds the resistances.

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

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Series–parallel reduction: First combine the two parallel $4\ \Omega$ resistors, then add the series $4\ \Omega$.

Step 1 — Parallel pair:

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

Step 2 — Add the series resistor:

$$R_{XY} = 4 + 2 = 6\ \Omega.$$

Why other options are wrong:

- (B) $12\ \Omega$ adds all three in series.
- (C) $2\ \Omega$ is only the parallel part, omitting the series $4\ \Omega$.
- (D) $8\ \Omega$ uses the wrong parallel value.

Final Answer: $R_{XY} = 6\ \Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Resistance from resistivity: $R = \dfrac{\rho L}{A}$.

Step 1 — Substitute the values:

$$R = \frac{(5 \times 10^{-7})(2)}{1 \times 10^{-6}}.$$

Step 2 — Evaluate:

$$R = \frac{10 \times 10^{-7}}{10^{-6}} = \frac{10^{-6}}{10^{-6}} = 1\ \Omega.$$

Why other options are wrong:

- (A) 0.5 drops the factor from the length.
- (C) 2 uses the length without the resistivity coefficient correctly.
- (D) 0.25 misplaces two factors.

Final Answer: $R = 1\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Force on a current-carrying wire: $F = BIL\sin\theta$, where θ is the angle between the wire and the field.

Step 1 — Substitute ($B = 0.2$, $I = 4$, $L = 0.5$, $\theta = 30°$):

$$F = 0.2 \times 4 \times 0.5 \times \sin 30°.$$

Step 2 — Evaluate ($\sin 30° = \frac{1}{2}$):

$$F = 0.2 \times 4 \times 0.5 \times 0.5 = 0.2\ \text{N}.$$

Why other options are wrong:

- (A) 0.4 omits the $\sin 30°$ factor (treats $\theta = 90°$).

- (B) 0.8 also drops $\sin\theta$ and doubles a factor.
- (D) 0.1 uses $\sin\theta = \frac{1}{4}$.

Final Answer: $F = 0.2$ N $\Rightarrow$ C

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Field at the centre of an N-turn coil: $B = \dfrac{\mu_0 N I}{2r}$.

Step 1 — Substitute ($N = 50$, $I = 1$, $r = 0.1$):

$$B = \frac{(4\pi \times 10^{-7})(50)(1)}{2(0.1)}.$$

Step 2 — Evaluate:

$$B = \frac{4\pi \times 10^{-7} \times 50}{0.2} = \frac{200\pi \times 10^{-7}}{0.2} = \pi \times 10^{-4}\ \text{T} \approx 3.14 \times 10^{-4}\ \text{T}.$$

Why other options are wrong:

- (A) $2\pi \times 10^{-4}$ forgets the factor of 2 in the denominator (uses $\mu_0 N I / r$).
- (B) $\pi \times 10^{-5}$ and (C) $\pi \times 10^{-6}$ misplace one or two powers of ten.

Final Answer: $B = \pi \times 10^{-4}$ T $\approx 3.14 \times 10^{-4}$ T $\Rightarrow$ D

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Angle of dip: The vertical and horizontal components of the Earth's field are related by $B_V = B_H \tan\delta$, so $\tan\delta = \dfrac{B_V}{B_H}$.

Step 1 — Substitute:

$$\tan\delta = \frac{B_V}{B_H} = \frac{\sqrt{3}\,B_H}{B_H} = \sqrt{3}.$$

Step 2 — Solve: $\tan\delta = \sqrt{3} \Rightarrow \delta = 60^\circ$.

Why other options are wrong:

- (B) 30° would give $\tan\delta = \frac{1}{\sqrt{3}}$.
- (C) 45° would need $B_V = B_H$; (D) 90° needs $B_H = 0$.

Final Answer: $\delta = 60^\circ \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Magnetic field inside a material: The total field is the sum of the field due to the magnetising intensity H and that due to the magnetisation M: $B = \mu_0(H + M)$.

Step 1 — Identify the correct relation: Both H and M have units of A m^{-1}; multiplying their sum by μ_0 gives a quantity in tesla, as required for B.

Why other options are wrong:

- (A) $\mu_0 HM$ has the wrong dimensions (a product, not a sum).
- (C) $\mu_0(H - M)$ has the wrong sign on M.
- (D) $\mu_0 H/M$ is dimensionally and physically incorrect.

Final Answer: $B = \mu_0(H + M) \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Energy stored in an inductor: $U = \frac{1}{2}LI^2$.

Step 1 — Substitute ($L = 0.4$ H, $I = 5$ A):

$$U = \frac{1}{2} \times 0.4 \times (5)^2.$$

Step 2 — Evaluate:

$$U = \frac{1}{2} \times 0.4 \times 25 = 0.2 \times 25 = 5 \text{ J}.$$

Why other options are wrong:

- (A) 2 uses I instead of I^2.

- (B) 10 forgets the factor $\frac{1}{2}$.
- (D) 1 drops the square as well as a factor.

Final Answer: $U = 5$ J $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Pure capacitor in AC: The capacitive reactance is $X_C = \dfrac{1}{2\pi fC}$, and the rms current is $I = \dfrac{V}{X_C}$.

Step 1 — Capacitive reactance: With $C = \dfrac{10^{-3}}{\pi}$ F and $f = 50$ Hz,

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times \frac{10^{-3}}{\pi}} = \frac{1}{2 \times 50 \times 10^{-3}} = \frac{1}{0.1} = 10\ \Omega.$$

Step 2 — Current:

$$I = \frac{V}{X_C} = \frac{20}{10} = 2\text{ A}.$$

Why other options are wrong:

- (A) 0.5 A uses $X_C = 40\ \Omega$ (an extra factor of 2).
- (B) 1 A uses $X_C = 20\ \Omega$ (forgets the factor of 2 from $2\pi f$).
- (C) 4 A uses $X_C = 5\ \Omega$.

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

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Electromagnetic spectrum: Wavelength increases (frequency decreases) in the order: gamma $<$ X-ray $<$ ultraviolet $<$ visible $<$ infrared $<$ microwave $<$ radio.

Step 1 — Order the four given radiations by increasing wavelength:

$$\text{X-rays} < \text{ultraviolet} < \text{visible} < \text{microwaves}.$$

Step 2 — Check: X-rays ($\sim 10^{-10}$ m), UV ($\sim 10^{-8}$ m), visible ($\sim 5 \times 10^{-7}$ m), microwaves ($\sim 10^{-2}$ m) — strictly increasing.

Why other options are wrong:

- (B) lists them in *decreasing* wavelength.
- (C),(D) misplace X-rays/UV/visible.

Final Answer: X-rays $<$ UV $<$ visible $<$ microwaves $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Object at the centre of curvature of a concave mirror: The centre of curvature is at $R = 2f$. For an object at C, the image forms at C, is real, inverted and the same size, so the magnification is $m = -1$.

Step 1 — Object distance: $u = -2f = -30$ cm (since $f = 15$ cm, $R = 30$ cm).

Step 2 — Mirror formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} = \frac{1}{-15} - \frac{1}{-30} = \frac{-2+1}{30} = -\frac{1}{30}$, so $v = -30$ cm.

Step 3 — Magnification: $m = -\frac{v}{u} = -\frac{-30}{-30} = -1$.

Why other options are wrong:

- (A) $+1$ implies an erect, same-size image (a plane mirror).
- (C) -2 and (D) -0.5 correspond to other object positions.

Final Answer: $m = -1 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Total internal reflection in a 45° prism: For glass of refractive index 1.5, the critical angle is $\theta_c = \sin^{-1}(1/1.5) \approx 41.8^\circ$. A ray hitting the hypotenuse at 45° exceeds this, so it undergoes total internal reflection and is bent through 90°.

Step 1 — Compare angles: angle of incidence at the hypotenuse $= 45^\circ > \theta_c = 41.8^\circ$, so the ray is totally internally reflected (not refracted out).

Step 2 — Identify the phenomenon: This 90° turning by a 45° prism is the basis of periscopes and binoculars and relies on total internal reflection.

Why other options are wrong:

- (A) dispersion separates colours, it does not turn the beam.
- (B) diffraction and (D) polarisation are unrelated to the 90° deviation here.

Final Answer: Total internal reflection $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Path difference and phase difference: They are related by $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$. A path difference of $\frac{\lambda}{2}$ (an odd multiple of half a wavelength) gives destructive interference.

Step 1 — Phase difference:

$$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{2} = \pi.$$

Step 2 — Nature of interference: A phase difference of π (path difference $\lambda/2$) means the waves are exactly out of step, so they interfere *destructively*.

Why other options are wrong:

- (A) $\pi/2$ would correspond to a path difference of $\lambda/4$.
- (B) 2π (path difference λ) gives constructive interference.
- (C) correctly finds π but wrongly calls it constructive.

Final Answer: $\Delta\phi = \pi$, destructive $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Malus's law: For already plane-polarised light, the transmitted intensity through a polaroid is $I = I_0 \cos^2\theta$, where θ is the angle between the incident polarisation and the transmission axis.

Step 1 — Set $I = \frac{I_0}{2}$:

$$I_0 \cos^2\theta = \frac{I_0}{2} \Rightarrow \cos^2\theta = \frac{1}{2} \Rightarrow \cos\theta = \frac{1}{\sqrt{2}}.$$

Step 2 — Solve: $\theta = 45^\circ$.

Why other options are wrong:

- (B) 60° gives $\cos^2\theta = \frac{1}{4}$, i.e. $I_0/4$.
- (C) 30° gives $\cos^2\theta = \frac{3}{4}$; (D) 90° gives zero (extinction).

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

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Threshold frequency: The work function and threshold frequency are related by $\phi = h\nu_0$, so $\nu_0 = \frac{\phi}{h}$.

Step 1 — Substitute ($\phi = 3.3 \times 10^{-19}$ J, $h = 6.6 \times 10^{-34}$ J s):

$$\nu_0 = \frac{3.3 \times 10^{-19}}{6.6 \times 10^{-34}}.$$

Step 2 — Evaluate:

$$\nu_0 = 0.5 \times 10^{15} = 5 \times 10^{14} \text{ Hz}.$$

Why other options are wrong:

- (A) 2×10^{14} inverts the ratio of the leading digits.
- (C),(D) misplace a power of ten.

Final Answer: $\nu_0 = 5 \times 10^{14}$ Hz $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Series limit of the Lyman series: The shortest wavelength corresponds to $n = \infty \to n = 1$:

$$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = R.$$

Step 1 — Compute λ:

$$\lambda = \frac{1}{R} = \frac{1}{1.1 \times 10^7} \approx 9.1 \times 10^{-8} \text{ m} = 91 \text{ nm}.$$

Step 2 — Check: The Lyman series lies in the ultraviolet; its series limit (≈ 91 nm) is the shortest wavelength in the entire hydrogen spectrum.

Why other options are wrong:

- (A) 364 nm is the Balmer series limit.
- (B) 122 nm is the longest (first) Lyman line; (D) 656 nm is the Hα Balmer line.

Final Answer: $\lambda \approx 91$ nm $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Activity of a sample: The activity is $A = \lambda N$; initially $A_0 = \lambda N_0$.

Step 1 — Substitute ($N_0 = 2 \times 10^{20}$, $\lambda = 10^{-6}$ s^{-1}):

$$A_0 = \lambda N_0 = (10^{-6})(2 \times 10^{20}).$$

Step 2 — Evaluate:

$$A_0 = 2 \times 10^{20-6} = 2 \times 10^{14} \text{ decays s}^{-1}.$$

Why other options are wrong:

- (A) 2×10^{26} *multiplies* the exponents wrongly.
- (B) 10^{14} drops the factor of 2; (C) 2×10^{12} misplaces a power of ten.

Final Answer: $A_0 = 2 \times 10^{14}$ decays $s^{-1} \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Binding energy per nucleon and stability: The greater the binding energy per nucleon, the more tightly bound and the more stable the nucleus.

Step 1 — Compare: P has 7.6 MeV/nucleon while Q has 7.1 MeV/nucleon; since $7.6 > 7.1$, P is bound more strongly per nucleon.

Step 2 — Conclusion: P (near the peak of the binding-energy curve, $A \approx 56$) is more stable than Q.

Why other options are wrong:

- (B) reverses the comparison; (C) ignores the clear difference in the values.
- (D) is wrong — binding energy per nucleon *is* the standard measure of relative stability.

Final Answer: P is more stable than $Q \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — NOR gate as a NOT gate: A NOR gate gives $Y = \overline{A+B}$. Joining both inputs ($A = B$) makes $Y = \overline{A+A} = \overline{A}$, i.e. it acts as a NOT (inverter).

Step 1 — Set both inputs equal: With $A = B = 1$,

$$Y = \overline{1+1} = \overline{1} = 0.$$

Step 2 — Confirm the NOT behaviour: For $A = 0$, $Y = \overline{0+0} = \overline{0} = 1$; for $A = 1$, $Y = 0$. So the gate inverts the input, and for $A = 1$ the output is 0.

Why other options are wrong:

- (A) 1 would be the output for $A = 0$, not $A = 1$.
- (C) "equal to A" describes a buffer, not an inverter.
- (D) a gate output is always a definite logic level.

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

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Majority carriers in doped semiconductors: Doping decides which carrier dominates. Pentavalent (donor) doping makes an *n-type* semiconductor with electrons as majority carriers; trivalent (acceptor) doping makes a *p-type* semiconductor with holes as majority carriers.

Step 1 — n-type: A donor atom contributes a free electron, so *electrons* are the majority carriers (holes are the minority).

Step 2 — p-type: An acceptor atom creates a hole, so *holes* are the majority carriers (electrons are the minority).

Why other options are wrong:

- (A) swaps the two; (B) and (D) make both the same carrier type.

Final Answer: n-type: electrons; p-type: holes $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q35

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	C	4	D	5	A
6	B	7	C	8	D	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	A	30	B
31	C	32	D	33	A	34	B	35	C