JCECE Physics Sample Paper – 9

Duration: 60 Minutes **Maximum Marks: 50**

Instructions

- This paper contains **50** Multiple Choice Questions (Single Correct Answer), modelled on the Physics portion of **JCECE** entrance.
- Each correct answer carries **+1 mark**. There is -0.25 **mark** for each incorrect answer; unattempted questions get 0.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 and Class 12 NCERT Physics (Jharkhand JAC / CBSE aligned).**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. Impulse has the same dimensional formula as which physical quantity?

(A) Force, $[\mathrm{MLT^{-2}}]$

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

(C) Linear momentum, $[\mathrm{MLT^{-1}}]$

(D) Pressure, $[\mathrm{ML^{-1}T^{-2}}]$

Q2. The radius of a hydrogen atom is about 0.53×10^{-10} m. The order of magnitude of this length (in metre) is:

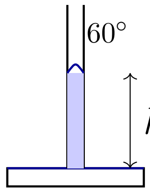
(A) 10^{-9}

(B) 10^{-10}

(C) 10^{-11}

(D) 10^{-8}

Q3. A liquid of surface tension 4.8×10^{-2} N/m rises in a capillary of radius 0.3 mm making a contact angle of 60° ($\rho = 800$ kg/m^3, $g = 10$ m/s^2). The capillary rise h is:



(A) 4.0 cm

(B) 1.0 cm

(C) 0.5 cm

(D) 2.0 cm

Q4. A steel rod of Young's modulus 2×10^{11} N/m^2 and coefficient of linear expansion $1.2 \times 10^{-5}\,°\text{C}^{-1}$ is clamped rigidly at both ends and heated through $25\,°\text{C}$. The thermal stress developed is:

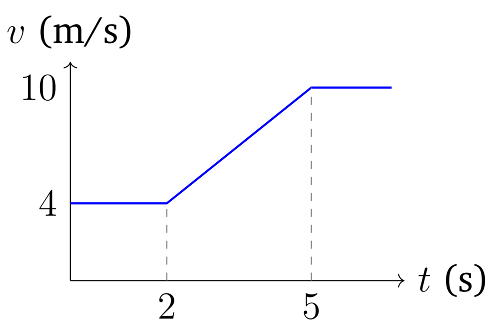
(A) 6×10^7 N/m^2

(B) 3×10^7 N/m^2

(C) 6×10^6 N/m^2

(D) 1.2×10^8 N/m^2

Q5. The velocity–time graph of a particle is shown. The magnitude of its acceleration during the segment from $t = 2$ s to $t = 5$ s is:



(A) 1 m/s^2

(B) 2 m/s^2

(C) 3 m/s^2

(D) 6 m/s^2

Q6. A ball is thrown horizontally with speed 15 m/s from the top of a tower of height 80 m ($g = 10$ m/s^2). The horizontal distance from the foot of the tower at which it lands is:

(A) 60 m

(B) 45 m

(C) 80 m

(D) 120 m

Q7. A swimmer can swim at 5 m/s in still water. A river 60 m wide flows at 3 m/s. The time taken to swim 60 m downstream and then 60 m upstream (relative to the bank) is:

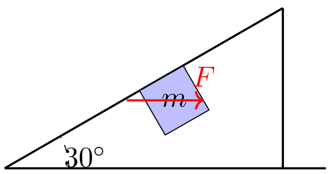
(A) 24 s

(B) 30 s

(C) 37.5 s

(D) 15 s

Q8. A block of mass 2 kg is on a smooth incline of angle $30°$. A horizontal force of 20 N pushes it as shown ($g = 10$ m/s^2). The acceleration of the block along the incline (up the plane) is:



(A) 1.34 m/s^2

(B) 2.5 m/s^2

(C) 5.0 m/s^2

(D) 3.66 m/s^2

Q9. A car moving at 20 m/s is brought to rest on a rough road for which the coefficient of friction is 0.5 ($g = 10$ m/s^2). The distance covered before stopping is:

(A) 20 m

(B) 40 m

(C) 80 m

(D) 10 m

Q10. A vehicle moves on a flat circular track of radius 90 m with coefficient of friction 0.1 ($g = 10$ m/s^2). The maximum speed at which it can take the turn without skidding is:

(A) 3 m/s

(B) 6 m/s

(C) 9.5 m/s

(D) 30 m/s

Q11. A motor does 9000 J of work in 15 s. The average power developed by the motor is:

(A) 135 W

(B) 900 W

(C) 450 W

(D) 600 W

Q12. A machine receives input power 800 W and delivers useful output power 600 W. Its efficiency is:

(A) 75%

(B) 80%

(C) 25%

(D) 133%

Q13. A light ball moving with speed u makes a one-dimensional elastic collision with a very heavy stationary ball. After the collision, the light ball:

(A) Continues with speed u in the same direction

(B) Rebounds with nearly speed u in the opposite direction

(C) Comes to rest

(D) Moves with speed $u/2$

Q14. A torque of 12 N·m acts on a wheel of moment of inertia 3 kg·m^2. The angular acceleration produced is:

(A) 36 rad/s^2

(B) 9 rad/s^2

(C) 4 rad/s^2

(D) 0.25 rad/s^2

Q15. A planet revolves around the Sun in an orbit of radius 4 times that of Earth. Its period of revolution (in Earth-years) is:

(A) 4

(B) 2

(C) 16

(D) 8

Q16. A Carnot engine operating between 600 K and 300 K absorbs 800 J of heat from the source per cycle. The maximum work it can do per cycle is:

(A) 400 J

(B) 200 J

(C) 800 J

(D) 600 J

Q17. For a diatomic ideal gas, $C_V = \frac{5}{2}R$. Using $C_P - C_V = R$, the molar specific heat at constant pressure C_P is:

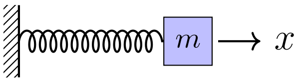
(A) $\frac{3}{2}R$

(B) $\frac{7}{2}R$
(C) $\frac{5}{2}R$
(D) $3R$

Q18. The average translational kinetic energy of one mole of an ideal gas at temperature T is (R is the gas constant):

(A) $\frac{1}{2}RT$
(B) RT
(C) $\frac{3}{2}RT$
(D) $\frac{5}{2}RT$

Q19. A mass attached to a spring of force constant 200 N/m oscillates as shown with amplitude 0.05 m. The total mechanical energy of the oscillation is:



(A) 0.25 J

(B) 0.5 J

(C) 5 J

(D) 10 J

Q20. A particle executes SHM with acceleration related to displacement by $a = -16x$ (SI units). The time period of the motion is:

(A) $\frac{\pi}{4}$ s
(B) $\frac{\pi}{2}$ s
(C) π s
(D) 4 s

Q21. The speed of sound in air at $0\,^{\circ}\mathrm{C}$ (i.e. 273 K) is 330 m/s. Its speed at $27\,^{\circ}\mathrm{C}$ (i.e. 300 K), since $v \propto \sqrt{T}$, is approximately:

(A) 300 m/s

(B) 315 m/s

(C) 363 m/s

(D) 346 m/s

Q22. A source emitting sound of frequency 500 Hz and an observer both move in the same direction along a line; the source (ahead) moves away at 30 m/s and the observer (behind) chases at 30 m/s. Taking speed of sound 330 m/s, the observed frequency is:

(A) 545 Hz

(B) 455 Hz

(C) 600 Hz

(D) 500 Hz

Q23. Three equal point charges of $2\,\mu$C each are fixed at the vertices of an equilateral triangle of side 0.1 m ($k = 9 \times 10^9$ N·m^2/C^2). The magnitude of the net Coulomb force on any one charge is:

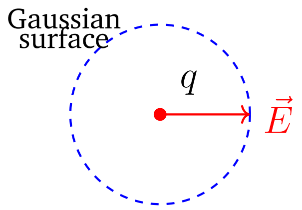
(A) 3.6 N

(B) 7.2 N

(C) 6.2 N

(D) 12.5 N

Q24. A point charge of $17.7\,\mu$C is placed at the centre of a closed Gaussian surface as shown ($\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N·m^2). The total electric flux through the surface is:



(A) 1×10^6 N·m^2/C

(B) 4×10^6 N·m^2/C

(C) 2×10^6 N·m^2/C

(D) 2×10^7 N·m^2/C

Q25. An electric dipole of moment $p = 2 \times 10^{-6}$ C·m is placed in a uniform field $E = 5 \times 10^4$ N/C. The work required to rotate it from alignment with the field ($0°$) to perpendicular ($90°$) is:

(A) 0.2 J

(B) 0.05 J

(C) 0.2 J (negative)

(D) 0.1 J

Q26. A parallel-plate capacitor has plate area $A = 2 \times 10^{-2}$ m^2, separation $d = 1$ mm, and is filled with a dielectric of constant $K = 5$ ($\varepsilon_0 = 8.85 \times 10^{-12}$ F/m). Its capacitance is approximately:

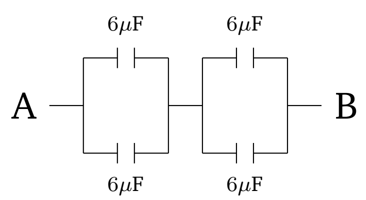
(A) 177 pF

(B) 885 pF

(C) 442 pF

(D) 1770 pF

Q27. In the network shown, two 6 μF capacitors are in parallel, this combination is in series with another such parallel pair of two 6 μF capacitors. The equivalent capacitance between A and B is:



(A) 6 μF

(B) 12 μF

(C) $3\ \mu$F

(D) $24\ \mu$F

Q28. A current of 1.6 A flows through a wire ($e = 1.6 \times 10^{-19}$ C). The number of electrons crossing any cross-section per second is:

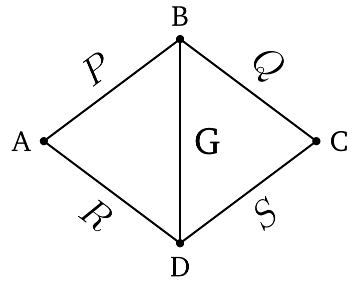
(A) 1×10^{18}

(B) 1.6×10^{19}

(C) 6.25×10^{18}

(D) 1×10^{19}

Q29. In the balanced Wheatstone bridge shown, $P = 3\,\Omega$, $Q = 12\,\Omega$ and $R = 5\,\Omega$. The unknown resistance S is:



(A) $10\,\Omega$

(B) $20\,\Omega$

(C) $15\,\Omega$

(D) $25\,\Omega$

Q30. Two cells, each of EMF 1.5 V and internal resistance $0.5\,\Omega$, are connected in series across an external resistance of $5\,\Omega$. The current in the circuit is:

(A) 0.5 A

(B) 0.6 A

(C) 0.3 A

(D) 1.0 A

Q31. An electrical appliance rated 1100 W operates on a 220 V supply. The minimum current rating of the fuse that should be used with it is:

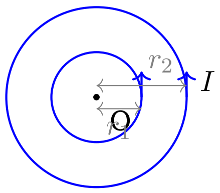
(A) 2 A

(B) 3 A

(C) 5 A

(D) 10 A

Q32. Two concentric circular loops of radii 0.1 m and 0.2 m carry equal currents of 2 A in the same sense, as shown. The net magnetic field at their common centre is ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A):



(A) 0.94×10^{-5} T

(B) 1.26×10^{-5} T

(C) 3.14×10^{-5} T

(D) 1.88×10^{-5} T

Q33. A straight wire of length 0.4 m carrying 5 A makes an angle of $30°$ with a uniform magnetic field of 0.6 T. The force on the wire is:

(A) 1.2 N

(B) 0.6 N

(C) 1.04 N

(D) 0.3 N

Q34. The magnetic field deep inside a long solenoid is B_0. The magnetic field at one open end of the same solenoid (along its axis) is:

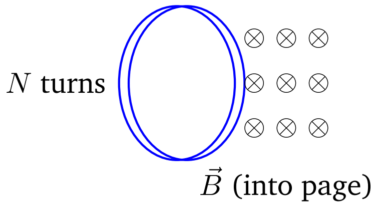
(A) B_0

(B) $2B_0$

(C) Zero

(D) $\frac{B_0}{2}$

Q35. A coil of 200 turns is placed in a magnetic field so that the flux through each turn changes from 4×10^{-3} Wb to 1×10^{-3} Wb uniformly in 0.1 s, as shown. The magnitude of the induced EMF is:



(A) 1.5 V

(B) 3.0 V

(C) 6.0 V

(D) 12.0 V

Q36. In an AC circuit the rms voltage is 200 V, the rms current is 5 A, and the phase difference between them is $60°$. The average power consumed is:

(A) 500 W

(B) 1000 W

(C) 866 W

(D) 250 W

Q37. The peak value of an alternating current is π A. Its average value over a half cycle is:

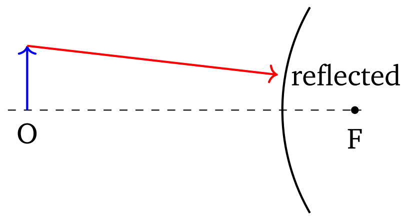
(A) π A

(B) 2 A

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

(D) 1 A

Q38. An object is placed 20 cm in front of a convex mirror of focal length 20 cm, as shown. The magnification produced is:



(A) $+1$

(B) -0.5

(C) $+0.5$

(D) $+2$

Q39. Light travels from a medium of refractive index 1.5 into air. The critical angle is about 42°. A ray strikes the interface at an angle of incidence 50°. The ray will:

(A) Undergo total internal reflection

(B) Refract and pass into air bending away from the normal

(C) Refract and pass into air bending towards the normal

(D) Travel along the interface

Q40. A biconcave lens has both radii of curvature equal to 20 cm in magnitude and is made of glass of refractive index 1.5. Its focal length is:

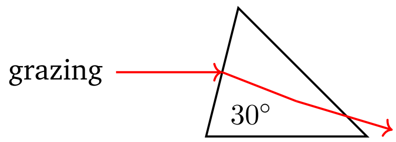
(A) $+20$ cm

(B) -20 cm

(C) -40 cm

(D) $+40$ cm

Q41. A ray enters one face of a prism at grazing incidence ($i = 90^\circ$). The prism has refractive index 1.5 and angle 30°, as shown. The angle of refraction at the first face is (take $\sin^{-1}(2/3) \approx 41.8^\circ$):



(A) 30°

(B) 90°

(C) 48.2°

(D) 41.8°

Q42. In a Young's double-slit experiment with light of wavelength λ, the path difference between the two waves at a point of destructive interference (dark fringe) must equal:

(A) $(2n+1)\frac{\lambda}{2},\ n = 0, 1, 2, \ldots$

(B) $n\lambda,\ n = 0, 1, 2, \ldots$

(C) $\frac{n\lambda}{2},\ n = 0, 1, 2, \ldots$

(D) $(2n+1)\lambda,\ n = 0, 1, 2, \ldots$

Q43. Unpolarised light of intensity I_0 passes through a polariser and then through a second polaroid whose axis is at 60° to the first. The intensity of the emergent light is:

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

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

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

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

Q44. The work function of a metal is 6.4×10^{-19} J (1 eV $= 1.6 \times 10^{-19}$ J). In electron-volts, the work function is:

(A) 2 eV

(B) 3 eV

(C) 4 eV

(D) 6.4 eV

Q45. A particle has a de Broglie wavelength of 3.3 Å ($h = 6.6 \times 10^{-34}$ J·s, 1 Å $= 10^{-10}$ m). Its momentum is:

(A) 1×10^{-24} kg·m/s

(B) 5×10^{-24} kg·m/s

(C) 3.3×10^{-24} kg·m/s

(D) 2×10^{-24} kg·m/s

Q46. According to Bohr's model, the angular momentum of the electron in the nth orbit of a hydrogen atom is:

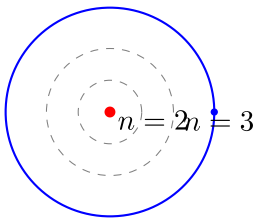
(A) $\frac{nh}{2\pi}$

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

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

(D) $\frac{2\pi n}{h}$

Q47. In Bohr's model the radius of the nth orbit is $r_n = n^2 a_0$ with $a_0 = 0.53$ Å. The radius of the third orbit ($n = 3$) shown below is:



(A) 1.59 Å

(B) 4.77 Å

(C) 2.12 Å

(D) 9.0 Å

Q48. A radioactive sample has a half-life of 4 days. The ratio of its activity after 12 days to its initial activity is:

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

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

(C) $\frac{1}{6}$

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

Q49. Since the nuclear radius varies as $R = R_0 A^{1/3}$, the nuclear density of different nuclei is:

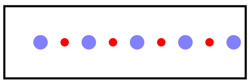
(A) Nearly the same for all nuclei (independent of A)

(B) Proportional to A

(C) Proportional to A^2

(D) Inversely proportional to A

Q50. In the doped semiconductor sample shown, pentavalent atoms are added to pure silicon. The majority charge carriers in the resulting material are:



Si doped with pentavalent atoms

(A) Holes (p-type)

(B) Protons

(C) Electrons (n-type)

(D) Positive ions

Detailed Solutions

Q1.

Solution

Concept — Dimensions of impulse: Impulse equals change in momentum, and also force $\times$ time. So impulse must share the dimensional formula of momentum.

Step 1 — Impulse as force $\times$ time: $[\text{Impulse}] = [F][t] = \text{MLT}^{-2} \cdot \text{T} = \text{MLT}^{-1}$.

Step 2 — Momentum dimension: $[p] = [m][v] = \text{M} \cdot \text{LT}^{-1} = \text{MLT}^{-1}$.

Step 3 — Compare: Both equal MLT^{-1}, confirming impulse has the dimensions of linear momentum.

Why other options are wrong:

- (A) Force is MLT^{-2}, one power of time short.
- (B) Energy is ML^2T^{-2}.
- (D) Pressure is $\text{ML}^{-1}\text{T}^{-2}$.

Final Answer: Impulse $= \text{MLT}^{-1} =$ linear momentum $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Order of magnitude: Write the number as $a \times 10^n$ with $1 \leq a < 10$; the order of magnitude is 10^n if $a < \sqrt{10} \approx 3.16$, else 10^{n+1}.

Step 1 — Express the number: $0.53 \times 10^{-10} = 5.3 \times 10^{-11}$.

Step 2 — Compare the mantissa: $a = 5.3$, which is greater than 3.16.

Step 3 — Round up the power: Since $5.3 > \sqrt{10}$, raise the exponent by one: order $= 10^{-11+1} = 10^{-10}$.

Why other options are wrong:

- (A) is one power too large.
- (C) ignores the rounding of 5.3 up.
- (D) is two powers too large.

Final Answer: Order of magnitude $= 10^{-10}$ m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Capillary rise with contact angle: $h = \dfrac{2T\cos\theta}{r\rho g}$.

Step 1 — List data: $T = 4.8 \times 10^{-2}$ N/m, $\theta = 60^\circ$ so $\cos\theta = 0.5$, $r = 0.3$ mm $= 3 \times 10^{-4}$ m, $\rho = 800$ kg/m^3, $g = 10$ m/s^2.

Step 2 — Numerator: $2T\cos\theta = 2 \times 4.8 \times 10^{-2} \times 0.5 = 4.8 \times 10^{-2}$.

Step 3 — Denominator: $r\rho g = 3 \times 10^{-4} \times 800 \times 10 = 2.4$.

Step 4 — Divide: $h = \dfrac{4.8 \times 10^{-2}}{2.4} = 2.0 \times 10^{-2}$ m.

Step 5 — Convert to cm: 2.0×10^{-2} m $= 2.0$ cm.

Why other options are wrong:

- (A) ignores the $\cos 60^\circ$ factor (uses $\cos\theta = 1$).
- (B) halves the correct value.
- (C) carries a power-of-ten slip.

Final Answer: $h = 2.0$ cm $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

Solution

Concept — Thermal stress: A rod clamped at both ends and heated cannot expand, so it develops a compressive stress $\sigma = Y\alpha\Delta T$.

Step 1 — List data: $Y = 2 \times 10^{11}$ N/m^2, $\alpha = 1.2 \times 10^{-5}\,^\circ\text{C}^{-1}$, $\Delta T = 25\,^\circ$C.

Step 2 — Multiply α and ΔT: $\alpha\Delta T = 1.2 \times 10^{-5} \times 25 = 3.0 \times 10^{-4}$.

Step 3 — Multiply by Y: $\sigma = 2 \times 10^{11} \times 3.0 \times 10^{-4}$.

Step 4 — Evaluate: $\sigma = 6.0 \times 10^{7}$ N/m^2.

Why other options are wrong:

- (B) halves the temperature change.
- (C) carries a power-of-ten slip.
- (D) doubles the correct stress.

Final Answer: $\sigma = 6 \times 10^{7}$ N/m^2 $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept — Acceleration from a v–t graph: Instantaneous acceleration is the slope of the v–t graph; on a straight segment it is $\frac{\Delta v}{\Delta t}$.

Step 1 — Read endpoints of the segment: From the graph, at $t = 2$ s, $v = 4$ m/s; at $t = 5$ s, $v = 10$ m/s.

Step 2 — Change in velocity: $\Delta v = 10 - 4 = 6$ m/s.

Step 3 — Change in time: $\Delta t = 5 - 2 = 3$ s.

Step 4 — Divide: $a = \frac{6}{3} = 2$ m/s^2.

Why other options are wrong:

- (A) divides by a wrong interval.
- (C) and (D) use wrong velocity or time differences.

Final Answer: $a = 2$ m/s$^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Horizontal projectile: The time to fall a height H is $t = \sqrt{2H/g}$; the horizontal range is $x = ut$.

Step 1 — List data: $u = 15$ m/s, $H = 80$ m, $g = 10$ m/s^2.

Step 2 — Time of flight: $t = \sqrt{\frac{2 \times 80}{10}} = \sqrt{16} = 4$ s.

Step 3 — Horizontal distance: $x = u\,t = 15 \times 4 = 60$ m.

Why other options are wrong:

- (B) uses $t = 3$ s.
- (C) confuses height with horizontal range.
- (D) doubles the time of flight.

Final Answer: $x = 60$ m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Downstream and upstream speeds: Downstream speed $= v + u$, upstream speed $= v - u$, where v is the swimmer's still-water speed and u the current.

Step 1 — List data: $v = 5$ m/s, $u = 3$ m/s, each leg $= 60$ m.

Step 2 — Downstream time: speed $= 5 + 3 = 8$ m/s, so $t_1 = \frac{60}{8} = 7.5$ s.

Step 3 — Upstream time: speed $= 5 - 3 = 2$ m/s, so $t_2 = \frac{60}{2} = 30$ s.

Step 4 — Total time: $t = t_1 + t_2 = 7.5 + 30 = 37.5$ s.

Why other options are wrong:

- (A) and (D) use only one leg.
- (B) ignores the slow upstream leg.

Final Answer: $t = 37.5 \text{ s} \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Block pushed by a horizontal force on a smooth incline: Resolve both gravity and the applied horizontal force along the incline. Up-the-plane component of F is $F\cos\theta$; down-the-plane component of gravity is $mg\sin\theta$.

Step 1 — List data: $m = 2$ kg, $\theta = 30°$, $F = 20$ N, $g = 10$ m/s^2.

Step 2 — Component of F up the incline: $F\cos 30° = 20 \times \frac{\sqrt{3}}{2} = 10\sqrt{3} \approx 17.32$ N.

Step 3 — Component of gravity down the incline: $mg\sin 30° = 2 \times 10 \times 0.5 = 10$ N.

Step 4 — Net force up the incline: $F_{net} = 17.32 - 10 = 7.32$ N.

Step 5 — Acceleration: $a = \frac{F_{net}}{m} = \frac{7.32}{2} \approx 3.66$ m/s^2.

Why other options are wrong:

- (A) and (B) use wrong force components.
- (C) ignores the gravity component.

Final Answer: $a \approx 3.66\ \text{m/s}^2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Stopping distance with friction: Friction gives a retardation $a = \mu g$; then $v^2 = u^2 - 2as$ with final speed 0 gives $s = \dfrac{u^2}{2\mu g}$.

Step 1 — List data: $u = 20$ m/s, $\mu = 0.5$, $g = 10$ m/s^2.

Step 2 — Retardation: $a = \mu g = 0.5 \times 10 = 5$ m/s^2.

Step 3 — Numerator: $u^2 = 20^2 = 400$.

Step 4 — Divide: $s = \dfrac{400}{2 \times 5} = \dfrac{400}{10} = 40$ m.

Why other options are wrong:

- (A) drops the factor of 2 incorrectly.
- (C) omits the μ in the retardation.
- (D) uses a wrong retardation.

Final Answer: $s = 40\ \text{m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Maximum speed on an unbanked curve: $v_{\max} = \sqrt{\mu r g}$.

Step 1 — List data: $\mu = 0.1$, $r = 90$ m, $g = 10$ m/s^2.

Step 2 — Multiply inside the root: $\mu r g = 0.1 \times 90 \times 10 = 90$.

Step 3 — Take square root: $v_{\max} = \sqrt{90}$.

Step 4 — Evaluate: $\sqrt{90} \approx 9.5$ m/s.

Why other options are wrong:

- (A) takes $\sqrt{\mu r}$ only.
- (B) uses a wrong product.
- (D) drops μ entirely.

Final Answer: $v_{\max} \approx 9.5$ m/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Average power: Power $= \dfrac{\text{work done}}{\text{time}}$.

Step 1 — List data: $W = 9000$ J, $t = 15$ s.

Step 2 — Divide: $P = \dfrac{9000}{15}$.

Step 3 — Evaluate: $P = 600$ W.

Why other options are wrong:

- (A) multiplies instead of dividing correctly.
- (B) and (C) use wrong arithmetic.

Final Answer: $P = 600$ W $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Efficiency: $\eta = \dfrac{\text{useful output power}}{\text{input power}} \times 100\%$.

Step 1 — List data: output $= 600$ W, input $= 800$ W.

Step 2 — Form the ratio: $\dfrac{600}{800} = 0.75$.

Step 3 — Convert to percent: $0.75 = 75\%$.

Why other options are wrong:

- (B) uses a wrong ratio.

- (C) takes the loss fraction.
- (D) inverts the ratio (output over loss), exceeding 100%.

Final Answer: $\eta = 75\% \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Light body hitting a heavy body elastically: For a one-dimensional elastic collision where a very light mass strikes a much heavier one at rest, the light body rebounds with nearly its original speed reversed, and the heavy body barely moves.

Step 1 — Elastic velocity formula: $v_1' = \dfrac{m_1 - m_2}{m_1 + m_2} u$.

Step 2 — Take $m_2 \gg m_1$**:** $\dfrac{m_1 - m_2}{m_1 + m_2} \to \dfrac{-m_2}{m_2} = -1$.

Step 3 — Conclude: $v_1' \approx -u$, i.e. speed nearly u but reversed in direction.

Why other options are wrong:

- (A) would require equal or larger light mass.
- (C) holds only for equal masses.
- (D) has no basis for an elastic collision.

Final Answer: The light ball rebounds with nearly speed $u \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Rotational Newton's second law: $\tau = I\alpha$, so $\alpha = \dfrac{\tau}{I}$.

Step 1 — List data: $\tau = 12$ N·m, $I = 3$ kg·m^2.

Step 2 — Divide: $\alpha = \dfrac{12}{3}$.

Step 3 — Evaluate: $\alpha = 4$ rad/s^2.

Why other options are wrong:

- (A) multiplies τ and I.

- (B) uses a wrong divisor.
- (D) inverts the ratio.

Final Answer: $\alpha = 4 \text{ rad/s}^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Kepler's third law: $T = \left(\frac{r}{r_E}\right)^{3/2}$ Earth-years.

Step 1 — Ratio of radii: $\frac{r}{r_E} = 4.$

Step 2 — Raise to the $3/2$ **power:** $4^{3/2} = (2^2)^{3/2} = 2^3.$

Step 3 — Evaluate: $2^3 = 8$ years.

Step 4 — Cross-check: $T^2 = r^3 \Rightarrow T^2 = 4^3 = 64 \Rightarrow T = 8.$

Why other options are wrong:

- (A) takes r/r_E directly.
- (B) takes $\sqrt{4}$.
- (C) takes r^2.

Final Answer: $T = 8$ years $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Maximum work of a Carnot engine: $W = \eta Q_H$, where $\eta = 1 - \frac{T_C}{T_H}$ is the Carnot efficiency.

Step 1 — Efficiency: $\eta = 1 - \frac{300}{600} = 1 - 0.5 = 0.5.$

Step 2 — Heat absorbed: $Q_H = 800$ J.

Step 3 — Work done: $W = \eta Q_H = 0.5 \times 800.$

Step 4 — Evaluate: $W = 400$ J.

Why other options are wrong:

- (B) uses $\eta = 0.25$.
- (C) takes all heat as work (ignores second law).
- (D) uses a wrong efficiency.

Final Answer: $W = 400$ J $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Mayer's relation: For an ideal gas, $C_P - C_V = R$, so $C_P = C_V + R$.

Step 1 — Substitute C_V: $C_P = \frac{5}{2}R + R$.

Step 2 — Add the terms: $\frac{5}{2}R + R = \frac{5}{2}R + \frac{2}{2}R = \frac{7}{2}R$.

Why other options are wrong:

- (A) and (C) forget to add R.
- (D) adds the wrong amount.

Final Answer: $C_P = \frac{7}{2}R \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Average translational KE per mole: A mole has N_A molecules, each with mean translational KE $\frac{3}{2}k_BT$; since $N_Ak_B = R$, the total is $\frac{3}{2}RT$.

Step 1 — Per molecule: $\langle KE \rangle = \frac{3}{2}k_BT$.

Step 2 — Multiply by N_A: $\frac{3}{2}N_Ak_BT$.

Step 3 — Use $N_Ak_B = R$: $= \frac{3}{2}RT$.

Why other options are wrong:

- (A) and (B) use wrong numerical factors.

- (D) is the internal energy of a diatomic gas, not translational only.

Final Answer: Average translational KE per mole $= \frac{3}{2}RT \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Total energy in SHM: $E = \frac{1}{2}kA^2$.

Step 1 — List data: $k = 200$ N/m, $A = 0.05$ m.

Step 2 — Square the amplitude: $A^2 = (0.05)^2 = 2.5 \times 10^{-3}$ m^2.

Step 3 — Multiply by k: $kA^2 = 200 \times 2.5 \times 10^{-3} = 0.5$.

Step 4 — Halve: $E = \frac{1}{2} \times 0.5 = 0.25$ J.

Why other options are wrong:

- (B) forgets the factor of $\frac{1}{2}$.
- (C) and (D) carry power-of-ten or factor errors.

Final Answer: $E = 0.25$ J $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — SHM from $a = -\omega^2 x$: Comparing $a = -16x$ with $a = -\omega^2 x$ gives $\omega^2 = 16$; the period is $T = \frac{2\pi}{\omega}$.

Step 1 — Find ω: $\omega = \sqrt{16} = 4$ rad/s.

Step 2 — Apply $T = 2\pi/\omega$: $T = \frac{2\pi}{4}$.

Step 3 — Simplify: $T = \frac{\pi}{2}$ s.

Why other options are wrong:

- (A) uses $\omega = 8$.
- (C) drops a factor of 2.
- (D) takes $T = \omega$.

Final Answer: $T = \frac{\pi}{2}\text{ s} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q20

Q21.

Solution

Concept — Speed of sound and temperature: $v \propto \sqrt{T}$, so $v_2 = v_1\sqrt{\frac{T_2}{T_1}}$.

Step 1 — List data: $v_1 = 330$ m/s at $T_1 = 273$ K; $T_2 = 300$ K.

Step 2 — Temperature ratio: $\frac{T_2}{T_1} = \frac{300}{273} \approx 1.099$.

Step 3 — Square root: $\sqrt{1.099} \approx 1.048$.

Step 4 — Multiply: $v_2 = 330 \times 1.048 \approx 346$ m/s.

Why other options are wrong:

- (A) and (B) understate the increase.
- (C) scales by T instead of $\sqrt{T}$.

Final Answer: $v_2 \approx 346\text{ m/s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Doppler effect, source and observer moving the same way: The observer (behind) chases the source (ahead). With both moving in the same direction, $f' = f\frac{v + v_o}{v + v_s}$ where the observer trails the source.

Step 1 — List data: $f = 500$ Hz, $v = 330$ m/s, $v_o = 30$ m/s, $v_s = 30$ m/s.

Step 2 — Numerator: $v + v_o = 330 + 30 = 360$.

Step 3 — Denominator: $v + v_s = 330 + 30 = 360$.

Step 4 — Form the ratio: $\frac{360}{360} = 1$.

Step 5 — Multiply by f: $f' = 500 \times 1 = 500$ Hz.

Why other options are wrong:

- (A) and (B) drop one of the equal velocity terms.
- (C) uses a wrong sign combination.

Final Answer: $f' = 500$ Hz (no change, equal speeds) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept — Net force at a triangle vertex: Each of the two other charges exerts an equal force F_0; the two forces are at $60°$, so the resultant is $F = \sqrt{3}\,F_0$.

Step 1 — Single-pair force: $F_0 = \dfrac{kq^2}{a^2} = \dfrac{9 \times 10^9 \times (2 \times 10^{-6})^2}{(0.1)^2}$.

Step 2 — Numerator: $9 \times 10^9 \times 4 \times 10^{-12} = 3.6 \times 10^{-2}$.

Step 3 — Divide by $a^2 = 0.01$: $F_0 = \dfrac{3.6 \times 10^{-2}}{0.01} = 3.6$ N.

Step 4 — Combine at $60°$: $F = \sqrt{3}\,F_0 = 1.732 \times 3.6$.

Step 5 — Evaluate: $F \approx 6.2$ N.

Why other options are wrong:

- (A) gives only one pair's force.
- (B) adds the two forces arithmetically (uses factor 2).
- (D) uses a wrong resultant factor.

Final Answer: $F \approx 6.2$ N $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Gauss's law: $\Phi = \dfrac{q_{enc}}{\varepsilon_0}$.

Step 1 — List data: $q = 17.7 \times 10^{-6}$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$.

Step 2 — Form the ratio: $\Phi = \dfrac{17.7 \times 10^{-6}}{8.85 \times 10^{-12}}$.

Step 3 — Divide the mantissas: $\dfrac{17.7}{8.85} = 2$.

Step 4 — Subtract exponents: $10^{-6-(-12)} = 10^6$.

Step 5 — Combine: $\Phi = 2 \times 10^6$ N·m^2/C.

Why other options are wrong:

- (A) uses $q = 8.85\ \mu$C.
- (B) doubles the mantissa wrongly.
- (D) carries a power-of-ten error.

Final Answer: $\Phi = 2 \times 10^6$ N·m^2/C $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Work to rotate a dipole: $W = pE(\cos\theta_1 - \cos\theta_2)$ for rotation from θ_1 to θ_2.

Step 1 — List data: $p = 2 \times 10^{-6}$ C·m, $E = 5 \times 10^4$ N/C, $\theta_1 = 0°$, $\theta_2 = 90°$.

Step 2 — Cosine values: $\cos 0° = 1$, $\cos 90° = 0$.

Step 3 — Product pE: $pE = 2 \times 10^{-6} \times 5 \times 10^4 = 0.1$.

Step 4 — Apply formula: $W = pE(1-0) = 0.1 \times 1 = 0.1$ J.

Why other options are wrong:

- (A) doubles the value.
- (B) halves pE wrongly.
- (C) takes a wrong sign (rotation from aligned needs positive work).

Final Answer: $W = 0.1$ J $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q25

Q26.

Solution

Concept — Capacitance with dielectric: $C = \dfrac{K\varepsilon_0 A}{d}$.

Step 1 — List data: $K = 5$, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m, $A = 2 \times 10^{-2}$ m^2, $d = 1 \times 10^{-3}$ m.

Step 2 — Numerator: $K\varepsilon_0 A = 5 \times 8.85 \times 10^{-12} \times 2 \times 10^{-2} = 8.85 \times 10^{-13}$.

Step 3 — Divide by d: $C = \dfrac{8.85 \times 10^{-13}}{1 \times 10^{-3}} = 8.85 \times 10^{-10}$ F.

Step 4 — Convert to pF: 8.85×10^{-10} F $= 885 \times 10^{-12}$ F $= 885$ pF.

Why other options are wrong:

- (A) omits the dielectric constant.
- (C) halves the result.
- (D) doubles the result.

Final Answer: $C \approx 885$ pF $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Parallel pairs in series: Each parallel pair of two 6 μF gives $6+6=12$ μF; two such 12 μF blocks in series combine reciprocally.

Step 1 — One parallel pair: $C_p = 6 + 6 = 12$ μF.

Step 2 — Two 12 μF in series: $\dfrac{1}{C_{eq}} = \dfrac{1}{12} + \dfrac{1}{12} = \dfrac{2}{12} = \dfrac{1}{6}$.

Step 3 — Invert: $C_{eq} = 6$ μF.

Why other options are wrong:

- (B) gives just one parallel pair.
- (C) halves wrongly.
- (D) adds all four in parallel.

Final Answer: $C_{eq} = 6$ μF $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept — Charge and number of electrons: Current $I = \frac{q}{t} = \frac{Ne}{t}$, so the number per second is $\frac{N}{t} = \frac{I}{e}$.

Step 1 — List data: $I = 1.6$ A, $e = 1.6 \times 10^{-19}$ C.

Step 2 — Form the ratio: $\frac{N}{t} = \frac{1.6}{1.6 \times 10^{-19}}$.

Step 3 — Cancel the 1.6**:** $\frac{N}{t} = \frac{1}{10^{-19}} = 10^{19}$.

Step 4 — State result: 1×10^{19} electrons per second.

Why other options are wrong:

- (A) and (C) carry power-of-ten or mantissa slips.
- (B) multiplies instead of dividing by e.

Final Answer: 1×10^{19} electrons/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Balanced Wheatstone bridge: $\frac{P}{Q} = \frac{R}{S}$, so $S = \frac{QR}{P}$.

Step 1 — List data: $P = 3\,\Omega$, $Q = 12\,\Omega$, $R = 5\,\Omega$.

Step 2 — Numerator: $QR = 12 \times 5 = 60$.

Step 3 — Divide by P**:** $S = \frac{60}{3} = 20\,\Omega$.

Why other options are wrong:

- (A) divides by a wrong factor.
- (C) uses a wrong pairing of arms.
- (D) overshoots the correct value.

Final Answer: $S = 20\,\Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Cells in series: EMFs add and internal resistances add: $I = \dfrac{nE}{R + nr}$.

Step 1 — Total EMF: $nE = 2 \times 1.5 = 3$ V.

Step 2 — Total internal resistance: $nr = 2 \times 0.5 = 1\,\Omega$.

Step 3 — Total circuit resistance: $R + nr = 5 + 1 = 6\,\Omega$.

Step 4 — Current: $I = \dfrac{3}{6} = 0.5$ A.

Why other options are wrong:

- (B) ignores internal resistance.
- (C) uses one cell only.
- (D) doubles the current.

Final Answer: $I = 0.5 \text{ A} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q30**

Q31.

Solution

Concept — Operating current: The fuse must carry the appliance's working current $I = \dfrac{P}{V}$.

Step 1 — List data: $P = 1100$ W, $V = 220$ V.

Step 2 — Form the ratio: $I = \dfrac{1100}{220}$.

Step 3 — Evaluate: $I = 5$ A.

Step 4 — Interpret: The fuse must be rated at least 5 A to carry this current.

Why other options are wrong:

- (A) and (B) are below the operating current (fuse would blow).
- (D) is unnecessarily high.

Final Answer: $I = 5 \text{ A} \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q31**

Q32.

Solution

Concept — Net field of two concentric loops: Each loop gives $B = \dfrac{\mu_0 I}{2r}$ at the common centre. With both currents in the same sense the fields add, so $B_{\text{net}} = \dfrac{\mu_0 I}{2}\left(\dfrac{1}{r_1} + \dfrac{1}{r_2}\right)$.

Step 1 — List data: $\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $I = 2$ A, $r_1 = 0.1$ m, $r_2 = 0.2$ m.

Step 2 — Reciprocals of the radii: $\dfrac{1}{r_1} = \dfrac{1}{0.1} = 10$ and $\dfrac{1}{r_2} = \dfrac{1}{0.2} = 5$.

Step 3 — Add the reciprocals: $10 + 5 = 15$ m^{-1}.

Step 4 — Prefactor $\dfrac{\mu_0 I}{2}$: $\dfrac{4\pi \times 10^{-7} \times 2}{2} = 4\pi \times 10^{-7}$.

Step 5 — Multiply: $B_{\text{net}} = 4\pi \times 10^{-7} \times 15 = 60\pi \times 10^{-7}$.

Step 6 — Evaluate: $60\pi \times 10^{-7} \approx 1.88 \times 10^{-5}$ T.

Why other options are wrong:

- (A) uses only the outer loop.
- (B) uses only the inner-loop type contribution.
- (C) subtracts the fields instead of adding them.

Final Answer: $B_{\text{net}} \approx 1.88 \times 10^{-5}$ T $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Force on a current-carrying wire at an angle: $F = BIL \sin\theta$.

Step 1 — List data: $B = 0.6$ T, $I = 5$ A, $L = 0.4$ m, $\theta = 30°$.

Step 2 — Sine value: $\sin 30° = 0.5$.

Step 3 — Multiply B, I, L: $0.6 \times 5 \times 0.4 = 1.2$.

Step 4 — Multiply by $\sin\theta$: $F = 1.2 \times 0.5 = 0.6$ N.

Why other options are wrong:

- (A) omits the $\sin 30°$ factor.
- (C) uses $\cos 30°$ instead.

- (D) halves twice.

Final Answer: $F = 0.6 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — Field at the end of a solenoid: Deep inside, $B_{inside} = \mu_0 n I = B_0$. At an open end, only half the solenoid contributes, giving $B_{end} = \frac{1}{2}\mu_0 n I = \frac{B_0}{2}$.

Step 1 — Inside field: $B_{inside} = \mu_0 n I = B_0$.

Step 2 — End field: The end sees the field of a semi-infinite solenoid, which is half the interior value.

Step 3 — Conclude: $B_{end} = \frac{B_0}{2}$.

Why other options are wrong:

- (A) ignores the end effect.
- (B) doubles instead of halving.
- (C) is the field far outside, not at the end.

Final Answer: $B_{end} = \frac{B_0}{2} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q34

Q35.

Solution

Concept — Faraday's law for an N-turn coil: $|\varepsilon| = N\frac{|\Delta\Phi|}{\Delta t}$.

Step 1 — List data: $N = 200$, $\Phi_1 = 4 \times 10^{-3}$ Wb, $\Phi_2 = 1 \times 10^{-3}$ Wb, $\Delta t = 0.1$ s.

Step 2 — Change in flux: $|\Delta\Phi| = |1 \times 10^{-3} - 4 \times 10^{-3}| = 3 \times 10^{-3}$ Wb.

Step 3 — Rate of change: $\frac{|\Delta\Phi|}{\Delta t} = \frac{3 \times 10^{-3}}{0.1} = 3 \times 10^{-2}$ Wb/s.

Step 4 — Multiply by N: $|\varepsilon| = 200 \times 3 \times 10^{-2} = 6.0$ V.

Why other options are wrong:

- (A) and (B) drop or halve the turns factor.

- (D) doubles the flux change.

Final Answer: $|\varepsilon| = 6.0\text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — Average power in AC: $P_{avg} = V_{rms}I_{rms}\cos\phi$.

Step 1 — List data: $V_{rms} = 200$ V, $I_{rms} = 5$ A, $\phi = 60°$.

Step 2 — Power factor: $\cos 60° = 0.5$.

Step 3 — Multiply $V_{rms}I_{rms}$: $200 \times 5 = 1000$.

Step 4 — Multiply by $\cos\phi$: $P_{avg} = 1000 \times 0.5 = 500$ W.

Why other options are wrong:

- (B) omits the power factor.
- (C) uses $\cos 30°$.
- (D) halves twice.

Final Answer: $P_{avg} = 500\text{ W} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q36

Q37.

Solution

Concept — Mean value of AC over a half cycle: $I_{avg} = \frac{2I_0}{\pi}$, where I_0 is the peak value.

Step 1 — List data: $I_0 = \pi$ A.

Step 2 — Apply the formula: $I_{avg} = \frac{2 \times \pi}{\pi}$.

Step 3 — Cancel π: $I_{avg} = 2$ A.

Why other options are wrong:

- (A) takes the peak itself.
- (C) uses the rms relation $I_0/\sqrt{2}$.
- (D) drops the factor of 2.

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

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — Convex mirror magnification: Use the mirror formula with $f = +20$ cm (convex) and $u = -20$ cm, then $m = -\frac{v}{u}$.

Step 1 — Mirror formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} = \frac{1}{20} - \frac{1}{-20} = \frac{1}{20} + \frac{1}{20} = \frac{2}{20} = \frac{1}{10}$.

Step 2 — Find v: $v = +10$ cm.

Step 3 — Magnification: $m = -\frac{v}{u} = -\frac{10}{-20} = +0.5$.

Step 4 — Interpret: The image is virtual, erect, and half the size, as expected for a convex mirror.

Why other options are wrong:

- (A) and (D) give wrong magnitudes.
- (B) has the wrong sign (image is erect).

Final Answer: $m = +0.5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept — Total internal reflection condition: TIR occurs when light travels from a denser to a rarer medium and the angle of incidence exceeds the critical angle θ_c.

Step 1 — Compare angles: The critical angle is $\theta_c \approx 42^\circ$; the angle of incidence is 50°.

Step 2 — Test the condition: Since $50^\circ > 42^\circ$, the incidence angle exceeds the critical angle.

Step 3 — Conclude: The ray cannot refract into air; it undergoes total internal reflection.

Why other options are wrong:

- (B) and (C) would require the incidence angle to be below θ_c.
- (D) describes incidence exactly at θ_c.

Final Answer: The ray undergoes total internal reflection $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q39

Q40.

Solution

Concept — Lens maker's formula for a biconcave lens: $\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$. For a biconcave lens $R_1 = -R$, $R_2 = +R$.

Step 1 — Insert radii: $\frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{-R} - \frac{1}{+R} = -\frac{2}{R}$.

Step 2 — Substitute $n = 1.5$, $R = 20$ cm: $\frac{1}{f} = (1.5 - 1) \times \left(-\frac{2}{20}\right)$.

Step 3 — Simplify $(n - 1)$: $1.5 - 1 = 0.5$.

Step 4 — Multiply: $\frac{1}{f} = 0.5 \times \left(-\frac{2}{20}\right) = -\frac{1}{20}$.

Step 5 — Invert: $f = -20$ cm.

Why other options are wrong:

- (A) gives the wrong sign (a concave lens diverges, $f < 0$).
- (C) and (D) mishandle the factor of $2/R$.

Final Answer: $f = -20$ cm $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept — Refraction at grazing incidence: At $i = 90^\circ$, Snell's law $\sin i = n \sin r$ gives the refraction angle at the first face.

Step 1 — Apply Snell's law: $\sin 90^\circ = n \sin r$, so $1 = 1.5 \sin r$.

Step 2 — Solve for $\sin r$: $\sin r = \frac{1}{1.5} = \frac{2}{3}$.

Step 3 — Take the inverse sine: $r = \sin^{-1}\left(\frac{2}{3}\right)$.

Step 4 — Evaluate: $r \approx 41.8°$.

Why other options are wrong:

- (A) is the prism angle, not the refraction angle.
- (B) repeats the incidence angle.
- (C) is the complement, $90° - 41.8°$.

Final Answer: $r \approx 41.8° \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

Concept — Condition for a dark fringe: Destructive interference occurs when the path difference equals an odd multiple of half the wavelength.

Step 1 — Recall the rule: Dark fringe $\Rightarrow$ path difference $= (2n+1)\frac{\lambda}{2}$.

Step 2 — Contrast with bright fringe: A bright fringe needs path difference $= n\lambda$ (constructive).

Step 3 — Select: The destructive (dark) condition is $(2n+1)\frac{\lambda}{2}$.

Why other options are wrong:

- (B) is the bright-fringe condition.
- (C) and (D) are not the correct half-integer multiples.

Final Answer: Dark fringe at path difference $(2n+1)\frac{\lambda}{2} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q42

Q43.

Solution

Concept — Malus's law with an unpolarised source: The first polariser halves the intensity; the second applies $I = I' \cos^2\theta$.

Step 1 — After the first polariser: $I' = \frac{I_0}{2}$.

Step 2 — Angle factor: $\cos 60^\circ = \frac{1}{2}$, so $\cos^2 60^\circ = \frac{1}{4}$.

Step 3 — Apply Malus's law: $I = \frac{I_0}{2} \times \frac{1}{4}$.

Step 4 — Multiply: $I = \frac{I_0}{8}$.

Why other options are wrong:

- (A) stops after the first polariser.
- (C) uses $\cos^2 45^\circ$.
- (D) uses a wrong angle factor.

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

Answer: (B) Go Back to Q43

Q44.

Solution

Concept — Energy unit conversion: To convert joules to electron-volts, divide by 1.6×10^{-19} J/eV.

Step 1 — List data: $\phi = 6.4 \times 10^{-19}$ J, 1 eV $= 1.6 \times 10^{-19}$ J.

Step 2 — Form the ratio: $\phi = \frac{6.4 \times 10^{-19}}{1.6 \times 10^{-19}}$ eV.

Step 3 — Cancel the powers of ten: $\frac{6.4}{1.6} = 4$.

Step 4 — State result: $\phi = 4$ eV.

Why other options are wrong:

- (A) and (B) divide incorrectly.
- (D) leaves the value unconverted.

Final Answer: $\phi = 4$ eV $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q44

Q45.

Solution

Concept — Momentum from de Broglie wavelength: $\lambda = \frac{h}{p}$, so $p = \frac{h}{\lambda}$.

Step 1 — List data: $h = 6.6 \times 10^{-34}$ J·s, $\lambda = 3.3$ Å $= 3.3 \times 10^{-10}$ m.

Step 2 — Form the ratio: $p = \frac{6.6 \times 10^{-34}}{3.3 \times 10^{-10}}$.

Step 3 — Divide the mantissas: $\frac{6.6}{3.3} = 2$.

Step 4 — Subtract exponents: $10^{-34-(-10)} = 10^{-24}$.

Step 5 — Combine: $p = 2 \times 10^{-24}$ kg·m/s.

Why other options are wrong:

- (A) and (C) carry mantissa slips.
- (B) uses a wrong mantissa.

Final Answer: $p = 2 \times 10^{-24}$ kg·m/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q45

Q46.

Solution

Concept — Bohr's quantisation of angular momentum: The angular momentum is quantised as $L = \frac{nh}{2\pi}$, an integer multiple of $\frac{h}{2\pi}$.

Step 1 — State the postulate: $L = mvr = \frac{nh}{2\pi}$.

Step 2 — Identify the n-dependence: L is directly proportional to n (first power).

Step 3 — Select: $L = \frac{nh}{2\pi}$.

Why other options are wrong:

- (B) uses n^2, which is the orbit radius dependence.
- (C) and (D) invert the factors.

Final Answer: $L = \frac{nh}{2\pi} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q46

Q47.

Solution

Concept — Bohr orbit radius: $r_n = n^2 a_0$.

Step 1 — Insert $n = 3$**:** $r_3 = 3^2 a_0$.

Step 2 — Square: $3^2 = 9$.

Step 3 — Multiply by a_0**:** $r_3 = 9 \times 0.53 = 4.77$ Å.

Why other options are wrong:

- (A) uses $n = \sqrt{9}$ incorrectly.
- (C) uses $n = 2$.
- (D) forgets to multiply by a_0.

Final Answer: $r_3 = 4.77$ Å $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q47

Q48.

Solution

Concept — Activity and half-life: Activity is proportional to the number of nuclei, so after n half-lives $\frac{A}{A_0} = \left(\frac{1}{2}\right)^n$.

Step 1 — Number of half-lives: $n = \frac{12}{4} = 3$.

Step 2 — Decay factor: $\left(\frac{1}{2}\right)^3 = \frac{1}{8}$.

Step 3 — State the ratio: $\frac{A}{A_0} = \frac{1}{8}$.

Why other options are wrong:

- (A) uses $n = 1$.
- (B) uses $n = 2$.
- (C) is not a power of $\frac{1}{2}$.

Final Answer: $\frac{A}{A_0} = \frac{1}{8} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q48

Q49.

Solution

Concept — Nuclear density: Density $= \dfrac{\text{mass}}{\text{volume}} = \dfrac{Am_p}{\frac{4}{3}\pi R^3}$ with $R = R_0 A^{1/3}$.

Step 1 — Volume: $V = \dfrac{4}{3}\pi R^3 = \dfrac{4}{3}\pi R_0^3 A$.

Step 2 — Mass: $M \approx Am_p$.

Step 3 — Form the ratio: $\rho = \dfrac{Am_p}{\frac{4}{3}\pi R_0^3 A}$.

Step 4 — Cancel A: $\rho = \dfrac{m_p}{\frac{4}{3}\pi R_0^3}$, independent of A.

Why other options are wrong:

- (B), (C), (D) all assume an A-dependence that cancels out.

Final Answer: Nuclear density is nearly the same for all nuclei $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q49

Q50.

Solution

Concept — Doping with a pentavalent impurity: Each pentavalent atom (e.g. P, As) provides one extra electron, making the material n-type with electrons as majority carriers.

Step 1 — Count valence electrons: A pentavalent atom has 5 valence electrons; silicon needs only 4 for bonding.

Step 2 — Identify the extra carrier: The fifth electron is loosely bound and becomes a free conduction electron.

Step 3 — Classify: Free electrons dominate, so the material is n-type with electrons as majority carriers.

Why other options are wrong:

- (A) describes trivalent (acceptor) doping.
- (B) and (D) are not mobile charge carriers in a semiconductor.

Final Answer: Majority carriers are electrons (n-type) $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q50

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	B	3	D	4	A	5	B
6	A	7	C	8	D	9	B	10	C
11	D	12	A	13	B	14	C	15	D
16	A	17	B	18	C	19	A	20	B
21	D	22	D	23	C	24	C	25	D
26	B	27	A	28	D	29	B	30	A
31	C	32	D	33	B	34	D	35	C
36	A	37	B	38	C	39	A	40	B
41	D	42	A	43	B	44	C	45	D
46	A	47	B	48	D	49	A	50	C