JCECE Physics Sample Paper – 10

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. The dimensional formula of specific heat capacity (heat energy per unit mass per unit temperature) is:

(A) $[\mathrm{ML^2T^{-2}K^{-1}}]$

(B) $[\mathrm{M^0L^2T^{-3}K^{-1}}]$

(C) $[\mathrm{M^0L^2T^{-2}K^{-1}}]$

(D) $[\mathrm{ML^2T^{-3}K^{-1}}]$

Q2. A vernier callipers has 10 vernier divisions matching 9 main-scale divisions, and each main-scale division is 1 mm. Its least count is:

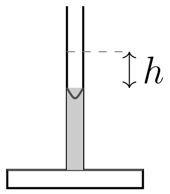
(A) 0.1 mm

(B) 0.01 mm

(C) 1.0 mm

(D) 0.05 mm

Q3. Mercury (surface tension 0.48 N/m, density 13600 kg/m^3, contact angle $135°$) is placed in a glass capillary of radius 1.0 mm ($g = 10$ m/s^2). The depression h of the mercury level is closest to:



(A) 1.0 mm

(B) 2.5 mm

(C) 7.0 mm

(D) 5.0 mm

Q4. A pressure increase of 2×10^7 Pa produces a fractional volume decrease of 0.01 in a liquid. The bulk modulus of the liquid is:

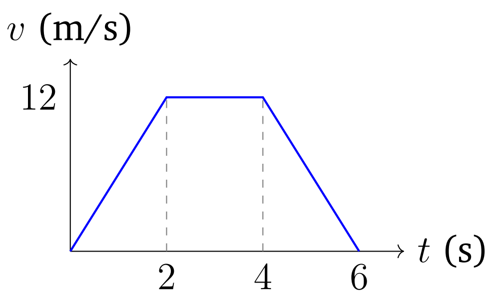
(A) 2×10^7 Pa

(B) 2×10^9 Pa

(C) 2×10^8 Pa

(D) 5×10^8 Pa

Q5. The velocity–time graph of a particle is shown. The distance covered during the last 2 s of the motion (from $t = 4$ s to $t = 6$ s) is:



(A) 12 m

(B) 24 m

(C) 6 m

(D) 36 m

Q6. For a projectile launched with a fixed speed, the angle of projection at which the horizontal range equals the maximum height is:

(A) $\tan^{-1}(1)$

(B) $\tan^{-1}(2)$

(C) $\tan^{-1}(3)$

(D) $\tan^{-1}(4)$

Q7. Two cars A and B are 100 m apart. A moves east at 6 m/s and B, due north of A, moves north at 8 m/s, both starting together. The shortest (closest) distance between them during the motion is:

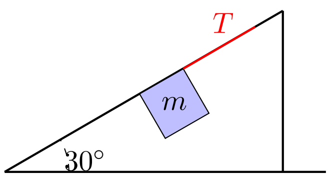
(A) 100 m

(B) 80 m

(C) 60 m

(D) 48 m

Q8. A block of mass 2 kg rests on a smooth incline of angle 30° and is held in place by a light string running up along the incline, as shown ($g = 10\ \text{m/s}^2$). The tension in the string is:



(A) 20 N

(B) 10 N

(C) 17.3 N

(D) 5 N

Q9. A block A of mass 1 kg rests on a block B of mass 3 kg which lies on a frictionless floor. A horizontal force of 8 N is applied to B so that both move together. The minimum coefficient of friction between A and B needed to prevent slipping ($g = 10$ m/s^2) is:

(A) 0.2

(B) 0.4

(C) 0.8

(D) 0.1

Q10. A stone of mass 0.5 kg is whirled in a horizontal circle of radius 2 m at the end of a string that breaks at a tension of 100 N. The maximum speed of the stone before the string breaks is:

(A) 10 m/s

(B) 15 m/s

(C) 20 m/s

(D) 25 m/s

Q11. A variable force $F = (4x - 1)$ N acts on a particle along the x-axis. The work done in moving it from $x = 1$ m to $x = 3$ m is:

(A) 12 J

(B) 14 J

(C) 16 J

(D) 10 J

Q12. An electric motor of power 750 W runs for 4 minutes. The energy it consumes is:

(A) 3000 J

(B) 45 J

(C) 12500 J

(D) 1.8×10^5 J

Q13. A ball of mass 0.2 kg moving at 10 m/s strikes a wall normally and rebounds along the same line at 6 m/s. The magnitude of the impulse imparted to the ball is:

(A) 3.2 N·s

(B) 0.8 N·s

(C) 2.0 N·s

(D) 1.6 N·s

Q14. A solid sphere of mass M and radius R has moment of inertia $\frac{2}{5}MR^2$ about a diameter. Its moment of inertia about a tangent line is:

(A) $\frac{2}{5}MR^2$

(B) $\frac{7}{5}MR^2$

(C) $\frac{3}{5}MR^2$

(D) $\frac{7}{2}MR^2$

Q15. Owing to the rotation of the Earth, the effective acceleration due to gravity g' at a place of latitude λ (with ω the angular speed and R the radius) is given by $g' = g - \omega^2 R \cos^2 \lambda$. The value of g' is therefore:

(A) Greatest at the equator

(B) The same at all latitudes

(C) Greatest at the poles

(D) Independent of ω

Q16. Which statement correctly expresses the second law of thermodynamics (Kelvin–Planck form)?

(A) No engine can convert heat completely into work in a cycle with no other effect

(B) Heat can flow spontaneously from a colder to a hotter body

(C) The internal energy of an isolated system always decreases

(D) A Carnot engine can have 100% efficiency

Q17. A gas is taken round a rectangular cycle on a P–V diagram between pressures 1×10^5 Pa and 3×10^5 Pa and volumes 2×10^{-3} m^3 and 5×10^{-3} m^3. The net work done per cycle (magnitude, equal to the enclosed area) is:

(A) 200 J

(B) 1200 J

(C) 300 J

(D) 600 J

Q18. For an ideal gas, the mean free path λ of its molecules is related to the number density n and molecular diameter d by $\lambda = \dfrac{1}{\sqrt{2}\,\pi d^2 n}$. The mean free path therefore:

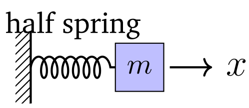
(A) Increases as n increases

(B) Is independent of the molecular diameter

(C) Decreases as the number density increases

(D) Increases with the square of the diameter

Q19. A mass m on a spring of force constant k has period T_0. The same spring is cut into two equal halves and the mass is attached to one half, as shown. The new period of oscillation is:



(A) $2T_0$

(B) T_0

(C) $\sqrt{2}\,T_0$

(D) $\dfrac{T_0}{\sqrt{2}}$

Q20. For a particle in SHM of total energy E and amplitude A, the potential energy when the displacement is $A/3$ is:

(A) $\dfrac{E}{3}$

(B) $\dfrac{E}{9}$

(C) $\dfrac{E}{6}$

(D) $\dfrac{2E}{9}$

Q21. Two points on a progressive wave of wavelength 0.5 m are separated by a path difference of 0.125 m. The phase difference between the oscillations at these points is:

(A) $\dfrac{\pi}{2}$ rad

(B) $\dfrac{\pi}{4}$ rad

(C) π rad

(D) 2π rad

Q22. A stationary source emits sound of frequency 500 Hz towards a stationary observer. Wind blows from the source to the observer at 20 m/s (speed of sound in still air $= 340$ m/s). The frequency heard by the observer is:

(A) 530 Hz

(B) 470 Hz

(C) 500 Hz

(D) 360 Hz

Q23. A charge of $5\,\mu$C is placed in a uniform electric field of magnitude 4×10^4 N/C. The force experienced by the charge is:

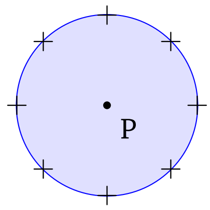
(A) 0.8 N

(B) 2.0 N

(C) 8.0 N

(D) 0.2 N

Q24. A solid metallic sphere carries a charge Q on its surface, as shown. The electrostatic field at a point inside the conductor (in the bulk metal) is:



charged conductor

(A) Zero

(B) $\frac{kQ}{R^2}$ directed outward

(C) $\frac{kQ}{R^2}$ directed inward

(D) Equal to the surface field

Q25. The electric potential at a point 0.3 m from a point charge of 6 nC in vacuum ($k = 9 \times 10^9$ N·m^2/C^2) is:

(A) 90 V

(B) 360 V

(C) 180 V

(D) 540 V

Q26. A parallel-plate capacitor has plate separation 2 mm and is connected to a 20 V battery. A dielectric of constant $K = 2$ completely fills the gap (battery remains connected). The electric field between the plates becomes:

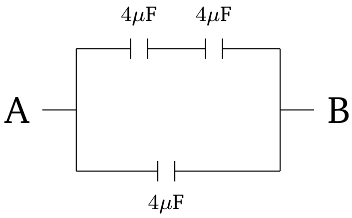
(A) 2×10^4 V/m

(B) 1×10^4 V/m

(C) 5×10^3 V/m

(D) 4×10^4 V/m

Q27. In the network shown, two $4\,\mu$F capacitors in series are connected in parallel with a third $4\,\mu$F capacitor, and the combination is charged to 2 V. The energy stored in the network is:



(A) $4\,\mu$J

(B) $8\,\mu$J

(C) $6\,\mu$J

(D) $12\,\mu$J

Q28. A wire of cross-section 1 mm^2 carries a current of 1.6 A with electron drift speed 1.25×10^{-4} m/s ($e = 1.6 \times 10^{-19}$ C). The free-electron density n is:

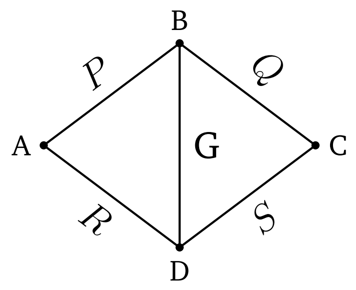
(A) 8×10^{28} m^{-3}

(B) 4×10^{28} m^{-3}

(C) 8×10^{27} m^{-3}

(D) 1.6×10^{29} m^{-3}

Q29. A Wheatstone bridge is balanced as shown so that the galvanometer reads zero. If the cell and the galvanometer are now interchanged (the cell put where G was and G where the cell was), the galvanometer will:



(A) Show a large deflection

(B) Still read zero (remain balanced)

(C) Deflect to one side only

(D) Read the full cell current

Q30. Two identical cells, each of EMF 1.5 V and internal resistance $1\,\Omega$, are connected in parallel and then to an external resistance of $1.5\,\Omega$. The current drawn from the combination is:

(A) 1.5 A

(B) 0.5 A

(C) 1.0 A

(D) 0.75 A

Q31. An immersion heater of power 1000 W is used to heat 2 kg of water from 20°C to 70°C (specific heat of water $= 4200$ J/kg·K, no losses). The time required is:

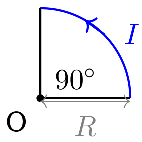
(A) 210 s

(B) 315 s

(C) 420 s

(D) 700 s

Q32. A wire bent into a circular arc of radius 0.1 m subtending an angle of 90° at the centre carries a current of 3 A ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A). The magnetic field at the centre O is:



(A) 9.4×10^{-6} T

(B) 4.7×10^{-6} T

(C) 1.9×10^{-5} T

(D) 1.5×10^{-6} T

Q33. A proton ($m = 1.6 \times 10^{-27}$ kg, $q = 1.6 \times 10^{-19}$ C) moves in a magnetic field of 0.5 T. Its cyclotron frequency is approximately:

(A) 1.6×10^{6} Hz

(B) 3.2×10^{6} Hz

(C) 5.0×10^{6} Hz

(D) 8.0×10^{6} Hz

Q34. The magnetic field inside a region is 2×10^{-2} T ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A). The energy density of the magnetic field is approximately:

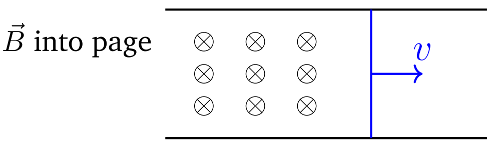
(A) 159 J/m^3

(B) 318 J/m^3

(C) 80 J/m^3

(D) 400 J/m^3

Q35. A conducting rod of length 0.4 m slides at 5 m/s perpendicular to itself across rails in a uniform field of 0.6 T directed into the page, as shown. The induced EMF is:



(A) 0.6 V

(B) 1.2 V

(C) 2.4 V

(D) 0.3 V

Q36. In a series LCR circuit, $R = 10\,\Omega$, $X_L = 20\,\Omega$ and $X_C = 10\,\Omega$. The phase angle between the current and the applied voltage is:

(A) 0°

(B) 30°

(C) 45°

(D) 60°

Q37. An ideal step-down transformer has a turns ratio $N_p : N_s = 5 : 1$. If the primary current is 2 A, the secondary current is:

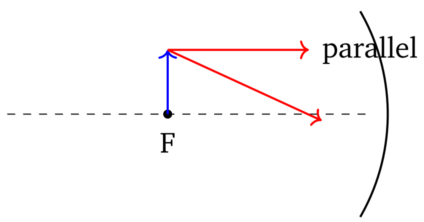
(A) 10 A

(B) 0.4 A

(C) 2 A

(D) 5 A

Q38. An object is placed exactly at the focus of a concave mirror of focal length 20 cm, as shown. The image is formed at:



(A) The pole of the mirror

(B) The centre of curvature

(C) Infinity

(D) The focus itself

Q39. The refractive index of a transparent medium is 1.5. The speed of light in this medium (with $c = 3 \times 10^8$ m/s) is:

(A) 4.5×10^8 m/s

(B) 2×10^8 m/s

(C) 3×10^8 m/s

(D) 1.5×10^8 m/s

Q40. Two thin lenses of focal lengths $+20$ cm and -30 cm are placed in contact. The power of the combination is:

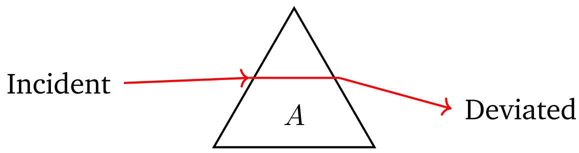
(A) $+5.0$ D

(B) -1.67 D

(C) $+3.33$ D

(D) $+1.67$ D

Q41. A thin prism made of glass of refractive index 1.5 produces a deviation of 2.5°, as shown. The refracting angle of the prism is:



(A) 2.5°

(B) 3.75°

(C) 1.25°

(D) 5°

Q42. In a Young's double-slit experiment the fringe width is 0.5 mm. The number of bright fringes that lie within a region of width 5 mm on the screen is:

(A) 10

(B) 5

(C) 20

(D) 25

Q43. In single-slit diffraction, light of wavelength 600 nm gives its first minimum at an angle of 3×10^{-3} rad. The width of the slit is:

(A) 0.1 mm

(B) 0.2 mm

(C) 0.4 mm

(D) 0.05 mm

Q44. A monochromatic source emits light of photon energy 3.3×10^{-19} J at a power of 6.6 W. The number of photons emitted per second is:

(A) 1×10^{19}

(B) 5×10^{19}

(C) 2×10^{19}

(D) 2×10^{20}

Q45. An electron is accelerated through a potential difference of 100 V. Using $\lambda = \frac{12.27}{\sqrt{V}}$ Å, its de Broglie wavelength is approximately:

(A) 0.5 Å

(B) 2.5 Å

(C) 12.3 Å

(D) 1.23 Å

Q46. In the photoelectric effect, the graph of stopping potential V_s against incident frequency ν is a straight line. Its intercept on the V_s-axis (at $\nu = 0$) equals:

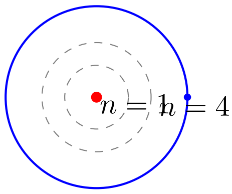
(A) $-\frac{\phi}{e}$

(B) $\dfrac{h}{e}$

(C) $\dfrac{\phi}{h}$

(D) $h\nu_0$

Q47. In Bohr's model of hydrogen the orbit radius is $r_n = n^2 a_0$ with $a_0 = 0.53$ Å. The radius of the $n = 4$ orbit is shown below. Its value is:



(A) 4.24 Å

(B) 8.48 Å

(C) 2.12 Å

(D) 0.53 Å

Q48. A radioactive isotope has a half-life of 1386 s. Its decay constant (taking $\ln 2 = 0.693$) is:

(A) 2×10^{-3} s^{-1}

(B) 1×10^{-3} s^{-1}

(C) 5×10^{-4} s^{-1}

(D) 1.386 s^{-1}

Q49. The nuclear radius is given by $R = R_0 A^{1/3}$. The ratio of the radius of a nucleus with mass number $A = 216$ to that of a nucleus with $A = 27$ is:

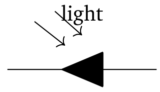
(A) 8

(B) 2

(C) 4

(D) 6

Q50. The circuit symbol shown represents a photodiode used in a particular mode. A photodiode in a circuit is normally operated under:



(A) Reverse bias, converting incident light into an electrical signal

(B) Forward bias, converting current into light

(C) No bias, acting as a pure resistor

(D) Forward bias, blocking all current

Detailed Solutions

Q1.

Solution

Concept — Specific heat capacity: $c = \dfrac{Q}{m\,\Delta T}$, the heat energy per unit mass per unit temperature change.

Step 1 — Dimension of heat energy: $[Q] = \mathrm{ML^2T^{-2}}$.

Step 2 — Dimension of mass: $[m] = \mathrm{M}$.

Step 3 — Dimension of temperature: $[\Delta T] = \mathrm{K}$.

Step 4 — Divide: $[c] = \dfrac{\mathrm{ML^2T^{-2}}}{\mathrm{M\cdot K}} = \mathrm{M^0L^2T^{-2}K^{-1}}$.

Why other options are wrong:

- (A) keeps a mass dimension that should cancel.
- (B) and (D) have $\mathrm{T^{-3}}$, the dimension of power per unit temperature, not energy.

Final Answer: $[c] = \mathrm{M^0L^2T^{-2}K^{-1}} \Rightarrow \boxed{\mathrm{C}}$

Answer: (C) **Go Back to Q1**

Q2.

Solution

Concept — Least count of a vernier callipers: $\mathrm{LC} = \text{(value of one main-scale division)} - \text{(value of one vernier division)}$, equivalently $\mathrm{LC} = \dfrac{1\ \mathrm{MSD}}{N}$ when N vernier divisions span $N-1$ main divisions.

Step 1 — One main-scale division: $1\ \mathrm{MSD} = 1\ \mathrm{mm}$.

Step 2 — Vernier divisions: $10\ \mathrm{VSD} = 9\ \mathrm{MSD}$, so $1\ \mathrm{VSD} = \dfrac{9}{10}\ \mathrm{mm} = 0.9\ \mathrm{mm}$.

Step 3 — Subtract: $\mathrm{LC} = 1\ \mathrm{mm} - 0.9\ \mathrm{mm} = 0.1\ \mathrm{mm}$.

Why other options are wrong:

- (B) is the least count of a screw gauge, not this vernier.
- (C) is one full MSD, ignoring the vernier.
- (D) would need 20 vernier divisions per 19 MSD.

Final Answer: $\mathrm{LC} = 0.1\ \mathrm{mm} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Capillary depression: The same formula $h = \dfrac{2T\cos\theta}{r\rho g}$ applies; for mercury $\theta = 135°$ gives $\cos\theta < 0$, so h is negative, i.e. a depression.

Step 1 — List data: $T = 0.48$ N/m, $\theta = 135°$, $r = 1.0$ mm $= 1 \times 10^{-3}$ m, $\rho = 13600$ kg/m^3, $g = 10$ m/s^2.

Step 2 — Cosine of the angle: $\cos 135° = -\dfrac{1}{\sqrt{2}} \approx -0.707$.

Step 3 — Numerator: $2T\cos\theta = 2 \times 0.48 \times (-0.707) = -0.679$.

Step 4 — Denominator: $r\rho g = 1 \times 10^{-3} \times 13600 \times 10 = 136$.

Step 5 — Divide: $h = \dfrac{-0.679}{136} = -4.99 \times 10^{-3}$ m.

Step 6 — Interpret: Magnitude $\approx 5.0 \times 10^{-3}$ m $= 5.0$ mm; the minus sign means the level is depressed.

Why other options are wrong:

- (A) and (B) come from dropping the factor of 2 or mis-reading $\cos\theta$.
- (C) uses water-like data, not mercury.

Final Answer: Depression ≈ 5.0 mm $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

Solution

Concept — Bulk modulus: $B = \dfrac{\Delta P}{|\Delta V/V|}$, the ratio of pressure change to fractional volume change.

Step 1 — List data: $\Delta P = 2 \times 10^7$ Pa, fractional volume decrease $\left|\dfrac{\Delta V}{V}\right| = 0.01$.

Step 2 — Write the formula: $B = \dfrac{\Delta P}{|\Delta V/V|}$.

Step 3 — Substitute: $B = \dfrac{2 \times 10^7}{0.01}$.

Step 4 — Evaluate: $B = \dfrac{2 \times 10^7}{1 \times 10^{-2}} = 2 \times 10^9$ Pa.

Why other options are wrong:

- (A) forgets to divide by the strain.
- (C) and (D) carry power-of-ten slips.

Final Answer: $B = 2 \times 10^9$ Pa $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Area under a v–t graph: Distance equals the area between the curve and the t-axis. The last 2 s ($t = 4$ to 6 s) is the falling triangle.

Step 1 — Read the segment: From $t = 4$ s to $t = 6$ s the velocity falls linearly from 12 m/s to 0.

Step 2 — Identify the shape: A triangle of base $6 - 4 = 2$ s and height 12 m/s.

Step 3 — Apply triangle area: Distance $= \frac{1}{2} \times$ base $\times$ height.

Step 4 — Substitute: $= \frac{1}{2} \times 2 \times 12$.

Step 5 — Evaluate: $= 12$ m.

Why other options are wrong:

- (B) doubles the area (forgets the $\frac{1}{2}$).
- (C) halves the height incorrectly.
- (D) gives the total distance over all 6 s, not the last 2 s.

Final Answer: Distance in last 2 s $= 12$ m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Range and maximum height: $R = \dfrac{u^2 \sin 2\theta}{g}$ and $H = \dfrac{u^2 \sin^2\theta}{2g}$. Set $R = H$.

Step 1 — Write the equality: $\dfrac{u^2 \sin 2\theta}{g} = \dfrac{u^2 \sin^2\theta}{2g}$.

Step 2 — Cancel u^2/g: $\sin 2\theta = \dfrac{\sin^2\theta}{2}$.

Step 3 — Expand $\sin 2\theta$: $2\sin\theta\cos\theta = \dfrac{\sin^2\theta}{2}$.

Step 4 — Divide by $\sin\theta$: $2\cos\theta = \dfrac{\sin\theta}{2}$.

Step 5 — Rearrange: $\dfrac{\sin\theta}{\cos\theta} = 4$, so $\tan\theta = 4$.

Step 6 — Solve: $\theta = \tan^{-1}(4)$.

Why other options are wrong:

- (A) is 45°, which gives $R = 4H$, not $R = H$.
- (B) and (C) come from arithmetic slips in the algebra.

Final Answer: $\theta = \tan^{-1}(4) \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q6

Q7.

Solution

Concept — Closest approach: Work in the rest frame of A. The relative velocity of B with respect to A is constant; the closest distance is the perpendicular distance from A to the line of relative motion.

Step 1 — Set up geometry: Place A at the origin; B starts at $(0, 100)$ m (due north). A moves east at 6 m/s, B moves north at 8 m/s.

Step 2 — Relative velocity of B w.r.t. A: $\vec{v}_{BA} = \vec{v}_B - \vec{v}_A = (0, 8) - (6, 0) = (-6, 8)$ m/s.

Step 3 — Speed of relative motion: $|\vec{v}_{BA}| = \sqrt{(-6)^2 + 8^2} = \sqrt{36 + 64} = \sqrt{100} = 10$ m/s.

Step 4 — Initial relative position: $\vec{r}_{BA} = (0, 100)$ m; its magnitude is 100 m.

Step 5 — Perpendicular (closest) distance: $d_{\min} = \dfrac{|\vec{r}_{BA} \times \vec{v}_{BA}|}{|\vec{v}_{BA}|}$. The cross-product magnitude $= |0 \cdot 8 - 100 \cdot (-6)| = |600| = 600$.

Step 6 — Divide: $d_{\min} = \dfrac{600}{10} = 60$ m.

Why other options are wrong:

- (A) is the initial separation, before they approach.
- (B) and (D) come from mis-resolving the relative velocity.

Final Answer: Closest distance $= 60$ m $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Block held on a smooth incline: With the string along the incline, equilibrium along the slope gives $T = mg \sin\theta$ (the smooth surface contributes no friction).

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

Step 2 — Component of weight along incline: $mg \sin\theta = 2 \times 10 \times \sin 30^\circ$.

Step 3 — Insert $\sin 30^\circ = 0.5$**:** $= 2 \times 10 \times 0.5$.

Step 4 — Evaluate: $T = 10$ N.

Why other options are wrong:

- (A) uses the full weight $mg = 20$ N.
- (C) uses $mg \cos 30^\circ$ (the normal force, not the tension).
- (D) halves the correct value.

Final Answer: $T = 10$ N $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Friction needed to move blocks together: The common acceleration is $a = \dfrac{F}{m_A + m_B}$. Friction on the top block must provide $m_A a$, and the maximum available friction is $\mu m_A g$. Require $\mu m_A g \geq m_A a$, i.e. $\mu \geq a/g$.

Step 1 — Common acceleration: $a = \dfrac{F}{m_A + m_B} = \dfrac{8}{1+3} = \dfrac{8}{4} = 2\ \text{m/s}^2$.

Step 2 — Friction condition: $\mu_{\min} = \dfrac{a}{g}$.

Step 3 — Substitute: $\mu_{\min} = \dfrac{2}{10}$.

Step 4 — Evaluate: $\mu_{\min} = 0.2$.

Why other options are wrong:

- (B) doubles the value.
- (C) uses $a = 8\ \text{m/s}^2$ (ignores total mass).
- (D) halves the value.

Final Answer: $\mu_{\min} = 0.2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — String tension as centripetal force: For a horizontal circle, the maximum tension equals the centripetal force, $T_{\max} = \dfrac{mv_{\max}^2}{r}$, so $v_{\max} = \sqrt{\dfrac{T_{\max}\, r}{m}}$.

Step 1 — List data: $T_{\max} = 100$ N, $r = 2$ m, $m = 0.5$ kg.

Step 2 — Numerator: $T_{\max}\, r = 100 \times 2 = 200$.

Step 3 — Divide by mass: $\dfrac{200}{0.5} = 400\ \text{m}^2/\text{s}^2$.

Step 4 — Take square root: $v_{\max} = \sqrt{400} = 20$ m/s.

Why other options are wrong:

- (A) and (B) come from arithmetic slips inside the root.
- (D) overestimates by mis-dividing by the mass.

Final Answer: $v_{\max} = 20\ \text{m/s} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Work by a variable force: $W = \int_{x_1}^{x_2} F\,dx$.

Step 1 — Set up integral: $W = \int_1^3 (4x - 1)\,dx$.

Step 2 — Integrate: $\int (4x - 1)\,dx = 2x^2 - x$.

Step 3 — Evaluate at $x = 3$: $2(3)^2 - 3 = 18 - 3 = 15$.

Step 4 — Evaluate at $x = 1$: $2(1)^2 - 1 = 2 - 1 = 1$.

Step 5 — Subtract: $W = 15 - 1 = 14$ J.

Why other options are wrong:

- (A) integrates only the $4x$ term.
- (C) drops the lower-limit contribution.
- (D) mis-evaluates the antiderivative.

Final Answer: $W = 14$ J $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Energy from power and time: $E = P \times t$, with t in seconds.

Step 1 — List data: $P = 750$ W, $t = 4$ min.

Step 2 — Convert time: $t = 4 \times 60 = 240$ s.

Step 3 — Multiply: $E = 750 \times 240$.

Step 4 — Evaluate: $E = 180000 = 1.8 \times 10^5$ J.

Why other options are wrong:

- (A) uses $t = 4$ s.
- (B) divides instead of multiplying.

- (C) uses a wrong time conversion.

Final Answer: $E = 1.8 \times 10^5$ J $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Impulse equals change in momentum: $J = \Delta p = m(v_f - v_i)$. Taking the incoming direction as positive, the rebound velocity is negative.

Step 1 — List data: $m = 0.2$ kg, $v_i = +10$ m/s, $v_f = -6$ m/s (rebound).

Step 2 — Change in velocity: $v_f - v_i = -6 - 10 = -16$ m/s.

Step 3 — Multiply by mass: $J = 0.2 \times (-16) = -3.2$ N·s.

Step 4 — Take magnitude: $|J| = 3.2$ N·s.

Why other options are wrong:

- (B) uses the difference $10 - 6 = 4$ instead of the sum.
- (C) and (D) carry arithmetic slips in Δv.

Final Answer: $|J| = 3.2$ N·s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Parallel-axis theorem: $I_{\text{tangent}} = I_{\text{cm}} + MR^2$, where the tangent is parallel to a diameter at distance R.

Step 1 — Moment of inertia about diameter: $I_{\text{cm}} = \frac{2}{5}MR^2$.

Step 2 — Distance of tangent from centre: $d = R$, so $Md^2 = MR^2$.

Step 3 — Add: $I_{\text{tangent}} = \frac{2}{5}MR^2 + MR^2$.

Step 4 — Combine: $= \frac{2}{5}MR^2 + \frac{5}{5}MR^2 = \frac{7}{5}MR^2$.

Why other options are wrong:

- (A) is the value about a diameter only.

- (C) adds $\frac{1}{5}MR^2$ instead of MR^2.
- (D) is the tangent value for a hollow sphere/disc form.

Final Answer: $I_{\text{tangent}} = \dfrac{7}{5}MR^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Variation of g with latitude: $g' = g - \omega^2 R\cos^2\lambda$. The reduction is largest where $\cos^2\lambda$ is largest.

Step 1 — At the equator: $\lambda = 0°$, $\cos^2\lambda = 1$; reduction is maximum, so g' is smallest there.

Step 2 — At the poles: $\lambda = 90°$, $\cos^2\lambda = 0$; no reduction, so $g' = g$ (the largest value).

Step 3 — Conclude: g' is greatest at the poles.

Why other options are wrong:

- (A) is the opposite; g' is least at the equator.
- (B) is false; g' varies with λ.
- (D) is false; the correction term contains ω^2.

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

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Kelvin–Planck statement: It is impossible to construct an engine that, operating in a cycle, takes heat from a single reservoir and converts it entirely into work with no other effect.

Step 1 — Test option (A): It states exactly this impossibility of complete heat-to-work conversion in a cycle. Correct.

Step 2 — Test option (B): Spontaneous heat flow from cold to hot violates the Clausius statement; it does not happen. Wrong.

Step 3 — Test option (C): The internal energy of an isolated system is conserved, not always decreasing. Wrong.

Step 4 — Test option (D): A Carnot engine has $\eta = 1 - T_C/T_H < 100\%$ for finite temperatures. Wrong.

Final Answer: The Kelvin–Planck statement is option (A) $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Work in a closed cycle: The net work per cycle equals the area enclosed by the loop on the P–V diagram. For a rectangle, area $= \Delta P \times \Delta V$.

Step 1 — Pressure range: $\Delta P = 3 \times 10^5 - 1 \times 10^5 = 2 \times 10^5$ Pa.

Step 2 — Volume range: $\Delta V = 5 \times 10^{-3} - 2 \times 10^{-3} = 3 \times 10^{-3}$ m^3.

Step 3 — Multiply: $W = \Delta P \times \Delta V = 2 \times 10^5 \times 3 \times 10^{-3}$.

Step 4 — Evaluate: $= 6 \times 10^2 = 600$ J.

Why other options are wrong:

- (A) and (C) use only one side of the rectangle.
- (B) multiplies the full pressures and volumes rather than their differences.

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

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — Mean free path: $\lambda = \dfrac{1}{\sqrt{2}\,\pi d^2 n}$. Read off the dependence on each variable.

Step 1 — Dependence on n: $\lambda \propto \dfrac{1}{n}$, so increasing n (more crowded molecules) shortens λ.

Step 2 — Dependence on d: $\lambda \propto \dfrac{1}{d^2}$, so larger molecules give a smaller mean free path.

Step 3 — Identify the true statement: The mean free path decreases as the number density increases.

Why other options are wrong:

- (A) reverses the n-dependence.
- (B) is false; λ depends on d^2.
- (D) reverses the d-dependence.

Final Answer: λ decreases as n increases $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Spring constant of a half-spring: Cutting a spring in half doubles its force constant: each half has $k' = 2k$. Then $T = 2\pi\sqrt{m/k'}$.

Step 1 — Original period: $T_0 = 2\pi\sqrt{\frac{m}{k}}$.

Step 2 — New force constant: $k' = 2k$.

Step 3 — New period: $T = 2\pi\sqrt{\frac{m}{2k}}$.

Step 4 — Form the ratio: $\frac{T}{T_0} = \sqrt{\frac{m/2k}{m/k}} = \sqrt{\frac{1}{2}} = \frac{1}{\sqrt{2}}$.

Step 5 — Solve: $T = \frac{T_0}{\sqrt{2}}$.

Why other options are wrong:

- (A) and (C) increase the period; cutting the spring stiffens it, shortening T.
- (B) ignores the change in k.

Final Answer: $T = \frac{T_0}{\sqrt{2}} \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — SHM potential energy: $U = \frac{1}{2}kx^2$ and total energy $E = \frac{1}{2}kA^2$, so $\frac{U}{E} = \frac{x^2}{A^2}$.

Step 1 — Insert $x = A/3$**:** $\frac{U}{E} = \frac{(A/3)^2}{A^2}$.

Step 2 — Square the numerator: $(A/3)^2 = \frac{A^2}{9}$.

Step 3 — Divide: $\frac{A^2/9}{A^2} = \frac{1}{9}$.

Step 4 — Solve for U**:** $U = \frac{E}{9}$.

Why other options are wrong:

- (A) forgets to square the one-third.
- (C) and (D) come from arithmetic slips.

Final Answer: $U = \frac{E}{9} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q20

Q21.

Solution

Concept — Phase difference from path difference: $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$.

Step 1 — List data: $\lambda = 0.5$ m, $\Delta x = 0.125$ m.

Step 2 — Form the ratio $\Delta x/\lambda$**:** $\frac{0.125}{0.5} = \frac{1}{4}$.

Step 3 — Multiply by 2π**:** $\Delta\phi = 2\pi \times \frac{1}{4}$.

Step 4 — Evaluate: $\Delta\phi = \frac{\pi}{2}$ rad.

Why other options are wrong:

- (B) uses $\Delta x/\lambda = 1/8$.
- (C) corresponds to $\Delta x = \lambda/2$.
- (D) corresponds to a full wavelength.

Final Answer: $\Delta\phi = \frac{\pi}{2}$ rad $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Doppler effect with wind, both source and observer at rest: When both are stationary, a steady wind shifts the sound speed but not the frequency. The wavelength changes with the wind, keeping $f' = f$.

Step 1 — Effective sound speed: Wind towards observer adds to the speed: $v' = 340 + 20 = 360$ m/s.

Step 2 — Source frequency unchanged: The source still emits $f = 500$ Hz per second, and the medium carries the same number of waves past the observer per second.

Step 3 — Observed frequency: Since neither source nor observer moves relative to the ground, $f' = f = 500$ Hz.

Step 4 — Note: The wind changes the wavelength ($\lambda' = v'/f$) but not the heard frequency.

Why other options are wrong:

- (A) and (B) wrongly apply a moving-source formula to a wind.
- (D) confuses wavelength change with a frequency change.

Final Answer: $f' = 500$ Hz $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Force on a charge in a field: $F = qE$.

Step 1 — List data: $q = 5 \times 10^{-6}$ C, $E = 4 \times 10^{4}$ N/C.

Step 2 — Multiply the mantissas: $5 \times 4 = 20$.

Step 3 — Add the exponents: $10^{-6} \times 10^{4} = 10^{-2}$.

Step 4 — Combine: $F = 20 \times 10^{-2} = 0.2$ N.

Why other options are wrong:

- (A), (B), (C) carry power-of-ten slips.

Final Answer: $F = 0.2\ \text{N} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Field inside a conductor: In electrostatic equilibrium, free charges redistribute on the surface so that the net electric field everywhere inside the bulk of a conductor is exactly zero.

Step 1 — Equilibrium condition: If any field existed inside, free electrons would keep moving, contradicting equilibrium.

Step 2 — Charge location: All excess charge resides on the outer surface, leaving no net charge in the interior.

Step 3 — Conclude: The field at interior point P is zero.

Why other options are wrong:

- (B) and (C) are the field of a point charge, not inside a conductor.
- (D) is the field just outside the surface, not inside.

Final Answer: Field inside $= 0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Potential of a point charge: $V = \dfrac{kq}{r}$.

Step 1 — List data: $k = 9 \times 10^9$, $q = 6 \times 10^{-9}$ C, $r = 0.3$ m.

Step 2 — Numerator: $kq = 9 \times 10^9 \times 6 \times 10^{-9} = 54$.

Step 3 — Divide by r: $V = \dfrac{54}{0.3}$.

Step 4 — Evaluate: $V = 180$ V.

Why other options are wrong:

- (A) divides by a wrong distance.

- (B) and (D) carry arithmetic slips.

Final Answer: $V = 180$ V $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q25

Q26.

Solution

Concept — Field between plates at constant voltage: With the battery connected, the voltage across the plates stays fixed, so $E = \frac{V}{d}$ is unchanged by inserting a dielectric (the dielectric changes charge, not voltage).

Step 1 — List data: $V = 20$ V, $d = 2$ mm $= 2 \times 10^{-3}$ m.

Step 2 — Apply $E = V/d$: $E = \frac{20}{2 \times 10^{-3}}$.

Step 3 — Evaluate: $E = 1 \times 10^4$ V/m.

Step 4 — Effect of dielectric: Since V is held constant by the battery, $E = V/d$ is independent of K; it stays 1×10^4 V/m.

Why other options are wrong:

- (A) multiplies by K (would apply at constant charge, not constant V).
- (C) divides by K.
- (D) doubles the value wrongly.

Final Answer: $E = 1 \times 10^4$ V/m $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Equivalent capacitance then energy: First find C_{eq}, then use $U = \frac{1}{2}C_{eq}V^2$.

Step 1 — Two $4\ \mu$**F in series:** $\frac{1}{C_s} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$, so $C_s = 2\ \mu$F.

Step 2 — Parallel with the third $4\ \mu$**F:** $C_{eq} = 2 + 4 = 6\ \mu$F.

Step 3 — Apply the energy formula: $U = \frac{1}{2}C_{eq}V^2$.

Step 4 — Substitute: $U = \frac{1}{2} \times 6 \times 10^{-6} \times (2)^2$.

Step 5 — Evaluate: $= \frac{1}{2} \times 6 \times 10^{-6} \times 4 = 12 \times 10^{-6}$ J $= 12\ \mu$J.

Why other options are wrong:

- (A) uses only the series pair (2 μF).
- (B) drops the factor of $\frac{1}{2}$ with the wrong C.
- (C) mis-multiplies V^2.

Final Answer: $U = 12\ \mu\text{J} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Free-electron density: From $I = nAev_d$, solve $n = \dfrac{I}{Aev_d}$.

Step 1 — List data: $I = 1.6$ A, $A = 1$ mm^2 $= 1 \times 10^{-6}$ m^2, $e = 1.6 \times 10^{-19}$ C, $v_d = 1.25 \times 10^{-4}$ m/s.

Step 2 — Denominator Aev_d: $1 \times 10^{-6} \times 1.6 \times 10^{-19} \times 1.25 \times 10^{-4}$.

Step 3 — Multiply mantissas: $1 \times 1.6 \times 1.25 = 2.0$.

Step 4 — Add exponents: $10^{-6-19-4} = 10^{-29}$, so $Aev_d = 2.0 \times 10^{-29}$.

Step 5 — Divide: $n = \dfrac{1.6}{2.0 \times 10^{-29}} = 0.8 \times 10^{29} = 8 \times 10^{28}$ m^{-3}.

Why other options are wrong:

- (B) halves the value.
- (C) carries a power-of-ten error.
- (D) doubles the value.

Final Answer: $n = 8 \times 10^{28}\ \text{m}^{-3} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q28

Q29.

Solution

Concept — Symmetry of a balanced bridge: A Wheatstone bridge is balanced when $\frac{P}{Q} = \frac{R}{S}$. This balance condition is symmetric: interchanging the cell (battery) and the galvanometer leaves the same condition, so the bridge stays balanced.

Step 1 — Balance condition before: $\frac{P}{Q} = \frac{R}{S}$ with G between B and D.

Step 2 — After interchange: The cell now sits between B and D and G between A and C; the algebraic balance condition is unchanged.

Step 3 — Conclude: The galvanometer still reads zero.

Why other options are wrong:

- (A), (C), (D) assume the balance is lost, but the condition is symmetric in the two diagonals.

Final Answer: The galvanometer still reads zero $\Rightarrow$ B

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Identical cells in parallel: Two identical cells of EMF E and internal resistance r in parallel give net EMF E and net internal resistance $r/2$. Then $I = \frac{E}{R + r/2}$.

Step 1 — Net EMF: $E_{eq} = 1.5$ V (unchanged for identical cells in parallel).

Step 2 — Net internal resistance: $r_{eq} = \frac{r}{2} = \frac{1}{2} = 0.5\,\Omega$.

Step 3 — Total resistance: $R + r_{eq} = 1.5 + 0.5 = 2.0\,\Omega$.

Step 4 — Current: $I = \frac{1.5}{2.0} = 0.75$ A.

Why other options are wrong:

- (A) ignores all internal resistance.
- (B) uses $r_{eq} = 1\,\Omega$ wrongly.
- (C) uses a wrong total resistance.

Final Answer: $I = 0.75$ A $\Rightarrow$ D

Answer: (D) Go Back to Q30

Q31.

Solution

Concept — Heating time: Energy needed $= mc\Delta T$; with constant power, $t = \dfrac{mc\Delta T}{P}$.

Step 1 — List data: $m = 2$ kg, $c = 4200$ J/kg·K, $\Delta T = 70 - 20 = 50$ K, $P = 1000$ W.

Step 2 — Heat required: $Q = mc\Delta T = 2 \times 4200 \times 50$.

Step 3 — Evaluate Q: $= 2 \times 4200 \times 50 = 420000$ J.

Step 4 — Divide by power: $t = \dfrac{420000}{1000} = 420$ s.

Why other options are wrong:

- (A) uses $\Delta T = 25$ K.
- (B) uses a wrong heat value.
- (D) carries an arithmetic slip.

Final Answer: $t = 420$ s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Field of a circular arc: A full loop gives $\dfrac{\mu_0 I}{2R}$. An arc subtending angle θ (in radians) at the centre gives $B = \dfrac{\mu_0 I}{2R} \cdot \dfrac{\theta}{2\pi} = \dfrac{\mu_0 I\theta}{4\pi R}$.

Step 1 — List data: $\mu_0 = 4\pi \times 10^{-7}$, $I = 3$ A, $R = 0.1$ m, $\theta = 90^\circ = \dfrac{\pi}{2}$ rad.

Step 2 — Use $B = \dfrac{\mu_0 I\theta}{4\pi R}$: $B = \dfrac{4\pi \times 10^{-7} \times 3 \times (\pi/2)}{4\pi \times 0.1}$.

Step 3 — Cancel 4π: $B = \dfrac{10^{-7} \times 3 \times (\pi/2)}{0.1}$.

Step 4 — Simplify numerator: $3 \times \dfrac{\pi}{2} = 4.712$, so numerator $= 4.712 \times 10^{-7}$.

Step 5 — Divide by 0.1: $B = \dfrac{4.712 \times 10^{-7}}{0.1} = 4.712 \times 10^{-6}$ T.

Step 6 — Round: $B \approx 4.7 \times 10^{-6}$ T.

Why other options are wrong:

- (A) uses the half-loop (180°) value.
- (C) uses the full-loop value.
- (D) carries a factor error.

Final Answer: $B \approx 4.7 \times 10^{-6}$ T $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q32

Q33.

Solution

Concept — Cyclotron frequency: $f = \dfrac{qB}{2\pi m}$, independent of the particle's speed.

Step 1 — List data: $q = 1.6 \times 10^{-19}$ C, $B = 0.5$ T, $m = 1.6 \times 10^{-27}$ kg.

Step 2 — Numerator: $qB = 1.6 \times 10^{-19} \times 0.5 = 0.8 \times 10^{-19} = 8 \times 10^{-20}$.

Step 3 — Denominator: $2\pi m = 2\pi \times 1.6 \times 10^{-27} = 10.05 \times 10^{-27} \approx 1.005 \times 10^{-26}$.

Step 4 — Divide: $f = \dfrac{8 \times 10^{-20}}{1.005 \times 10^{-26}} \approx 7.96 \times 10^{6}$ Hz.

Step 5 — Round: $f \approx 8.0 \times 10^{6}$ Hz.

Why other options are wrong:

- (A), (B), (C) drop the factor 2π or carry arithmetic slips.

Final Answer: $f \approx 8.0 \times 10^{6}$ Hz $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q33

Q34.

Solution

Concept — Magnetic energy density: $u = \dfrac{B^2}{2\mu_0}$.

Step 1 — List data: $B = 2 \times 10^{-2}$ T, $\mu_0 = 4\pi \times 10^{-7}$.

Step 2 — Square the field: $B^2 = (2 \times 10^{-2})^2 = 4 \times 10^{-4}$.

Step 3 — Denominator: $2\mu_0 = 2 \times 4\pi \times 10^{-7} = 8\pi \times 10^{-7} \approx 2.513 \times 10^{-6}$.

Step 4 — Divide: $u = \dfrac{4 \times 10^{-4}}{2.513 \times 10^{-6}} \approx 159\ \text{J/m}^3$.

Why other options are wrong:

- (B) drops the factor of 2 in the denominator.
- (C) and (D) carry arithmetic slips.

Final Answer: $u \approx 159\ \text{J/m}^3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Motional EMF: $\varepsilon = BLv$ for a rod moving perpendicular to both $\vec{B}$ and its length.

Step 1 — List data: $B = 0.6$ T, $L = 0.4$ m, $v = 5$ m/s.

Step 2 — Multiply B and L: $0.6 \times 0.4 = 0.24$.

Step 3 — Multiply by v: $\varepsilon = 0.24 \times 5 = 1.2$ V.

Why other options are wrong:

- (A) uses only BL scaled wrongly.
- (C) doubles the value.
- (D) halves the value.

Final Answer: $\varepsilon = 1.2\ \text{V} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q35

Q36.

Solution

Concept — Phase angle of LCR: $\tan\varphi = \dfrac{X_L - X_C}{R}$.

Step 1 — Net reactance: $X_L - X_C = 20 - 10 = 10\,\Omega$.

Step 2 — Form the ratio: $\tan\varphi = \dfrac{10}{10} = 1$.

Step 3 — Take the inverse tangent: $\varphi = \tan^{-1}(1)$.

Step 4 — Evaluate: $\varphi = 45^\circ$.

Why other options are wrong:

- (A) would need $X_L = X_C$ (resonance).
- (B) corresponds to $\tan\varphi = 1/\sqrt{3}$.
- (D) corresponds to $\tan\varphi = \sqrt{3}$.

Final Answer: $\varphi = 45^\circ \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept — Transformer current ratio: For an ideal transformer $\frac{I_s}{I_p} = \frac{N_p}{N_s}$ (current is stepped up when voltage is stepped down).

Step 1 — Turns ratio: $\frac{N_p}{N_s} = \frac{5}{1}$.

Step 2 — Apply the relation: $I_s = I_p \times \frac{N_p}{N_s} = 2 \times 5$.

Step 3 — Evaluate: $I_s = 10$ A.

Why other options are wrong:

- (B) steps the current down (inverts the ratio).
- (C) leaves the current unchanged.
- (D) uses a ratio of $5/2$.

Final Answer: $I_s = 10\text{ A} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Object at the focus: For a concave mirror, an object placed at the focus produces an image at infinity (the reflected rays emerge parallel). Check with the mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$.

Step 1 — Sign convention: $f = -20$ cm, $u = -20$ cm (object at focus).

Step 2 — Rearrange: $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-20} - \frac{1}{-20}$.

Step 3 — Simplify: $\frac{1}{v} = -\frac{1}{20} + \frac{1}{20} = 0.$

Step 4 — Invert: $v \to \infty$, the image is at infinity.

Why other options are wrong:

- (A), (B), (D) would require other object positions; here $1/v = 0$.

Final Answer: Image at infinity $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept — Speed of light in a medium: $n = \frac{c}{v}$, so $v = \frac{c}{n}$.

Step 1 — List data: $c = 3 \times 10^8$ m/s, $n = 1.5$.

Step 2 — Divide: $v = \frac{3 \times 10^8}{1.5}$.

Step 3 — Evaluate: $v = 2 \times 10^8$ m/s.

Why other options are wrong:

- (A) multiplies instead of dividing.
- (C) ignores the medium.
- (D) divides by 2 instead of 1.5.

Final Answer: $v = 2 \times 10^8$ m/s $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q39

Q40.

Solution

Concept — Power of lenses in contact: Powers add: $P = P_1 + P_2$, with $P = \frac{1}{f\ (\text{m})}$ (or $\frac{100}{f\ (\text{cm})}$).

Step 1 — Power of first lens: $P_1 = \frac{100}{+20} = +5$ D.

Step 2 — Power of second lens: $P_2 = \frac{100}{-30} = -3.33$ D.

Step 3 — Add: $P = 5 + (-3.33) = +1.67$ D.

Why other options are wrong:

- (A) uses only the convex lens.
- (B) reverses the sign.
- (C) uses a wrong second-lens power.

Final Answer: $P = +1.67\ \text{D} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q40

Q41.

Solution

Concept — Refracting angle from thin-prism deviation: For a small refracting angle, $\delta = (n-1)A$, so the refracting angle is $A = \dfrac{\delta}{n-1}$.

Step 1 — List data: $n = 1.5$, $\delta = 2.5°$.

Step 2 — Compute $(n-1)$: $1.5 - 1 = 0.5$.

Step 3 — Form the ratio: $A = \dfrac{2.5°}{0.5}$.

Step 4 — Evaluate: $A = 5°$.

Why other options are wrong:

- (A) just echoes the deviation δ.
- (B) multiplies instead of dividing in part.
- (C) halves the deviation instead of dividing by $(n-1)$.

Final Answer: $A = 5° \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

Concept — Counting fringes: The number of bright fringes in a width W is $N = \dfrac{W}{\beta}$, where β is the fringe width.

Step 1 — List data: $\beta = 0.5$ mm, $W = 5$ mm.

Step 2 — Divide: $N = \dfrac{5}{0.5}$.

Step 3 — Evaluate: $N = 10$.

Why other options are wrong:

- (B) uses $\beta = 1$ mm.
- (C) doubles the count.
- (D) uses a wrong fringe width.

Final Answer: $N = 10$ fringes $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q42

Q43.

Solution

Concept — Single-slit first minimum: $a \sin\theta = \lambda$; for small θ, $a = \dfrac{\lambda}{\theta}$.

Step 1 — List data: $\lambda = 600$ nm $= 6 \times 10^{-7}$ m, $\theta = 3 \times 10^{-3}$ rad.

Step 2 — Apply $a = \lambda/\theta$**:** $a = \dfrac{6 \times 10^{-7}}{3 \times 10^{-3}}$.

Step 3 — Divide mantissas: $\dfrac{6}{3} = 2$.

Step 4 — Subtract exponents: $10^{-7-(-3)} = 10^{-4}$, so $a = 2 \times 10^{-4}$ m.

Step 5 — Convert: 2×10^{-4} m $= 0.2$ mm.

Why other options are wrong:

- (A) halves the value.
- (C) doubles it.
- (D) carries a power-of-ten slip.

Final Answer: $a = 0.2$ mm $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q43

Q44.

Solution

Concept — Photon count: Power $=$ (photons per second) $\times$ (energy per photon), so $N = \dfrac{P}{E_{\text{photon}}}$.

Step 1 — List data: $P = 6.6$ W, $E_{\text{photon}} = 3.3 \times 10^{-19}$ J.

Step 2 — Form the ratio: $N = \frac{6.6}{3.3 \times 10^{-19}}$.

Step 3 — Divide mantissas: $\frac{6.6}{3.3} = 2.0$.

Step 4 — Handle the exponent: $\frac{1}{10^{-19}} = 10^{19}$, so $N = 2 \times 10^{19}$.

Why other options are wrong:

- (A) halves the value.
- (B) carries a mantissa error.
- (D) is an order of magnitude too high.

Final Answer: $N = 2 \times 10^{19}$ photons per second $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q44

Q45.

Solution

Concept — de Broglie wavelength of an accelerated electron: $\lambda = \frac{12.27}{\sqrt{V}}$ Å, with V in volts.

Step 1 — List data: $V = 100$ V.

Step 2 — Take the square root: $\sqrt{100} = 10$.

Step 3 — Divide: $\lambda = \frac{12.27}{10}$.

Step 4 — Evaluate: $\lambda = 1.227 \approx 1.23$ Å.

Why other options are wrong:

- (A) uses $V = 600$ V roughly.
- (B) and (C) carry power-of-ten or arithmetic slips.

Final Answer: $\lambda \approx 1.23$ Å $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q45

Q46.

Solution

Concept — Stopping-potential graph: Einstein's relation gives $V_s = \frac{h}{e}\nu - \frac{\phi}{e}$. This is a straight line with slope h/e and V_s-intercept (at $\nu = 0$) equal to $-\frac{\phi}{e}$.

Step 1 — Set $\nu = 0$**:** $V_s = \frac{h}{e}(0) - \frac{\phi}{e}$.

Step 2 — Read the intercept: $V_s = -\frac{\phi}{e}$.

Why other options are wrong:

- (B) is the slope, not the intercept.
- (C) is the threshold frequency.
- (D) is an energy, not a potential.

Final Answer: Intercept $= -\frac{\phi}{e} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q46

Q47.

Solution

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

Step 1 — Insert $n = 4$**:** $r_4 = 4^2 a_0$.

Step 2 — Square: $4^2 = 16$.

Step 3 — Multiply by a_0**:** $r_4 = 16 \times 0.53$.

Step 4 — Evaluate: $r_4 = 8.48$ Å.

Why other options are wrong:

- (A) uses $n^2 = 8$ instead of 16.
- (C) uses $n = 2$.
- (D) is the ground-state radius.

Final Answer: $r_4 = 8.48$ Å $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q47

Q48.

Solution

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

Step 1 — List data: $T_{1/2} = 1386$ s, $\ln 2 = 0.693$.

Step 2 — Form the ratio: $\lambda = \dfrac{0.693}{1386}$.

Step 3 — Evaluate: $\lambda = 5 \times 10^{-4}\ \text{s}^{-1}$.

Why other options are wrong:

- (A) and (B) carry power-of-ten or arithmetic slips.
- (D) takes $\lambda = \ln 2$ without dividing by $T_{1/2}$.

Final Answer: $\lambda = 5 \times 10^{-4}\ \text{s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q48

Q49.

Solution

Concept — Nuclear radius: $R = R_0 A^{1/3}$, so the ratio of two radii is $\dfrac{R_1}{R_2} = \left(\dfrac{A_1}{A_2}\right)^{1/3}$.

Step 1 — Form the mass-number ratio: $\dfrac{A_1}{A_2} = \dfrac{216}{27} = 8$.

Step 2 — Take the cube root: $\dfrac{R_1}{R_2} = 8^{1/3}$.

Step 3 — Evaluate: $8^{1/3} = 2$.

Why other options are wrong:

- (A) is the mass-number ratio itself, not its cube root.
- (C) and (D) come from arithmetic slips.

Final Answer: $\dfrac{R_1}{R_2} = 2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q49

Q50.

Solution

Concept — Photodiode operation: A photodiode is a light-detecting device. It is operated in reverse bias; incident photons generate electron–hole pairs that increase the reverse (leakage) current in proportion to the light intensity, giving an electrical signal.

Step 1 — Biasing: The photodiode is reverse biased so that the dark current is small and the photocurrent dominates.

Step 2 — Function: Incident light is converted into a measurable electrical signal (a light-to-current converter).

Step 3 — Contrast with an LED: An LED does the opposite (forward bias, current to light); a photodiode detects light.

Why other options are wrong:

- (B) describes an LED, not a photodiode.
- (C) is false; an unbiased junction is not how a photodiode is used in a circuit.
- (D) is false; a reverse-biased photodiode still passes a small photocurrent.

Final Answer: Reverse bias, light converted to an electrical signal $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q50

Answer Key

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