JCECE Physics Sample Paper – 8

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 magnetic flux ϕ is:

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

(B) $[ML^2T^{-3}A^{-1}]$

(C) $[ML^2T^{-2}A^{-1}]$

(D) $[MLT^{-2}A^{-1}]$

Q2. The number 0.0036749 rounded off to three significant figures is:

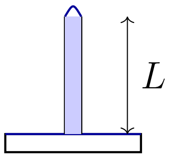
(A) 0.00368

(B) 0.00367

(C) 0.0037

(D) 0.003675

Q3. A clean glass capillary of radius 0.15 mm but length only 5 cm is dipped vertically in water ($T = 7.5 \times 10^{-2}$ N/m, contact angle $0°$, $\rho = 1000$ kg/m^3, $g = 10$ m/s^2). The free calculated rise exceeds the tube length. The water in the tube then:



(A) Rises to the top (5 cm) and does not overflow

(B) Overflows continuously as a fountain

(C) Rises only 5 cm then drips out

(D) Falls back to the reservoir level

Q4. A wire of Young's modulus 2×10^{11} N/m^2 is stretched to a longitudinal strain of 1×10^{-3}. The elastic strain energy stored per unit volume of the wire is:

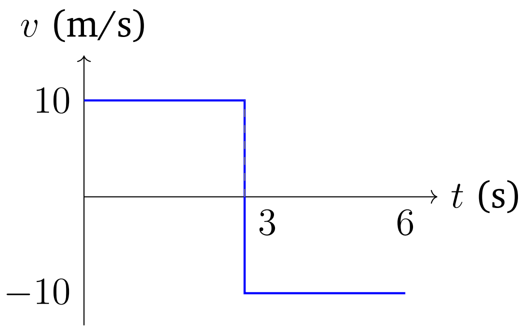
(A) 2×10^5 J/m^3

(B) 2×10^2 J/m^3

(C) 1×10^2 J/m^3

(D) 1×10^5 J/m^3

Q5. The velocity–time graph of a particle moving along a straight line is shown ($+v$ is rightward). Over the 0–6 s interval, the ratio of its average speed to the magnitude of its average velocity is:



(A) 1

(B) ∞ (average velocity is zero)

(C) 2

(D) 1/2

Q6. A projectile is launched with speed 25 m/s at an angle whose $\sin = 0.8$ and $\cos = 0.6$ above the horizontal ($g = 10$ m/s^2). The magnitude of its velocity 1 s after launch is:

(A) 15 m/s

(B) 25 m/s

(C) $\sqrt{325} \approx 18.0$ m/s

(D) 10 m/s

Q7. A train 120 m long moving at 20 m/s has its front 100 m behind the rear of a train 180 m long moving at 12 m/s on a parallel track in the same direction. The time for the faster train to completely overtake the slower one is:

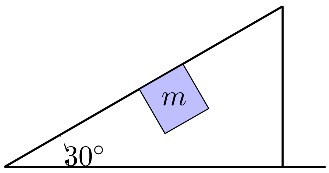
(A) 37.5 s

(B) 25 s

(C) 12.5 s

(D) 50 s

Q8. A block of mass 2 kg rests in equilibrium on a rough incline of angle $30°$ as shown ($g = 10$ m/s^2). The magnitude of the static friction force acting on the block is:



(A) 5 N

(B) 10 N

(C) 17.3 N

(D) 20 N

Q9. A block of mass 5 kg is dragged 4 m across a horizontal floor where the coefficient of kinetic friction is 0.3 ($g = 10$ m/s^2). The work done against friction is:

(A) 60 J

(B) 15 J

(C) 30 J

(D) 200 J

Q10. A wheel rotates at 300 revolutions per minute. Its angular speed is:

(A) 5π rad/s

(B) 300π rad/s

(C) 10π rad/s

(D) 20π rad/s

Q11. A spring of force constant 200 N/m is compressed by 0.1 m from its natural length. The work done in compressing it is:

(A) 2 J

(B) 1 J

(C) 20 J

(D) 0.5 J

Q12. An electric motor lifts a load of mass 200 kg through a height of 15 m in 30 s at constant speed ($g = 10$ m/s^2). The power of the motor is:

(A) 300 W

(B) 600 W

(C) 3000 W

(D) 1000 W

Q13. A body of mass 2 kg moving at 6 m/s collides head-on and sticks to an identical stationary body of mass 2 kg. The fraction of the initial kinetic energy lost in the collision is:

(A) 0

(B) $1/4$

(C) $1/2$

(D) $3/4$

Q14. A ring rolls without slipping on a horizontal surface. The ratio of its rotational kinetic energy to its total kinetic energy is:

(A) $1/2$

(B) $2/7$

(C) $5/7$

(D) $2/5$

Q15. A body weighs 600 N on Earth. On a planet whose mass is twice that of Earth and whose radius is twice that of Earth, the weight of the same body is:

(A) 150 N

(B) 300 N

(C) 600 N

(D) 1200 N

Q16. A Carnot heat pump operates between an indoor temperature of 300 K and an outdoor temperature of 250 K. Its (ideal) coefficient of performance for heating is:

(A) 1.2

(B) 0.83

(C) 5

(D) 6

Q17. An ideal gas is taken through a complete thermodynamic cycle and returns to its initial state. The change in its internal energy over the whole cycle is:

(A) Zero

(B) Equal to the heat supplied

(C) Equal to the work done

(D) Equal to $nC_V\Delta T$ for one stroke

Q18. At the same temperature, the ratio of the rms speed of hydrogen molecules (molar mass 2 g/mol) to that of oxygen molecules (molar mass 32 g/mol) is:

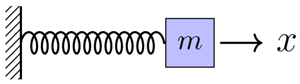
(A) 16

(B) $1/4$

(C) 4

(D) $1/16$

Q19. A mass of 0.8 kg attached to a spring of force constant 20 N/m executes SHM as shown. The time period of oscillation is:



(A) 0.1π s

(B) 0.2π s

(C) 0.8π s

(D) 0.4π s

Q20. A particle executes SHM of amplitude A. The ratio of its speed at the mean position to its speed at displacement $x = A/2$ is:

(A) $\sqrt{3} : 2$

(B) $2 : \sqrt{3}$

(C) $2 : 1$

(D) $1 : 2$

Q21. A stretched wire of mass 10 g and length 0.5 m is under a tension of 200 N. The fundamental frequency of vibration of the wire is:

(A) 100 Hz

(B) 50 Hz

(C) 200 Hz

(D) 25 Hz

Q22. A source of sound moves towards a stationary observer at 33 m/s (speed of sound 330 m/s). The percentage increase in the observed frequency over the emitted frequency is approximately:

(A) 10%

(B) 9.1%

(C) 11.1%

(D) 33%

Q23. Two point charges $2\,\mu$C and $6\,\mu$C are placed 0.2 m apart in vacuum ($k = 9 \times 10^9$ N·m^2/C^2). The magnitude of the Coulomb force between them is:

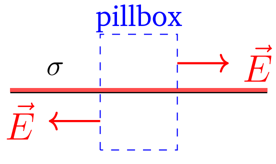
(A) 1.35 N

(B) 2.7 N

(C) 5.4 N

(D) 0.27 N

Q24. An infinite plane sheet carries a uniform surface charge density $\sigma = 8.85\,\mu$C/m^2 ($\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N·m^2). The electric field just outside the sheet, found using a Gaussian pillbox as shown, is:



(A) 1×10^6 N/C

(B) 2×10^6 N/C

(C) 1×10^5 N/C

(D) 5×10^5 N/C

Q25. Two charges $+5\ \mu$C and $-5\ \mu$C are separated by 4 cm in air. The electric dipole moment of this arrangement is:

(A) 2×10^{-7} C·m

(B) 5×10^{-7} C·m

(C) 2×10^{-5} C·m

(D) 1×10^{-7} C·m

Q26. A parallel-plate capacitor is charged to 12 V and then disconnected from the battery. A dielectric slab of constant $K = 4$ is now inserted, completely filling the gap. The new potential difference across the plates is:

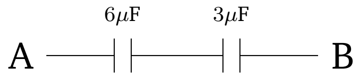
(A) 48 V

(B) 12 V

(C) 3 V

(D) 6 V

Q27. In the network shown, a $6\ \mu$F capacitor is connected in series with a $3\ \mu$F capacitor between A and B. The equivalent capacitance is:



(A) $9\ \mu$F

(B) $2\ \mu$F

(C) $18\ \mu$F

(D) $4.5\ \mu$F

Q28. A conductor carries a steady current of 3.2 A ($e = 1.6 \times 10^{-19}$ C). The number of electrons passing a cross-section every second is:

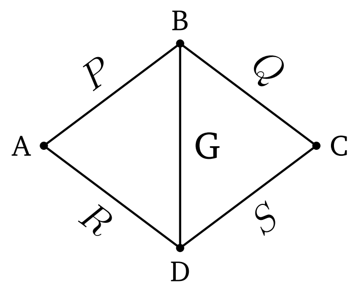
(A) 2×10^{18}

(B) 5×10^{18}

(C) 1.6×10^{19}

(D) 2×10^{19}

Q29. In the Wheatstone bridge shown, the arm $R = 2\,\Omega$ and the arm $S = 8\,\Omega$. For the bridge to be balanced, the ratio $P : Q$ of the other two arms must be:



(A) $1 : 4$

(B) $4 : 1$

(C) $1 : 2$

(D) $2 : 1$

Q30. A cell of EMF 2 V and internal resistance $0.5\,\Omega$ is connected to an external resistance of $3.5\,\Omega$. The terminal voltage across the cell is:

(A) 2 V

(B) 0.25 V

(C) 1.75 V

(D) 0.5 V

Q31. Two identical bulbs are connected, first in series and then in parallel, across the same supply. The ratio of total power consumed in series to that in parallel is:

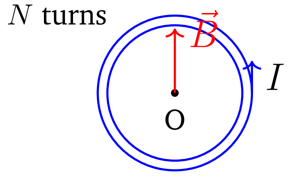
(A) $4 : 1$

(B) $1 : 4$

(C) $1 : 2$

(D) $2 : 1$

Q32. A circular coil of 100 turns and radius 0.05 m carries a current of 0.4 A, as shown. The magnetic moment of the coil is:



(A) 0.126 A·m^2

(B) 0.628 A·m^2

(C) 1.256 A·m^2

(D) 0.314 A·m^2

Q33. A charged particle moves through a uniform magnetic field. The work done by the magnetic force on the particle is:

(A) Always zero

(B) Equal to qvB

(C) Equal to the change in kinetic energy

(D) Maximum when velocity is parallel to the field

Q34. When the current in one coil changes at the rate of 4 A/s, an EMF of 8 V is induced in a neighbouring coil. The mutual inductance of the pair is:

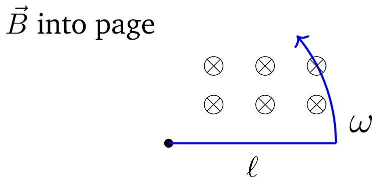
(A) 0.5 H

(B) 32 H

(C) 2 H

(D) 4 H

Q35. A conducting rod of length 0.5 m rotates about one end in a plane perpendicular to a uniform magnetic field of 0.4 T with angular speed 10 rad/s, as shown. The EMF induced between its ends is:



(A) 0.25 V

(B) 0.5 V

(C) 1.0 V

(D) 2.0 V

Q36. A series LCR circuit has $L = 2$ H, $C = 8\,\mu$F and $R = 10\,\Omega$. The quality factor $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ of the circuit is:

(A) 5

(B) 10

(C) 25

(D) 50

Q37. In an ideal transformer the primary draws a current of 2 A at 220 V. The power delivered to the secondary is:

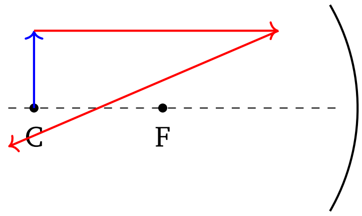
(A) 440 W

(B) 110 W

(C) 220 W

(D) 880 W

Q38. An object is placed 30 cm in front of a concave mirror of focal length 20 cm, as shown. The linear magnification of the image is:



(A) -1

(B) -3

(C) -2

(D) $+2$

Q39. A coin lies at the bottom of a vessel containing 12 cm of water (refractive index 1.5). Viewed normally from above, the coin appears raised by:

(A) 8 cm

(B) 4 cm

(C) 6 cm

(D) 2 cm

Q40. A thin glass lens (refractive index 1.5) has focal length 20 cm in air. When immersed in a liquid of refractive index 1.25, its new focal length is:

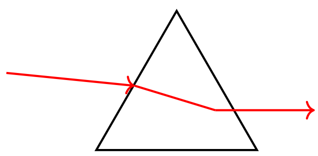
(A) 20 cm

(B) 40 cm

(C) 25 cm

(D) 50 cm

Q41. A ray strikes one face of a prism of refracting angle 30° (refractive index $\sqrt{2}$) at an angle of incidence 45°, as shown. The ray emerges normally through the second face. The angle of deviation produced by the prism is:



(A) 15°

(B) 30°

(C) 45°

(D) 60°

Q42. In a Young's double-slit experiment with light of wavelength 600 nm and a screen 1 m from the slits, the fringe width is found to be 1.2 mm. The separation between the slits is:

(A) 0.25 mm

(B) 1.0 mm

(C) 0.5 mm

(D) 0.72 mm

Q43. In single-slit diffraction the slit width is 0.2 mm and the wavelength is 500 nm. The angular position of the second minimum is:

(A) 2.5×10^{-3} rad

(B) 5×10^{-3} rad

(C) 7.5×10^{-3} rad

(D) 1×10^{-2} rad

Q44. Light of frequency 1.5×10^{15} Hz falls on a metal of work function 5.4×10^{-19} J ($h = 6.6 \times 10^{-34}$ J·s, electron mass 9.0×10^{-31} kg). The maximum speed of the emitted photoelectrons is:

(A) 5×10^5 m/s

(B) 2×10^6 m/s

(C) 4.5×10^{-19} m/s

(D) 1×10^6 m/s

Q45. An alpha particle moves with a linear momentum of 3.3×10^{-23} kg·m/s ($h = 6.6 \times 10^{-34}$ J·s). Its de Broglie wavelength is:

(A) 0.2 Å

(B) 2 Å

(C) 0.5 Å

(D) 1 Å

Q46. In Bohr's model of hydrogen the total energy of the electron in the nth orbit is $-13.6/n^2$ eV. The kinetic energy of the electron in the second orbit ($n = 2$) is:

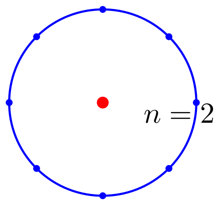
(A) -3.4 eV

(B) 13.6 eV

(C) 3.4 eV

(D) 6.8 eV

Q47. In Bohr's hydrogen atom the radius of the nth orbit is $r_n = n^2 a_0$ with $a_0 = 0.53$ Å. The orbit holds a whole number of electron de Broglie wavelengths, as shown. The de Broglie wavelength of the electron in the second orbit ($n = 2$) is:



(A) 3.33 Å

(B) 6.66 Å

(C) 2.12 Å

(D) 13.3 Å

Q48. A radioactive sample has a half-life of 4 years. The time required for 75% of the sample to decay is:

(A) 3 years

(B) 4 years

(C) 6 years

(D) 8 years

Q49. A nucleus of mass number 4 is formed with a mass defect of 0.0305 u ($1\text{ u} = 931\text{ MeV}/c^2$). Its binding energy per nucleon is approximately:

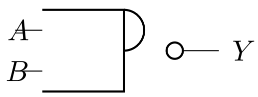
(A) 7.1 MeV

(B) 28.4 MeV

(C) 14.2 MeV

(D) 3.55 MeV

Q50. For the two-input logic gate built from the diode–transistor block shown, the output Y is LOW only when both inputs are HIGH; for every other input combination Y is HIGH. This gate is a:



(A) AND gate

(B) OR gate

(C) NAND gate

(D) NOR gate

Detailed Solutions

Q1.

Solution

Concept — Dimensions of magnetic flux: From $\phi = BA$ and B from the force law $F = qvB$, we find $[B]$ first, then multiply by area.

Step 1 — Get $[B]$ from $F = qvB$: $[B] = \dfrac{[F]}{[q][v]} = \dfrac{\text{MLT}^{-2}}{(\text{AT})(\text{LT}^{-1})}$.

Step 2 — Simplify $[B]$: $[B] = \dfrac{\text{MLT}^{-2}}{\text{ALT}^0} = \text{MT}^{-2}\text{A}^{-1}$.

Step 3 — Multiply by area: $[\phi] = [B][A] = \text{MT}^{-2}\text{A}^{-1} \times \text{L}^2$.

Step 4 — Collect: $[\phi] = \text{ML}^2\text{T}^{-2}\text{A}^{-1}$.

Why other options are wrong:

- (A) has T^{-1}, the dimension of charge$\times$flux, not flux.
- (B) is the dimension of EMF (volt).
- (D) is the dimension of B, not of flux.

Final Answer: $[\phi] = \text{ML}^2\text{T}^{-2}\text{A}^{-1} \Rightarrow \boxed{\text{C}}$

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

Q2.

Solution

Concept — Rounding to a fixed number of significant figures: Count significant figures from the first non-zero digit; keep three and round using the next digit.

Step 1 — Identify significant digits: In 0.0036749 the leading zeros are not significant; the significant digits begin at 3: they are $3, 6, 7, 4, 9$.

Step 2 — Keep the first three: The first three significant digits are 3, 6, 7.

Step 3 — Look at the next digit: The fourth digit is 4 (< 5), so we round down (no change to the 7).

Step 4 — Write the result: $0.0036749 \to 0.00367$.

Why other options are wrong:

- (A) wrongly rounds the 7 up, treating the next digit (4) as if it were ≥ 5.
- (C) keeps only two significant figures.

- (D) keeps four significant figures.

Final Answer: 0.00367 (three significant figures) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Capillary rise limited by tube length: The free capillary rise is $h = \dfrac{2T\cos\theta}{r\rho g}$. If the tube is shorter than h, the water can only rise to the top; the meniscus simply flattens (larger radius of curvature) so that the column is supported. Water does not overflow.

Step 1 — Compute the free rise h: $h = \dfrac{2T\cos\theta}{r\rho g}$ with $T = 7.5 \times 10^{-2}$ N/m, $\cos\theta = 1$, $r = 0.15$ mm $= 1.5 \times 10^{-4}$ m, $\rho = 1000$, $g = 10$.

Step 2 — Numerator: $2T\cos\theta = 2 \times 7.5 \times 10^{-2} = 1.5 \times 10^{-1}$.

Step 3 — Denominator: $r\rho g = 1.5 \times 10^{-4} \times 1000 \times 10 = 1.5$.

Step 4 — Divide: $h = \dfrac{0.15}{1.5} = 0.10$ m $= 10$ cm.

Step 5 — Compare with tube length: $h = 10$ cm $>$ tube length 5 cm, so the water rises only to the top of the tube (5 cm).

Why other options are wrong:

- (B) and (C) wrongly assume the liquid keeps flowing out; capillarity cannot pump liquid out of a short tube.
- (D) ignores that capillary action still lifts the water to the top.

Final Answer: Water rises to the top (5 cm) without overflowing $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Strain energy per unit volume: $u = \frac{1}{2} \times \text{stress} \times \text{strain} = \frac{1}{2} Y(\text{strain})^2$.

Step 1 — List data: $Y = 2 \times 10^{11}$ N/m^2, strain $= 1 \times 10^{-3}$.

Step 2 — Square the strain: $(1 \times 10^{-3})^2 = 1 \times 10^{-6}$.

Step 3 — Multiply by Y: $Y(\text{strain})^2 = 2 \times 10^{11} \times 1 \times 10^{-6} = 2 \times 10^5$.

Step 4 — Halve: $u = \frac{1}{2} \times 2 \times 10^5 = 1 \times 10^5$ J/m^3.

Why other options are wrong:

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

Final Answer: $u = 1 \times 10^5$ J/m$^3 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Average speed vs average velocity: Average speed uses total distance (path length); average velocity uses net displacement. When the particle reverses direction equally, displacement can be zero while distance is not.

Step 1 — Distance in 0–3 s: Velocity $= +10$ m/s for 3 s, so distance $= 10 \times 3 = 30$ m (displacement $+30$ m).

Step 2 — Distance in 3–6 s: Velocity $= -10$ m/s for 3 s, so distance $= 10 \times 3 = 30$ m (displacement -30 m).

Step 3 — Total distance: $30 + 30 = 60$ m.

Step 4 — Net displacement: $+30 - 30 = 0$ m.

Step 5 — Compare: Average speed $= 60/6 = 10$ m/s; average velocity $= 0/6 = 0$. The ratio (speed to magnitude of velocity) is $10 \div 0$, which is infinite.

Why other options are wrong:

- (A), (C), (D) assume a finite, non-zero average velocity, but the displacement here is exactly zero.

Final Answer: Average velocity is zero, so the ratio is infinite $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Velocity components in projectile motion: The horizontal component v_x stays constant; the vertical component changes as $v_y = u\sin\theta - gt$. The speed is $\sqrt{v_x^2 + v_y^2}$.

Step 1 — Horizontal component: $v_x = u\cos\theta = 25 \times 0.6 = 15$ m/s.

Step 2 — Initial vertical component: $u\sin\theta = 25 \times 0.8 = 20$ m/s.

Step 3 — Vertical component at $t = 1$ s: $v_y = 20 - 10 \times 1 = 10$ m/s.

Step 4 — Combine: speed $= \sqrt{15^2 + 10^2} = \sqrt{225 + 100} = \sqrt{325}$.

Step 5 — Evaluate: $\sqrt{325} \approx 18.0$ m/s.

Why other options are wrong:

- (A) gives only the horizontal component.
- (B) gives the launch speed.
- (D) gives only the vertical component.

Final Answer: speed $= \sqrt{325} \approx 18.0$ m/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Overtaking with an initial gap: Relative to the slower train, the faster train must close the gap and then move past both train lengths: total relative displacement = gap + both lengths.

Step 1 — Relative speed: $20 - 12 = 8$ m/s.

Step 2 — Total relative displacement: gap + lengths $= 100 + 120 + 180 = 400$ m.

Step 3 — Divide: $t = \dfrac{400}{8} = 50$ s.

Why other options are wrong:

- (A) omits the 100 m gap.
- (B) and (C) drop one or more lengths.

Final Answer: $t = 50$ s $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Static friction on an incline: For a block at rest on an incline, the friction force balances the component of gravity along the surface: $f = mg\sin\theta$.

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

Step 2 — Component along incline: $mg\sin\theta = 2 \times 10 \times \sin 30°$.

Step 3 — Insert $\sin 30° = 0.5$: $= 2 \times 10 \times 0.5$.

Step 4 — Evaluate: $f = 10$ N.

Why other options are wrong:

- (A) halves the result.
- (C) uses $mg\cos\theta$ (the normal force).
- (D) uses the full weight mg.

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

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Work against friction: On a horizontal surface the friction force is $f = \mu mg$, and the work done against it over distance d is $W = fd = \mu mgd$.

Step 1 — List data: $\mu = 0.3$, $m = 5$ kg, $g = 10$ m/s^2, $d = 4$ m.

Step 2 — Friction force: $f = \mu mg = 0.3 \times 5 \times 10 = 15$ N.

Step 3 — Multiply by distance: $W = 15 \times 4$.

Step 4 — Evaluate: $W = 60$ J.

Why other options are wrong:

- (B) forgets to multiply by the distance.
- (C) halves the result.
- (D) drops the coefficient μ.

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

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Angular speed from rpm: $\omega = 2\pi\nu$, where ν is in revolutions per second; convert rpm to rev/s by dividing by 60.

Step 1 — Convert rpm to rev/s: $\nu = \dfrac{300}{60} = 5$ rev/s.

Step 2 — Multiply by 2π: $\omega = 2\pi \times 5$.

Step 3 — Evaluate: $\omega = 10\pi$ rad/s.

Why other options are wrong:

- (A) takes only $\pi\nu$.
- (B) forgets to convert minutes to seconds.
- (D) doubles the value.

Final Answer: $\omega = 10\pi$ rad/s $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Work to compress a spring: The work stored equals the elastic potential energy $W = \dfrac{1}{2}kx^2$.

Step 1 — List data: $k = 200$ N/m, $x = 0.1$ m.

Step 2 — Square the compression: $x^2 = (0.1)^2 = 0.01$.

Step 3 — Multiply by k: $kx^2 = 200 \times 0.01 = 2$.

Step 4 — Halve: $W = \dfrac{1}{2} \times 2 = 1$ J.

Why other options are wrong:

- (A) forgets the factor $\frac{1}{2}$.
- (C) uses $x = 1$ m.
- (D) halves once too many times.

Final Answer: $W = 1\text{ J} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Power of a lifting motor: Power $= \dfrac{\text{work done against gravity}}{\text{time}} = \dfrac{mgh}{t}$.

Step 1 — List data: $m = 200$ kg, $g = 10$ m/s^2, $h = 15$ m, $t = 30$ s.

Step 2 — Work done: $mgh = 200 \times 10 \times 15 = 30000$ J.

Step 3 — Divide by time: $P = \dfrac{30000}{30}$.

Step 4 — Evaluate: $P = 1000$ W.

Why other options are wrong:

- (A) and (B) use wrong arithmetic.
- (C) forgets to divide by the time.

Final Answer: $P = 1000\text{ W} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Fractional KE loss in a perfectly inelastic collision: For one body of mass m_1 hitting a stationary mass m_2 and sticking, the fraction of KE lost is $\dfrac{m_2}{m_1 + m_2}$.

Step 1 — Find the common velocity: Momentum: $2 \times 6 = (2+2)v \Rightarrow v = \dfrac{12}{4} = 3$ m/s.

Step 2 — Initial KE: $\frac{1}{2} \times 2 \times 6^2 = \frac{1}{2} \times 2 \times 36 = 36$ J.

Step 3 — Final KE: $\frac{1}{2} \times 4 \times 3^2 = \frac{1}{2} \times 4 \times 9 = 18$ J.

Step 4 — Fraction lost: $\frac{36-18}{36} = \frac{18}{36} = \frac{1}{2}$.

Why other options are wrong:

- (A) would hold only for an elastic collision (no loss).
- (B) and (D) come from arithmetic slips.

Final Answer: Fraction lost $= 1/2 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Rolling KE split: $\frac{KE_{rot}}{KE_{total}} = \frac{I/MR^2}{1+I/MR^2}$. For a ring $I = MR^2$, so $I/MR^2 = 1$.

Step 1 — Insert $I/MR^2 = 1$: Numerator $= 1$.

Step 2 — Denominator: $1 + 1 = 2$.

Step 3 — Divide: $\frac{1}{2}$.

Why other options are wrong:

- (B) is the ratio for a solid sphere.
- (C) is the translational fraction of a solid sphere.
- (D) is I/MR^2 for a solid sphere, not a ratio of energies.

Final Answer: $KE_{rot}/KE_{total} = 1/2 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Surface gravity on another planet: $g = \frac{GM}{R^2}$, so $\frac{g_p}{g_E} = \frac{M_p}{M_E}\left(\frac{R_E}{R_p}\right)^2$. Weight scales with g.

Step 1 — Mass ratio: $\frac{M_p}{M_E} = 2$.

Step 2 — Radius factor: $\left(\frac{R_E}{R_p}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$.

Step 3 — Combine: $\dfrac{g_p}{g_E} = 2 \times \dfrac{1}{4} = \dfrac{1}{2}$.

Step 4 — New weight: $W_p = 600 \times \dfrac{1}{2} = 300$ N.

Why other options are wrong:

- (A) divides by 4 only (ignores the doubled mass).
- (C) ignores the change in g.
- (D) multiplies instead of dividing the radius factor.

Final Answer: $W_p = 300 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — COP of a Carnot heat pump (heating): $\text{COP}_{\text{HP}} = \dfrac{T_H}{T_H - T_C}$, with temperatures in kelvin.

Step 1 — List data: $T_H = 300$ K, $T_C = 250$ K.

Step 2 — Temperature difference: $T_H - T_C = 300 - 250 = 50$ K.

Step 3 — Form the ratio: $\text{COP} = \dfrac{300}{50}$.

Step 4 — Evaluate: $\text{COP} = 6$.

Why other options are wrong:

- (C) is the COP of a refrigerator ($T_C/(T_H - T_C) = 5$).
- (A) and (B) come from inverting or mis-forming the ratio.

Final Answer: $\text{COP} = 6 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Internal energy in a cyclic process: Internal energy U is a state function. Over a complete cycle the system returns to its initial state, so the net change in U is exactly zero.

Step 1 — State-function property: U depends only on the state, not on the path taken.

Step 2 — Cycle returns to start: Final state = initial state, so $U_f = U_i$.

Step 3 — Conclude: $\Delta U = U_f - U_i = 0$ for the whole cycle.

Why other options are wrong:

- (B) and (C) describe the net heat and net work, which are equal to each other ($Q_{\text{net}} = W_{\text{net}}$) but not to ΔU.
- (D) applies to a single constant-volume stroke, not the whole cycle.

Final Answer: $\Delta U = 0$ over the cycle $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — rms speed and molar mass: At a given temperature $v_{rms} = \sqrt{\frac{3RT}{M}}$, so $v_{rms} \propto \frac{1}{\sqrt{M}}$, giving $\frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}}$.

Step 1 — Form the mass ratio: $\frac{M_{O_2}}{M_{H_2}} = \frac{32}{2} = 16$.

Step 2 — Take the square root: $\frac{v_{H_2}}{v_{O_2}} = \sqrt{16}$.

Step 3 — Evaluate: $\sqrt{16} = 4$.

Why other options are wrong:

- (A) forgets the square root.
- (B) and (D) invert the ratio.

Final Answer: $v_{H_2}/v_{O_2} = 4 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Spring–mass SHM period: $T = 2\pi\sqrt{\dfrac{m}{k}}$.

Step 1 — List data: $m = 0.8$ kg, $k = 20$ N/m.

Step 2 — Form m/k: $\dfrac{0.8}{20} = 0.04$ s^2.

Step 3 — Take the square root: $\sqrt{0.04} = 0.2$ s.

Step 4 — Multiply by 2π: $T = 2\pi \times 0.2 = 0.4\pi$ s.

Why other options are wrong:

- (A) and (B) mis-take the square root of m/k.
- (C) doubles the correct coefficient.

Final Answer: $T = 0.4\pi$ s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Speed in SHM: $v = \omega\sqrt{A^2 - x^2}$. The speed is maximum ($\omega A$) at the mean position ($x = 0$).

Step 1 — Speed at mean position: $v_0 = \omega\sqrt{A^2 - 0} = \omega A$.

Step 2 — Speed at $x = A/2$: $v_1 = \omega\sqrt{A^2 - (A/2)^2} = \omega\sqrt{A^2 - \dfrac{A^2}{4}}$.

Step 3 — Simplify under the root: $A^2 - \dfrac{A^2}{4} = \dfrac{3A^2}{4}$, so $v_1 = \omega A\dfrac{\sqrt{3}}{2}$.

Step 4 — Form the ratio: $\dfrac{v_0}{v_1} = \dfrac{\omega A}{\omega A\sqrt{3}/2} = \dfrac{2}{\sqrt{3}}$.

Why other options are wrong:

- (A) inverts the ratio.
- (C) and (D) ignore the square-root dependence.

Final Answer: $v_0 : v_1 = 2 : \sqrt{3} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q20

Q21.

Solution

Concept — Fundamental frequency of a stretched wire: $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$, with linear density $\mu = \frac{\text{mass}}{\text{length}}$.

Step 1 — Linear density: $\mu = \frac{0.010 \text{ kg}}{0.5 \text{ m}} = 0.02$ kg/m.

Step 2 — Wave speed: $v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{200}{0.02}} = \sqrt{10000} = 100$ m/s.

Step 3 — Fundamental frequency: $f = \frac{v}{2L} = \frac{100}{2 \times 0.5}$.

Step 4 — Evaluate: $f = \frac{100}{1} = 100$ Hz.

Why other options are wrong:

- (B) and (D) come from arithmetic slips in μ or v.
- (C) uses v/L instead of $v/2L$.

Final Answer: $f = 100 \text{ Hz} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Percentage change in observed frequency: For a source approaching a stationary observer, $f' = f\frac{v}{v - v_s}$, so the fractional increase is $\frac{f' - f}{f} = \frac{v_s}{v - v_s}$.

Step 1 — List data: $v = 330$ m/s, $v_s = 33$ m/s.

Step 2 — Denominator: $v - v_s = 330 - 33 = 297$ m/s.

Step 3 — Fractional increase: $\frac{v_s}{v - v_s} = \frac{33}{297} = \frac{1}{9}$.

Step 4 — Convert to percent: $\frac{1}{9} \times 100 \approx 11.1\%$.

Why other options are wrong:

- (A) uses $v_s/v = 33/330 = 10\%$ (wrong denominator).
- (B) uses $33/363$.

- (D) takes $v_s/v_s\times$ wrong scaling.

Final Answer: Increase $\approx 11.1\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Coulomb's law: $F = \dfrac{kq_1q_2}{r^2}$.

Step 1 — List data: $q_1 = 2\times10^{-6}$ C, $q_2 = 6\times10^{-6}$ C, $r = 0.2$ m, $k = 9\times10^9$.

Step 2 — Product of charges: $q_1q_2 = 2\times10^{-6}\times6\times10^{-6} = 12\times10^{-12}$ C^2.

Step 3 — Square the distance: $r^2 = (0.2)^2 = 0.04$ m^2.

Step 4 — Numerator: $kq_1q_2 = 9\times10^9\times12\times10^{-12} = 108\times10^{-3} = 0.108$.

Step 5 — Divide by r^2: $F = \dfrac{0.108}{0.04} = 2.7$ N.

Why other options are wrong:

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

Final Answer: $F = 2.7\text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Field of an infinite charged sheet: A Gaussian pillbox gives $E = \dfrac{\sigma}{2\varepsilon_0}$, the same on both sides and independent of distance.

Step 1 — List data: $\sigma = 8.85\times10^{-6}$ C/m^2, $\varepsilon_0 = 8.85\times10^{-12}$ C^2/N·m^2.

Step 2 — Form σ/ε_0: $\dfrac{8.85\times10^{-6}}{8.85\times10^{-12}} = 10^6$.

Step 3 — Divide by 2: $E = \dfrac{10^6}{2} = 5\times10^5$ N/C.

Why other options are wrong:

- (A) forgets the factor of 2 (that would be a conductor surface).
- (B) doubles the field.
- (C) carries a power-of-ten error.

Final Answer: $E = 5 \times 10^5$ N/C $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Electric dipole moment: $p = q \times (2a)$, where q is the magnitude of either charge and $2a$ the separation.

Step 1 — List data: $q = 5 \times 10^{-6}$ C, $2a = 4$ cm $= 0.04$ m.

Step 2 — Multiply: $p = 5 \times 10^{-6} \times 0.04$.

Step 3 — Evaluate: $p = 5 \times 10^{-6} \times 4 \times 10^{-2} = 20 \times 10^{-8} = 2 \times 10^{-7}$ C·m.

Why other options are wrong:

- (B) forgets to convert cm to m.
- (C) and (D) carry power-of-ten errors.

Final Answer: $p = 2 \times 10^{-7}$ C·m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Dielectric inserted at constant charge: When the battery is disconnected the charge Q is fixed. Since $C' = KC$ and $V = Q/C$, the voltage falls by the factor K: $V' = \dfrac{V}{K}$.

Step 1 — List data: $V = 12$ V, $K = 4$.

Step 2 — Apply $V' = V/K$: $V' = \dfrac{12}{4}$.

Step 3 — Evaluate: $V' = 3$ V.

Why other options are wrong:

- (A) multiplies by K (would need a fixed-voltage source, not fixed charge).

- (B) ignores the dielectric.
- (D) uses $K/2$.

Final Answer: $V' = 3\text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q26

Q27.

Solution

Concept — Capacitors in series: $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2}$, equivalently $C_s = \frac{C_1 C_2}{C_1 + C_2}$.

Step 1 — List data: $C_1 = 6\,\mu\text{F}$, $C_2 = 3\,\mu\text{F}$.

Step 2 — Product: $C_1 C_2 = 6 \times 3 = 18$.

Step 3 — Sum: $C_1 + C_2 = 6 + 3 = 9$.

Step 4 — Divide: $C_s = \frac{18}{9} = 2\,\mu\text{F}$.

Why other options are wrong:

- (A) adds the capacitors as if in parallel.
- (C) uses the product only.
- (D) takes half the parallel value.

Final Answer: $C_s = 2\,\mu\text{F} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept — Charge and number of electrons: The current is $I = \frac{ne}{t}$ where n is the number of electrons passing in time t; per second $\frac{n}{t} = \frac{I}{e}$.

Step 1 — List data: $I = 3.2$ A, $e = 1.6 \times 10^{-19}$ C.

Step 2 — Form the ratio: $\frac{n}{t} = \frac{3.2}{1.6 \times 10^{-19}}$.

Step 3 — Divide the mantissas: $\frac{3.2}{1.6} = 2$.

Step 4 — Handle the power: $\frac{2}{10^{-19}} = 2 \times 10^{19}$ electrons per second.

Why other options are wrong:

- (A), (B), (C) carry mantissa or exponent slips.

Final Answer: 2×10^{19} electrons per second $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Wheatstone balance condition: At balance $\dfrac{P}{Q} = \dfrac{R}{S}$.

Step 1 — List data: $R = 2\,\Omega$, $S = 8\,\Omega$.

Step 2 — Form R/S**:** $\dfrac{R}{S} = \dfrac{2}{8} = \dfrac{1}{4}$.

Step 3 — Equate: $\dfrac{P}{Q} = \dfrac{1}{4}$, so $P : Q = 1 : 4$.

Why other options are wrong:

- (B) inverts the ratio.
- (C) and (D) use a wrong R/S.

Final Answer: $P : Q = 1 : 4 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Terminal voltage: Current $I = \dfrac{E}{R + r}$; terminal voltage $V = IR$.

Step 1 — Total resistance: $R + r = 3.5 + 0.5 = 4\,\Omega$.

Step 2 — Current: $I = \dfrac{2}{4} = 0.5$ A.

Step 3 — Terminal voltage: $V = IR = 0.5 \times 3.5 = 1.75$ V.

Why other options are wrong:

- (A) is the EMF (no internal drop).
- (B) is the internal drop Ir.
- (D) uses wrong arithmetic.

Final Answer: $V = 1.75$ V $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept — Power of equal resistors in series vs parallel: For the same supply V, $P = \dfrac{V^2}{R_{eq}}$. Series of two equal R: $R_s = 2R$; parallel: $R_p = R/2$.

Step 1 — Series power: $P_s = \dfrac{V^2}{2R}$.

Step 2 — Parallel power: $P_p = \dfrac{V^2}{R/2} = \dfrac{2V^2}{R}$.

Step 3 — Form the ratio: $\dfrac{P_s}{P_p} = \dfrac{V^2/2R}{2V^2/R} = \dfrac{1}{4}$.

Why other options are wrong:

- (A) inverts the ratio.
- (C) and (D) use a wrong equivalent resistance.

Final Answer: $P_s : P_p = 1 : 4 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept — Magnetic moment of a current coil: For a coil of N turns, each of area A, carrying current I, the magnetic moment is $m = NIA$, with $A = \pi R^2$.

Step 1 — List data: $N = 100$, $I = 0.4$ A, $R = 0.05$ m.

Step 2 — Area of one turn: $A = \pi R^2 = \pi \times (0.05)^2 = \pi \times 2.5 \times 10^{-3}$.

Step 3 — Evaluate the area: $A = 2.5\pi \times 10^{-3} \approx 7.85 \times 10^{-3}$ m^2.

Step 4 — Multiply $N \times I$**:** $100 \times 0.4 = 40$.

Step 5 — Form NIA**:** $m = 40 \times 7.85 \times 10^{-3}$.

Step 6 — Evaluate: $m \approx 0.314$ A·m^2.

Why other options are wrong:

- (A) uses R instead of R^2 in the area.
- (B) doubles the correct value.
- (C) uses $2\pi R$ (circumference) instead of πR^2.

Final Answer: $m \approx 0.314$ A·m^2 $\Rightarrow$ D

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Work by the magnetic force: The magnetic force $\vec{F} = q\vec{v} \times \vec{B}$ is always perpendicular to the velocity $\vec{v}$. Power $= \vec{F} \cdot \vec{v} = 0$, so the work done is always zero.

Step 1 — Direction of the force: $\vec{v} \times \vec{B}$ is perpendicular to $\vec{v}$.

Step 2 — Compute power: $P = \vec{F} \cdot \vec{v} = |F||v| \cos 90^\circ = 0$.

Step 3 — Conclude: Zero power for all time $\Rightarrow$ zero work; the speed (and kinetic energy) stays constant.

Why other options are wrong:

- (B) is the magnitude of the force, not the work.
- (C) is zero here, since KE does not change.
- (D) is false; when $\vec{v} \parallel \vec{B}$ the force is zero, not maximal.

Final Answer: The work done is always zero $\Rightarrow$ A

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Mutual inductance: The EMF induced in the second coil is $\varepsilon_2 = M\dfrac{dI_1}{dt}$, so $M = \dfrac{\varepsilon_2}{dI_1/dt}$.

Step 1 — List data: $\varepsilon_2 = 8$ V, $\dfrac{dI_1}{dt} = 4$ A/s.

Step 2 — Form the ratio: $M = \dfrac{8}{4}$.

Step 3 — Evaluate: $M = 2$ H.

Why other options are wrong:

- (A) inverts the ratio.
- (B) multiplies instead of dividing.
- (D) uses a wrong rate.

Final Answer: $M = 2\text{ H} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q34

Q35.

Solution

Concept — EMF of a rotating rod: A rod of length ℓ rotating at angular speed ω about one end in a field B develops $\varepsilon = \frac{1}{2}B\omega\ell^2$.

Step 1 — List data: $B = 0.4$ T, $\omega = 10$ rad/s, $\ell = 0.5$ m.

Step 2 — Square the length: $\ell^2 = (0.5)^2 = 0.25\text{ m}^2$.

Step 3 — Multiply: $B\omega\ell^2 = 0.4 \times 10 \times 0.25 = 1.0$.

Step 4 — Halve: $\varepsilon = \frac{1}{2} \times 1.0 = 0.5$ V.

Why other options are wrong:

- (A) carries an arithmetic slip.
- (C) forgets the factor $\frac{1}{2}$.
- (D) doubles the result.

Final Answer: $\varepsilon = 0.5\text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q35

Q36.

Solution

Concept — Quality factor of a series LCR circuit: $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$.

Step 1 — List data: $L = 2$ H, $C = 8 \times 10^{-6}$ F, $R = 10\,\Omega$.

Step 2 — Form L/C: $\frac{2}{8 \times 10^{-6}} = 0.25 \times 10^6 = 2.5 \times 10^5$.

Step 3 — Take the square root: $\sqrt{2.5 \times 10^5} = 500$.

Step 4 — Divide by R: $Q = \frac{500}{10} = 50$.

Why other options are wrong:

- (A), (B), (C) come from arithmetic slips in L/C or its root.

Final Answer: $Q = 50 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — Power equality in an ideal transformer: An ideal transformer has no losses, so the secondary power equals the primary power: $P_s = P_p = V_p I_p$.

Step 1 — List data: $V_p = 220$ V, $I_p = 2$ A.

Step 2 — Primary power: $P_p = V_p I_p = 220 \times 2 = 440$ W.

Step 3 — Conclude: $P_s = P_p = 440$ W.

Why other options are wrong:

- (B) and (C) halve the power.
- (D) doubles it.

Final Answer: $P_s = 440 \text{ W} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Magnification of a mirror: First find the image distance from $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, then $m = -\frac{v}{u}$. With the sign convention, $f = -20$ cm and $u = -30$ cm.

Step 1 — Rearrange: $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-20} - \frac{1}{-30}$.

Step 2 — Common denominator: $\frac{1}{v} = -\frac{3}{60} + \frac{2}{60} = -\frac{1}{60}$, so $v = -60$ cm.

Step 3 — Magnification: $m = -\frac{v}{u} = -\frac{-60}{-30}$.

Step 4 — Evaluate: $m = -\frac{60}{30} = -2$.

Why other options are wrong:

- (A) would need the object at C ($u = 40$ cm here).
- (B) uses $v = -90$ cm.
- (D) drops the sign (image is inverted, so m is negative).

Final Answer: $m = -2$ (real, inverted, magnified) $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept — Apparent rise (real vs apparent depth): The coin appears raised by $\Delta = t\left(1 - \frac{1}{n}\right)$, where t is the real depth.

Step 1 — List data: $t = 12$ cm, $n = 1.5$.

Step 2 — Compute $1/n$**:** $\frac{1}{1.5} = \frac{2}{3}$.

Step 3 — Bracket: $1 - \frac{2}{3} = \frac{1}{3}$.

Step 4 — Multiply by t**:** $\Delta = 12 \times \frac{1}{3} = 4$ cm.

Why other options are wrong:

- (A) gives the apparent depth $t/n = 8$ cm, not the shift.
- (C) and (D) use wrong fractions.

Final Answer: Apparent rise $= 4$ cm $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q39

Q40.

Solution

Concept — Lens in a liquid: $\frac{f_\ell}{f_a} = \frac{(n_g - 1)}{\left(\frac{n_g}{n_\ell} - 1\right)}$, where n_g is the glass index and n_ℓ the liquid index.

Step 1 — List data: $f_a = 20$ cm, $n_g = 1.5$, $n_\ell = 1.25$.

Step 2 — Numerator $(n_g - 1)$**:** $1.5 - 1 = 0.5$.

Step 3 — Denominator $\frac{n_g}{n_\ell} - 1$**:** $\frac{1.5}{1.25} - 1 = 1.2 - 1 = 0.2$.

Step 4 — Form the factor: $\frac{0.5}{0.2} = 2.5$.

Step 5 — New focal length: $f_\ell = 20 \times 2.5 = 50$ cm.

Why other options are wrong:

- (A) ignores the change in surrounding medium.
- (B) and (C) use a wrong factor.

Final Answer: $f_\ell = 50 \text{ cm} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q40

Q41.

Solution

Concept — Deviation by a prism: $\delta = i_1 + i_2 - A$, where i_1, i_2 are the angles of incidence and emergence and A is the refracting angle. Apply Snell's law at each face.

Step 1 — Refraction at the first face: $\sin i_1 = n \sin r_1 \Rightarrow \sin 45^\circ = \sqrt{2} \sin r_1$, so $\sin r_1 = \frac{1/\sqrt{2}}{\sqrt{2}} = \frac{1}{2}$, giving $r_1 = 30^\circ$.

Step 2 — Angle at the second face: $r_1 + r_2 = A \Rightarrow r_2 = 30^\circ - 30^\circ = 0^\circ$, so the ray meets the second face normally.

Step 3 — Emergence: With $r_2 = 0^\circ$, the emergent angle $i_2 = 0^\circ$.

Step 4 — Apply the deviation formula: $\delta = i_1 + i_2 - A = 45^\circ + 0^\circ - 30^\circ$.

Step 5 — Evaluate: $\delta = 15^\circ$.

Why other options are wrong:

- (B) takes $\delta = A$.
- (C) takes $\delta = i_1$.
- (D) adds the angles incorrectly.

Final Answer: $\delta = 15^\circ \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q41

Q42.

Solution

Concept — Slit separation from fringe width: $\beta = \frac{\lambda D}{d}$, so $d = \frac{\lambda D}{\beta}$.

Step 1 — List data: $\lambda = 600$ nm $= 6 \times 10^{-7}$ m, $D = 1$ m, $\beta = 1.2$ mm $= 1.2 \times 10^{-3}$ m.

Step 2 — Numerator: $\lambda D = 6 \times 10^{-7} \times 1 = 6 \times 10^{-7}$.

Step 3 — Divide by β: $d = \frac{6 \times 10^{-7}}{1.2 \times 10^{-3}}$.

Step 4 — Evaluate: $d = 5 \times 10^{-4}$ m $= 0.5$ mm.

Why other options are wrong:

- (A), (B), (D) come from arithmetic or power-of-ten slips.

Final Answer: $d = 0.5$ mm $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q42

Q43.

Solution

Concept — Single-slit minima: The mth minimum is at $a \sin\theta = m\lambda$; for small angles $\theta \approx \frac{m\lambda}{a}$. For the second minimum $m = 2$.

Step 1 — List data: $a = 0.2$ mm $= 2 \times 10^{-4}$ m, $\lambda = 500$ nm $= 5 \times 10^{-7}$ m, $m = 2$.

Step 2 — Numerator: $m\lambda = 2 \times 5 \times 10^{-7} = 1 \times 10^{-6}$.

Step 3 — Divide by a: $\theta = \frac{1 \times 10^{-6}}{2 \times 10^{-4}}$.

Step 4 — Evaluate: $\theta = 5 \times 10^{-3}$ rad.

Why other options are wrong:

- (A) gives the first minimum ($m = 1$).
- (C) and (D) carry arithmetic slips.

Final Answer: $\theta = 5 \times 10^{-3}$ rad $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q43

Q44.

Solution

Concept — Maximum speed of a photoelectron: $KE_{\max} = h\nu - \phi$, then $v_{\max} = \sqrt{\dfrac{2\,KE_{\max}}{m}}$.

Step 1 — Photon energy: $h\nu = 6.6 \times 10^{-34} \times 1.5 \times 10^{15} = 9.9 \times 10^{-19}$ J.

Step 2 — Subtract the work function: $KE_{\max} = 9.9 \times 10^{-19} - 5.4 \times 10^{-19} = 4.5 \times 10^{-19}$ J.

Step 3 — Form $2KE/m$**:** $\dfrac{2 \times 4.5 \times 10^{-19}}{9.0 \times 10^{-31}} = \dfrac{9.0 \times 10^{-19}}{9.0 \times 10^{-31}} = 1 \times 10^{12}$.

Step 4 — Take the square root: $v_{\max} = \sqrt{1 \times 10^{12}} = 1 \times 10^{6}$ m/s.

Why other options are wrong:

- (A) carries a power-of-ten error in the root.
- (B) doubles the value.
- (C) wrongly quotes the kinetic energy as a speed.

Final Answer: $v_{\max} = 1 \times 10^{6}$ m/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q44

Q45.

Solution

Concept — de Broglie wavelength: $\lambda = \dfrac{h}{p}$, where p is the momentum.

Step 1 — List data: $h = 6.6 \times 10^{-34}$ J·s, $p = 3.3 \times 10^{-23}$ kg·m/s.

Step 2 — Form the ratio: $\lambda = \dfrac{6.6 \times 10^{-34}}{3.3 \times 10^{-23}}$.

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

Step 4 — Subtract exponents: $10^{-34-(-23)} = 10^{-11}$, so $\lambda = 2 \times 10^{-11}$ m.

Step 5 — Convert to angstrom: 2×10^{-11} m $= 0.2$ Å.

Why other options are wrong:

- (B), (C), (D) carry power-of-ten or mantissa slips.

Final Answer: $\lambda = 0.2$ Å $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q45

Q46.

Solution

Concept — Kinetic energy in a Bohr orbit: For hydrogen, $E_n = -\frac{13.6}{n^2}$ eV, and the kinetic energy equals $-E_n = +\frac{13.6}{n^2}$ eV.

Step 1 — Total energy for $n = 2$: $E_2 = -\frac{13.6}{2^2} = -\frac{13.6}{4} = -3.4$ eV.

Step 2 — Kinetic energy: $KE = -E_2 = +3.4$ eV.

Why other options are wrong:

- (A) is the total energy (negative), not the kinetic energy.
- (B) uses $n = 1$.
- (D) doubles the value.

Final Answer: $KE = 3.4$ eV $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q46

Q47.

Solution

Concept — de Broglie wavelength in a Bohr orbit: The nth orbit fits exactly n electron wavelengths: $2\pi r_n = n\lambda$, so $\lambda = \frac{2\pi r_n}{n}$.

Step 1 — Radius of the $n = 2$ orbit: $r_2 = 2^2 a_0 = 4 \times 0.53 = 2.12$ Å.

Step 2 — Circumference: $2\pi r_2 = 2\pi \times 2.12 \approx 13.32$ Å.

Step 3 — Divide by $n = 2$: $\lambda = \frac{13.32}{2}$.

Step 4 — Evaluate: $\lambda \approx 6.66$ Å.

Why other options are wrong:

- (A) corresponds to the $n = 1$ orbit.
- (C) quotes the orbit radius, not the wavelength.

- (D) forgets to divide by n.

Final Answer: $\lambda \approx 6.66$ Å $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q47

Q48.

Solution

Concept — Time for a given fraction to decay: If 75% decays, $25\% = \frac{1}{4}$ remains; $\left(\frac{1}{2}\right)^n = \frac{1}{4}$ gives n half-lives.

Step 1 — Fraction remaining: $100\% - 75\% = 25\% = \frac{1}{4}$.

Step 2 — Number of half-lives: $\left(\frac{1}{2}\right)^n = \frac{1}{4} \Rightarrow n = 2$.

Step 3 — Total time: $t = n \times T_{1/2} = 2 \times 4 = 8$ years.

Why other options are wrong:

- (B) is one half-life (50% decay).
- (A) and (C) do not correspond to a whole number of half-lives for 75% decay.

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

Answer: (D) Go Back to Q48

Q49.

Solution

Concept — Binding energy per nucleon: Total binding energy $= \Delta m \times 931$ MeV; divide by the mass number A.

Step 1 — List data: $\Delta m = 0.0305$ u, $A = 4$, 1 u $= 931$ MeV.

Step 2 — Total binding energy: $E = 0.0305 \times 931 \approx 28.4$ MeV.

Step 3 — Divide by A: $\frac{E}{A} = \frac{28.4}{4}$.

Step 4 — Evaluate: $\frac{E}{A} \approx 7.1$ MeV.

Why other options are wrong:

- (B) is the total binding energy, not per nucleon.

- (C) and (D) come from dividing by a wrong number.

Final Answer: $E/A \approx 7.1$ MeV $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q49

Q50.

Solution

Concept — NAND gate: A NAND gate is an AND gate followed by an inverter (shown by the small bubble at the output). Its output is LOW only when all inputs are HIGH, and HIGH otherwise.

Step 1 — Match the description: The stated behaviour "Y LOW only when both inputs are HIGH" is exactly the NAND truth table.

Step 2 — Truth table check: $(0,0) \to 1$, $(0,1) \to 1$, $(1,0) \to 1$, $(1,1) \to 0$.

Step 3 — Conclude: This is a NAND gate.

Why other options are wrong:

- (A) AND gives 1 only when both inputs are HIGH (opposite output).
- (B) OR gives 0 only when both inputs are LOW.
- (D) NOR gives 1 only when both inputs are LOW.

Final Answer: The gate is a NAND gate $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q50

Answer Key

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