JCECE Physics Sample Paper – 6

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. Surface tension is defined as force per unit length. Its dimensional formula is:

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

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

(C) $[\mathrm{ML^{0}T^{-2}}]$

(D) $[\mathrm{M^{0}LT^{-2}}]$

Q2. A quantity $Z = A/B$ is computed from measurements $A = 20.0 \pm 0.2$ and $B = 10.0 \pm 0.1$. The maximum relative error in Z is:

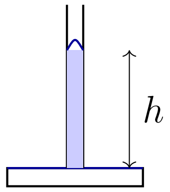
(A) 0.5%

(B) 2%

(C) 1%

(D) 3%

Q3. Water rises to a height $h = 5$ cm in a clean glass capillary of radius $r = 0.4$ mm (contact angle $0°$, $\rho = 1000$ kg/m^3, $g = 10$ m/s^2). The weight of the water column raised in the tube is approximately:



(A) 2.5×10^{-4} N

(B) 5.0×10^{-4} N

(C) 1.5×10^{-4} N

(D) 1.0×10^{-4} N

Q4. Two wires of the same material have lengths in the ratio $2 : 1$ and radii in the ratio $1 : 2$. They are stretched by the same force. The ratio of their elongations ($\Delta L_1 : \Delta L_2$) is:

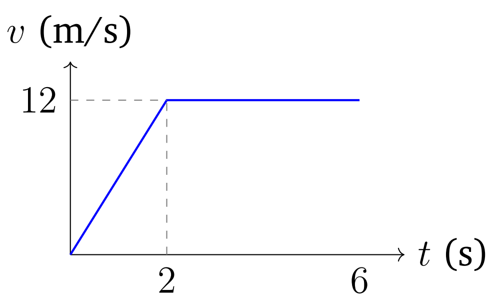
(A) $8 : 1$

(B) $1 : 8$

(C) $2 : 1$

(D) $4 : 1$

Q5. The velocity–time graph of a particle moving in a straight line is shown. The displacement of the particle in the 6 s shown is:



(A) 48 m

(B) 60 m

(C) 72 m

(D) 36 m

Q6. A ball is projected with speed 20 m/s at 60° above the horizontal ($g = 10$ m/s^2). Its maximum height is:

(A) 5 m

(B) 10 m

(C) 15 m

(D) 20 m

Q7. Car A moves due east at 30 km/h and car B moves due north at 40 km/h. The magnitude of the velocity of A relative to B is:

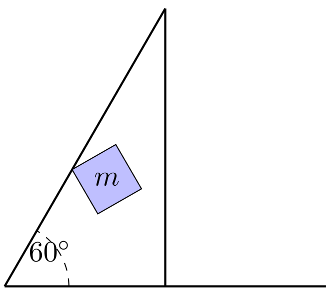
(A) 10 km/h

(B) 35 km/h

(C) 70 km/h

(D) 50 km/h

Q8. A block is released from rest on a smooth incline of angle 60° as shown. Its acceleration down the incline ($g = 10$ m/s^2) is:



(A) 8.7 m/s^2

(B) 5.0 m/s^2

(C) 10 m/s^2

(D) 7.1 m/s^2

Q9. A block of mass 5 kg rests on a rough horizontal floor with coefficient of kinetic friction 0.3. It is pulled so that it slides at constant velocity ($g = 10$ m/s^2). The force of friction acting on the block is:

(A) 5 N

(B) 15 N

(C) 25 N

(D) 50 N

Q10. The minimum speed required at the highest point of a vertical circular loop of radius 2.5 m, so that a body just maintains contact with the track, is ($g = 10$ m/s^2):

(A) 25 m/s

(B) 2.5 m/s

(C) 10 m/s

(D) 5 m/s

Q11. A body of mass 2 kg has its speed increased from 3 m/s to 5 m/s. The change in its kinetic energy is:

(A) 4 J

(B) 9 J

(C) 16 J

(D) 25 J

Q12. A pump lifts 300 kg of water per minute to a tank at a height of 20 m ($g = 10$ m/s^2). The minimum power of the pump is:

(A) 1000 W

(B) 600 W

(C) 1200 W

(D) 500 W

Q13. A gun of mass 4 kg fires a bullet of mass 20 g with a muzzle speed of 400 m/s. The recoil speed of the gun is:

(A) 1 m/s

(B) 2 m/s

(C) 4 m/s

(D) 0.5 m/s

Q14. A solid cylinder rolls without slipping down an incline of angle 30° ($g = 10$ m/s^2). Its linear acceleration down the incline is:

(A) 5 m/s^2

(B) 2.5 m/s^2

(C) 3.3 m/s^2

(D) 10 m/s^2

Q15. The gravitational potential energy of a body of mass 2 kg at the surface of Earth (mass $M = 6 \times 10^{24}$ kg, radius $R = 6.4 \times 10^6$ m, $G = 6.67 \times 10^{-11}$) is approximately:

(A) -3.1×10^7 J

(B) -6.4×10^6 J

(C) -6.25×10^8 J

(D) -1.25×10^8 J

Q16. A heat reservoir at constant temperature 400 K absorbs 800 J of heat reversibly. The change in its entropy is:

(A) 0.5 J/K

(B) 2 J/K

(C) 4 J/K

(D) 0.25 J/K

Q17. Three moles of an ideal gas expand isothermally and reversibly from volume V to $3V$ at temperature T ($R = 8.31$ J/mol·K). The work done by the gas is:

(A) $RT \ln 3$

(B) $2RT \ln 3$

(C) $3RT \ln 2$

(D) $3RT \ln 3$

Q18. An ideal gas of density 1.2 kg/m^3 has molecules whose root-mean-square speed is 500 m/s. Using $P = \frac{1}{3}\rho v_{rms}^2$, the pressure of the gas is:

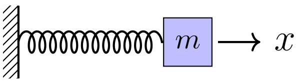
(A) 1.0×10^5 Pa

(B) 3.0×10^5 Pa

(C) 0.5×10^5 Pa

(D) 2.0×10^5 Pa

Q19. A mass attached to a spring executes SHM of amplitude 0.05 m with angular frequency 20 rad/s, as shown. The maximum speed of the mass is:



(A) 0.25 m/s

(B) 4 m/s

(C) 1 m/s

(D) 2 m/s

Q20. A particle in SHM has period $T = 12$ s and starts from its mean position. The time taken to reach a displacement equal to half the amplitude ($x = A/2$) for the first time is:

(A) 2 s

(B) 1 s

(C) 3 s

(D) 1.5 s

Q21. A stretched string has linear mass density 0.01 kg/m and is under a tension of 64 N. The speed of a transverse wave on it is:

(A) 40 m/s

(B) 64 m/s

(C) 6400 m/s

(D) 80 m/s

Q22. A tuning fork of unknown frequency gives 5 beats per second with a standard fork of frequency 256 Hz. When a little wax is loaded onto the *unknown* fork, the beat frequency increases to 8 per second. The original frequency of the unknown fork was:

(A) 261 Hz

(B) 251 Hz

(C) 248 Hz

(D) 264 Hz

Q23. Two point charges $2\,\mu$C and $5\,\mu$C are placed 0.1 m apart in vacuum ($k = 9 \times 10^9$ N·m^2/C^2). The magnitude of the Coulomb force between them is:

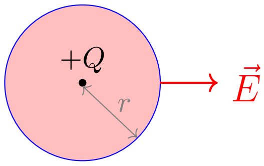
(A) 4.5 N

(B) 9 N

(C) 18 N

(D) 90 N

Q24. A conducting sphere of radius 0.1 m carries a charge of 1×10^{-7} C, as shown ($k = 9 \times 10^9$ N·m^2/C^2). The electric field just outside its surface is:



(A) 9×10^3 N/C

(B) 4.5×10^4 N/C

(C) 9×10^4 N/C

(D) 1.8×10^5 N/C

Q25. For a short electric dipole, the ratio of the electric field on its axis to the field at the same distance on its equatorial line is:

(A) $1 : 2$

(B) $1 : 1$

(C) $1 : 4$

(D) $2 : 1$

Q26. A parallel-plate capacitor of capacitance $12\,\mu$F is charged and then disconnected from the battery. If the separation between its plates is now doubled, the new capacitance becomes:

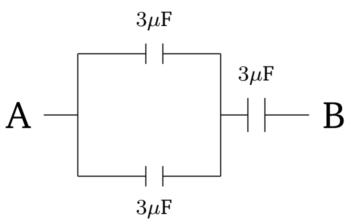
(A) $6\,\mu$F

(B) $24\,\mu$F

(C) $12\,\mu$F

(D) $3\,\mu$F

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



(A) $1.5\ \mu F$

(B) $2\ \mu F$

(C) $9\ \mu F$

(D) $3\ \mu F$

Q28. A copper wire of cross-section $1\ \text{mm}^2$ carries a current of 1.6 A. With free-electron density $n = 8 \times 10^{28}\ \text{m}^{-3}$ and $e = 1.6 \times 10^{-19}$ C, the drift speed of electrons is:

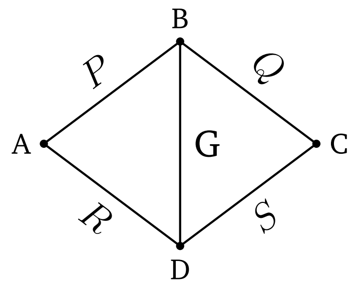
(A) 1.25×10^{-3} m/s

(B) 2.5×10^{-4} m/s

(C) 1.25×10^{-5} m/s

(D) 1.25×10^{-4} m/s

Q29. In the Wheatstone bridge shown the arms are $P = 2\,\Omega$, $Q = 4\,\Omega$, $R = 3\,\Omega$ and $S = 6\,\Omega$, and a galvanometer G connects B and D. The potential difference across the galvanometer is:



(A) 0 V

(B) 2 V

(C) 6 V

(D) 12 V

Q30. A cell of EMF 6 V and internal resistance $1\,\Omega$ is connected to an external resistance of $2\,\Omega$. The power delivered to the external resistance is:

(A) 4 W

(B) 8 W

(C) 12 W

(D) 18 W

Q31. Two identical bulbs, each rated 100 W, 220 V, are connected in series across a 220 V supply. The total power consumed by the combination is:

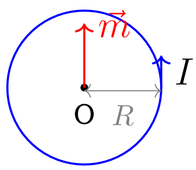
(A) 200 W

(B) 100 W

(C) 50 W

(D) 25 W

Q32. A circular loop of radius 0.1 m carries a current of 5 A as shown. Its magnetic dipole moment ($\pi = 3.14$) is:



(A) 0.0157 A·m^2

(B) 1.57 A·m^2

(C) 0.314 A·m^2

(D) 0.157 A·m^2

Q33. A straight wire of length 0.4 m carrying 5 A lies perpendicular to a uniform magnetic field of 0.6 T. The force on the wire is:

(A) 1.2 N

(B) 1.0 N

(C) 2.4 N

(D) 0.6 N

Q34. A long straight wire carries a current of 10 A. The magnetic field at a perpendicular distance of 0.05 m from the wire ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A) is:

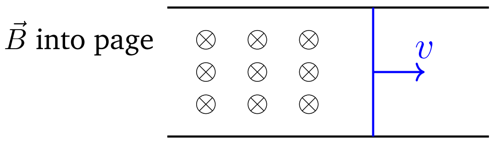
(A) 4×10^{-5} T

(B) 2×10^{-5} T

(C) 8×10^{-5} T

(D) 1×10^{-5} T

Q35. A conducting rod of length 0.5 m slides at 4 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) 0.8 V

(C) 1.2 V

(D) 2.4 V

Q36. In a series LCR circuit, $R = 12\,\Omega$, $X_L = 20\,\Omega$ and $X_C = 4\,\Omega$. The impedance of the circuit is:

(A) $12\,\Omega$

(B) $16\,\Omega$

(C) $20\,\Omega$

(D) $36\,\Omega$

Q37. An ideal transformer has 800 turns in the primary and 200 turns in the secondary. If the primary is connected to a 240 V supply, the secondary voltage is:

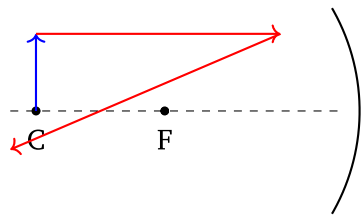
(A) 60 V

(B) 120 V

(C) 480 V

(D) 960 V

Q38. A concave mirror forms a real image at 20 cm from the mirror of an object placed 60 cm in front of it, as shown. The focal length of the mirror is:



(A) -12 cm

(B) -15 cm

(C) -30 cm

(D) -10 cm

Q39. A ray of light passes from air into a medium of refractive index $\sqrt{3}$. If the angle of incidence is 60°, the angle of refraction is:

(A) 45°

(B) 60°

(C) 20°

(D) 30°

Q40. A thin convex lens of focal length 20 cm forms an image of an object placed 30 cm in front of it. The image distance is:

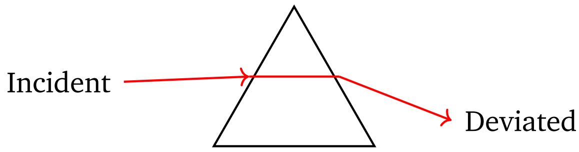
(A) $+12$ cm

(B) $+30$ cm

(C) $+60$ cm

(D) -60 cm

Q41. A ray passes through an equilateral glass prism of refractive index 1.5 at minimum deviation, as shown. Using $n = \frac{\sin\frac{A+D_m}{2}}{\sin\frac{A}{2}}$ and $\sin 49^\circ \approx 0.75$, the angle of minimum deviation is closest to:



(A) 30°

(B) 45°

(C) 38°

(D) 60°

Q42. In a Young's double-slit experiment the slit separation is $d = 3a$, where a is the slit width. The order of the interference maximum that will be missing (coinciding with the first diffraction minimum) is:

(A) 1

(B) 2

(C) 6

(D) 3

Q43. In single-slit diffraction with slit width 0.2 mm and light of wavelength 500 nm, the angular position of the first minimum is:

(A) 2.5×10^{-3} rad

(B) 5×10^{-3} rad

(C) 1.25×10^{-3} rad

(D) 5×10^{-2} rad

Q44. The work function of a metal is 6.6×10^{-19} J ($h = 6.6 \times 10^{-34}$ J·s). Its photoelectric threshold frequency is:

(A) 5×10^{14} Hz

(B) 1×10^{15} Hz

(C) 2×10^{15} Hz

(D) 1×10^{14} Hz

Q45. An electron and a proton are accelerated so that they have the same kinetic energy. Taking $m_p/m_e = 1836$, the ratio of the de Broglie wavelength of the electron to that of the proton (λ_e/λ_p) is:

(A) 1836

(B) 1

(C) $1/\sqrt{1836}$

(D) $\sqrt{1836}$

Q46. An electron in an atom makes a transition emitting a photon of energy 3.3×10^{-19} J ($h = 6.6 \times 10^{-34}$ J·s). The frequency of the emitted radiation is:

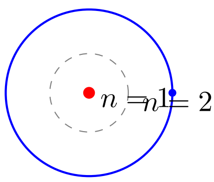
(A) 5×10^{14} Hz

(B) 2×10^{15} Hz

(C) 1×10^{15} Hz

(D) 2.5×10^{14} Hz

Q47. In Bohr's model of hydrogen the period of revolution of the electron in the nth orbit satisfies $T_n \propto n^3$. If the period in the first orbit ($n = 1$) is 1.5×10^{-16} s, the period in the second orbit ($n = 2$) shown is:



(A) 3.0×10^{-16} s

(B) 1.2×10^{-15} s

(C) 6.0×10^{-16} s

(D) 4.5×10^{-16} s

Q48. A radioactive sample of initial mass 64 g has a half-life of 4 years. The mass remaining undecayed after 12 years is:

(A) 16 g

(B) 32 g

(C) 8 g

(D) 4 g

Q49. The mass defect in the formation of a certain nucleus is 0.2 u. Taking 1 u $= 931$ MeV$/c^2$, the binding energy released is approximately:

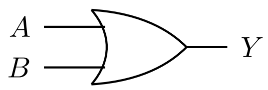
(A) 93.1 MeV

(B) 186.2 MeV

(C) 46.6 MeV

(D) 372.4 MeV

Q50. The two-input logic gate whose circuit symbol is shown gives output $Y = 1$ whenever at least one input is 1, and $Y = 0$ only when both inputs are 0. This gate is:



(A) an OR gate

(B) an AND gate

(C) a NOT gate

(D) a NAND gate

Detailed Solutions

Q1.

Solution

Concept — Dimensions of surface tension: Surface tension $S = \frac{\text{force}}{\text{length}}$, so $[S] = \frac{[\text{force}]}{[\text{length}]}$.

Step 1 — Dimension of force: $[F] = \mathrm{MLT^{-2}}$.

Step 2 — Dimension of length: $[L] = \mathrm{L}$.

Step 3 — Divide: $[S] = \frac{\mathrm{MLT^{-2}}}{\mathrm{L}}$.

Step 4 — Cancel the length: $[S] = \mathrm{ML^{1-1}T^{-2}} = \mathrm{ML^0T^{-2}}$.

Why other options are wrong:

- (A) keeps an extra power of length (that of force).
- (B) has $\mathrm{L^{-1}}$, the dimension of pressure, not surface tension.
- (D) drops the mass dimension.

Final Answer: $[S] = [\mathrm{ML^0T^{-2}}] \Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Relative error in a quotient: For $Z = A/B$, the maximum relative error is $\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$.

Step 1 — Relative error in A: $\frac{\Delta A}{A} = \frac{0.2}{20.0} = 0.01$.

Step 2 — Relative error in B: $\frac{\Delta B}{B} = \frac{0.1}{10.0} = 0.01$.

Step 3 — Add them: $\frac{\Delta Z}{Z} = 0.01 + 0.01 = 0.02$.

Step 4 — Convert to percent: $0.02 = 2\%$.

Why other options are wrong:

- (A) takes only one of the two contributions.

- (C) averages instead of adding.
- (D) over-counts the errors.

Final Answer: $\dfrac{\Delta Z}{Z} = 2\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Weight of the raised liquid column: The weight is $W = mg = (\rho V)g = \rho(\pi r^2 h)g$, where $\pi r^2 h$ is the volume of liquid in the tube up to height h.

Step 1 — List data: $h = 5$ cm $= 0.05$ m, $r = 0.4$ mm $= 4 \times 10^{-4}$ m, $\rho = 1000$ kg/m^3, $g = 10$ m/s^2.

Step 2 — Square the radius: $r^2 = (4 \times 10^{-4})^2 = 1.6 \times 10^{-7}$ m^2.

Step 3 — Cross-sectional area: $\pi r^2 = 3.14 \times 1.6 \times 10^{-7} = 5.03 \times 10^{-7}$ m^2.

Step 4 — Volume of column: $V = \pi r^2 h = 5.03 \times 10^{-7} \times 0.05 = 2.51 \times 10^{-8}$ m^3.

Step 5 — Multiply by ρg: $W = \rho V g = 1000 \times 2.51 \times 10^{-8} \times 10 = 2.51 \times 10^{-4}$ N.

Why other options are wrong:

- (B) carries an arithmetic slip in the area.
- (C) and (D) drop the factor π or use a wrong radius.

Final Answer: $W \approx 2.5 \times 10^{-4}\ \text{N} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Elongation under a load: $\Delta L = \dfrac{FL}{AY} = \dfrac{FL}{\pi r^2 Y}$. For the same material and same force, $\Delta L \propto \dfrac{L}{r^2}$.

Step 1 — Write the proportionality: $\dfrac{\Delta L_1}{\Delta L_2} = \dfrac{L_1/r_1^2}{L_2/r_2^2} = \dfrac{L_1}{L_2} \cdot \dfrac{r_2^2}{r_1^2}$.

Step 2 — Insert length ratio: $\dfrac{L_1}{L_2} = \dfrac{2}{1}$.

Step 3 — Insert radius ratio: $\frac{r_1}{r_2} = \frac{1}{2}$, so $\frac{r_2^2}{r_1^2} = \left(\frac{2}{1}\right)^2 = 4$.

Step 4 — Multiply: $\frac{\Delta L_1}{\Delta L_2} = 2 \times 4 = 8$.

Why other options are wrong:

- (B) inverts the ratio.
- (C) keeps only the length factor.
- (D) keeps only the radius factor.

Final Answer: $\Delta L_1 : \Delta L_2 = 8 : 1 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept — Displacement as area under a v–t graph: For unidirectional motion, displacement equals the area between the curve and the t-axis. Here there are two phases: an accelerating triangle then a constant-velocity rectangle.

Step 1 — Phase 1 (0–2 s), triangle: Velocity rises from 0 to 12 m/s. Area $= \frac{1}{2} \times$ base $\times$ height $= \frac{1}{2} \times 2 \times 12$.

Step 2 — Evaluate phase 1: $= 12$ m.

Step 3 — Phase 2 (2–6 s), rectangle: Velocity constant at 12 m/s for 4 s. Area $= 12 \times 4$.

Step 4 — Evaluate phase 2: $= 48$ m.

Step 5 — Total displacement: $12 + 48 = 60$ m.

Why other options are wrong:

- (A) counts only the rectangle.
- (C) treats the first phase as a full rectangle.
- (D) miscounts the rectangle width.

Final Answer: Displacement $= 60$ m $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Maximum height of a projectile: $H = \dfrac{u^2 \sin^2\theta}{2g}$.

Step 1 — List data: $u = 20$ m/s, $\theta = 60°$, $g = 10$ m/s^2.

Step 2 — Find $\sin\theta$**:** $\sin 60° = \dfrac{\sqrt{3}}{2}$.

Step 3 — Square it: $\sin^2 60° = \dfrac{3}{4} = 0.75$.

Step 4 — Numerator: $u^2\sin^2\theta = (20)^2 \times 0.75 = 400 \times 0.75 = 300$.

Step 5 — Divide by $2g$**:** $H = \dfrac{300}{2\times 10} = \dfrac{300}{20} = 15$ m.

Why other options are wrong:

- (A) uses $\theta = 30°$ ($\sin^2 = 0.25$).
- (B) uses $\theta = 45°$.
- (D) ignores the factor $2g$ partly.

Final Answer: $H = 15 \text{ m} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Relative velocity of perpendicular motions: $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$; since $\vec{v}_A$ (east) and $\vec{v}_B$ (north) are perpendicular, $|\vec{v}_{AB}| = \sqrt{v_A^2 + v_B^2}$.

Step 1 — List data: $v_A = 30$ km/h (east), $v_B = 40$ km/h (north).

Step 2 — Square each: $v_A^2 = 30^2 = 900$; $v_B^2 = 40^2 = 1600$.

Step 3 — Add: $900 + 1600 = 2500$.

Step 4 — Take square root: $|\vec{v}_{AB}| = \sqrt{2500} = 50$ km/h.

Why other options are wrong:

- (A) subtracts the speeds (as if parallel, same direction).
- (B) averages.
- (C) adds the speeds (as if parallel, opposite directions).

Final Answer: $|\vec{v}_{AB}| = 50 \text{ km/h} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Acceleration on a smooth incline: The component of gravity along the frictionless incline gives $a = g\sin\theta$.

Step 1 — List data: $g = 10$ m/s^2, $\theta = 60°$.

Step 2 — Value of $\sin 60°$: $\sin 60° = \frac{\sqrt{3}}{2} \approx 0.866$.

Step 3 — Multiply: $a = 10 \times 0.866 = 8.66$ m/s^2.

Step 4 — Round: $a \approx 8.7$ m/s^2.

Why other options are wrong:

- (B) uses $\sin 30° = 0.5$.
- (C) uses the full g (vertical free fall).
- (D) uses $\sin 45°$.

Final Answer: $a \approx 8.7$ m/s$^2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Kinetic friction on a horizontal surface: While sliding, the friction force is $f = \mu_k N = \mu_k mg$ (the normal force equals the weight).

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

Step 2 — Normal force: $N = mg = 5 \times 10 = 50$ N.

Step 3 — Friction force: $f = \mu_k N = 0.3 \times 50$.

Step 4 — Evaluate: $f = 15$ N.

Why other options are wrong:

- (A) multiplies μ_k by m only.
- (C) and (D) use wrong factors (the normal force or a doubled value).

Final Answer: $f = 15\text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Minimum speed at the top of a vertical loop: At the highest point, for the body to just stay in contact, gravity alone supplies the centripetal force: $mg = \frac{mv^2}{r}$. This gives $v = \sqrt{gr}$.

Step 1 — List data: $g = 10$ m/s^2, $r = 2.5$ m.

Step 2 — Form the product gr**:** $gr = 10 \times 2.5 = 25$.

Step 3 — Take the square root: $v = \sqrt{25}$.

Step 4 — Evaluate: $v = 5$ m/s.

Why other options are wrong:

- (A) gives gr itself without taking the square root.
- (B) divides r by g wrongly.
- (C) uses a wrong radius or skips the square root.

Final Answer: $v = 5$ m/s $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q10

Q11.

Solution

Concept — Change in kinetic energy: $\Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(v_f^2 - v_i^2)$.

Step 1 — List data: $m = 2$ kg, $v_i = 3$ m/s, $v_f = 5$ m/s.

Step 2 — Square the speeds: $v_f^2 = 25$; $v_i^2 = 9$.

Step 3 — Difference: $v_f^2 - v_i^2 = 25 - 9 = 16$.

Step 4 — Multiply by $\frac{1}{2}m$**:** $\Delta KE = \frac{1}{2} \times 2 \times 16$.

Step 5 — Evaluate: $\Delta KE = 16$ J.

Why other options are wrong:

- (A) takes only the initial KE.
- (B) uses the difference of speeds, not of their squares.

- (D) takes only the final KE.

Final Answer: $\Delta KE = 16 \text{ J} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Power of a pump: $P = \dfrac{mgh}{t}$, the rate of doing work against gravity.

Step 1 — List data: $m = 300$ kg, $g = 10$ m/s^2, $h = 20$ m, $t = 60$ s.

Step 2 — Work done: $mgh = 300 \times 10 \times 20 = 60000$ J.

Step 3 — Divide by time: $P = \dfrac{60000}{60}$.

Step 4 — Evaluate: $P = 1000$ W.

Why other options are wrong:

- (B) and (D) use wrong mass or height.
- (C) carries an arithmetic slip.

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

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Conservation of momentum (recoil): Initial momentum is zero, so $m_g v_g = m_b v_b$ in magnitude, giving $v_g = \dfrac{m_b v_b}{m_g}$.

Step 1 — List data: $m_g = 4$ kg, $m_b = 20$ g $= 0.02$ kg, $v_b = 400$ m/s.

Step 2 — Bullet momentum: $m_b v_b = 0.02 \times 400 = 8$ kg·m/s.

Step 3 — Divide by gun mass: $v_g = \dfrac{8}{4}$.

Step 4 — Evaluate: $v_g = 2$ m/s.

Why other options are wrong:

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

- (C) forgets to convert grams to kilograms correctly.

Final Answer: $v_g = 2$ m/s $\Rightarrow$ B

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Rolling on an incline: For a body rolling without slipping, $a = \dfrac{g\sin\theta}{1 + I/MR^2}$. For a solid cylinder $I/MR^2 = \frac{1}{2}$.

Step 1 — List data: $\theta = 30°$, $g = 10$ m/s^2, $I/MR^2 = \frac{1}{2}$.

Step 2 — Numerator: $g\sin 30° = 10 \times 0.5 = 5$.

Step 3 — Denominator: $1 + \frac{1}{2} = \frac{3}{2}$.

Step 4 — Divide: $a = \dfrac{5}{3/2} = 5 \times \dfrac{2}{3} = \dfrac{10}{3}$.

Step 5 — Evaluate: $a \approx 3.3$ m/s^2.

Why other options are wrong:

- (A) ignores the rolling term (slipping block).
- (B) uses the wrong moment-of-inertia factor.
- (D) uses the full g.

Final Answer: $a \approx 3.3$ m/s$^2 \Rightarrow$ C

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Gravitational potential energy at the surface: $U = -\dfrac{GMm}{R}$.

Step 1 — List data: $G = 6.67 \times 10^{-11}$, $M = 6 \times 10^{24}$ kg, $m = 2$ kg, $R = 6.4 \times 10^6$ m.

Step 2 — Numerator GMm: $6.67 \times 10^{-11} \times 6 \times 10^{24} \times 2$.

Step 3 — Multiply mantissas: $6.67 \times 6 \times 2 = 80.0$.

Step 4 — Combine powers: $10^{-11+24} = 10^{13}$, so $GMm = 80.0 \times 10^{13} = 8.0 \times 10^{14}$.

Step 5 — Divide by R: $U = -\dfrac{8.0 \times 10^{14}}{6.4 \times 10^{6}} = -1.25 \times 10^{8}$ J.

Why other options are wrong:

- (A) and (B) carry power-of-ten slips.
- (C) uses $m = 10$ kg.

Final Answer: $U \approx -1.25 \times 10^{8}$ J $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Entropy change of a reservoir: For heat Q exchanged reversibly at constant temperature T, $\Delta S = \dfrac{Q}{T}$.

Step 1 — List data: $Q = 800$ J, $T = 400$ K.

Step 2 — Form the ratio: $\Delta S = \dfrac{800}{400}$.

Step 3 — Evaluate: $\Delta S = 2$ J/K.

Why other options are wrong:

- (A) inverts the ratio's scale.
- (C) doubles the result.
- (D) divides by an extra factor.

Final Answer: $\Delta S = 2$ J/K $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Isothermal work: For n moles, $W = nRT \ln \dfrac{V_2}{V_1}$.

Step 1 — Volume ratio: $\dfrac{V_2}{V_1} = \dfrac{3V}{V} = 3$.

Step 2 — Substitute $n = 3$: $W = 3RT \ln 3$.

Why other options are wrong:

- (A) uses $n = 1$.
- (B) uses $n = 2$.
- (C) uses the wrong volume ratio ($\ln 2$).

Final Answer: $W = 3RT \ln 3 \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — Pressure from kinetic theory: $P = \frac{1}{3}\rho v_{rms}^2$.

Step 1 — List data: $\rho = 1.2$ kg/m^3, $v_{rms} = 500$ m/s.

Step 2 — Square the speed: $v_{rms}^2 = (500)^2 = 2.5 \times 10^5$ m^2/s^2.

Step 3 — Multiply by ρ: $\rho v_{rms}^2 = 1.2 \times 2.5 \times 10^5 = 3.0 \times 10^5$.

Step 4 — Multiply by $\frac{1}{3}$: $P = \dfrac{3.0 \times 10^5}{3} = 1.0 \times 10^5$ Pa.

Why other options are wrong:

- (B) forgets the factor $\frac{1}{3}$.
- (C) halves the result.
- (D) carries an arithmetic slip.

Final Answer: $P = 1.0 \times 10^5$ Pa $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Maximum speed in SHM: $v_{\max} = A\omega$.

Step 1 — List data: $A = 0.05$ m, $\omega = 20$ rad/s.

Step 2 — Multiply: $v_{\max} = 0.05 \times 20$.

Step 3 — Evaluate: $v_{\max} = 1$ m/s.

Why other options are wrong:

- (A) divides instead of multiplying.
- (B) uses $A\omega^2$-type slip.

- (D) doubles the result.

Final Answer: $v_{max} = 1$ m/s $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — SHM starting from the mean position: $x = A\sin(\omega t)$. Setting $x = A/2$ gives $\sin(\omega t) = \frac{1}{2}$.

Step 1 — Solve the sine: $\omega t = \frac{\pi}{6}$ (first time).

Step 2 — Express ω: $\omega = \frac{2\pi}{T}$, so $\frac{2\pi}{T} t = \frac{\pi}{6}$.

Step 3 — Solve for t: $t = \frac{T}{12}$.

Step 4 — Insert $T = 12$ s: $t = \frac{12}{12} = 1$ s.

Why other options are wrong:

- (A) uses $\omega t = \pi/3$ (that is for cosine starting at extreme).
- (C) and (D) use the wrong fraction of the period.

Final Answer: $t = 1$ s $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q20

Q21.

Solution

Concept — Transverse wave speed on a string: $v = \sqrt{\frac{T}{\mu}}$.

Step 1 — List data: $T = 64$ N, $\mu = 0.01$ kg/m.

Step 2 — Form T/μ: $\frac{64}{0.01} = 6400$ m^2/s^2.

Step 3 — Take square root: $v = \sqrt{6400} = 80$ m/s.

Why other options are wrong:

- (A) and (B) come from arithmetic slips.
- (C) forgets to take the square root.

Final Answer: $v = 80$ m/s $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Beats and wax loading: The beat frequency equals the magnitude of the difference between the two frequencies. So the unknown fork is 256 ± 5 Hz. Loading a fork with wax *lowers* its frequency; whether the beats then rise or fall tells us which sign is correct.

Step 1 — Two candidates: The unknown fork is either $256 + 5 = 261$ Hz or $256 - 5 = 251$ Hz.

Step 2 — Effect of waxing: Wax is added to the unknown fork, so its frequency *decreases*.

Step 3 — Test the 261 Hz candidate: Lowering 261 Hz moves it *towards* 256 Hz, shrinking the gap, so the beat frequency would *decrease*. This contradicts the observed rise.

Step 4 — Test the 251 Hz candidate: Lowering 251 Hz moves it *further from* 256 Hz, widening the gap, so the beat frequency *increases* ($5 \to 8$). This matches the observation.

Step 5 — Conclusion: The unknown fork's original frequency was 251 Hz.

Why other options are wrong:

- (A) is ruled out because waxing it would lower the beats, not raise them.
- (C) and (D) do not differ from 256 Hz by the original 5 beats.

Final Answer: Original frequency $= 251$ Hz $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

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

Step 1 — List data: $q_1 = 2 \times 10^{-6}$ C, $q_2 = 5 \times 10^{-6}$ C, $r = 0.1$ m, $k = 9 \times 10^9$.

Step 2 — Product of charges: $q_1 q_2 = 2 \times 10^{-6} \times 5 \times 10^{-6} = 10 \times 10^{-12} = 1 \times 10^{-11}$ C^2.

Step 3 — Square the distance: $r^2 = (0.1)^2 = 0.01$ m^2.

Step 4 — Numerator: $kq_1q_2 = 9 \times 10^9 \times 1 \times 10^{-11} = 9 \times 10^{-2} = 0.09$.

Step 5 — Divide by r^2: $F = \frac{0.09}{0.01} = 9$ N.

Why other options are wrong:

- (A) halves the result.
- (C) and (D) carry power-of-ten or distance slips.

Final Answer: $F = 9\text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Field just outside a charged conducting sphere: The field equals that of a point charge at the centre, $E = \frac{kQ}{R^2}$.

Step 1 — List data: $k = 9 \times 10^9$, $Q = 1 \times 10^{-7}$ C, $R = 0.1$ m.

Step 2 — Numerator: $kQ = 9 \times 10^9 \times 1 \times 10^{-7} = 9 \times 10^2 = 900$.

Step 3 — Square the radius: $R^2 = (0.1)^2 = 0.01$ m^2.

Step 4 — Divide: $E = \frac{900}{0.01} = 90000 = 9 \times 10^4$ N/C.

Why other options are wrong:

- (A) and (B) carry power-of-ten or factor slips.
- (D) doubles the result.

Final Answer: $E = 9 \times 10^4\text{ N/C} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Axial and equatorial fields of a short dipole: $E_{axial} = \frac{2kp}{r^3}$ and $E_{equatorial} = \frac{kp}{r^3}$.

Step 1 — Form the ratio: $\frac{E_{axial}}{E_{equatorial}} = \frac{2kp/r^3}{kp/r^3}$.

Step 2 — Cancel common factors: kp/r^3 cancels.

Step 3 — Result: $\frac{E_{axial}}{E_{equatorial}} = 2$, i.e. $2 : 1$.

Why other options are wrong:

- (A) inverts the ratio.
- (B) ignores the factor of 2.
- (C) squares the factor wrongly.

Final Answer: $E_{axial} : E_{equatorial} = 2 : 1 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q25

Q26.

Solution

Concept — Capacitance and plate separation: $C = \frac{\varepsilon_0 A}{d}$, so $C \propto \frac{1}{d}$. Doubling d halves C (the charge being constant does not change this geometric capacitance).

Step 1 — Write the dependence: $C' = \frac{\varepsilon_0 A}{2d} = \frac{1}{2} \cdot \frac{\varepsilon_0 A}{d} = \frac{C}{2}$.

Step 2 — Insert $C = 12\,\mu$F: $C' = \frac{12}{2}$.

Step 3 — Evaluate: $C' = 6\,\mu$F.

Why other options are wrong:

- (B) doubles instead of halving.
- (C) ignores the change.
- (D) quarters the value.

Final Answer: $C' = 6\,\mu\text{F} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

Concept — Parallel then series: Two equal capacitors C in parallel give $2C$; this in series with a third C gives $\frac{1}{C_{eq}} = \frac{1}{2C} + \frac{1}{C}$.

Step 1 — Two $3\ \mu$F in parallel: $C_p = 3 + 3 = 6\ \mu$F.

Step 2 — Series with the third $3\ \mu$F: $\frac{1}{C_{eq}} = \frac{1}{6} + \frac{1}{3}$.

Step 3 — Common denominator: $\frac{1}{6} + \frac{2}{6} = \frac{3}{6} = \frac{1}{2}$.

Step 4 — Invert: $C_{eq} = 2\ \mu$F.

Why other options are wrong:

- (A) halves once too often.
- (C) adds all three in parallel.
- (D) gives only the single capacitor.

Final Answer: $C_{eq} = 2\ \mu\text{F} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept — Drift velocity: $v_d = \frac{I}{nAe}$.

Step 1 — List data: $I = 1.6$ A, $n = 8 \times 10^{28}\ \text{m}^{-3}$, $A = 1\ \text{mm}^2 = 1 \times 10^{-6}\ \text{m}^2$, $e = 1.6 \times 10^{-19}$ C.

Step 2 — Compute nAe: $8 \times 10^{28} \times 1 \times 10^{-6} \times 1.6 \times 10^{-19}$.

Step 3 — Multiply mantissas: $8 \times 1 \times 1.6 = 12.8$.

Step 4 — Add exponents: $10^{28-6-19} = 10^3$, so $nAe = 12.8 \times 10^3 = 1.28 \times 10^4$.

Step 5 — Divide: $v_d = \frac{1.6}{1.28 \times 10^4} = 1.25 \times 10^{-4}$ m/s.

Why other options are wrong:

- (A) and (C) carry power-of-ten errors.
- (B) doubles the result.

Final Answer: $v_d = 1.25 \times 10^{-4}\ \text{m/s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Balanced Wheatstone bridge: The bridge is balanced when $\frac{P}{Q} = \frac{R}{S}$; at balance no current flows through the galvanometer and the points B and D are at the same potential.

Step 1 — Check the balance ratio: $\frac{P}{Q} = \frac{2}{4} = \frac{1}{2}$.

Step 2 — Other ratio: $\frac{R}{S} = \frac{3}{6} = \frac{1}{2}$.

Step 3 — Compare: The ratios are equal, so the bridge is balanced.

Step 4 — Conclude: The potential difference between B and D, hence across the galvanometer, is 0 V.

Why other options are wrong:

- (B), (C), (D) would arise only if the bridge were unbalanced.

Final Answer: $V_{BD} = 0\text{ V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Power delivered to the load: $I = \frac{E}{R+r}$ and $P_R = I^2R$.

Step 1 — Total resistance: $R + r = 2 + 1 = 3\,\Omega$.

Step 2 — Current: $I = \frac{6}{3} = 2$ A.

Step 3 — Square the current: $I^2 = 2^2 = 4\text{ A}^2$.

Step 4 — Power in load: $P_R = I^2R = 4 \times 2 = 8$ W.

Why other options are wrong:

- (A) uses the internal resistance.
- (C) is the total power of the cell ($EI = 12$ W).
- (D) ignores the internal drop.

Final Answer: $P_R = 8\text{ W} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Identical bulbs in series: Each bulb has resistance $R = \dfrac{V^2}{P}$. In series the total resistance is $2R$ across the same supply voltage, so the total power is $P_{tot} = \dfrac{V^2}{2R}$.

Step 1 — Single-bulb resistance: $R = \dfrac{(220)^2}{100} = 484\,\Omega$.

Step 2 — Series resistance: $2R = 968\,\Omega$.

Step 3 — Total power: $P_{tot} = \dfrac{(220)^2}{968} = \dfrac{48400}{968}$.

Step 4 — Evaluate: $P_{tot} = 50$ W.

Step 5 — Cross-check: For two identical bulbs in series on their rated voltage, total power $= \dfrac{P_{rated}}{2} = \dfrac{100}{2} = 50$ W.

Why other options are wrong:

- (A) assumes parallel connection.
- (B) is the single-bulb rating.
- (D) halves once too often.

Final Answer: $P_{tot} = 50\text{ W} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Magnetic moment of a current loop: $m = IA = I\pi R^2$ (single turn).

Step 1 — List data: $I = 5$ A, $R = 0.1$ m, $\pi = 3.14$.

Step 2 — Square the radius: $R^2 = (0.1)^2 = 0.01\text{ m}^2$.

Step 3 — Area: $A = \pi R^2 = 3.14 \times 0.01 = 0.0314\text{ m}^2$.

Step 4 — Multiply by current: $m = IA = 5 \times 0.0314$.

Step 5 — Evaluate: $m = 0.157$ A·m^2.

Why other options are wrong:

- (A) drops a factor of ten (uses the area as the moment).
- (B) is ten times too large.
- (C) forgets to multiply by the current correctly (uses $2\times$ the area only).

Final Answer: $m = 0.157$ A·m$^2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Force on a current-carrying wire: $F = BIL\sin\theta$; perpendicular means $\sin\theta = 1$.

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

Step 2 — Multiply B and I: $0.6 \times 5 = 3.0$.

Step 3 — Multiply by L: $F = 3.0 \times 0.4 = 1.2$ N.

Why other options are wrong:

- (B), (C), (D) come from arithmetic slips.

Final Answer: $F = 1.2$ N $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Field of a long straight wire (Ampere's law): $B = \dfrac{\mu_0 I}{2\pi d}$.

Step 1 — List data: $\mu_0 = 4\pi \times 10^{-7}$, $I = 10$ A, $d = 0.05$ m.

Step 2 — Numerator: $\mu_0 I = 4\pi \times 10^{-7} \times 10 = 40\pi \times 10^{-7}$.

Step 3 — Denominator: $2\pi d = 2\pi \times 0.05 = 0.1\pi$.

Step 4 — Divide: $B = \dfrac{40\pi \times 10^{-7}}{0.1\pi} = \dfrac{40 \times 10^{-7}}{0.1} = 400 \times 10^{-7}$.

Step 5 — Simplify: $B = 4 \times 10^{-5}$ T.

Why other options are wrong:

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

Final Answer: $B = 4 \times 10^{-5}$ T $\Rightarrow \boxed{A}$

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, $L = 0.5$ m, $v = 4$ m/s.

Step 2 — Multiply B and L: $0.6 \times 0.5 = 0.3$.

Step 3 — Multiply by v: $\varepsilon = 0.3 \times 4 = 1.2$ V.

Why other options are wrong:

- (A), (B), (D) come from arithmetic slips.

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

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — Impedance of series LCR: $Z = \sqrt{R^2 + (X_L - X_C)^2}$.

Step 1 — Net reactance: $X_L - X_C = 20 - 4 = 16\,\Omega$.

Step 2 — Square the terms: $R^2 = 12^2 = 144$; $(X_L - X_C)^2 = 16^2 = 256$.

Step 3 — Add: $144 + 256 = 400$.

Step 4 — Take square root: $Z = \sqrt{400} = 20\,\Omega$.

Why other options are wrong:

- (A) ignores the reactance.

- (B) takes only the net reactance.
- (D) adds resistance and reactance arithmetically.

Final Answer: $Z = 20\,\Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept — Transformer turns ratio: $\dfrac{V_s}{V_p} = \dfrac{N_s}{N_p}$.

Step 1 — Turns ratio: $\dfrac{N_s}{N_p} = \dfrac{200}{800} = \dfrac{1}{4}$.

Step 2 — Solve for V_s: $V_s = V_p \times \dfrac{1}{4} = 240 \times \dfrac{1}{4}$.

Step 3 — Evaluate: $V_s = 60$ V.

Why other options are wrong:

- (B) uses a ratio of $1/2$.
- (C) steps up with the inverted ratio.
- (D) uses the wrong (multiplied) factor.

Final Answer: $V_s = 60\text{ V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Mirror formula: $\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$. With the sign convention, the real image distance $v = -20$ cm and the object distance $u = -60$ cm.

Step 1 — Substitute: $\dfrac{1}{f} = \dfrac{1}{-20} + \dfrac{1}{-60}$.

Step 2 — Common denominator: $\dfrac{1}{f} = -\dfrac{3}{60} - \dfrac{1}{60} = -\dfrac{4}{60}$.

Step 3 — Simplify: $\dfrac{1}{f} = -\dfrac{1}{15}$.

Step 4 — Invert: $f = -15$ cm.

Why other options are wrong:

- (A), (C), (D) come from mis-adding the fractions or sign errors.

Final Answer: $f = -15$ cm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Snell's law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$; here $n_1 = 1$ (air), $n_2 = \sqrt{3}$.

Step 1 — Apply Snell's law: $1 \times \sin 60° = \sqrt{3}\,\sin\theta_2$.

Step 2 — Value of $\sin 60°$: $\sin 60° = \dfrac{\sqrt{3}}{2}$.

Step 3 — Solve for $\sin\theta_2$: $\sin\theta_2 = \dfrac{\sqrt{3}/2}{\sqrt{3}} = \dfrac{1}{2}$.

Step 4 — Find the angle: $\theta_2 = \sin^{-1}\left(\frac{1}{2}\right) = 30°$.

Why other options are wrong:

- (A) is $\sin^{-1}(1/\sqrt{2})$, a wrong ratio.
- (B) ignores refraction.
- (C) is not a standard value of the computed sine.

Final Answer: $\theta_2 = 30° \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q39

Q40.

Solution

Concept — Thin lens formula: $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$. For a convex lens $f = +20$ cm; with the object on the left, $u = -30$ cm.

Step 1 — Rearrange: $\dfrac{1}{v} = \dfrac{1}{f} + \dfrac{1}{u}$.

Step 2 — Substitute: $\dfrac{1}{v} = \dfrac{1}{20} + \dfrac{1}{-30} = \dfrac{1}{20} - \dfrac{1}{30}$.

Step 3 — Common denominator: $\dfrac{3}{60} - \dfrac{2}{60} = \dfrac{1}{60}$.

Step 4 — Invert: $v = +60$ cm (real image on the far side).

Why other options are wrong:

- (A) adds the reciprocals wrongly.
- (B) equates v with u.
- (D) gives the wrong sign (virtual image).

Final Answer: $v = +60$ cm $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q40

Q41.

Solution

Concept — Prism at minimum deviation: $n = \frac{\sin\frac{A+D_m}{2}}{\sin\frac{A}{2}}$, with $A = 60°$ for an equilateral prism.

Step 1 — Insert $A = 60°$**:** $\sin\frac{A}{2} = \sin 30° = 0.5$.

Step 2 — Right-hand side: $\sin\frac{A+D_m}{2} = n\sin\frac{A}{2} = 1.5 \times 0.5 = 0.75$.

Step 3 — Solve the sine: $\frac{A+D_m}{2} = \sin^{-1}(0.75) \approx 49°$ (using $\sin 49° \approx 0.75$).

Step 4 — Multiply by 2**:** $A + D_m \approx 98°$.

Step 5 — Subtract A**:** $D_m \approx 98° - 60° = 38°$.

Why other options are wrong:

- (A) corresponds to $n = \sqrt{2}$.
- (B) and (D) use a wrong sine value.

Final Answer: $D_m \approx 38° \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q41

Q42.

Solution

Concept — Missing orders in YDSE: An interference maximum of order m is missing when it falls on a diffraction minimum. The condition is $\frac{d}{a} = \frac{m}{p}$ (with p the diffraction-minimum order); for the first diffraction minimum ($p = 1$), the missing order is $m = \frac{d}{a}$.

Step 1 — Insert the data: $d = 3a$, so $\frac{d}{a} = 3$.

Step 2 — First diffraction minimum, $p = 1$**:** $m = \frac{d}{a} \times p = 3 \times 1$.

Step 3 — Evaluate: $m = 3$.

Why other options are wrong:

- (A) and (B) use a wrong d/a ratio.
- (C) corresponds to $d = 6a$.

Final Answer: The 3rd-order maximum is missing $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q42

Q43.

Solution

Concept — Single-slit first minimum: $a \sin\theta = \lambda$; for small angles $\theta \approx \frac{\lambda}{a}$.

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

Step 2 — Form λ/a**:** $\frac{5 \times 10^{-7}}{2 \times 10^{-4}}$.

Step 3 — Divide mantissas: $\frac{5}{2} = 2.5$.

Step 4 — Subtract exponents: $10^{-7-(-4)} = 10^{-3}$.

Step 5 — Combine: $\theta = 2.5 \times 10^{-3}$ rad.

Why other options are wrong:

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

Final Answer: $\theta = 2.5 \times 10^{-3}$ rad $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q43

Q44.

Solution

Concept — Threshold frequency: $\phi = h\nu_0$, so $\nu_0 = \dfrac{\phi}{h}$.

Step 1 — List data: $\phi = 6.6 \times 10^{-19}$ J, $h = 6.6 \times 10^{-34}$ J·s.

Step 2 — Form the ratio: $\nu_0 = \dfrac{6.6 \times 10^{-19}}{6.6 \times 10^{-34}}$.

Step 3 — Cancel mantissas: $\dfrac{6.6}{6.6} = 1$.

Step 4 — Subtract exponents: $10^{-19-(-34)} = 10^{15}$.

Step 5 — Combine: $\nu_0 = 1 \times 10^{15}$ Hz.

Why other options are wrong:

- (A) and (D) carry mantissa or exponent slips.
- (C) is twice the correct value.

Final Answer: $\nu_0 = 1 \times 10^{15}$ Hz $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q44

Q45.

Solution

Concept — de Broglie wavelength at equal kinetic energy: $\lambda = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mE}}$, so for the same E, $\lambda \propto \dfrac{1}{\sqrt{m}}$.

Step 1 — Form the ratio: $\dfrac{\lambda_e}{\lambda_p} = \dfrac{1/\sqrt{m_e}}{1/\sqrt{m_p}} = \sqrt{\dfrac{m_p}{m_e}}$.

Step 2 — Insert the mass ratio: $\dfrac{m_p}{m_e} = 1836$.

Step 3 — Take the square root: $\dfrac{\lambda_e}{\lambda_p} = \sqrt{1836}$.

Why other options are wrong:

- (A) forgets the square root.
- (B) ignores the mass difference.
- (C) inverts the ratio.

Final Answer: $\frac{\lambda_e}{\lambda_p} = \sqrt{1836} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q45

Q46.

Solution

Concept — Photon frequency: A photon of energy E has frequency $\nu = \frac{E}{h}$.

Step 1 — List data: $E = 3.3 \times 10^{-19}$ J, $h = 6.6 \times 10^{-34}$ J·s.

Step 2 — Form the ratio: $\nu = \frac{3.3 \times 10^{-19}}{6.6 \times 10^{-34}}$.

Step 3 — Divide mantissas: $\frac{3.3}{6.6} = 0.5$.

Step 4 — Subtract exponents: $10^{-19-(-34)} = 10^{15}$.

Step 5 — Combine: $\nu = 0.5 \times 10^{15} = 5 \times 10^{14}$ Hz.

Why other options are wrong:

- (B) and (C) carry mantissa or exponent slips.
- (D) halves the correct value.

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

Answer: (A) Go Back to Q46

Q47.

Solution

Concept — Period of revolution in Bohr orbits: $T_n \propto n^3$, so $\frac{T_2}{T_1} = \left(\frac{2}{1}\right)^3 = 8$.

Step 1 — Cube the ratio: $2^3 = 8$.

Step 2 — Multiply T_1: $T_2 = 8 \times T_1 = 8 \times 1.5 \times 10^{-16}$.

Step 3 — Evaluate the mantissa: $8 \times 1.5 = 12$.

Step 4 — Combine: $T_2 = 12 \times 10^{-16} = 1.2 \times 10^{-15}$ s.

Why other options are wrong:

- (A) uses n^1 (factor 2).
- (C) uses n^2 (factor 4).
- (D) uses $n^{3/2}$-type slip.

Final Answer: $T_2 = 1.2 \times 10^{-15}$ s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q47

Q48.

Solution

Concept — Radioactive decay: After n half-lives, $m = m_0 \left(\frac{1}{2}\right)^n$.

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

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

Step 3 — Multiply by initial mass: $m = 64 \times \dfrac{1}{8}$.

Step 4 — Evaluate: $m = 8$ g.

Why other options are wrong:

- (A) uses $n = 2$.
- (B) uses $n = 1$.
- (D) uses $n = 4$.

Final Answer: $m = 8$ g $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q48

Q49.

Solution

Concept — Mass–energy equivalence: Binding energy $= \Delta m \times 931$ MeV with Δm in u.

Step 1 — List data: $\Delta m = 0.2$ u, energy per u $= 931$ MeV.

Step 2 — Multiply: $E = 0.2 \times 931$.

Step 3 — Evaluate: $E = 186.2$ MeV.

Why other options are wrong:

- (A) uses $\Delta m = 0.1$ u.
- (C) uses $\Delta m = 0.05$ u.
- (D) doubles the correct value.

Final Answer: $E \approx 186.2$ MeV $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q49

Q50.

Solution

Concept — OR gate: A two-input OR gate gives output $Y = 1$ if either or both inputs are 1, and $Y = 0$ only when both inputs are 0. This matches the stated behaviour, $Y = A + B$.

Step 1 — Read the description: $Y = 1$ whenever at least one input is 1.

Step 2 — Read the second clause: $Y = 0$ only when both inputs are 0.

Step 3 — Match to a gate: These two statements together are exactly the OR truth table ($0{+}0 = 0$, $0{+}1 = 1$, $1{+}0 = 1$, $1{+}1 = 1$).

Why other options are wrong:

- (B) AND gives $Y = 1$ only when both inputs are 1.
- (C) NOT has a single input.
- (D) NAND gives $Y = 0$ only when both inputs are 1, the opposite trend.

Final Answer: The gate is an OR gate $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q50

Answer Key

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