NEST Physics Sample Paper – 4

Duration: 45 Minutes **Maximum Marks: 60**

Instructions

- This paper contains **20 Multiple Choice Questions (single correct answer)**, modelled on the Physics section of **NEST 2026**.
- Each correct answer carries **+3 marks**. There is a deduction of -1 **mark** for each incorrect answer; **no marks** are deducted for an unattempted question.
- Every question has exactly **four options**, of which only **one** is correct. Choose carefully.
- Personal calculators, log tables, mobile phones, and other electronic gadgets are strictly prohibited in the examination hall.
- A simple on-screen (virtual) calculator is provided in the computer-based test interface and may be used; blank sheets for rough work are supplied at the exam centre.

Q1. The mass of a small metal cube is measured as $m = (8.00 \pm 0.04)$ g and the length of its side as $a = (2.00 \pm 0.01)$ cm. The density is computed from $\rho = \frac{m}{a^3}$. The percentage error in the computed density is

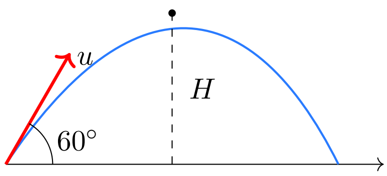
(A) 2.0%

(B) 1.5%

(C) 0.5%

(D) 3.5%

Q2. A stone is projected from level ground with speed $u = 20\ \mathrm{m\,s^{-1}}$ at 60° above the horizontal (take $g = 10\ \mathrm{m\,s^{-2}}$, neglect air resistance). The maximum height reached above the launch point is



(A) 10 m

(B) 20 m

(C) 15 m

(D) 5 m

Q3. A person of mass 60 kg stands on a weighing scale inside a lift. The lift accelerates *downward* at $2\ \mathrm{m\,s^{-2}}$ (take $g = 10\ \mathrm{m\,s^{-2}}$). The reading of the scale (the apparent weight) is

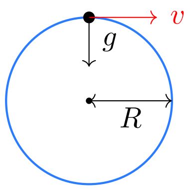
(A) 720 N

(B) 600 N

(C) 120 N

(D) 480 N

Q4. A small bead is threaded on a frictionless circular loop of radius $R = 0.4$ m kept in a vertical plane (take $g = 10\ \mathrm{m\,s^{-2}}$). For the bead to just maintain contact while passing the highest point of the loop, its minimum speed there must be



(A) $4\ \mathrm{m\,s^{-1}}$

(B) $2\ \mathrm{m\,s^{-1}}$

(C) $8\ \mathrm{m\,s^{-1}}$

(D) $2\sqrt{2}\ \text{m s}^{-1}$

Q5. A disc of moment of inertia I rotates freely about its central vertical axis at angular speed ω_0. A second, non-rotating disc of moment of inertia $2I$ is gently dropped coaxially onto it and the two stick together. The common final angular speed is

(A) $\dfrac{\omega_0}{3}$

(B) $\dfrac{\omega_0}{2}$

(C) $\dfrac{2\omega_0}{3}$

(D) $3\omega_0$

Q6. A satellite of mass m orbits the Earth (mass M, radius R) in a circular orbit of radius $2R$. The minimum work that must be done to move it into a circular orbit of radius $4R$ is

(A) $\dfrac{GMm}{16R}$

(B) $\dfrac{GMm}{8R}$

(C) $\dfrac{GMm}{4R}$

(D) $\dfrac{GMm}{2R}$

Q7. A solid sphere of radius $r = 1.0$ mm and density $\rho = 2000\ \text{kg m}^{-3}$ falls through a viscous liquid of density $\sigma = 1000\ \text{kg m}^{-3}$ and coefficient of viscosity $\eta = 0.1$ Pa s (take $g = 10\ \text{m s}^{-2}$). Its terminal velocity is approximately

(A) $4.4 \times 10^{-2}\ \text{m s}^{-1}$

(B) $2.2 \times 10^{-2}\ \text{m s}^{-1}$

(C) $1.1 \times 10^{-2}\ \text{m s}^{-1}$

(D) $6.7 \times 10^{-2}\ \text{m s}^{-1}$

Q8. A fixed mass of an ideal diatomic gas ($\gamma = \frac{7}{5}$) at temperature T_0 is compressed *adiabatically* to one-thirty-second ($\frac{1}{32}$) of its initial volume. The final temperature of the gas is

(A) $2T_0$

(B) $4T_0$

(C) $8T_0$

(D) $32T_0$

Q9. At absolute temperature T, the internal energy of 2 moles of an ideal diatomic gas (which has 5 degrees of freedom per molecule) is

(A) $3RT$

(B) $\frac{5}{2}RT$

(C) $5RT$

(D) $\frac{7}{2}RT$

Q10. A block of mass $m = 2$ kg is connected to two light springs of force constants $k_1 = 300\ \mathrm{N\,m^{-1}}$ and $k_2 = 200\ \mathrm{N\,m^{-1}}$ arranged in *parallel* on a smooth horizontal surface, and set into simple harmonic motion. The time period of oscillation is

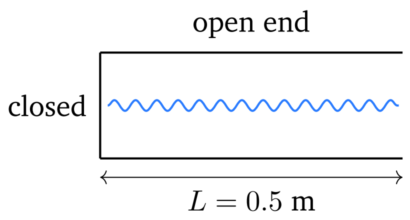
(A) $\frac{2\pi}{\sqrt{50}}$ s

(B) $\frac{2\pi}{\sqrt{1000}}$ s

(C) $\frac{\pi}{\sqrt{250}}$ s

(D) $\frac{2\pi}{\sqrt{250}}$ s

Q11. A pipe of length $L = 0.5$ m is closed at one end and open at the other. Taking the speed of sound in air as $340\ \mathrm{m\,s^{-1}}$, the fundamental frequency of the air column is



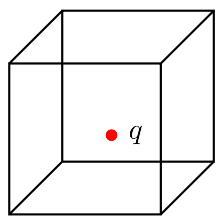
(A) 340 Hz

(B) 85 Hz

(C) 170 Hz

(D) 680 Hz

Q12. A point charge $q = 8.85 \times 10^{-9}$ C is placed at the centre of a cubical Gaussian surface. Take $\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2N^{-1}m^{-2}$. The total electric flux through the *entire* cube is



(A) 1.0×10^3 N m^{2}C^{-1}

(B) 1.0×10^2 N m^{2}C^{-1}

(C) 1.67×10^2 N m^{2}C^{-1}

(D) 6.0×10^3 N m^{2}C^{-1}

Q13. A capacitor of capacitance $4\,\mu$F is charged to a potential difference of 50 V using a battery, then disconnected. The energy stored in the capacitor is

(A) 1×10^{-2} J

(B) 5×10^{-3} J

(C) 2×10^{-3} J

(D) 1×10^{-4} J

Q14. A cylindrical wire of length 2 m and uniform cross-sectional area 0.5 mm^2 is made of a material of resistivity $\rho = 2.0 \times 10^{-7}\,\Omega$m. The resistance of the wire is

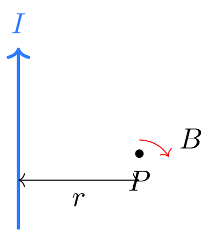
(A) $0.8\,\Omega$

(B) $0.4\,\Omega$

(C) $1.6\,\Omega$

(D) $0.2\,\Omega$

Q15. A long straight wire carries a steady current $I = 5$ A. The magnitude of the magnetic field at a perpendicular distance $r = 0.1$ m from the wire is ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})



(A) 2.0×10^{-5} T

(B) 0.5×10^{-5} T

(C) 4.0×10^{-5} T

(D) 1.0×10^{-5} T

Q16. A flat rectangular coil of 200 turns, each of area 5×10^{-3} m^2, rotates about an axis in its plane at a constant angular speed $\omega = 100$ rad s^{-1} in a uniform magnetic field of 0.2 T perpendicular to the rotation axis. The peak (maximum) emf induced in the coil is

(A) 40 V

(B) 20 V

(C) 80 V

(D) 200 V

Q17. A series RL circuit has $R = 30\,\Omega$ and inductive reactance $X_L = 40\,\Omega$, and is driven by an AC source of rms voltage 100 V. The average power dissipated in the circuit is

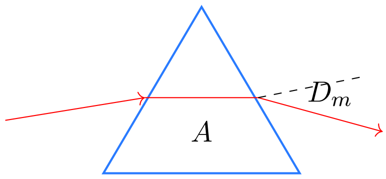
(A) 200 W

(B) 160 W

(C) 120 W

(D) 333 W

Q18. A thin prism of apex angle $A = 60^\circ$ produces a minimum deviation of $D_m = 30^\circ$ for a beam of monochromatic light. The refractive index of the prism material is



(A) $\sqrt{3}$

(B) 1.33

(C) 1.5

(D) $\sqrt{2}$

Q19. In a two-source interference experiment using light of wavelength $\lambda = 500$ nm, the two waves arriving at a point on the screen have a path difference of 1250 nm. The interference at that point is

(A) constructive (the path difference is 2.5λ)

(B) destructive (the path difference is 2λ)

(C) destructive (the path difference is 2.5λ)

(D) constructive (the path difference is 3λ)

Q20. A radioactive sample has a half-life of 20 minutes. Starting from an initial number of nuclei N_0, the fraction of the original nuclei that remains undecayed after 1 hour is

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

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

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

(D) $\frac{1}{16}$

Detailed Solutions

Q1.

Solution

Concept — Propagation of errors: For $\rho = m\,a^{-3}$, fractional errors add, with each exponent acting as a multiplier on that term: $\dfrac{\Delta\rho}{\rho} = \dfrac{\Delta m}{m} + 3\,\dfrac{\Delta a}{a}$.

Step 1 — Individual fractional errors: $\dfrac{\Delta m}{m} = \dfrac{0.04}{8.00} = 0.005$ and $\dfrac{\Delta a}{a} = \dfrac{0.01}{2.00} = 0.005$.

Step 2 — Combine: $\dfrac{\Delta\rho}{\rho} = 0.005 + 3(0.005) = 0.005 + 0.015 = 0.020$, i.e. 2.0%.

Why other options are wrong:

- (B) 1.5% counts only the volume term (3×0.005) and drops the mass error.
- (C) 0.5% counts only the mass term.
- (D) 3.5% wrongly uses a factor of 3 on the mass error as well.

Final Answer: percentage error $= 2.0\% \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Maximum height of a projectile: Only the vertical component of velocity decides the height; $H = \dfrac{u^2 \sin^2\theta}{2g}$.

Step 1 — Vertical component: $u \sin 60^\circ = 20 \cdot \dfrac{\sqrt{3}}{2} = 10\sqrt{3}\ \text{m}\,\text{s}^{-1}$, so $(u\sin\theta)^2 = 300\ \text{m}^2\text{s}^{-2}$.

Step 2 — Height: $H = \dfrac{(u\sin\theta)^2}{2g} = \dfrac{300}{2(10)} = \dfrac{300}{20} = 15$ m.

Why other options are wrong:

- (A) 10 m uses $\sin^2 45^\circ = \frac{1}{2}$ instead of $\sin^2 60^\circ = \frac{3}{4}$.
- (B) 20 m forgets the factor $2g$ (divides by g only and mis-scales).
- (D) 5 m uses $\sin\theta$ in place of $\sin^2\theta$ (and a 30° value).

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

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Apparent weight in a lift: The scale reads the normal force N. With downward acceleration a, Newton's second law gives $mg - N = ma$, so $N = m(g - a)$.

Step 1 — Substitute: $N = 60(10 - 2) = 60(8)$.

Step 2 — Compute: $N = 480$ N.

Why other options are wrong:

- (A) 720 N uses $N = m(g + a)$, valid for *upward* acceleration.
- (B) 600 N is the true weight mg (lift at rest or constant velocity).
- (C) 120 N uses $N = ma$ alone, ignoring gravity.

Final Answer: apparent weight $= 480$ N $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

Solution

Concept — Critical speed at the top of a vertical loop: At the topmost point the minimum-speed condition is set by gravity alone supplying the centripetal force: $mg = \frac{mv^2}{R}$, giving $v_{\text{min}} = \sqrt{gR}$.

Step 1 — Substitute: $v_{\text{min}} = \sqrt{gR} = \sqrt{(10)(0.4)} = \sqrt{4}$.

Step 2 — Compute: $v_{\text{min}} = 2\ \text{m s}^{-1}$.

Why other options are wrong:

- (A) $4\ \text{m s}^{-1}$ uses $v = \sqrt{2gR}$ (a height relation, not the loop condition).
- (C) $8\ \text{m s}^{-1}$ drops the square root ($gR = 4$ taken as the speed).
- (D) $2\sqrt{2}\ \text{m s}^{-1}$ uses $v = \sqrt{2gR}$ with a further slip.

Final Answer: $v_{\text{min}} = \sqrt{gR} = 2\ \text{m s}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Conservation of angular momentum: When the dropped disc lands coaxially, no external torque acts about the axis, so total angular momentum is conserved: $I_{\text{initial}}\,\omega_0 = I_{\text{total}}\,\omega_f$.

Step 1 — Initial and final inertia: Initially only the bottom disc spins: $L_i = I\omega_0$. Finally both turn together: $I_{\text{total}} = I + 2I = 3I$.

Step 2 — Solve: $I\omega_0 = 3I\,\omega_f \Rightarrow \omega_f = \dfrac{\omega_0}{3}$.

Why other options are wrong:

- (B) $\frac{\omega_0}{2}$ uses $I_{\text{total}} = 2I$ (forgets to add the original disc).
- (C) $\frac{2\omega_0}{3}$ inverts the inertia ratio.
- (D) $3\omega_0$ multiplies instead of dividing by the inertia ratio.

Final Answer: $\omega_f = \dfrac{\omega_0}{3} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Energy of circular orbits: The total mechanical energy of a circular orbit of radius r is $E = -\dfrac{GMm}{2r}$. The work needed equals the change in total energy.

Step 1 — Energies of the two orbits: $E_i = -\dfrac{GMm}{2(2R)} = -\dfrac{GMm}{4R}$ and $E_f = -\dfrac{GMm}{2(4R)} = -\dfrac{GMm}{8R}$.

Step 2 — Work done:

$$W = E_f - E_i = -\frac{GMm}{8R} - \left(-\frac{GMm}{4R}\right) = \frac{GMm}{4R} - \frac{GMm}{8R} = \frac{GMm}{8R}.$$

Why other options are wrong:

- (A) $\dfrac{GMm}{16R}$ uses $E = -\dfrac{GMm}{4r}$ by mistake.
- (C) $\dfrac{GMm}{4R}$ is $|E_i|$ alone, not the difference.
- (D) $\dfrac{GMm}{2R}$ uses only PE changes without the orbital factor $\frac{1}{2}$.

Final Answer: $W = \dfrac{GMm}{8R} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Terminal velocity (Stokes' law): At terminal speed the net force is zero; balancing weight against buoyancy and viscous drag gives $v_t = \dfrac{2r^2(\rho-\sigma)g}{9\eta}$.

Step 1 — Substitute ($r = 1.0 \times 10^{-3}$ m):

$$v_t = \frac{2(1.0 \times 10^{-3})^2(2000-1000)(10)}{9(0.1)}.$$

Step 2 — Compute numerator and denominator: numerator $= 2(10^{-6})(1000)(10) = 2.0 \times 10^{-2}$; denominator $= 0.9$.

$$v_t = \frac{2.0 \times 10^{-2}}{0.9} \approx 2.2 \times 10^{-2}\ \mathrm{m\,s^{-1}}.$$

Why other options are wrong:

- (A) $4.4 \times 10^{-2}\ \mathrm{m\,s^{-1}}$ uses the full density ρ instead of $(\rho - \sigma)$.
- (C) $1.1 \times 10^{-2}\ \mathrm{m\,s^{-1}}$ drops the factor 2 in the numerator.
- (D) $6.7 \times 10^{-2}\ \mathrm{m\,s^{-1}}$ uses $9\eta \to 3\eta$ (wrong Stokes constant).

Final Answer: $v_t \approx 2.2 \times 10^{-2}\ \mathrm{m\,s^{-1}} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Adiabatic process: For a reversible adiabatic change, $TV^{\gamma-1} =$ constant, so $T_f = T_0\left(\dfrac{V_0}{V_f}\right)^{\gamma-1}$.

Step 1 — Exponent: For a diatomic gas $\gamma = \frac{7}{5}$, so $\gamma - 1 = \frac{2}{5}$.

Step 2 — Volume ratio: $\dfrac{V_0}{V_f} = 32$, and $32 = 2^5$, so

$$T_f = T_0\,(32)^{2/5} = T_0\,(2^5)^{2/5} = T_0\,2^2 = 4T_0.$$

Why other options are wrong:

- (A) $2T_0$ uses exponent $\frac{1}{5}$ (i.e. 2^1).
- (C) $8T_0$ uses exponent $\frac{3}{5}$ (a monatomic-type slip, 2^3).
- (D) $32T_0$ ignores the exponent entirely ($T \propto V^{-1}$).

Final Answer: $T_f = 4T_0 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Equipartition of energy: A molecule with f degrees of freedom has average energy $\frac{f}{2}k_BT$; for n moles the internal energy is $U = \dfrac{f}{2}nRT$.

Step 1 — Insert values: For a diatomic gas $f = 5$, and here $n = 2$.

$$U = \frac{5}{2}nRT = \frac{5}{2}(2)RT.$$

Step 2 — Simplify: $U = 5RT$.

Why other options are wrong:

- (A) $3RT$ uses $f = 3$ (a monatomic value) with $n = 2$.
- (B) $\frac{5}{2}RT$ forgets to include $n = 2$ (uses 1 mole).
- (D) $\frac{7}{2}RT$ uses $f = 7$ (includes vibration, not asked here).

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

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Springs in parallel: Parallel springs share the same displacement, so their constants add: $k_{\text{eff}} = k_1 + k_2$. The period is $T = 2\pi\sqrt{\dfrac{m}{k_{\text{eff}}}}$.

Step 1 — Effective constant: $k_{\text{eff}} = 300 + 200 = 500\ \text{N m}^{-1}$.

Step 2 — Period:

$$T = 2\pi\sqrt{\frac{m}{k_{\text{eff}}}} = 2\pi\sqrt{\frac{2}{500}} = 2\pi\sqrt{\frac{1}{250}} = \frac{2\pi}{\sqrt{250}}\text{ s.}$$

Why other options are wrong:

- (A) $\frac{2\pi}{\sqrt{50}}$ treats the springs as in series (smaller effective constant).
- (B) $\frac{2\pi}{\sqrt{1000}}$ uses k_{eff}/m inverted ($m = 1$, $k = 1000$).
- (C) $\frac{\pi}{\sqrt{250}}$ drops the factor 2 in 2π.

Final Answer: $T = \frac{2\pi}{\sqrt{250}}\text{ s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q10

Q11.

Solution

Concept — Closed organ pipe: A pipe closed at one end has a displacement node at the closed end and an antinode at the open end. Its fundamental corresponds to a quarter wavelength: $L = \frac{\lambda}{4}$, so $f_1 = \frac{v}{4L}$.

Step 1 — Substitute: $f_1 = \frac{v}{4L} = \frac{340}{4(0.5)} = \frac{340}{2.0}$.

Step 2 — Compute: $f_1 = 170$ Hz. (Only odd harmonics $170, 510, 850, \ldots$ Hz are present.)

Why other options are wrong:

- (A) 340 Hz uses $f = \frac{v}{2L}$ (an open-open pipe relation).
- (B) 85 Hz uses $f = \frac{v}{8L}$ by mistake.
- (D) 680 Hz uses $f = \frac{v}{L}$.

Final Answer: $f_1 = 170\text{ Hz} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Gauss's law: The total flux through any closed surface depends only on the charge enclosed: $\Phi = \frac{q_{\text{enc}}}{\varepsilon_0}$, independent of the surface's shape.

Step 1 — Substitute:

$$\Phi = \frac{q}{\varepsilon_0} = \frac{8.85 \times 10^{-9}}{8.85 \times 10^{-12}}.$$

Step 2 — Compute: $\Phi = 10^3 = 1.0 \times 10^3 \text{ N m}^2\text{C}^{-1}$.

Why other options are wrong:

- (B) 1.0×10^2 is a power-of-ten slip in the division.
- (C) 1.67×10^2 wrongly divides the total flux by 6 (one face value, not the whole cube).
- (D) 6.0×10^3 multiplies the total flux by 6.

Final Answer: $\Phi = 1.0 \times 10^3 \text{ N m}^2\text{C}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Energy stored in a capacitor: A charged capacitor stores energy $U = \frac{1}{2}CV^2$ in its electric field.

Step 1 — Substitute ($C = 4 \times 10^{-6}$ F, $V = 50$ V):

$$U = \tfrac{1}{2}(4 \times 10^{-6})(50)^2.$$

Step 2 — Compute: $(50)^2 = 2500$, so $U = \frac{1}{2}(4 \times 10^{-6})(2500) = \frac{1}{2}(10^{-2}) = 5 \times 10^{-3}$ J.

Why other options are wrong:

- (A) 1×10^{-2} J forgets the factor $\frac{1}{2}$ (uses CV^2).
- (C) 2×10^{-3} J uses $\frac{1}{2}CV$ (linear in V).
- (D) 1×10^{-4} J is a power-of-ten slip.

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

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Resistance from resistivity: For a uniform conductor, $R = \dfrac{\rho L}{A}$, where A is the cross-sectional area.

Step 1 — Convert area: $A = 0.5\ \text{mm}^2 = 0.5 \times 10^{-6}\ \text{m}^2 = 5 \times 10^{-7}\ \text{m}^2$.

Step 2 — Substitute:

$$R = \frac{(2.0 \times 10^{-7})(2)}{5 \times 10^{-7}} = \frac{4.0 \times 10^{-7}}{5 \times 10^{-7}} = 0.8\ \Omega.$$

Why other options are wrong:

- (B) $0.4\,\Omega$ uses $L = 1$ m (or halves the length).
- (C) $1.6\,\Omega$ uses $A = 0.25\ \text{mm}^2$ (doubles the resistance).
- (D) $0.2\,\Omega$ slips one power of ten in the area conversion.

Final Answer: $R = 0.8\,\Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q14**

Q15.

Solution

Concept — Field of a long straight wire: A long straight current-carrying wire produces a magnetic field $B = \dfrac{\mu_0 I}{2\pi r}$ at perpendicular distance r.

Step 1 — Substitute:

$$B = \frac{(4\pi \times 10^{-7})(5)}{2\pi(0.1)}.$$

Step 2 — Simplify: $\dfrac{4\pi}{2\pi} = 2$, so $B = \dfrac{2 \times 10^{-7} \times 5}{0.1} = \dfrac{10 \times 10^{-7}}{0.1} = 1.0 \times 10^{-5}$ T.

Why other options are wrong:

- (A) 2.0×10^{-5} T uses $\dfrac{\mu_0 I}{\pi r}$ (drops the factor 2).
- (B) 0.5×10^{-5} T uses $r = 0.2$ m.
- (C) 4.0×10^{-5} T mishandles the 2π factor entirely.

Final Answer: $B = 1.0 \times 10^{-5}\ \text{T} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q15**

Q16.

Solution

Concept — Rotating coil (AC generator): A coil of N turns and area A rotating at angular speed ω in a field B generates an emf $\varepsilon = NAB\omega \sin \omega t$, whose peak value is $\varepsilon_0 = NAB\omega$.

Step 1 — Substitute:

$$\varepsilon_0 = NAB\omega = (200)(5 \times 10^{-3})(0.2)(100).$$

Step 2 — Compute step by step: $200 \times 5 \times 10^{-3} = 1.0$; $1.0 \times 0.2 = 0.2$; $0.2 \times 100 = 20$ V.

Why other options are wrong:

- (A) 40 V double-counts a factor of 2 (e.g. uses $2NAB\omega$).
- (C) 80 V uses $\omega = 400$ or an extra factor of 4.
- (D) 200 V drops the area factor 5×10^{-3} inconsistently.

Final Answer: $\varepsilon_0 = 20$ V $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Average power in an AC circuit: The average (real) power is $P = V_{\text{rms}} I_{\text{rms}} \cos\phi$, where $\cos\phi = \dfrac{R}{Z}$ is the power factor and $Z = \sqrt{R^2 + X_L^2}$.

Step 1 — Impedance: $Z = \sqrt{30^2 + 40^2} = \sqrt{900 + 1600} = \sqrt{2500} = 50\,\Omega$.

Step 2 — Current and power factor: $I_{\text{rms}} = \dfrac{V}{Z} = \dfrac{100}{50} = 2$ A; $\cos\phi = \dfrac{R}{Z} = \dfrac{30}{50} = 0.6$.

Step 3 — Average power: $P = V_{\text{rms}} I_{\text{rms}} \cos\phi = (100)(2)(0.6) = 120$ W. (Check: $P = I^2 R = (2)^2(30) = 120$ W. ✓)

Why other options are wrong:

- (A) 200 W omits the power factor (VI only).
- (B) 160 W uses $\cos\phi = \dfrac{X_L}{Z} = 0.8$ (reactive, not real, power).
- (D) 333 W uses $\dfrac{V^2}{R}$, ignoring the inductor.

Final Answer: $P = 120\text{ W} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — Prism at minimum deviation: The refractive index follows from $n = \dfrac{\sin\left(\dfrac{A+D_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$.

Step 1 — Evaluate the angles: $\dfrac{A+D_m}{2} = \dfrac{60^\circ + 30^\circ}{2} = 45^\circ$ and $\dfrac{A}{2} = 30^\circ$.

Step 2 — Substitute:

$$n = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}.$$

Why other options are wrong:

- (A) $\sqrt{3}$ comes from $\dfrac{\sin 60^\circ}{\sin 30^\circ}$ (mis-takes the top angle as 60°).
- (B) 1.33 is the index of water, not consistent with these angles.
- (C) 1.5 is a generic glass value, but does not satisfy $\sin 45^\circ / \sin 30^\circ$.

Final Answer: $n = \sqrt{2} \approx 1.41 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept — Interference conditions: Constructive interference needs a path difference of an *integer* number of wavelengths ($n\lambda$); destructive interference needs a *half-integer* multiple ($\left(n + \frac{1}{2}\right)\lambda$).

Step 1 — Express in wavelengths: $\dfrac{\Delta x}{\lambda} = \dfrac{1250}{500} = 2.5$, so $\Delta x = 2.5\lambda = \left(2 + \frac{1}{2}\right)\lambda$.

Step 2 — Classify: A half-integer multiple means the two waves arrive out of phase, giving *destructive* interference (a dark point).

Why other options are wrong:

- (A) 2.5λ is correctly identified but wrongly called constructive.
- (B) the path difference is 2.5λ, not 2λ.
- (D) 3λ misreads the ratio; $1250/500 = 2.5$, not 3.

Final Answer: destructive, since $\Delta x = 2.5\lambda \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Radioactive decay (half-life): After n half-lives the surviving fraction is $\left(\frac{1}{2}\right)^n$, where $n = \frac{t}{T_{1/2}}$.

Step 1 — Number of half-lives: $t = 1$ hour $= 60$ min, $T_{1/2} = 20$ min, so $n = \frac{60}{20} = 3$.

Step 2 — Surviving fraction: $\frac{N}{N_0} = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$.

Why other options are wrong:

- (B) $\frac{1}{4}$ uses $n = 2$ (only 40 min).
- (C) $\frac{1}{6}$ wrongly divides by $2n$ instead of using 2^n.
- (D) $\frac{1}{16}$ uses $n = 4$ (80 min).

Final Answer: fraction remaining $= \frac{1}{8} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	C	3	D	4	B	5	A
6	B	7	B	8	B	9	C	10	D
11	C	12	A	13	B	14	A	15	D
16	B	17	C	18	D	19	C	20	A