NEST Physics Sample Paper – 5

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 speed v of a transverse wave on a stretched string is believed to depend on the tension F in the string and on its linear mass density μ (mass per unit length). Using dimensional analysis, the only relation that is dimensionally consistent is

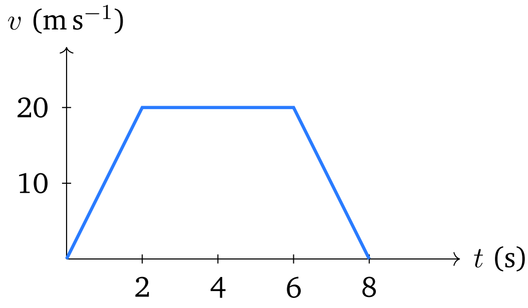
(A) $v = k\,F\mu$

(B) $v = k\sqrt{\dfrac{F}{\mu}}$

(C) $v = k\sqrt{F\mu}$

(D) $v = k\,\dfrac{\mu}{F}$

Q2. The velocity–time graph of a particle moving in a straight line is shown. The total distance travelled by the particle in the 8 s interval is



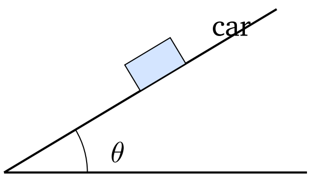
(A) 40 m

(B) 80 m

(C) 50 m

(D) 60 m

Q3. A car negotiates a circular curve of radius $r = 50$ m on a road banked at angle θ with $\tan\theta = 0.8$. Friction is neglected. Take $g = 10\ \mathrm{m\,s^{-2}}$. The maximum (and here the only) safe speed for which the banking alone provides the centripetal force is



(A) $20\ \mathrm{m\,s^{-1}}$

(B) $10\ \mathrm{m\,s^{-1}}$

(C) $25\ \mathrm{m\,s^{-1}}$

(D) $40\ \mathrm{m\,s^{-1}}$

Q4. An engine pulls a train of total mass 5×10^4 kg at a constant speed of $10\ \mathrm{m\,s^{-1}}$ along a horizontal track. The total resistive (frictional) force opposing the motion is 0.05 N per kg of train. The power output of the engine is

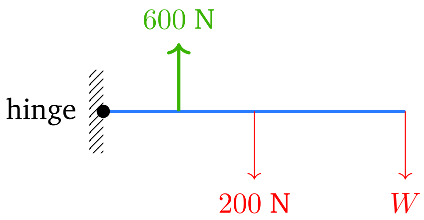
(A) 12.5 kW

(B) 50 kW

(C) 25 kW

(D) 2.5 kW

Q5. A uniform horizontal beam of weight 200 N and length 4 m is hinged to a wall at its left end. A load of weight W hangs from the right end, and the beam is held horizontal by a vertical support placed 1 m from the hinge that exerts an upward force of 600 N. Taking torques about the hinge, the load W is



(A) 200 N

(B) 50 N

(C) 150 N

(D) 100 N

Q6. A planet has twice the mass of the Earth and twice its radius. If the acceleration due to gravity at the Earth's surface is g, the acceleration due to gravity at the surface of this planet is

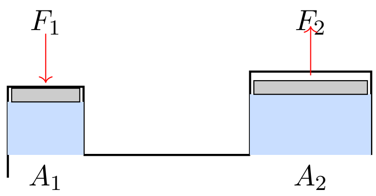
(A) $2g$

(B) g

(C) $\frac{g}{2}$

(D) $\frac{g}{4}$

Q7. In a hydraulic lift the small piston has cross-sectional area $A_1 = 5\ \text{cm}^2$ and the large piston has area $A_2 = 200\ \text{cm}^2$. A force $F_1 = 100$ N is applied on the small piston. By Pascal's law, the maximum load F_2 that can be supported on the large piston is



(A) 2000 N

(B) 4000 N

(C) 1000 N

(D) 40000 N

Q8. A gas absorbs 300 J of heat and at the same time does 120 J of work on its surroundings. The change in the internal energy of the gas is

(A) 180 J

(B) 420 J

(C) -180 J

(D) 120 J

Q9. For the molecules of an ideal gas in thermal equilibrium, let v_p, $\bar{v}$ and v_{rms} denote the most-probable, mean and root-mean-square speeds respectively. The correct ordering of these speeds is

(A) $v_p > \bar{v} > v_{\text{rms}}$

(B) $v_p < \bar{v} < v_{\text{rms}}$

(C) $v_p = \bar{v} = v_{\text{rms}}$

(D) $\bar{v} < v_p < v_{\text{rms}}$

Q10. A particle executes simple harmonic motion described by $x = 0.05\sin(10\,t)$ (SI units), where t is in seconds. At the instant $t = \frac{\pi}{30}$ s, the magnitude of the particle's acceleration is

(A) $5.0\ \text{m s}^{-2}$

(B) $0.5\ \text{m s}^{-2}$

(C) $4.33\ \mathrm{m\,s^{-2}}$

(D) $2.5\ \mathrm{m\,s^{-2}}$

Q11. A progressive wave on a string is described by $y = 0.02\sin(4\pi x - 200\pi t)$, where x and y are in metres and t in seconds. The speed of the wave is

(A) $50\ \mathrm{m\,s^{-1}}$

(B) $25\ \mathrm{m\,s^{-1}}$

(C) $200\ \mathrm{m\,s^{-1}}$

(D) $100\ \mathrm{m\,s^{-1}}$

Q12. Two fixed point charges $+9q$ and $+q$ are separated by a distance $d = 40$ cm on a straight line. A third charge Q is placed on the line between them so that the net force on Q is zero. The distance of Q from the $+q$ charge is

(A) 30 cm

(B) 20 cm

(C) 10 cm

(D) 15 cm

Q13. Four equal point charges, each $+Q$, are fixed at the four corners of a square of side a. Taking the Coulomb constant as $k = \dfrac{1}{4\pi\varepsilon_0}$, the electric potential at the centre of the square is

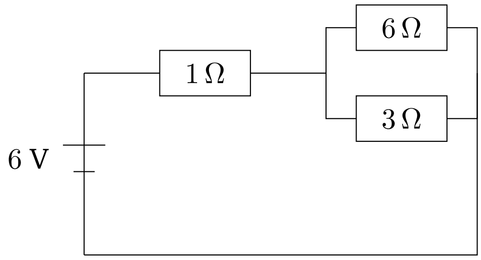
(A) $\dfrac{4kQ}{a}$

(B) $\dfrac{2kQ}{a}$

(C) $\dfrac{8kQ}{a}$

(D) $\dfrac{4\sqrt{2}\,kQ}{a}$

Q14. In the network shown, an ideal 6 V battery is connected to a $1\,\Omega$ resistor in series with a parallel combination of a $6\,\Omega$ and a $3\,\Omega$ resistor. The current supplied by the battery is



(A) 1 A

(B) 2 A

(C) 3 A

(D) 6 A

Q15. A long solenoid is wound with 500 turns per metre and carries a steady current of 4 A. The magnitude of the magnetic field at a point well inside the solenoid is ($\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T\,m\,A^{-1}}$)

(A) $\pi \times 10^{-3}$ T

(B) $4\pi \times 10^{-3}$ T

(C) $8\pi \times 10^{-4}$ T

(D) $2\pi \times 10^{-4}$ T

Q16. An ideal step-down transformer has 1000 turns in its primary and 50 turns in its secondary. The primary is connected to a 240 V AC supply. The output (secondary) voltage is

(A) 12 V

(B) 24 V

(C) 48 V

(D) 4800 V

Q17. An ideal L–C circuit consists of an inductor $L = 2$ mH and a capacitor $C = 8\,\mu$F. The angular frequency of free oscillation of the circuit is

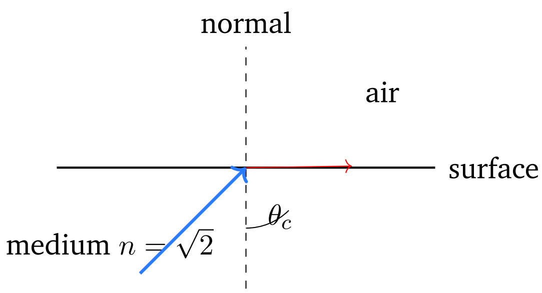
(A) 2.5×10^3 rad s^{-1}

(B) 7.9×10^3 rad s^{-1}

(C) 1.6×10^4 rad s^{-1}

(D) 4.0×10^3 rad s^{-1}

Q18. A ray of light travels inside a transparent medium of refractive index $n = \sqrt{2}$ and strikes the boundary with air $(n = 1)$. The critical angle for total internal reflection at this boundary is



(A) $30°$

(B) $60°$

(C) $45°$

(D) $90°$

Q19. Unpolarised light of intensity I_0 passes through two ideal polarisers whose transmission axes make an angle of $60°$ with each other. The intensity of the light emerging from the second polariser is

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

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

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

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

Q20. An electron is accelerated from rest through a potential difference of 100 V. Taking the electron mass $m = 9.1 \times 10^{-31}$ kg, charge $e = 1.6 \times 10^{-19}$

C and $h = 6.6 \times 10^{-34}$ J s, the de Broglie wavelength of the electron is approximately

(A) 1.2 nm

(B) 0.12 nm

(C) 12 nm

(D) 0.012 nm

Detailed Solutions

Q1.

Solution

Concept — Dimensional homogeneity: A correct physical relation must have the same dimensions on both sides. Assume $v = k\,F^a\mu^b$ and match dimensions.

Step 1 — Dimensions: $[v] = \mathrm{L\,T^{-1}}$, tension $[F] = \mathrm{M\,L\,T^{-2}}$, linear density $[\mu] = \mathrm{M\,L^{-1}}$.

Step 2 — Match powers: $\mathrm{L\,T^{-1}} = (\mathrm{M\,L\,T^{-2}})^a(\mathrm{M\,L^{-1}})^b$. For M: $a + b = 0$; for T: $-2a = -1 \Rightarrow a = \frac{1}{2}$; so $b = -\frac{1}{2}$. Check L: $a - b = \frac{1}{2} + \frac{1}{2} = 1$. ✓

Step 3 — Form: $v = k\,F^{1/2}\mu^{-1/2} = k\sqrt{F/\mu}$.

Why other options are wrong:

- (A) $F\mu$ gives $\mathrm{M^2\,T^{-2}}$, not a speed.
- (C) $\sqrt{F\mu}$ has dimensions $\mathrm{M\,T^{-1}}$, not $\mathrm{L\,T^{-1}}$.
- (D) μ/F gives $\mathrm{L^{-2}\,T^2}$, dimensionally wrong.

Final Answer: $v = k\sqrt{F/\mu} \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Area under a v–t graph: For motion in one direction, the displacement (and distance) equals the area enclosed between the graph and the time axis.

Step 1 — Identify the shape: The velocity rises from 0 to $20\ \mathrm{m\,s^{-1}}$ over 0–2 s, stays at $20\ \mathrm{m\,s^{-1}}$ from 2–6 s, then falls back to 0 over 6–8 s. This is a trapezium.

Step 2 — Area of the trapezium: Parallel sides are the top ($6 - 2 = 4$ s) and the base ($8 - 0 = 8$ s), height $= 20\ \mathrm{m\,s^{-1}}$:

$$s = \tfrac{1}{2}(4 + 8)(20) = \tfrac{1}{2}(12)(20) = 120 \div 2 = 60\ \text{m}.$$

Why other options are wrong:

- (A) 40 m counts only the flat top portion ($4 \times$ ... incorrectly).
- (B) 80 m treats the whole motion as 8 s at constant ... and double counts.

- (C) 50 m uses an arithmetic slip on the triangle areas.

Final Answer: $s = 60 \text{ m} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Banking without friction: On a frictionless banked road, the horizontal component of the normal reaction supplies the centripetal force, giving $\tan\theta = \dfrac{v^2}{rg}$.

Step 1 — Rearrange: $v = \sqrt{rg\tan\theta}$.

Step 2 — Substitute: $v = \sqrt{(50)(10)(0.8)} = \sqrt{400} = 20 \text{ m s}^{-1}$.

Why other options are wrong:

- (B) 10 m s^{-1} forgets the factor g (uses $\sqrt{r\tan\theta}$).
- (C) 25 m s^{-1} uses $\tan\theta = 1.25$ (inverts the tangent).
- (D) 40 m s^{-1} omits the square root ($rg\tan\theta = 400$ taken as the speed).

Final Answer: $v = 20 \text{ m s}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Power at constant speed: At constant velocity the engine force just balances the resistive force f, so the power output is $P = f\,v$.

Step 1 — Total resistive force: $f = (0.05 \text{ N kg}^{-1})(5 \times 10^4 \text{ kg}) = 2500 \text{ N}$.

Step 2 — Power: $P = f\,v = 2500 \times 10 = 25000 \text{ W} = 25 \text{ kW}$.

Why other options are wrong:

- (A) 12.5 kW halves the force (uses $v = 5$).
- (B) 50 kW doubles the speed by mistake.
- (D) 2.5 kW is a power-of-ten slip.

Final Answer: $P = 25 \text{ kW} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q4

Q5.

Solution

Concept — Rotational equilibrium: For a beam in equilibrium, the net torque about any point (here the hinge) is zero. Take anticlockwise as positive.

Step 1 — Torques about the hinge: The support force (600 N, 1 m away) is anticlockwise; the beam's own weight (200 N at its centre, 2 m away) and the load W (at 4 m) are clockwise.

$$600(1) = 200(2) + W(4).$$

Step 2 — Solve: $600 = 400 + 4W \Rightarrow 4W = 200 \Rightarrow W = 50$ N.

Why other options are wrong:

- (A) 200 N ignores the beam's own weight torque.
- (C) 150 N uses the beam weight arm as 1 m.
- (D) 100 N divides by the wrong moment arm.

Final Answer: $W = 50 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Surface gravity: The acceleration due to gravity at a planet's surface is $g = \frac{GM}{R^2}$, so $g \propto \frac{M}{R^2}$.

Step 1 — Ratio: With $M' = 2M$ and $R' = 2R$,

$$\frac{g'}{g} = \frac{M'/R'^2}{M/R^2} = \frac{2M/(2R)^2}{M/R^2} = \frac{2}{4} = \frac{1}{2}.$$

Step 2 — Result: $g' = \frac{g}{2}$.

Why other options are wrong:

- (A) $2g$ counts only the mass factor, ignoring the radius.
- (B) g would need $R' = \sqrt{2}R$.

- (D) $g/4$ uses $R' = 2R$ but forgets the mass doubling.

Final Answer: $g' = \frac{g}{2} \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Pascal's law: Pressure applied to an enclosed fluid is transmitted undiminished, so $\frac{F_1}{A_1} = \frac{F_2}{A_2}$.

Step 1 — Rearrange: $F_2 = F_1 \frac{A_2}{A_1}$.

Step 2 — Substitute: $F_2 = 100 \times \frac{200}{5} = 100 \times 40 = 4000$ N.

Why other options are wrong:

- (A) 2000 N uses area ratio 20 (drops a factor of 2).
- (C) 1000 N uses ratio 10.
- (D) 40000 N is a power-of-ten slip.

Final Answer: $F_2 = 4000$ N $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — First law of thermodynamics: $\Delta U = Q - W$, where Q is the heat *added to* the gas and W is the work done *by* the gas.

Step 1 — Identify signs: Heat absorbed $Q = +300$ J; work done by the gas $W = +120$ J.

Step 2 — Apply: $\Delta U = 300 - 120 = 180$ J.

Why other options are wrong:

- (B) 420 J adds Q and W ($\Delta U = Q + W$, wrong sign convention).
- (C) -180 J reverses the subtraction.
- (D) 120 J just repeats the work value.

Final Answer: $\Delta U = 180$ J $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Maxwell speed distribution: For an ideal gas the three characteristic speeds are $v_p = \sqrt{\frac{2RT}{M}}$, $\bar{v} = \sqrt{\frac{8RT}{\pi M}}$ and $v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$.

Step 1 — Compare the numerical factors: $\sqrt{2} \approx 1.414$, $\sqrt{8/\pi} \approx 1.596$, $\sqrt{3} \approx 1.732$.

Step 2 — Order: Since $1.414 < 1.596 < 1.732$, we have $v_p < \bar{v} < v_{\text{rms}}$ (ratio $\approx 1 : 1.13 : 1.22$).

Why other options are wrong:

- (A) reverses the order entirely.
- (C) equality would require a single-speed gas, not a thermal distribution.
- (D) misplaces the mean speed below the most-probable speed.

Final Answer: $v_p < \bar{v} < v_{\text{rms}} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Acceleration in SHM: For $x = A\sin(\omega t)$, the acceleration is $a = -\omega^2 x = -A\omega^2 \sin(\omega t)$, with maximum magnitude $A\omega^2$.

Step 1 — Read off: $A = 0.05$ m, $\omega = 10 \text{ rad s}^{-1}$.

Step 2 — Phase at the given instant: $\omega t = 10 \times \frac{\pi}{30} = \frac{\pi}{3}$, so $\sin(\omega t) = \sin 60^\circ = \frac{\sqrt{3}}{2} \approx 0.866$.

Step 3 — Acceleration:

$$|a| = A\omega^2 \sin(\omega t) = (0.05)(100)(0.866) = 5 \times 0.866 \approx 4.33 \text{ m s}^{-2}.$$

Why other options are wrong:

- (A) 5.0 m s^{-2} is the maximum acceleration $A\omega^2$ (at the extreme, not this phase).

- (B) $0.5\ \mathrm{m\,s^{-2}}$ uses $\omega^2 = 10$ instead of 100.
- (D) $2.5\ \mathrm{m\,s^{-2}}$ uses $\sin(\omega t) = \frac{1}{2}$ ($30°$).

Final Answer: $|a| \approx 4.33\ \mathrm{m\,s^{-2}} \Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Progressive wave: For $y = A\sin(kx - \omega t)$, the wave speed is $v = \dfrac{\omega}{k}$.

Step 1 — Read off: $k = 4\pi\ \mathrm{rad\,m^{-1}}$, $\omega = 200\pi\ \mathrm{rad\,s^{-1}}$.

Step 2 — Speed: $v = \dfrac{\omega}{k} = \dfrac{200\pi}{4\pi} = 50\ \mathrm{m\,s^{-1}}$.

Why other options are wrong:

- (B) $25\ \mathrm{m\,s^{-1}}$ uses $k = 8\pi$.
- (C) $200\ \mathrm{m\,s^{-1}}$ mistakes ω for the speed.
- (D) $100\ \mathrm{m\,s^{-1}}$ doubles the correct value.

Final Answer: $v = 50\ \mathrm{m\,s^{-1}} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Equilibrium of a charge between two like charges: The third charge feels zero net force where the two Coulomb forces balance: $\dfrac{k(9q)Q}{(d-x)^2} = \dfrac{k(q)Q}{x^2}$, with x measured from $+q$.

Step 1 — Set up: Let x be the distance from $+q$, so $40 - x$ from $+9q$:

$$\frac{9q}{(40-x)^2} = \frac{q}{x^2} \;\Rightarrow\; 9x^2 = (40-x)^2.$$

Step 2 — Solve: Take square roots: $3x = 40 - x \Rightarrow 4x = 40 \Rightarrow x = 10$ cm. So Q is 10 cm from $+q$ (and 30 cm from $+9q$).

Why other options are wrong:

- (A) 30 cm is the distance from the larger charge, not from $+q$.

- (B) 20 cm is the midpoint, where forces do not balance.
- (D) 15 cm comes from using $\sqrt{9} = 2$ by error.

Final Answer: 10 cm from the $+q$ charge $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Potential is a scalar sum: The potential at a point due to several charges is the algebraic sum $V = \sum \frac{kq_i}{r_i}$. All four corner charges are equidistant from the centre.

Step 1 — Distance to centre: The half-diagonal of a square of side a is $r = \frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}}$.

Step 2 — Sum the four contributions:

$$V = 4 \times \frac{kQ}{r} = 4 \times \frac{kQ}{a/\sqrt{2}} = \frac{4\sqrt{2}\,kQ}{a}.$$

Why other options are wrong:

- (A) $\frac{4kQ}{a}$ uses $r = a$ (side, not half-diagonal).
- (B) $\frac{2kQ}{a}$ counts only two charges.
- (C) $\frac{8kQ}{a}$ uses $r = a/2$.

Final Answer: $V = \frac{4\sqrt{2}\,kQ}{a} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept — Series–parallel reduction: Combine the parallel pair, add the series resistor, then apply Ohm's law to the whole loop.

Step 1 — Parallel pair: $\frac{6 \times 3}{6+3} = \frac{18}{9} = 2\,\Omega$.

Step 2 — Total resistance: $R_{\text{eq}} = 1 + 2 = 3\,\Omega$.

Step 3 — Battery current: $I = \frac{V}{R_{\text{eq}}} = \frac{6}{3} = 2$ A.

Why other options are wrong:

- (A) 1 A uses $R_{\text{eq}} = 6\,\Omega$ (adds the parallel resistors instead of combining them).
- (C) 3 A omits the series $1\,\Omega$ resistor $(6/2)$.
- (D) 6 A divides by $1\,\Omega$ only.

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

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Field inside a long solenoid: Well inside an ideal solenoid the field is uniform and given by $B = \mu_0 n I$, where n is the number of turns per unit length.

Step 1 — Substitute: $B = (4\pi \times 10^{-7})(500)(4)$.

Step 2 — Compute: $500 \times 4 = 2000$, so $B = (4\pi \times 10^{-7})(2000) = 8\pi \times 10^{-4}$ T $\approx 2.5 \times 10^{-3}$ T.

Why other options are wrong:

- (A) $\pi \times 10^{-3}$ T uses half the turn density.
- (B) $4\pi \times 10^{-3}$ T is a factor-of-five slip on n.
- (D) $2\pi \times 10^{-4}$ T drops a factor of 4 from the current.

Final Answer: $B = 8\pi \times 10^{-4}$ T $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Ideal transformer: The voltage ratio equals the turns ratio, $\frac{V_s}{V_p} = \frac{N_s}{N_p}$.

Step 1 — Rearrange: $V_s = V_p \frac{N_s}{N_p}$.

Step 2 — Substitute: $V_s = 240 \times \frac{50}{1000} = 240 \times 0.05 = 12$ V.

Why other options are wrong:

- (B) 24 V uses a turns ratio of $1/10$.
- (C) 48 V uses $1/5$.
- (D) 4800 V inverts the ratio (step-up by mistake).

Final Answer: $V_s = 12$ V $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — LC oscillation: A lossless L–C circuit oscillates at angular frequency $\omega = \frac{1}{\sqrt{LC}}$.

Step 1 — Product LC: $LC = (2 \times 10^{-3})(8 \times 10^{-6}) = 16 \times 10^{-9} = 1.6 \times 10^{-8}$.

Step 2 — Compute: $\sqrt{LC} = \sqrt{1.6 \times 10^{-8}} = 1.265 \times 10^{-4}$, so

$$\omega = \frac{1}{1.265 \times 10^{-4}} \approx 7.9 \times 10^3 \text{ rad s}^{-1}.$$

Why other options are wrong:

- (A) 2.5×10^3 uses $L = 2$ H (forgets the milli).
- (C) 1.6×10^4 forgets the square root on LC.
- (D) 4.0×10^3 comes from an arithmetic slip on $\sqrt{LC}$.

Final Answer: $\omega \approx 7.9 \times 10^3 \text{ rad s}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Critical angle: Total internal reflection sets in at the critical angle θ_c where the refracted ray grazes the surface ($90°$): $\sin\theta_c = \frac{n_{\text{rare}}}{n_{\text{dense}}} = \frac{1}{n}$.

Step 1 — Substitute: $\sin\theta_c = \frac{1}{\sqrt{2}}$.

Step 2 — Solve: $\theta_c = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45°$.

Why other options are wrong:

- (A) $30°$ would need $n = 2$.
- (B) $60°$ would need $n = \frac{2}{\sqrt{3}} \approx 1.15$.
- (D) $90°$ is the angle of the grazing refracted ray, not the angle of incidence.

Final Answer: $\theta_c = 45° \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Malus's law with unpolarised light: The first polariser passes half the unpolarised intensity; the second then transmits a fraction $\cos^2\theta$, where θ is the angle between the axes.

Step 1 — After the first polariser: $I_1 = \frac{I_0}{2}$.

Step 2 — After the second (Malus): $I_2 = I_1\cos^2 60° = \frac{I_0}{2}\left(\frac{1}{2}\right)^2 = \frac{I_0}{2}\cdot\frac{1}{4} = \frac{I_0}{8}$.

Why other options are wrong:

- (A) $\frac{I_0}{2}$ stops after the first polariser only.
- (B) $\frac{3I_0}{8}$ uses $\cos^2 30° = \frac{3}{4}$.
- (C) $\frac{I_0}{4}$ forgets the first polariser's factor of $\frac{1}{2}$ (uses $\cos^2 60°$ on I_0).

Final Answer: $I_2 = \frac{I_0}{8} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — de Broglie wavelength after acceleration: An electron accelerated through potential V acquires kinetic energy eV, so $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2meV}}$. A handy shortcut is $\lambda \approx \frac{1.227}{\sqrt{V}}$ nm.

Step 1 — Shortcut: $\lambda = \frac{1.227}{\sqrt{100}} = \frac{1.227}{10} \approx 0.123$ nm.

Step 2 — Check from first principles: $p = \sqrt{2meV} = \sqrt{2(9.1 \times 10^{-31})(1.6 \times 10^{-19})(100)} \approx 5.4 \times 10^{-24}$ kg m s^{-1}; then $\lambda = \frac{6.6 \times 10^{-34}}{5.4 \times 10^{-24}} \approx 1.2 \times 10^{-10}$ m $= 0.12$ nm. ✓

Why other options are wrong:

- (A) 1.2 nm is a power-of-ten slip (10^{-9} vs 10^{-10} m).
- (C) 12 nm is off by two orders of magnitude.
- (D) 0.012 nm uses $V = 10^4$ V.

Final Answer: $\lambda \approx 0.12$ nm $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q20

Answer Key

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