NEST Physics Sample Paper – 10

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 resistivity of a wire is determined from $\rho = \frac{RA}{L} = \frac{R\pi d^2}{4L}$, where R is its resistance, d its diameter and L its length. In a measurement the percentage errors are $\frac{\Delta R}{R} = 2\%$, $\frac{\Delta d}{d} = 1\%$ and $\frac{\Delta L}{L} = 2\%$. The maximum percentage error in the measured resistivity ρ is

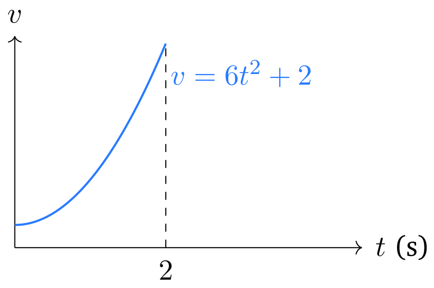
(A) 5%

(B) 6%

(C) 4%

(D) 9%

Q2. A particle moves along a straight line with velocity $v = 6t^2 + 2$ (SI units), starting from the origin at $t = 0$. Its acceleration at $t = 2$ s and its displacement during the first 2 s are, respectively,



(A) $12\ \mathrm{m\,s^{-2}}$ and 16 m

(B) $24\ \mathrm{m\,s^{-2}}$ and 16 m

(C) $24\ \mathrm{m\,s^{-2}}$ and 20 m

(D) $12\ \mathrm{m\,s^{-2}}$ and 20 m

Q3. A ball of mass 0.2 kg strikes a rigid wall normally with speed $10\ \mathrm{m\,s^{-1}}$ and rebounds along the same line with speed $8\ \mathrm{m\,s^{-1}}$. If the contact lasts 0.02 s, the magnitude of the average force exerted by the wall on the ball is

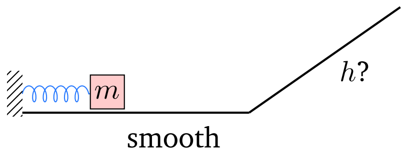
(A) 180 N

(B) 20 N

(C) 100 N

(D) 90 N

Q4. A block of mass 0.5 kg is pressed against a spring of force constant $k = 200\ \mathrm{N\,m^{-1}}$, compressing it by 0.1 m on a smooth horizontal floor. When released, the block leaves the spring and climbs a smooth incline. Take $g = 10\ \mathrm{m\,s^{-2}}$. The maximum vertical height it reaches on the incline is



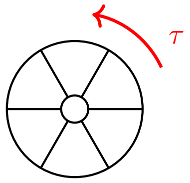
(A) 0.4 m

(B) 0.1 m

(C) 0.5 m

(D) 0.2 m

Q5. A flywheel of moment of inertia $I = 4$ kg m^2, initially at rest, is acted on by a constant torque $\tau = 8$ N m. The number of revolutions it completes in the first 10 s is



(A) $\dfrac{50}{\pi}$
(B) $\dfrac{25}{\pi}$
(C) 50π
(D) $\dfrac{100}{\pi}$

Q6. A satellite of mass $m = 200$ kg orbits the Earth in a circular orbit of radius equal to twice the Earth's radius, $r = 2R$. The Earth's radius is $R = 6.4 \times 10^6$ m and the acceleration due to gravity at its surface is $g = 10$ m s^{-2}. The binding energy of the satellite (the energy needed to just free it from the orbit) is

(A) 6.4×10^9 J

(B) 1.28×10^{10} J

(C) 3.2×10^9 J

(D) 1.6×10^9 J

Q7. A tank is open to the atmosphere and filled with a liquid of density 800 kg m^{-3} to a depth of 5 m. Take atmospheric pressure $P_0 = 1.0 \times 10^5$ Pa and $g = 10$ m s^{-2}. The *absolute* pressure at a point 5 m below the free surface is

(A) 1.4×10^5 Pa

(B) 4.0×10^4 Pa

(C) 1.0×10^5 Pa

(D) 5.4×10^5 Pa

Q8. A heat engine absorbs 600 J of heat from a hot reservoir and rejects 450 J to a cold reservoir in each cycle. The thermal efficiency of this engine is

(A) 33%

(B) 25%

(C) 75%

(D) 15%

Q9. For a diatomic ideal gas at ordinary temperatures (translational and rotational modes only, vibration not excited), the number of active degrees of freedom f and the molar specific heat at constant volume C_V are, respectively, (R = universal gas constant)

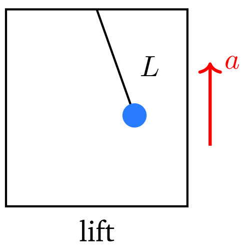
(A) $f = 3,\ C_V = \frac{3}{2}R$

(B) $f = 7,\ C_V = \frac{7}{2}R$

(C) $f = 6,\ C_V = 3R$

(D) $f = 5,\ C_V = \frac{5}{2}R$

Q10. A simple pendulum of length $L = 1.0$ m has a period T_0 in a stationary lift. The lift now accelerates *upward* with $a = g = 10\ \mathrm{m\,s^{-2}}$. The new time period of the pendulum is



(A) $2\pi\sqrt{\frac{L}{g}}$

(B) $2\pi\sqrt{\frac{2L}{g}}$

(C) $2\pi\sqrt{\frac{L}{2g}}$

(D) $\pi\sqrt{\frac{L}{g}}$

Q11. A resonance tube (closed at the lower end by the water level) first resonates with a tuning fork of frequency 480 Hz when the air column length is 17.5 cm. Neglecting the end correction, the speed of sound in air is

(A) $168\ \mathrm{m\,s^{-1}}$

(B) $672\ \mathrm{m\,s^{-1}}$

(C) $84\ \mathrm{m\,s^{-1}}$

(D) $336\ \mathrm{m\,s^{-1}}$

Q12. An infinite plane sheet carries a uniform surface charge density $\sigma = 8.85 \times 10^{-9}\ \mathrm{C\,m^{-2}}$. Take $\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2N^{-1}m^{-2}}$. The magnitude of the electric field at any point just outside the sheet is

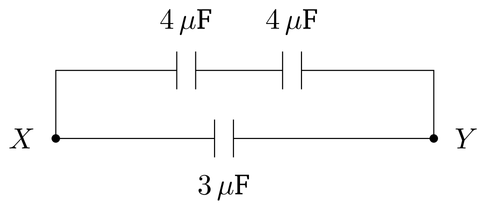
(A) $500\ \mathrm{N\,C^{-1}}$

(B) $1000\ \mathrm{N\,C^{-1}}$

(C) $250\ \mathrm{N\,C^{-1}}$

(D) $2000\ \mathrm{N\,C^{-1}}$

Q13. In the network shown, two $4\,\mu$F capacitors are in series, and that combination is connected in parallel with a $3\,\mu$F capacitor across the terminals X and Y. The equivalent capacitance between X and Y is



(A) $11\,\mu$F

(B) $5\,\mu$F

(C) $7\,\mu$F

(D) $2\,\mu$F

Q14. A metallic wire has resistance $20\,\Omega$ at $20°$C. Its temperature coefficient of resistance is $\alpha = 4 \times 10^{-3}\,°\text{C}^{-1}$. Assuming a linear variation, its resistance at $120°$C is

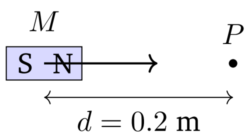
(A) $24\,\Omega$

(B) $20.8\,\Omega$

(C) $28\,\Omega$

(D) $32\,\Omega$

Q15. A short bar magnet of magnetic moment $M = 0.4$ A m^2 is placed with its axis along a line. The magnetic field on its axis at a distance $d = 0.2$ m from the centre is ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})



(A) 2×10^{-5} T

(B) 4×10^{-6} T

(C) 5×10^{-6} T

(D) 1×10^{-5} T

Q16. A conducting rod of length $L = 0.5$ m rotates about an axis through one end, perpendicular to a uniform magnetic field $B = 0.4$ T, with angular speed $\omega = 20$ rad s^{-1}. The emf induced between the centre of rotation and the free end is

(A) 1.0 V

(B) 2.0 V

(C) 0.5 V

(D) 4.0 V

Q17. A series RL circuit has resistance $R = 30\,\Omega$ and inductive reactance $X_L = 40\,\Omega$. It is driven by an AC source of rms voltage 200 V. The average power dissipated in the circuit is

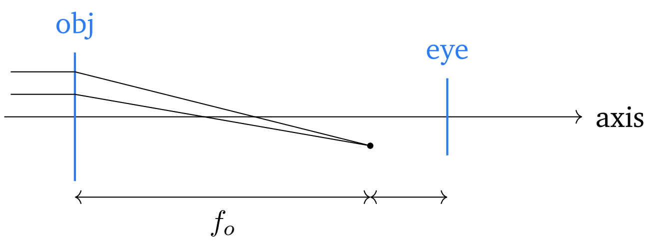
(A) 800 W

(B) 480 W

(C) 640 W

(D) 1333 W

Q18. An astronomical telescope in normal adjustment has an objective of focal length $f_o = 80$ cm and an eyepiece of focal length $f_e = 4$ cm. Its angular magnification and the length of the tube are, respectively,



(A) 20 and 76 cm

(B) 0.05 and 84 cm

(C) 20 and 84 cm

(D) 320 and 84 cm

Q19. In a Young's double-slit experiment the fringe width observed in air is 0.6 mm. Without changing the geometry or the source, the entire apparatus is immersed in a transparent liquid of refractive index 1.5. The new fringe width is

(A) 0.9 mm

(B) 0.4 mm

(C) 0.6 mm

(D) 0.3 mm

Q20. Which of the following statements about intrinsic and extrinsic semiconductors is correct?

(A) In an intrinsic semiconductor at room temperature, the number of free electrons is much greater than the number of holes.

(B) Doping a pure semiconductor with a pentavalent impurity produces a p-type semiconductor.

(C) In a p-type semiconductor, holes are the majority charge carriers and the dopant is a trivalent (acceptor) impurity.

(D) The forbidden energy gap of an insulator (about 0.7 eV) is smaller than that of a typical semiconductor.

Detailed Solutions

Q1.

Solution

Concept — Propagation of errors: For a product/quotient the fractional errors add, each multiplied by the magnitude of its exponent. Here $\rho = \frac{R\pi d^2}{4L}$, so R and L enter to the power 1 and d to the power 2.

Step 1 — Error formula: $\frac{\Delta \rho}{\rho} = \frac{\Delta R}{R} + 2\frac{\Delta d}{d} + \frac{\Delta L}{L}$ (the constant $\pi/4$ contributes no error).

Step 2 — Substitute: $\frac{\Delta \rho}{\rho} = 2\% + 2(1\%) + 2\% = 2 + 2 + 2 = 6\%$.

Why other options are wrong:

- (A) 5% uses the diameter error only once (forgets the factor of 2).
- (C) 4% drops the diameter term entirely.
- (D) 9% wrongly puts a factor of 2 on R or L as well.

Final Answer: maximum error $= 6\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Calculus kinematics: Acceleration is the time derivative of velocity, $a = \frac{dv}{dt}$; displacement is the time integral of velocity, $s = \int v\,dt$.

Step 1 — Acceleration: $a = \frac{d}{dt}(6t^2 + 2) = 12t$. At $t = 2$ s, $a = 12(2) = 24\ \text{m s}^{-2}$.

Step 2 — Displacement: $s = \int_0^2 (6t^2 + 2)\,dt = \left[2t^3 + 2t\right]_0^2 = 2(8) + 2(2) = 16 + 4 = 20$ m.

Why other options are wrong:

- (A) $12\ \text{m s}^{-2}$ fails to evaluate $a = 12t$ at $t = 2$; the displacement 16 m drops the $+2t$ contribution to the integral.
- (B) gets the acceleration right but the displacement 16 m omits the $+2t$ term ($\int 6t^2\,dt$ only).
- (D) $12\ \text{m s}^{-2}$ again leaves the acceleration as $12t$ without substituting $t = 2$.

Final Answer: $a = 24\ \mathrm{m\,s^{-2}}$, $s = 20$ m $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Impulse–momentum theorem: The average force equals the change in momentum divided by the contact time, $F_{\text{avg}} = \dfrac{\Delta p}{\Delta t}$. Take the outgoing direction as positive.

Step 1 — Change in momentum: The ball comes in at $-10\ \mathrm{m\,s^{-1}}$ and leaves at $+8\ \mathrm{m\,s^{-1}}$.

$$\Delta p = m(v_f - v_i) = 0.2\big(8 - (-10)\big) = 0.2(18) = 3.6\ \mathrm{kg\,m\,s^{-1}}.$$

Step 2 — Average force: $F_{\text{avg}} = \dfrac{\Delta p}{\Delta t} = \dfrac{3.6}{0.02} = 180$ N.

Why other options are wrong:

- (B) 20 N uses $\Delta v = 10 - 8 = 2$ (subtracts speeds instead of adding the reversed velocity).
- (C) 100 N keeps only the incoming speed (10).
- (D) 90 N uses $\Delta v = 18$ but with $m = 0.1$ kg.

Final Answer: $F_{\text{avg}} = 180$ N $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Energy conservation: The elastic potential energy stored in the compressed spring is fully converted to gravitational potential energy at the highest point (all surfaces smooth, so no losses).

Step 1 — Spring energy: $E_{\text{spring}} = \frac{1}{2}kx^2 = \frac{1}{2}(200)(0.1)^2 = \frac{1}{2}(200)(0.01) = 1$ J.

Step 2 — Equate to PE: $mgh = 1 \Rightarrow h = \dfrac{1}{mg} = \dfrac{1}{(0.5)(10)} = \dfrac{1}{5} = 0.2$ m.

Why other options are wrong:

- (A) 0.4 m forgets the factor $\frac{1}{2}$ in the spring energy.

- (B) 0.1 m uses $E = \frac{1}{2}kx$ (wrong power of x).
- (C) 0.5 m divides by g alone, dropping the mass.

Final Answer: $h = 0.2$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Rotational dynamics: A constant torque gives a constant angular acceleration $\alpha = \tau/I$; the angle swept follows $\theta = \frac{1}{2}\alpha t^2$, and the number of revolutions is $\theta/2\pi$.

Step 1 — Angular acceleration: $\alpha = \dfrac{\tau}{I} = \dfrac{8}{4} = 2\ \text{rad s}^{-2}$.

Step 2 — Angle in 10 s: $\theta = \frac{1}{2}\alpha t^2 = \frac{1}{2}(2)(10)^2 = 100$ rad.

Step 3 — Revolutions: $n = \dfrac{\theta}{2\pi} = \dfrac{100}{2\pi} = \dfrac{50}{\pi} \approx 16$ rev.

Why other options are wrong:

- (B) $\dfrac{25}{\pi}$ forgets the $\frac{1}{2}$ in $\theta = \frac{1}{2}\alpha t^2$ when converting (uses $\theta/4\pi$).
- (C) 50π multiplies by 2π instead of dividing.
- (D) $\dfrac{100}{\pi}$ uses θ/π instead of $\theta/2\pi$.

Final Answer: $n = \dfrac{50}{\pi}$ revolutions $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Binding energy of a satellite: For a circular orbit the total energy is $E = -\dfrac{GMm}{2r}$; the binding energy is $+\dfrac{GMm}{2r}$, the energy needed to bring it to rest at infinity. Using $GM = gR^2$.

Step 1 — Express in terms of g, R: B.E. $= \dfrac{GMm}{2r} = \dfrac{gR^2m}{2(2R)} = \dfrac{gRm}{4}$.

Step 2 — Substitute: B.E. $= \dfrac{(10)(6.4 \times 10^6)(200)}{4} = \dfrac{1.28 \times 10^{10}}{4} = 3.2 \times 10^9$ J.

Why other options are wrong:

- (A) 6.4×10^9 J uses $r = R$ instead of $2R$.
- (B) 1.28×10^{10} J forgets the factor $\frac{1}{2}$ (gives $|PE|$, not the orbital energy).
- (D) 1.6×10^9 J uses $r = 4R$ by mistake.

Final Answer: B.E. $= 3.2 \times 10^9$ J $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Hydrostatic pressure: The absolute pressure at depth h in a liquid open to the atmosphere is $P = P_0 + \rho g h$.

Step 1 — Gauge (liquid-column) pressure: $\rho g h = (800)(10)(5) = 4.0 \times 10^4$ Pa.

Step 2 — Add atmospheric: $P = 1.0 \times 10^5 + 4.0 \times 10^4 = 1.4 \times 10^5$ Pa.

Why other options are wrong:

- (B) 4.0×10^4 Pa is only the gauge pressure, not the absolute pressure.
- (C) 1.0×10^5 Pa is just atmospheric pressure, ignoring the depth.
- (D) 5.4×10^5 Pa uses $\rho = 1000$ and h inflated, an arithmetic slip.

Final Answer: $P = 1.4 \times 10^5$ Pa $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Engine efficiency: The thermal efficiency is the useful work output divided by heat absorbed, $\eta = \dfrac{W}{Q_H} = 1 - \dfrac{Q_C}{Q_H}$, where Q_C is the heat rejected.

Step 1 — Work per cycle: $W = Q_H - Q_C = 600 - 450 = 150$ J.

Step 2 — Efficiency: $\eta = \dfrac{150}{600} = 0.25 = 25\%$.

Why other options are wrong:

- (A) 33% uses $W/Q_C = 150/450$ (divides by the rejected heat).
- (C) 75% is Q_C/Q_H, the fraction rejected, not the efficiency.
- (D) 15% is an arithmetic slip (W taken as 90 J).

Final Answer: $\eta = 25\% \Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Equipartition of energy: Each active degree of freedom contributes $\frac{1}{2}R$ to the molar specific heat at constant volume, so $C_V = \frac{f}{2}R$. A diatomic gas (no vibration) has 3 translational + 2 rotational = 5 degrees of freedom.

Step 1 — Degrees of freedom: $f = 3 + 2 = 5$.

Step 2 — Molar specific heat: $C_V = \frac{f}{2}R = \frac{5}{2}R$.

Why other options are wrong:

- (A) $f = 3,\ C_V = \frac{3}{2}R$ is a monatomic gas.
- (B) $f = 7,\ C_V = \frac{7}{2}R$ includes vibrational modes (not excited at ordinary temperatures).
- (C) $f = 6,\ C_V = 3R$ over-counts the rotational modes.

Final Answer: $f = 5,\ C_V = \frac{5}{2}R \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q9

Q10.

Solution

Concept — Pendulum in an accelerating frame: In a lift accelerating upward with a, the effective gravity becomes $g_{\text{eff}} = g + a$, and the period is $T = 2\pi\sqrt{L/g_{\text{eff}}}$.

Step 1 — Effective gravity: With $a = g$, $g_{\text{eff}} = g + g = 2g$.

Step 2 — New period: $T = 2\pi\sqrt{\frac{L}{g_{\text{eff}}}} = 2\pi\sqrt{\frac{L}{2g}}$. (The period *decreases* compared with $T_0 = 2\pi\sqrt{L/g}$, as expected for an upward acceleration.)

Why other options are wrong:

- (A) $2\pi\sqrt{L/g}$ is the stationary-lift period T_0, ignoring the acceleration.
- (B) $2\pi\sqrt{2L/g}$ uses $g_{\text{eff}} = g/2$, which is the *downward*-acceleration case.
- (D) $\pi\sqrt{L/g}$ drops a factor of 2 incorrectly.

Final Answer: $T = 2\pi\sqrt{\frac{L}{2g}} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Resonance tube (closed pipe): The first resonance of an air column closed at one end occurs when the length equals a quarter wavelength, $L = \frac{\lambda}{4}$. The speed of sound is $v = f\lambda$.

Step 1 — Wavelength: $\lambda = 4L = 4(0.175 \text{ m}) = 0.70 \text{ m}$.

Step 2 — Speed of sound: $v = f\lambda = (480)(0.70) = 336 \text{ m s}^{-1}$.

Why other options are wrong:

- (A) 168 m s^{-1} uses $L = \lambda/2$ (treats it as an open pipe).
- (B) 672 m s^{-1} uses $\lambda = 8L$.
- (C) 84 m s^{-1} uses $L = \lambda$.

Final Answer: $v = 336 \text{ m s}^{-1} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Field of an infinite charged sheet: An infinite plane sheet of charge produces a uniform field $E = \frac{\sigma}{2\varepsilon_0}$ on each side, directed away from the sheet (for positive σ).

Step 1 — Substitute:

$$E = \frac{\sigma}{2\varepsilon_0} = \frac{8.85 \times 10^{-9}}{2(8.85 \times 10^{-12})}.$$

Step 2 — Simplify: $\frac{8.85 \times 10^{-9}}{8.85 \times 10^{-12}} = 10^3 = 1000$, so $E = \frac{1000}{2} = 500 \text{ N C}^{-1}$.

Why other options are wrong:

- (B) 1000 N C^{-1} uses $E = \sigma/\varepsilon_0$ (forgets the factor 2 for a single sheet).
- (C) 250 N C^{-1} divides by an extra factor of 2.
- (D) 2000 N C^{-1} uses $E = 2\sigma/\varepsilon_0$.

Final Answer: $E = 500 \text{ N C}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Series then parallel: Combine the two series capacitors first, then add the parallel capacitor directly (parallel capacitances add).

Step 1 — Series pair: $\frac{1}{C_s} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2} \Rightarrow C_s = 2\,\mu\text{F}$.

Step 2 — Parallel with $3\,\mu$F: $C_{\text{eq}} = C_s + 3 = 2 + 3 = 5\,\mu\text{F}$.

Why other options are wrong:

- (A) $11\,\mu$F adds all three in parallel $(4 + 4 + 3)$.
- (C) $7\,\mu$F treats the two $4\,\mu$F as parallel (8) then mishandles the series step, or adds $4 + 3$.
- (D) $2\,\mu$F gives only the series pair and forgets the parallel $3\,\mu$F.

Final Answer: $C_{\text{eq}} = 5\,\mu\text{F} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Temperature coefficient of resistance: For a linear variation, $R_t = R_0\left[1 + \alpha(t - t_0)\right]$, where R_0 is the resistance at the reference temperature t_0.

Step 1 — Temperature change: $\Delta t = 120 - 20 = 100\,°\text{C}$.

Step 2 — New resistance:

$$R = 20\left[1 + (4 \times 10^{-3})(100)\right] = 20\left[1 + 0.4\right] = 20(1.4) = 28\,\Omega.$$

Why other options are wrong:

- (A) $24\,\Omega$ uses $\alpha\Delta t = 0.2$ (takes $\Delta t = 50$).
- (B) $20.8\,\Omega$ uses $\Delta t = 10\,°\text{C}$.
- (D) $32\,\Omega$ uses $\Delta t = 150$ (measures from $0°$C, ignoring the $20°$C reference).

Final Answer: $R = 28\,\Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Axial field of a short magnetic dipole: On the axis at distance d the field is $B_{\text{axial}} = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3}$.

Step 1 — Substitute:

$$B = \frac{(10^{-7})\,(2)(0.4)}{(0.2)^3} = \frac{10^{-7} \times 0.8}{8 \times 10^{-3}}.$$

(Here $\mu_0/4\pi = 10^{-7}$ and $d^3 = (0.2)^3 = 8 \times 10^{-3}$.)

Step 2 — Simplify: $B = \frac{0.8 \times 10^{-7}}{8 \times 10^{-3}} = 0.1 \times 10^{-4} = 1 \times 10^{-5}$ T.

Why other options are wrong:

- (A) 2×10^{-5} T forgets to divide by d^3 correctly (uses $d^3 = 4 \times 10^{-3}$).
- (B) 4×10^{-6} T omits the factor 2 (uses the equatorial formula $\mu_0 M/4\pi d^3$).
- (C) 5×10^{-6} T is an arithmetic slip.

Final Answer: $B = 1 \times 10^{-5}$ T $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Rotating rod emf: A rod rotating about one end in a perpendicular field B at angular speed ω develops an emf $\varepsilon = \frac{1}{2}B\omega L^2$ between the axis and the free end (each element dr at radius r moves with speed ωr).

Step 1 — Substitute: $\varepsilon = \frac{1}{2}B\omega L^2 = \frac{1}{2}(0.4)(20)(0.5)^2$.

Step 2 — Compute: $(0.5)^2 = 0.25$, so $\varepsilon = \frac{1}{2}(0.4)(20)(0.25) = \frac{1}{2}(2.0) = 1.0$ V.

Why other options are wrong:

- (B) 2.0 V forgets the factor $\frac{1}{2}$ (uses $B\omega L^2$).
- (C) 0.5 V uses $\frac{1}{4}B\omega L^2$.
- (D) 4.0 V uses $\varepsilon = B\omega L$ (omits squaring L and the $\frac{1}{2}$).

Final Answer: $\varepsilon = 1.0$ V $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Average power in an AC circuit: $P_{avg} = V_{rms} I_{rms} \cos\phi$, with impedance $Z = \sqrt{R^2 + X_L^2}$, current $I_{rms} = V_{rms}/Z$ and power factor $\cos\phi = R/Z$. Only the resistor dissipates power.

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

Step 2 — Current: $I_{rms} = \dfrac{200}{50} = 4$ A.

Step 3 — Average power: $P = I_{rms}^2 R = (4)^2(30) = 480$ W. (Equivalently $P = V_{rms} I_{rms} \cos\phi = 200 \cdot 4 \cdot \frac{30}{50} = 480$ W.)

Why other options are wrong:

- (A) 800 W uses $P = V_{rms} I_{rms}$ (power factor $= 1$).
- (C) 640 W uses $P = I^2 X_L$ (power in the inductor, which is zero on average).
- (D) 1333 W uses $P = V^2/R$ ignoring the reactance.

Final Answer: $P = 480$ W $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Astronomical telescope (normal adjustment): The angular magnification is $m = \dfrac{f_o}{f_e}$ and the tube length is $L = f_o + f_e$ (the intermediate image lies at the common focal point).

Step 1 — Magnification: $m = \dfrac{f_o}{f_e} = \dfrac{80}{4} = 20$.

Step 2 — Tube length: $L = f_o + f_e = 80 + 4 = 84$ cm.

Why other options are wrong:

- (A) 20 and 76 cm uses $L = f_o - f_e$ (wrong; the foci coincide, lengths add).
- (B) 0.05 and 84 cm inverts the magnification ratio (f_e/f_o).
- (D) 320 and 84 cm multiplies the focal lengths instead of dividing.

Final Answer: $m = 20$, $L = 84$ cm $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Fringe width in a medium: $\beta = \frac{\lambda D}{d}$. Immersing the whole apparatus in a medium of refractive index μ shortens the wavelength to λ/μ, so the fringe width becomes $\beta' = \frac{\beta}{\mu}$.

Step 1 — Relation: $\beta' = \frac{\beta}{\mu}$, with $\beta = 0.6$ mm and $\mu = 1.5$.

Step 2 — Compute: $\beta' = \frac{0.6}{1.5} = 0.4$ mm.

Why other options are wrong:

- (A) 0.9 mm multiplies by μ instead of dividing (would mean the fringes widen, which is wrong).
- (C) 0.6 mm assumes immersion has no effect.
- (D) 0.3 mm divides by 2 instead of 1.5.

Final Answer: $\beta' = 0.4$ mm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Intrinsic vs extrinsic semiconductors: A pure (intrinsic) semiconductor has equal electron and hole concentrations. Doping creates extrinsic material: pentavalent (donor) impurities give n-type (electrons majority); trivalent (acceptor) impurities give p-type (holes majority).

Step 1 — Test each statement: In intrinsic material $n_e = n_h$, so (A) is false. Pentavalent doping gives n-type, not p-type, so (B) is false. For p-type, holes are indeed the majority carriers and the dopant is trivalent, so (C) is true.

Step 2 — Band-gap check: Insulators have a *large* gap (several eV), much larger than that of a semiconductor (about 1 eV), so (D) is false.

Why other options are wrong:

- (A) Intrinsic semiconductors have $n_e = n_h$, not $n_e \gg n_h$.
- (B) Pentavalent doping produces n-type material.
- (D) The forbidden gap of an insulator is larger, not smaller, than a semiconductor's.

Final Answer: p-type: holes are majority carriers, dopant is trivalent $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q20

Answer Key

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