NEST Physics Sample Paper – 8

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 energy of a photon is given by $E = h\nu$, where ν is the frequency. The dimensional formula of Planck's constant h is the same as that of

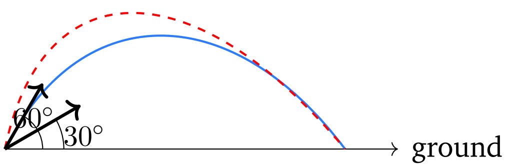
(A) linear momentum

(B) force

(C) angular momentum

(D) energy

Q2. A projectile launched from the ground with speed $u = 30\ \mathrm{m\,s^{-1}}$ at an angle of $30°$ has the same horizontal range as one launched at $60°$ with the same speed. Taking $g = 10\ \mathrm{m\,s^{-2}}$, that common range is



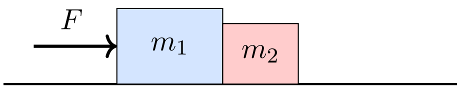
(A) 90 m

(B) $45\sqrt{3}$ m

(C) $90\sqrt{3}$ m

(D) 45 m

Q3. Two blocks of masses $m_1 = 4$ kg and $m_2 = 2$ kg are placed in contact on a smooth horizontal floor. A horizontal force $F = 18$ N is applied to the 4 kg block so that it pushes the 2 kg block, as shown. The contact force between the two blocks is



(A) 6 N

(B) 12 N

(C) 9 N

(D) 18 N

Q4. A body of mass 2 kg moving at $6\ \mathrm{m\,s^{-1}}$ collides head-on with a stationary body of mass 4 kg and the two stick together. The kinetic energy lost in this perfectly inelastic collision is

(A) 36 J

(B) 12 J

(C) 6 J

(D) 24 J

Q5. A uniform disc of mass M and radius R has a moment of inertia $\frac{1}{2}MR^2$ about the axis through its centre, perpendicular to its plane. Using the parallel-axis theorem, its moment of inertia about a parallel axis through a point on its rim is

(A) $\dfrac{3}{2}MR^2$

(B) $\frac{1}{2}MR^2$

(C) $2MR^2$

(D) $\frac{5}{2}MR^2$

Q6. A satellite orbits the Earth in a circular orbit of radius r. If g is the acceleration due to gravity at the Earth's surface and R is the Earth's radius, the time period of the satellite is

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

(B) $2\pi\sqrt{\frac{r^3}{gR^2}}$

(C) $2\pi\sqrt{\frac{R^2}{gr}}$

(D) $2\pi\sqrt{\frac{r^3}{gR}}$

Q7. A liquid of bulk modulus $B = 2 \times 10^9$ Pa is subjected to an additional pressure of 4×10^6 Pa. The fractional change in its volume $\left|\frac{\Delta V}{V}\right|$ is

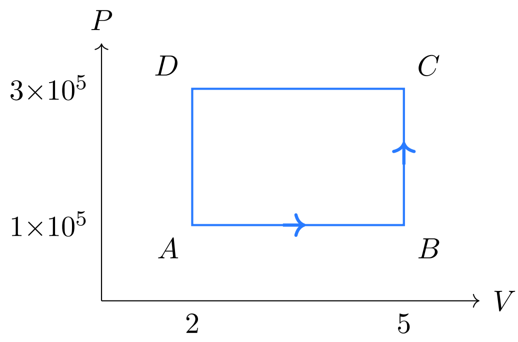
(A) 4×10^{-3}

(B) 1×10^{-3}

(C) 2×10^{-3}

(D) 5×10^{-4}

Q8. An ideal gas is taken around the rectangular cycle $A \to B \to C \to D \to A$ shown on the P–V diagram. The pressure values are 1×10^5 Pa and 3×10^5 Pa, and the volume values are 2 L and 5 L. The net work done by the gas per cycle is



(A) 600 J

(B) 1500 J

(C) 300 J

(D) 1200 J

Q9. A fixed mass of an ideal gas is heated so that its absolute temperature increases from 300 K to 1200 K. The ratio of the root-mean-square speed of its molecules at the higher temperature to that at the lower temperature is

(A) 4

(B) $\frac{1}{2}$

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

(D) 2

Q10. A simple pendulum that completes one full oscillation in 2 s is called a seconds pendulum. Taking $g = \pi^2$ m s^{-2}, the length of such a pendulum is

(A) 0.5 m

(B) 2 m

(C) 1 m

(D) 4 m

Q11. A stationary source emits sound of frequency 500 Hz. An observer moves directly toward the source with a speed of 34 m s^{-1}. Taking the speed of sound in air as 340 m s^{-1}, the frequency heard by the observer is

(A) 550 Hz

(B) 450 Hz

(C) 500 Hz

(D) 510 Hz

Q12. An electric dipole of dipole moment $p = 2 \times 10^{-6}$ C m is placed in a uniform electric field $E = 5 \times 10^5$ N C^{-1} such that its axis makes an angle of 30° with the field. The torque acting on the dipole is

(A) 1.0 N m

(B) 0.87 N m

(C) 2.0 N m

(D) 0.5 N m

Q13. A parallel-plate capacitor with air between its plates has capacitance $C = \dfrac{\varepsilon_0 A}{d}$. With the charge held fixed (battery disconnected), the plate separation d is doubled. The capacitance becomes

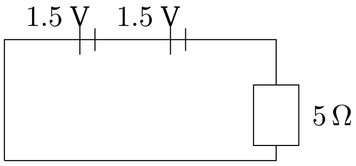
(A) $2C$

(B) $4C$

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

(D) C

Q14. Two identical cells, each of emf 1.5 V and internal resistance $0.5\,\Omega$, are connected in series across an external resistance of $5\,\Omega$, as shown. The current through the external resistance is



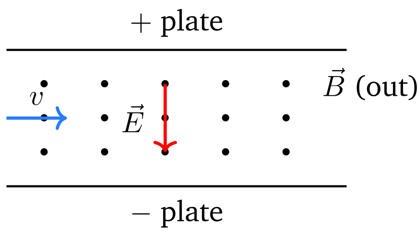
(A) 0.30 A

(B) 0.25 A

(C) 0.60 A

(D) 0.50 A

Q15. In a velocity selector, a charged particle passes undeflected through crossed electric and magnetic fields. The electric field is $E = 3 \times 10^4\ \mathrm{V\,m^{-1}}$ and the magnetic field is $B = 0.2$ T, mutually perpendicular and both perpendicular to the velocity, as shown. The speed of the selected particles is



(A) $6.0 \times 10^3\ \mathrm{m\,s^{-1}}$

(B) $1.5 \times 10^5\ \mathrm{m\,s^{-1}}$

(C) $6.0 \times 10^5\ \mathrm{m\,s^{-1}}$

(D) $1.5 \times 10^3\ \mathrm{m\,s^{-1}}$

Q16. A long air-core solenoid has $n = 1000$ turns per metre, cross-sectional area $A = 4 \times 10^{-4}$ m^2 and length $\ell = 0.5$ m. Taking $\mu_0 = 4\pi \times 10^{-7}$ $\mathrm{T\,m\,A^{-1}}$, its self-inductance $L = \mu_0 n^2 A\ell$ is approximately

(A) 1.26×10^{-4} H

(B) 2.51×10^{-4} H

(C) 5.03×10^{-4} H

(D) 6.28×10^{-4} H

Q17. An ideal (pure) inductor is connected across an AC source. The average power consumed by the inductor over a complete cycle, and the phase angle ϕ between the voltage and the current, are respectively

(A) maximum, $\phi = 0$

(B) $\frac{1}{2}V_0 I_0$, $\phi = 90^\circ$

(C) zero, $\phi = 90^\circ$

(D) zero, $\phi = 0$

Q18. A thin biconvex lens is made of glass of refractive index 1.5. Both faces have the same radius of curvature of magnitude 20 cm. Using the lens maker's formula $\dfrac{1}{f} = (\mu - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$, the focal length of the lens is

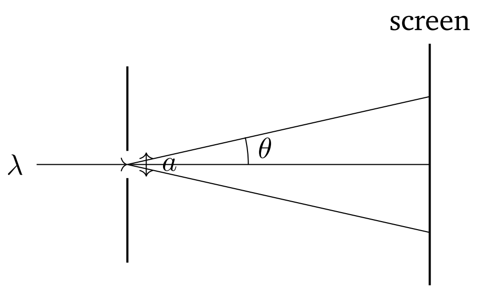
(A) 20 cm

(B) 40 cm

(C) 10 cm

(D) 30 cm

Q19. In a single-slit diffraction experiment, a slit of width $a = 0.2$ mm is illuminated by monochromatic light of wavelength $\lambda = 600$ nm. The angular width of the central maximum (the full angle between the first minima on either side) is



(A) 3×10^{-3} rad

(B) 6×10^{-3} rad

(C) 1.5×10^{-3} rad

(D) 12×10^{-3} rad

Q20. In the hydrogen atom, an electron makes a transition from the $n = 3$ level to the $n = 2$ level. Taking the Rydberg constant $R = 1.097 \times 10^7$

m^{-1} and using $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$, the wavelength of the emitted spectral line is approximately

(A) 410 nm

(B) 486 nm

(C) 122 nm

(D) 656 nm

Detailed Solutions

Q1.

Solution

Concept — Dimensional formula of Planck's constant: From $E = h\nu$, $h = \dfrac{E}{\nu}$, so h has the dimensions of energy divided by frequency.

Step 1 — Dimensions: $[E] = \mathrm{ML^2T^{-2}}$ and $[\nu] = \mathrm{T^{-1}}$, so

$$[h] = \frac{\mathrm{ML^2T^{-2}}}{\mathrm{T^{-1}}} = \mathrm{ML^2T^{-1}}.$$

Step 2 — Compare: Angular momentum $L = mvr$ has $[L] = \mathrm{M \cdot LT^{-1} \cdot L} = \mathrm{ML^2T^{-1}}$, identical to $[h]$.

Why other options are wrong:

- (A) Linear momentum has $\mathrm{MLT^{-1}}$ (one power of length short).
- (B) Force has $\mathrm{MLT^{-2}}$.
- (D) Energy has $\mathrm{ML^2T^{-2}}$ (one extra power of $\mathrm{T^{-1}}$ compared with h).

Final Answer: $[h] = \mathrm{ML^2T^{-1}}$ = angular momentum $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Complementary launch angles: Angles θ and $90^\circ - \theta$ give the same range because $\sin 2\theta = \sin(180^\circ - 2\theta)$. Here 30° and 60° are complementary, so both give $R = \dfrac{u^2 \sin 2\theta}{g}$.

Step 1 — Substitute ($\theta = 30^\circ$): $2\theta = 60^\circ$, $\sin 60^\circ = \dfrac{\sqrt{3}}{2}$, $u = 30\ \mathrm{m\,s^{-1}}$.

$$R = \frac{(30)^2 \cdot \frac{\sqrt{3}}{2}}{10} = \frac{900}{10} \cdot \frac{\sqrt{3}}{2} = 90 \cdot \frac{\sqrt{3}}{2} = 45\sqrt{3}\ \mathrm{m}.$$

Step 2 — Check with 60°: $2\theta = 120^\circ$, $\sin 120^\circ = \dfrac{\sqrt{3}}{2}$, giving the same $45\sqrt{3}$ m ≈ 77.9 m.

Why other options are wrong:

- (A) 90 m uses $\sin 2\theta = 1$ (the $45°$ value).
- (C) $90\sqrt{3}$ m forgets the factor $\frac{1}{2}$ in $\sin 60°$.
- (D) 45 m drops the $\sqrt{3}$ factor.

Final Answer: $R = 45\sqrt{3}$ m $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Blocks in contact: First find the common acceleration of the whole system, then isolate the rear block; the contact force is the only horizontal force pushing it.

Step 1 — System acceleration: $a = \dfrac{F}{m_1 + m_2} = \dfrac{18}{4+2} = 3\ \text{m}\,\text{s}^{-2}$.

Step 2 — Isolate the 2 kg block: The contact force N is what accelerates it:

$$N = m_2\,a = 2 \times 3 = 6\ \text{N}.$$

Why other options are wrong:

- (B) 12 N uses $m_1 a$ instead of $m_2 a$.
- (C) 9 N halves the applied force ($F/2$), which is not how contact force splits.
- (D) 18 N is the full applied force, not the internal contact force.

Final Answer: $N = 6$ N $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Perfectly inelastic collision: Momentum is conserved and the bodies move together afterwards. Kinetic energy is lost; the loss equals initial KE minus final KE.

Step 1 — Common velocity: $v = \dfrac{m_1 u_1}{m_1 + m_2} = \dfrac{2 \times 6}{2+4} = \dfrac{12}{6} = 2\ \text{m}\,\text{s}^{-1}$.

Step 2 — Kinetic energies: Initial $KE_i = \frac{1}{2}(2)(6)^2 = 36$ J. Final $KE_f = \frac{1}{2}(6)(2)^2 = 12$ J.

Step 3 — Energy lost: $\Delta KE = 36 - 12 = 24$ J.

Why other options are wrong:

- (A) 36 J is the initial KE, not the loss.
- (B) 12 J is the final KE that remains.
- (C) 6 J has no consistent basis (a mis-multiplied figure).

Final Answer: $\Delta KE = 24 \text{ J} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Parallel-axis theorem: $I = I_{\text{cm}} + Md^2$, where d is the distance between the new axis and the parallel axis through the centre of mass.

Step 1 — Set up: $I_{\text{cm}} = \frac{1}{2}MR^2$; the rim axis is a distance $d = R$ from the centre, so $Md^2 = MR^2$.

Step 2 — Add:

$$I = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2.$$

Why other options are wrong:

- (B) $\frac{1}{2}MR^2$ ignores the shift term Md^2.
- (C) $2MR^2$ uses $I_{\text{cm}} = MR^2$ (a ring, not a disc).
- (D) $\frac{5}{2}MR^2$ uses $d^2 = 2R^2$ instead of R^2.

Final Answer: $I = \dfrac{3}{2}MR^2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Orbital period: For a circular orbit, gravity provides the centripetal force: $\dfrac{GMm}{r^2} = \dfrac{mv^2}{r}$, and $T = \dfrac{2\pi r}{v}$. Use $GM = gR^2$ to express the answer in terms of g and R.

Step 1 — Orbital speed: $v = \sqrt{\dfrac{GM}{r}} = \sqrt{\dfrac{gR^2}{r}}$ (since $GM = gR^2$).

Step 2 — Period:

$$T = \frac{2\pi r}{v} = 2\pi r\sqrt{\frac{r}{gR^2}} = 2\pi\sqrt{\frac{r^3}{gR^2}}.$$

Why other options are wrong:

- (A) $2\pi\sqrt{r/g}$ is a pendulum-like form, dimensionally wrong for an orbit.
- (C) inverts the role of r and R.
- (D) $2\pi\sqrt{r^3/(gR)}$ has the wrong power of R (gR^2 is required).

Final Answer: $T = 2\pi\sqrt{\frac{r^3}{gR^2}} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Bulk modulus: $B = -\frac{\Delta P}{\Delta V/V}$, so the magnitude of the fractional volume change is $\left|\frac{\Delta V}{V}\right| = \frac{\Delta P}{B}$.

Step 1 — Substitute:

$$\left|\frac{\Delta V}{V}\right| = \frac{\Delta P}{B} = \frac{4\times10^6}{2\times10^9}.$$

Step 2 — Simplify: $\frac{4}{2}\times10^{6-9} = 2\times10^{-3}$.

Why other options are wrong:

- (A) 4×10^{-3} forgets the factor 2 in B.
- (B) 1×10^{-3} divides the mantissa incorrectly ($2/4$ instead of $4/2$).
- (D) 5×10^{-4} is an unrelated decimal slip.

Final Answer: $\left|\frac{\Delta V}{V}\right| = 2\times10^{-3} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Work in a cyclic process: The net work done by the gas in one cycle equals the area enclosed by the loop on the P–V diagram. For a clockwise loop the work is positive.

Step 1 — Side lengths: $\Delta P = (3-1)\times 10^5 = 2\times 10^5$ Pa and $\Delta V = (5-2)\,\text{L} = 3\times 10^{-3}\ \text{m}^3$.

Step 2 — Enclosed area:

$$W = \Delta P \cdot \Delta V = (2\times 10^5)(3\times 10^{-3}) = 600\ \text{J}.$$

The loop runs clockwise ($A\to B\to C\to D$), so $W = +600$ J.

Why other options are wrong:

- (B) 1500 J uses $\Delta P = 3\times 10^5$ and $\Delta V = 5\times 10^{-3}$ (absolute values, not differences).
- (C) 300 J halves the rectangle (treats it like a triangle).
- (D) 1200 J doubles the area.

Final Answer: $W = 600\ \text{J} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — RMS speed and temperature: $v_{\text{rms}} = \sqrt{\dfrac{3RT}{M}} \propto \sqrt{T}$ for a fixed gas, so the ratio of rms speeds is the square root of the temperature ratio.

Step 1 — Temperature ratio: $\dfrac{T_2}{T_1} = \dfrac{1200}{300} = 4.$

Step 2 — Speed ratio:

$$\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{4} = 2.$$

Why other options are wrong:

- (A) 4 uses the temperature ratio directly (forgets the square root).
- (B) $\frac{1}{2}$ inverts the ratio.
- (C) $\frac{1}{4}$ inverts and forgets the square root.

Final Answer: $\dfrac{v_2}{v_1} = 2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q9

Q10.

Solution

Concept — Simple pendulum: $T = 2\pi\sqrt{\dfrac{L}{g}}$, so $L = \dfrac{gT^2}{4\pi^2}$. A seconds pendulum has $T = 2$ s.

Step 1 — Substitute: $T = 2$ s, $g = \pi^2\ \text{m s}^{-2}$.

$$L = \frac{gT^2}{4\pi^2} = \frac{\pi^2 \times (2)^2}{4\pi^2} = \frac{4\pi^2}{4\pi^2} = 1 \text{ m}.$$

Why other options are wrong:

- (A) 0.5 m uses $T = \sqrt{2}$ s or halves the result.
- (B) 2 m doubles the correct length.
- (D) 4 m uses $T^2 = 16$ (i.e. $T = 4$ s).

Final Answer: $L = 1 \text{ m} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Doppler effect (observer moving toward a stationary source): The apparent frequency rises: $f' = f\left(\dfrac{v + v_o}{v}\right)$, where v is the speed of sound and v_o the observer's speed.

Step 1 — Substitute: $f = 500$ Hz, $v = 340\ \text{m s}^{-1}$, $v_o = 34\ \text{m s}^{-1}$.

$$f' = 500\left(\frac{340 + 34}{340}\right) = 500\left(\frac{374}{340}\right).$$

Step 2 — Compute: $\dfrac{374}{340} = 1.1$, so $f' = 500 \times 1.1 = 550$ Hz.

Why other options are wrong:

- (B) 450 Hz uses $(v - v_o)$, i.e. treats the observer as receding.

- (C) 500 Hz ignores the motion entirely.
- (D) 510 Hz uses a source-motion formula $v/(v - v_o)$ with wrong placement.

Final Answer: $f' = 550$ Hz $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Torque on a dipole: A dipole of moment p in a uniform field E experiences a torque $\tau = pE\sin\theta$, where θ is the angle between $\vec{p}$ and $\vec{E}$.

Step 1 — Substitute: $p = 2 \times 10^{-6}$ C m, $E = 5 \times 10^5$ N C^{-1}, $\theta = 30°$, $\sin 30° = \frac{1}{2}$.

$$\tau = (2 \times 10^{-6})(5 \times 10^5)\left(\tfrac{1}{2}\right).$$

Step 2 — Compute: $pE = (2 \times 10^{-6})(5 \times 10^5) = 1.0$ N m; then $\tau = 1.0 \times \frac{1}{2} = 0.5$ N m.

Why other options are wrong:

- (A) 1.0 N m forgets the $\sin 30°$ factor.
- (B) 0.87 N m uses $\sin 60°$ (i.e. $\cos 30°$).
- (C) 2.0 N m doubles pE and drops $\sin\theta$.

Final Answer: $\tau = 0.5$ N m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Parallel-plate capacitance: $C = \dfrac{\varepsilon_0 A}{d}$ depends only on geometry, so $C \propto \dfrac{1}{d}$. This is true whether the battery stays connected or not.

Step 1 — Double the separation: Replacing $d \to 2d$,

$$C' = \frac{\varepsilon_0 A}{2d} = \frac{1}{2} \cdot \frac{\varepsilon_0 A}{d} = \frac{C}{2}.$$

Step 2 — Note: Capacitance is purely geometric; holding the charge fixed changes the voltage and stored energy, but not the value of C.

Why other options are wrong:

- (A) $2C$ has the dependence inverted ($C \propto d$).
- (B) $4C$ uses $C \propto 1/d^2$.
- (D) C wrongly assumes capacitance is unchanged.

Final Answer: $C' = \dfrac{C}{2} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Identical cells in series: Series cells add their emfs and their internal resistances: $\varepsilon_{\text{eq}} = n\varepsilon$, $r_{\text{eq}} = nr$. The current is $I = \dfrac{n\varepsilon}{R + nr}$.

Step 1 — Equivalent source: $n = 2$, so $\varepsilon_{\text{eq}} = 2(1.5) = 3.0$ V and $r_{\text{eq}} = 2(0.5) = 1.0\,\Omega$.

Step 2 — Current:

$$I = \frac{\varepsilon_{\text{eq}}}{R + r_{\text{eq}}} = \frac{3.0}{5 + 1.0} = \frac{3.0}{6.0} = 0.50 \text{ A}.$$

Why other options are wrong:

- (A) 0.30 A treats the cells in parallel ($\varepsilon = 1.5$ V, $r = 0.25\,\Omega$).
- (B) 0.25 A uses a single cell ($1.5/6$).
- (C) 0.60 A omits the total internal resistance.

Final Answer: $I = 0.50$ A $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q14

Q15.

Solution

Concept — Velocity selector: A particle passes undeflected when the electric force balances the magnetic force: $qE = qvB$, giving $v = \dfrac{E}{B}$ (independent of charge and mass).

Step 1 — Substitute: $E = 3 \times 10^4\ \mathrm{V\,m^{-1}}$, $B = 0.2$ T.

$$v = \frac{E}{B} = \frac{3 \times 10^4}{0.2}.$$

Step 2 — Compute: $\dfrac{3 \times 10^4}{0.2} = 1.5 \times 10^5\ \mathrm{m\,s^{-1}}$.

Why other options are wrong:

- (A) $6.0 \times 10^3\ \mathrm{m\,s^{-1}}$ multiplies $E \times B$ instead of dividing.
- (C) $6.0 \times 10^5\ \mathrm{m\,s^{-1}}$ uses $B = 0.05$ T.
- (D) $1.5 \times 10^3\ \mathrm{m\,s^{-1}}$ is a power-of-ten slip.

Final Answer: $v = 1.5 \times 10^5\ \mathrm{m\,s^{-1}} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Self-inductance of a long solenoid: $L = \mu_0 n^2 A \ell$, where n is the number of turns per unit length, A the cross-section and ℓ the length.

Step 1 — Substitute: $\mu_0 = 4\pi \times 10^{-7}$, $n = 1000$, $n^2 = 10^6$, $A = 4 \times 10^{-4}\ \mathrm{m}^2$, $\ell = 0.5$ m.

$$L = (4\pi \times 10^{-7})(10^6)(4 \times 10^{-4})(0.5).$$

Step 2 — Compute: Numbers: $4\pi \times 10^{-7} \times 10^6 = 4\pi \times 10^{-1} = 1.2566$. Then $\times 4 \times 10^{-4} = 5.027 \times 10^{-4}$; $\times 0.5 = 2.51 \times 10^{-4}$ H.

Why other options are wrong:

- (A) 1.26×10^{-4} H omits a further factor (drops the A or ℓ contribution).
- (C) 5.03×10^{-4} H forgets the factor $\ell = 0.5$.
- (D) 6.28×10^{-4} H uses 2π in place of 4π somewhere.

Final Answer: $L \approx 2.51 \times 10^{-4}\ \mathrm{H} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Wattless current in a pure inductor: Average power is $P_{avg} = V_{rms} I_{rms} \cos\phi$. In a pure inductor the current lags the voltage by $\phi = 90°$, so $\cos\phi = 0$ and the average power is zero.

Step 1 — Phase angle: For a pure inductor, $V = V_0 \sin\omega t$ and $I = I_0 \sin(\omega t - 90°)$, so $\phi = 90°$.

Step 2 — Average power: $P_{avg} = V_{rms} I_{rms} \cos 90° = 0$. Energy is taken from the source for a quarter cycle and returned in the next; the net is zero (wattless current).

Why other options are wrong:

- (A) maximum, $\phi = 0$ describes a pure resistor.
- (B) $\frac{1}{2} V_0 I_0$ is the resistive average power, not that of an inductor.
- (D) zero with $\phi = 0$ is self-contradictory ($\phi = 0$ would give maximum power).

Final Answer: Average power $= 0$, $\phi = 90° \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — Lens maker's formula: $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$. For a biconvex lens, $R_1 > 0$ (first face convex) and $R_2 < 0$ (second face convex toward the object's far side).

Step 1 — Assign signs: $\mu = 1.5$, $R_1 = +20$ cm, $R_2 = -20$ cm.

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{20} - \frac{1}{-20}\right) = 0.5\left(\frac{1}{20} + \frac{1}{20}\right).$$

Step 2 — Compute: $\frac{1}{20} + \frac{1}{20} = \frac{2}{20} = \frac{1}{10}$, so $\frac{1}{f} = 0.5 \times \frac{1}{10} = \frac{1}{20}$, giving $f = 20$ cm.

Why other options are wrong:

- (B) 40 cm forgets that both faces contribute (uses a single $1/R$ term).
- (C) 10 cm uses $(\mu - 1) = 1$ instead of 0.5.

- (D) 30 cm has no consistent basis with these values.

Final Answer: $f = 20$ cm $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Single-slit diffraction: The first minima occur at $\sin\theta = \frac{\lambda}{a}$. For small angles the half-angular spread is $\theta \approx \frac{\lambda}{a}$, and the full angular width of the central maximum is $2\theta = \frac{2\lambda}{a}$.

Step 1 — Substitute (SI units): $\lambda = 600 \times 10^{-9}$ m, $a = 0.2 \times 10^{-3}$ m.

$$2\theta = \frac{2\lambda}{a} = \frac{2(600 \times 10^{-9})}{0.2 \times 10^{-3}}.$$

Step 2 — Compute: Numerator $= 1.2 \times 10^{-6}$; dividing by 2×10^{-4} gives 6×10^{-3} rad.

Why other options are wrong:

- (A) 3×10^{-3} rad is the half-width λ/a, not the full width.
- (C) 1.5×10^{-3} rad uses $\lambda/(2a)$.
- (D) 12×10^{-3} rad uses $a = 0.1$ mm.

Final Answer: $2\theta = 6 \times 10^{-3}$ rad $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Rydberg formula (Balmer line): $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ with $n_1 = 2$, $n_2 = 3$ for the $3 \to 2$ transition (the H-α line).

Step 1 — Bracket term: $\frac{1}{2^2} - \frac{1}{3^2} = \frac{1}{4} - \frac{1}{9} = \frac{9-4}{36} = \frac{5}{36}$.

Step 2 — Wavelength:

$$\frac{1}{\lambda} = (1.097 \times 10^7) \cdot \frac{5}{36} = 1.524 \times 10^6 \text{ m}^{-1} \Rightarrow \lambda = 6.56 \times 10^{-7} \text{ m} = 656 \text{ nm}.$$

Why other options are wrong:

- (A) 410 nm is the H-γ line $(5 \to 2)$.
- (B) 486 nm is the H-β line $(4 \to 2)$.
- (C) 122 nm is a Lyman line $(2 \to 1)$, in the ultraviolet.

Final Answer: $\lambda \approx 656$ nm $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q20**

Answer Key

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