GAT-B Physics

Sample Paper – 2

Duration: 23 Minutes **Maximum Marks: 15**

Instructions

- This paper contains **15 Multiple Choice Questions** (Single Correct Answer), modelled on the Physics portion of **GAT-B** Section A.
- Each correct answer carries **+1 mark**. There is a deduction of **0.5 mark** for each wrong answer. Unattempted questions carry zero marks.
- Only **one** option is correct per question.
- Syllabus level: **Class 11 & 12 (NCERT) Physics** — Mechanics, Thermodynamics, Waves, Optics, Electricity & Magnetism, Modern Physics.
- Personal calculators, mobile phones, and other electronic gadgets are strictly prohibited. A simple on-screen calculator is provided in the CBT interface.

Q1. The radius of a sphere is measured as (4.50 ± 0.05) cm. The percentage error in the volume of the sphere is closest to:

(A) 1.1%

(B) 2.2%

(C) 3.3%

(D) 4.4%

Q2. A car travelling at $20\,\mathrm{m\,s^{-1}}$ accelerates uniformly at $2\,\mathrm{m\,s^{-2}}$. A second car, initially $150\,\mathrm{m}$ ahead, moves at a constant $25\,\mathrm{m\,s^{-1}}$. The time taken by the first car to catch the second car is:

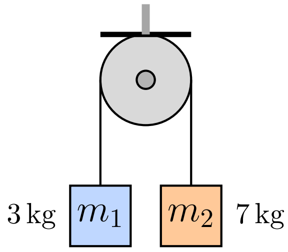
(A) $10\,\mathrm{s}$

(B) $15\,\text{s}$

(C) $20\,\text{s}$

(D) $25\,\text{s}$

Q3. In the Atwood machine shown below, masses $m_1 = 3\,\text{kg}$ and $m_2 = 7\,\text{kg}$ hang on either side of a light, frictionless pulley. Taking $g = 10\,\text{m}\,\text{s}^{-2}$, the tension in the string is:



(A) $30\,\text{N}$

(B) $35\,\text{N}$

(C) $40\,\text{N}$

(D) $42\,\text{N}$

Q4. An engine exerts a constant power of $18\,\text{kW}$ to move a vehicle against a constant resistive force of $600\,\text{N}$. The maximum speed the vehicle can attain is:

(A) $24\,\text{m}\,\text{s}^{-1}$

(B) $30\,\text{m}\,\text{s}^{-1}$

(C) $36\,\text{m}\,\text{s}^{-1}$

(D) $45\,\text{m}\,\text{s}^{-1}$

Q5. Water flows through a horizontal pipe that narrows from a cross-sectional area of $8\,\text{cm}^2$ to $2\,\text{cm}^2$. If the velocity in the wider section is $1\,\text{m}\,\text{s}^{-1}$, the pressure drop between the wide and narrow sections is (density of water $= 1000\,\text{kg}\,\text{m}^{-3}$):

(A) $4500\,\text{Pa}$

(B) $6000\,\mathrm{Pa}$

(C) $7500\,\mathrm{Pa}$

(D) $9000\,\mathrm{Pa}$

Q6. A planet orbits the Sun at a mean distance of 4 AU. Using Kepler's third law (Earth's period $= 1$ year at 1 AU), the orbital period of this planet is:

(A) $8\,\mathrm{years}$

(B) $4\,\mathrm{years}$

(C) $16\,\mathrm{years}$

(D) $64\,\mathrm{years}$

Q7. A figure skater spinning at $2\,\mathrm{rad\,s^{-1}}$ with moment of inertia $I_0 = 5\,\mathrm{kg\,m^2}$ pulls her arms in, reducing her moment of inertia to $2\,\mathrm{kg\,m^2}$. Her new angular velocity is:

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

(B) $6\,\mathrm{rad\,s^{-1}}$

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

(D) $5\,\mathrm{rad\,s^{-1}}$

Q8. An ideal gas at pressure P_0 and volume V_0 undergoes an isothermal compression to volume $V_0/3$. The work done *on* the gas (taking $\ln 3 \approx 1.10$) is:

(A) $-1.10\,P_0V_0$

(B) $+1.10\,P_0V_0$

(C) $+3\,P_0V_0$

(D) $-3\,P_0V_0$

Q9. A particle of mass $0.04\,\mathrm{kg}$ executes SHM with amplitude $A = 0.1\,\mathrm{m}$ and angular frequency $\omega = 10\,\mathrm{rad\,s^{-1}}$. At the instant when the displacement equals $A/2$, the kinetic energy of the particle is:

(A) $5\,\mathrm{mJ}$

(B) $10\,\mathrm{mJ}$

(C) $15\,\mathrm{mJ}$

(D) $20\,\mathrm{mJ}$

Q10. A train moving at $30\,\mathrm{m\,s^{-1}}$ sounds a whistle of frequency $600\,\mathrm{Hz}$ as it approaches a stationary observer. The apparent frequency heard by the observer is (speed of sound $= 330\,\mathrm{m\,s^{-1}}$):

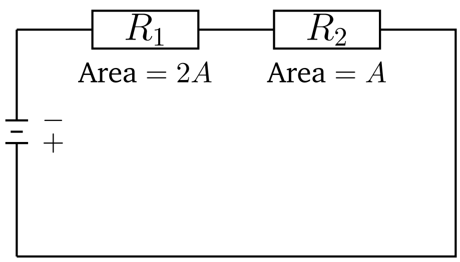
(A) $660\,\mathrm{Hz}$

(B) $630\,\mathrm{Hz}$

(C) $600\,\mathrm{Hz}$

(D) $545\,\mathrm{Hz}$

Q11. In the circuit below, the two resistors R_1 and R_2 are made of the same material and have the same length, but R_1 has twice the cross-sectional area of R_2. If the resistivity of the material increases by 10% when heated, by what percentage does the *total* resistance of the series combination change?



(A) 5%

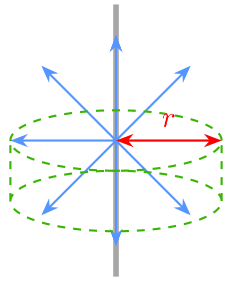
(B) 7%

(C) 8%

(D) 10%

Q12. A long straight wire carries a uniform linear charge density $\lambda = 2 \times 10^{-6}\,\mathrm{C\,m^{-1}}$. The electric field at a perpendicular distance $r = 0.18\,\mathrm{m}$

from the wire is (use $\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{C^2\,N^{-1}\,m^{-2}}$):



(A) $1.0 \times 10^5\,\mathrm{N\,C^{-1}}$

(B) $2.0 \times 10^5\,\mathrm{N\,C^{-1}}$

(C) $3.0 \times 10^5\,\mathrm{N\,C^{-1}}$

(D) $4.0 \times 10^5\,\mathrm{N\,C^{-1}}$

Q13. A ray of light travels from glass (refractive index $n = 1.5$) to air. The critical angle for total internal reflection is closest to:

(A) 30°

(B) 37°

(C) 42°

(D) 60°

Q14. An electron is accelerated through a potential difference of $150\,\mathrm{V}$. The de Broglie wavelength associated with the electron is (use $h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$, $m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$, $e = 1.6 \times 10^{-19}\,\mathrm{C}$):

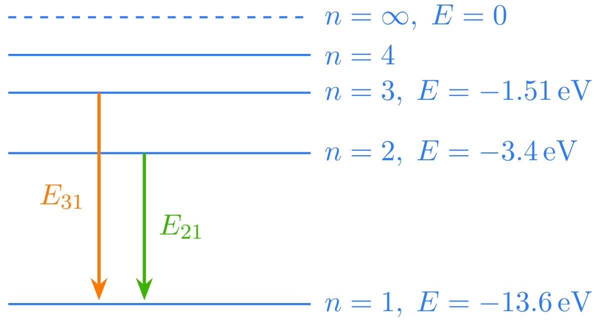
(A) 1.0

(B) 1.5

(C) 2.0

(D) 2.5

Q15. The energy level diagram for a hydrogen-like ion (nuclear charge Z) is shown below. If the transition from $n = 3$ to $n = 1$ emits a photon of energy E_{31}, and the transition from $n = 2$ to $n = 1$ emits energy E_{21}, then the ratio E_{31}/E_{21} for hydrogen ($Z = 1$) is:



(A) $\dfrac{4}{3}$

(B) $\dfrac{3}{2}$

(C) $\dfrac{16}{9}$

(D) $\dfrac{32}{27}$

Detailed Solutions

Q1.

Solution

Concept — Error Analysis: For a quantity $V = \frac{4}{3}\pi r^3$, the relative error in V is 3 times the relative error in r.

Step 1 — Relative error in radius:

$$\frac{\Delta r}{r} = \frac{0.05}{4.50} = \frac{1}{90} \approx 1.11\%$$

Step 2 — Relative error in volume:

$$\frac{\Delta V}{V} = 3\frac{\Delta r}{r} = 3 \times 1.11\% \approx 3.3\%$$

Why other options are wrong:

- Option A (1.1%): This is only the percentage error in r, not in V.
- Option B (2.2%): Corresponds to squaring, i.e., $V \propto r^2$ (area, not volume).
- Option D (4.4%): Uses a power of 4, which has no physical basis here.

Final Answer: $\Delta V/V \approx 3.3\% \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q 1**

Q2.

Solution

Concept — Relative Motion with Uniform Acceleration: Taking the first car's frame, the relative initial velocity is $u_{rel} = 20 - 25 = -5\,\mathrm{m\,s^{-1}}$ (i.e., $5\,\mathrm{m\,s^{-1}}$ toward the second car's direction) and relative acceleration $a_{rel} = 2 - 0 = 2\,\mathrm{m\,s^{-2}}$.

Step 1 — Set up the displacement equation:

The first car covers $s_1 = 20t + \frac{1}{2}(2)t^2$ and the second covers $s_2 = 150 + 25t$. Setting $s_1 = s_2$:

$$20t + t^2 = 150 + 25t \implies t^2 - 5t - 150 = 0$$

Step 2 — Solve the quadratic:

$$t = \frac{5 \pm \sqrt{25 + 600}}{2} = \frac{5 \pm 25}{2}$$

Taking the positive root: $t = \dfrac{30}{2} = 15\,\text{s}$.

Verification: $s_1 = 20(15) + (15)^2 = 300 + 225 = 525\,\text{m}$; $s_2 = 150 + 25(15) = 525\,\text{m}$. ✓

Why other options are wrong:

- Option A ($10\,\text{s}$): Arithmetic error — $30 \div 2 = 15$, not 10; at $t = 10$ car 1 has covered only 300 m while car 2 has covered 400 m, so they have not yet met.
- Option C ($20\,\text{s}$): Obtained by ignoring the constant initial gap of 150 m; sets $s_1 = s_2$ without the offset.
- Option D ($25\,\text{s}$): Obtained by dividing the gap (150 m) by the initial relative speed (5 m/s), neglecting the acceleration term entirely.

Final Answer: $t = 15\,\text{s} \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q 2**

Q3.

Solution

Concept — Atwood Machine: For masses m_1 and m_2 connected by a light inextensible string over a frictionless pulley, the acceleration and tension are:

$$a = \frac{(m_2 - m_1)g}{m_1 + m_2}, \qquad T = \frac{2m_1 m_2 g}{m_1 + m_2}$$

Step 1 — Calculate acceleration:

$$a = \frac{(7-3)\times 10}{3+7} = \frac{40}{10} = 4\,\text{m}\,\text{s}^{-2}$$

Step 2 — Calculate tension:

$$T = \frac{2\times 3\times 7\times 10}{3+7} = \frac{420}{10} = 42\,\text{N}$$

Verification: For m_1: $T - m_1 g = m_1 a \Rightarrow 42 - 30 = 12 = 3\times 4$. ✓

Why other options are wrong:

- Option A ($30\,\text{N}$): Equals $m_1 g$ alone; ignores the dynamical effect.
- Option B ($35\,\text{N}$): Average of the two weights; physically unjustified.
- Option C ($40\,\text{N}$): Equals $(m_2 - m_1)g$; incorrect formula.

Final Answer: $T = 42\,\mathrm{N} \Rightarrow \boxed{\mathrm{D}}$

Answer: (D) **Go Back to Q 3**

Q4.

Solution

Concept — Power, Force and Velocity: At maximum (terminal) speed the driving force equals the resistive force. Using $P = Fv$:

Step 1 — At maximum speed, net force = 0:

$$F_{\text{drive}} = F_{\text{resist}} = 600\,\mathrm{N}$$

Step 2 — Find maximum speed:

$$v_{\max} = \frac{P}{F} = \frac{18\,000\,\mathrm{W}}{600\,\mathrm{N}} = 30\,\mathrm{m\,s^{-1}}$$

Why other options are wrong:

- Option A ($24\,\mathrm{m\,s^{-1}}$): Uses $F = 750\,\mathrm{N}$; incorrect resistive force.
- Option C ($36\,\mathrm{m\,s^{-1}}$): Uses $P = 21.6\,\mathrm{kW}$; wrong power value.
- Option D ($45\,\mathrm{m\,s^{-1}}$): Uses $F = 400\,\mathrm{N}$; under-estimates resistance.

Final Answer: $v_{\max} = 30\,\mathrm{m\,s^{-1}} \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) **Go Back to Q 4**

Q5.

Solution

Concept — Bernoulli's Theorem + Continuity Equation:

$$A_1 v_1 = A_2 v_2 \qquad \text{and} \qquad P_1 + \tfrac{1}{2}\rho v_1^2 = P_2 + \tfrac{1}{2}\rho v_2^2$$

Step 1 — Find velocity in narrow section using continuity:

$$v_2 = v_1 \frac{A_1}{A_2} = 1 \times \frac{8}{2} = 4\,\mathrm{m\,s^{-1}}$$

Step 2 — Apply Bernoulli to get pressure drop $\Delta P = P_1 - P_2$:

$$\Delta P = \tfrac{1}{2}\rho\,(v_2^2 - v_1^2) = \tfrac{1}{2} \times 1000 \times (16 - 1) = 500 \times 15 = 7500\,\text{Pa}$$

Why other options are wrong:

- Option A $(4500\,\text{Pa})$: Uses $v_2 = 3\,\text{m}\,\text{s}^{-1}$ (wrong continuity ratio).
- Option B $(6000\,\text{Pa})$: Omits the v_1^2 term in the Bernoulli difference.
- Option D $(9000\,\text{Pa})$: Uses an incorrect area ratio of $1:9$.

Final Answer: $\Delta P = 7500\,\text{Pa} \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q 5**

Q6.

Solution

Concept — Kepler's Third Law: $T^2 \propto a^3$, where a is the semi-major axis. For Earth: $T_E = 1\,\text{yr}$, $a_E = 1\,\text{AU}$.

Step 1 — Apply the law:

$$\frac{T^2}{T_E^2} = \frac{a^3}{a_E^3} \implies T^2 = \frac{4^3}{1^3}\,\text{yr}^2 = 64\,\text{yr}^2$$

Step 2 — Solve for T:

$$T = \sqrt{64} = 8\,\text{years}$$

Why other options are wrong:

- Option B $(4\,\text{yr})$: Uses $T \propto a$ (linear law); incorrect.
- Option C $(16\,\text{yr})$: Uses $T \propto a^2$; wrong exponent.
- Option D $(64\,\text{yr})$: This is T^2, not T.

Final Answer: $T = 8\,\text{years} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q 6**

Q7.

Solution

Concept — Conservation of Angular Momentum: In the absence of external torques, $L = I\omega = \text{const}$.

Step 1 — Initial angular momentum:

$$L = I_0\,\omega_0 = 5 \times 2 = 10\,\mathrm{kg\,m^2\,s^{-1}}$$

Step 2 — New angular velocity with reduced moment of inertia:

$$\omega' = \frac{L}{I'} = \frac{10}{2} = 5\,\mathrm{rad\,s^{-1}}$$

Why other options are wrong:

- Option A ($4\,\mathrm{rad\,s^{-1}}$): Obtained by multiplying, not dividing, the ratio.
- Option B ($6\,\mathrm{rad\,s^{-1}}$): Uses $\omega' = \omega_0 \times (I_0/I') - 1$; no physical basis.
- Option C ($8\,\mathrm{rad\,s^{-1}}$): Uses the ratio of moments $5/2 = 2.5$ applied as an additive increase; incorrect.

Final Answer: $\omega' = 5\,\mathrm{rad\,s^{-1}} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q 7**

Q8.

Solution

Concept — Isothermal Process for Ideal Gas: Work done *by* the gas during isothermal compression from V_0 to $V_0/3$:

$$W_{\text{by}} = nRT\ln\left(\frac{V_f}{V_i}\right) = P_0V_0\ln\left(\frac{1}{3}\right) = -P_0V_0\ln 3$$

Step 1 — Work done *on* the gas (sign reversal):

$$W_{\text{on}} = -W_{\text{by}} = +P_0V_0\ln 3 \approx +1.10\,P_0V_0$$

Step 2 — Numerical value: Using $\ln 3 \approx 1.10$: $W_{\text{on}} \approx +1.10\,P_0V_0$.

Why other options are wrong:

- Option A ($-1.10\,P_0V_0$): This is work done *by* the gas; sign is flipped.

- Option C ($+3\,P_0V_0$): Arises from linear approximation $W = P\Delta V$ (valid only for isobaric processes).
- Option D ($-3\,P_0V_0$): Same linear approximation with wrong sign.

Final Answer: $W_{\text{on}} = +1.10\,P_0V_0 \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q 8**

Q9.

Solution

Concept — Kinetic Energy in SHM:

$$KE = \tfrac{1}{2}m\omega^2(A^2 - x^2)$$

Step 1 — Total energy:

$$E_{\text{total}} = \tfrac{1}{2}m\omega^2A^2 = \tfrac{1}{2}\times 0.04\times 10^2\times(0.1)^2 = 0.5\times 0.04\times 100\times 0.01 = 0.02\,\text{J} = 20\,\text{mJ}$$

Step 2 — KE at $x = A/2$:

At $x = A/2$, the fraction $x^2/A^2 = 1/4$, so

$$KE = E_{\text{total}}\left(1 - \frac{x^2}{A^2}\right) = 20\times\frac{3}{4} = 15\,\text{mJ}$$

Verification using direct formula:

$$KE = \tfrac{1}{2}\times 0.04\times 100\times\left[(0.1)^2 - \left(\tfrac{0.1}{2}\right)^2\right] = 2\times(0.01 - 0.0025) = 2\times 0.0075 = 0.015\,\text{J} = 15\,\text{mJ}\ \checkmark$$

Why other options are wrong:

- Option A ($5\,\text{mJ}$): Uses $KE = \frac{1}{4}E_{\text{total}}$; that fraction applies at $x = A\sqrt{3}/2$, not $A/2$.
- Option B ($10\,\text{mJ}$): Uses $KE = \frac{1}{2}E_{\text{total}}$; correct only at $x = A/\sqrt{2}$.
- Option D ($20\,\text{mJ}$): Equals E_{total}; kinetic energy equals total energy only at the equilibrium position ($x = 0$).

Final Answer: $KE = 15\,\text{mJ} \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q 9**

Q10.

Solution

Concept — Doppler Effect (source approaching observer):

$$f' = f_0 \frac{v}{v - v_s}$$

where v is the speed of sound and v_s is the source speed.

Step 1 — Substitute values:

$$f' = 600 \times \frac{330}{330 - 30} = 600 \times \frac{330}{300} = 600 \times 1.1 = 660\,\text{Hz}$$

Step 2 — Interpretation: The frequency increases because the source is approaching, compressing the wave fronts.

Why other options are wrong:

- Option B ($630\,\text{Hz}$): Uses denominator $330 + 30 = 360$ (formula for receding source); incorrect direction.
- Option C ($600\,\text{Hz}$): No Doppler shift applied; only valid if source is stationary.
- Option D ($545\,\text{Hz}$): Uses $f' = f(v - v_s)/v$; this is the formula for a *moving observer*, not a moving source.

Final Answer: $f' = 660\,\text{Hz} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q 10**

Q11.

Solution

Concept — Resistivity and Temperature Dependence: Resistance $R = \rho L/A$. With same material (ρ) and same length (L):

$$R_1 = \frac{\rho L}{2A}, \quad R_2 = \frac{\rho L}{A} \implies R_2 = 2R_1$$

Step 1 — Series total resistance:

$$R_{\text{total}} = R_1 + R_2 = R_1 + 2R_1 = 3R_1 = \frac{3\rho L}{2A}$$

Step 2 — Effect of 10% increase in ρ:

Since $R_{\text{total}} \propto \rho$, a 10% increase in ρ produces exactly a 10% increase in R_{total} (the geometric factors L and A are unchanged).

Why other options are wrong:

- Option A (5%): Incorrectly averages the two percentage changes (10% and 0%).
- Option B (7%): Uses a weighted average with wrong weightings.
- Option C (8%): A common distractor from erroneous partial application of the temperature coefficient.

Final Answer: Total resistance increases by $10\% \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q 11**

Q12.

Solution

Concept — Gauss's Law for a Line Charge: Using a coaxial cylindrical Gaussian surface of radius r and length ℓ:

$$E \cdot 2\pi r\ell = \frac{\lambda\ell}{\varepsilon_0} \implies E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

Step 1 — Calculate $2\pi\varepsilon_0$:

$$2\pi\varepsilon_0 = 2\pi \times 8.85 \times 10^{-12} \approx 55.6 \times 10^{-12}\,\mathrm{C^2\,N^{-1}\,m^{-1}}$$

Step 2 — Evaluate E at $r = 0.18\,\mathrm{m}$:

$$E = \frac{2 \times 10^{-6}}{55.6 \times 10^{-12} \times 0.18} = \frac{2 \times 10^{-6}}{10.0 \times 10^{-12}} = 2.0 \times 10^{5}\,\mathrm{N\,C^{-1}}$$

Why other options are wrong:

- Option A (1.0×10^5): Uses $r = 0.36\,\mathrm{m}$; twice the actual distance.
- Option C (3.0×10^5): Uses $r = 0.12\,\mathrm{m}$; two-thirds of the actual distance.
- Option D (4.0×10^5): Uses $r = 0.09\,\mathrm{m}$; half the actual distance.

Final Answer: $E = 2.0 \times 10^5\,\mathrm{N\,C^{-1}} \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q 12**

Q13.

Solution

Concept — Critical Angle for Total Internal Reflection: At the critical angle θ_c, refracted ray grazes the surface ($\theta_r = 90°$):

$$n \sin\theta_c = 1 \times \sin 90° = 1 \implies \sin\theta_c = \frac{1}{n}$$

Step 1 — Apply to glass-air interface:

$$\sin\theta_c = \frac{1}{1.5} = \frac{2}{3} \approx 0.667$$

Step 2 — Find θ_c:

$$\theta_c = \arcsin(0.667) \approx 41.8° \approx 42°$$

Why other options are wrong:

- Option A ($30°$): $\sin 30° = 0.5 = 1/2$; corresponds to $n = 2.0$, not 1.5.
- Option B ($37°$): $\sin 37° \approx 0.6 = 1/1.667$; corresponds to $n \approx 1.67$.
- Option D ($60°$): $\sin 60° \approx 0.866$; would require $n < 1$, physically impossible for glass.

Final Answer: $\theta_c \approx 42° \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q 13**

Q14.

Solution

Concept — de Broglie Wavelength of Accelerated Electron: An electron accelerated through potential V gains kinetic energy $eV = \frac{p^2}{2m}$, so $p = \sqrt{2meV}$:

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_e eV}}$$

Step 1 — Compute numerator h:

$$h = 6.63 \times 10^{-34}\,\text{J s}$$

Step 2 — Compute denominator $\sqrt{2m_e eV}$:

$$2m_e eV = 2 \times 9.11 \times 10^{-31} \times 1.6 \times 10^{-19} \times 150 = 2 \times 9.11 \times 10^{-31} \times 2.4 \times 10^{-17}$$

$$= 2 \times 2.186 \times 10^{-47} = 4.373 \times 10^{-47}$$

$$\sqrt{4.373 \times 10^{-47}} \approx 6.61 \times 10^{-24}\,\mathrm{kg\,m\,s^{-1}}$$

Step 3 — Wavelength:

$$\lambda = \frac{6.63 \times 10^{-34}}{6.61 \times 10^{-24}} \approx 1.003 \times 10^{-10}\,\mathrm{m} = 1.0$$

Why other options are wrong:

- Option B $(1.5\,)$: Corresponds to $V \approx 67\,\mathrm{V}$; wrong potential.
- Option C $(2.0\,)$: Corresponds to $V \approx 37\,\mathrm{V}$.
- Option D $(2.5\,)$: Corresponds to $V \approx 24\,\mathrm{V}$.

Final Answer: $\lambda \approx 1.0 \;\Rightarrow \boxed{\mathrm{A}}$

Answer: (A) **Go Back to Q 14**

Q15.

Solution

Concept — Bohr Model Energy Levels: For hydrogen, energy of level n is $E_n = -13.6/n^2\,\mathrm{eV}$. The photon energy for a transition $n_i \to n_f$ is $\Delta E = E_{n_f} - E_{n_i}$ (magnitude):

$$E_{ji} = 13.6\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)\,\mathrm{eV}$$

Step 1 — Compute E_{21} $(n = 2 \to n = 1)$:

$$E_{21} = 13.6\left(1 - \frac{1}{4}\right) = 13.6 \times \frac{3}{4} = \frac{3 \times 13.6}{4}$$

Step 2 — Compute E_{31} $(n = 3 \to n = 1)$:

$$E_{31} = 13.6\left(1 - \frac{1}{9}\right) = 13.6 \times \frac{8}{9} = \frac{8 \times 13.6}{9}$$

Step 3 — Find the ratio:

$$\frac{E_{31}}{E_{21}} = \frac{8/9}{3/4} = \frac{8}{9} \times \frac{4}{3} = \frac{32}{27}$$

Why other options are wrong:

- Option A $(4/3)$: Ratio of n values $3/2$ inverted; ignores the energy formula.
- Option B $(3/2)$: Direct ratio of quantum numbers; not the energy ratio.
- Option C $(16/9)$: Uses (n_i^2) ratio only; misapplies the energy formula.

Final Answer: $E_{31}/E_{21} = 32/27 \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q 15**

Answer Key

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