GAT-B Physics

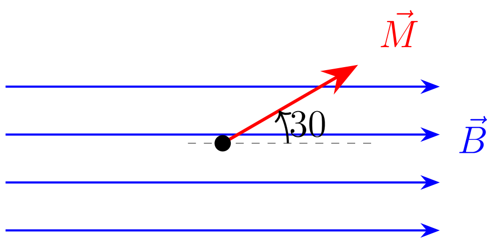
Sample Paper – 6

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. A magnetic dipole of moment $M = 2\ \mathrm{A\,m^2}$ is placed in a uniform magnetic field of strength $B = 0.5\ \mathrm{T}$. The torque acting on the dipole when $\vec{M}$ makes an angle of 30 with $\vec{B}$ is:



(A) $0.25\ \mathrm{N\,m}$
(B) $0.50\ \mathrm{N\,m}$
(C) $\frac{\sqrt{3}}{2}\ \mathrm{N\,m}$
(D) $1.00\ \mathrm{N\,m}$

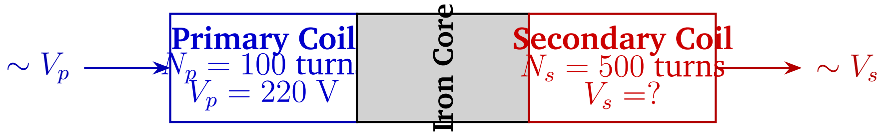
Q2. A ball is projected with speed $u = 20$ m/s at an angle of 45 above the horizontal. The maximum height attained by the ball is (take $g = 10$ m/s^2):

(A) 10 m
(B) 15 m
(C) 20 m
(D) 25 m

Q3. A rocket engine ejects exhaust gases at a rate of 5 kg/s with an exhaust speed of 2000 m/s relative to the rocket. The thrust force developed by the engine is:

(A) 5,000 N
(B) 8,000 N
(C) 10,000 N
(D) 15,000 N

Q4. A step-up transformer has $N_p = 100$ turns in the primary and $N_s = 500$ turns in the secondary. If the primary voltage is $V_p = 220$ V, the secondary voltage V_s is:



(A) 44 V
(B) 220 V
(C) 1100 V
(D) 2200 V

Q5. An ideal monatomic gas ($\gamma = 5/3$) undergoes a reversible adiabatic expansion such that its volume doubles ($V_2 = 2V_1$). The ratio T_2/T_1 of final to initial temperature is:

(A) $2^{-1/3}$
(B) $2^{-2/3}$

(C) $2^{+1/3}$
(D) $2^{+2/3}$

Q6. In a cyclotron used to accelerate charged particles, which of the following is **independent** of the speed of the particle?

(A) Radius of the circular orbit
(B) Kinetic energy of the particle
(C) Frequency of revolution
(D) Momentum of the particle

Q7. In Compton scattering, an X-ray photon is backscattered by a free electron at $\phi = 180$. The Compton wavelength shift $\Delta\lambda$ is: (Given: $\lambda_c = h/m_e c = 2.43$ pm)

(A) 0
(B) 1.21 pm
(C) 2.43 pm
(D) 4.86 pm

Q8. Plane polarized light of intensity I_0 is incident on a polaroid whose transmission axis makes an angle of 60 with the plane of polarization of the incident light. The transmitted intensity is:

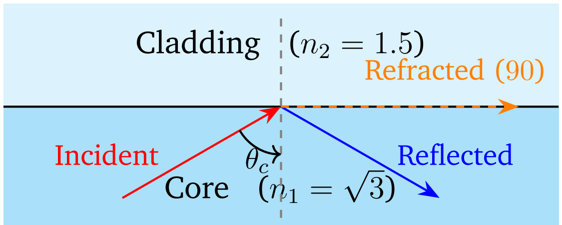
(A) $\frac{I_0}{2}$
(B) $\frac{I_0}{4}$
(C) $\frac{I_0}{\sqrt{2}}$
(D) $\frac{3I_0}{4}$

Q9. A series LCR circuit has inductance $L = 8$ H, capacitance $C = 50\ \mu$F, and resistance $R = 10\ \Omega$. The resonant angular frequency ω_0 of the circuit is:

(A) 50 rad/s
(B) 100 rad/s

(C) 200 rad/s
(D) 400 rad/s

Q10. An optical fiber has a core with refractive index $n_1 = \sqrt{3} \approx 1.73$ and cladding with refractive index $n_2 = 1.5$. The critical angle for total internal reflection at the core-cladding interface is:



(A) 30
(B) 45
(C) 53
(D) 60

Q11. The output of a NAND gate is logic 0 **only when**:

(A) Both inputs are logic 0
(B) Both inputs are logic 1
(C) The inputs are different (one is 0, the other is 1)
(D) At least one input is logic 0

Q12. When $^{14}_{6}\mathrm{C}$ (Carbon-14) undergoes β^- (beta-minus) decay, the daughter nucleus produced is:

(A) $^{14}_{5}\mathrm{B}$
(B) $^{13}_{6}\mathrm{C}$
(C) $^{14}_{7}\mathrm{N}$
(D) $^{15}_{7}\mathrm{N}$

Q13. The amplitude of the electric field of an electromagnetic wave in vacuum is $E_0 = 6 \times 10^5$ V/m. The amplitude of the magnetic field B_0 is:

(A) 2×10^{-3} T

(B) 2×10^{-3} mT
(C) 6×10^{3} T
(D) 18×10^{13} T

Q14. A body cools from $100\mathrm{C}$ to $80\mathrm{C}$ in 5 min in surroundings maintained at $20\mathrm{C}$. Using Newton's law of cooling (average-temperature approximation), the time taken to cool from $80\mathrm{C}$ to $60\mathrm{C}$ is approximately:

(A) 5 min
(B) 6 min
(C) 7 min
(D) 8 min

Q15. The first spectral line of the Balmer series in hydrogen (H_α) is emitted due to the electronic transition $n = 3 \rightarrow n = 2$. Using the Rydberg formula with $R_H = 1.097 \times 10^7\ \mathrm{m}^{-1}$, the wavelength of this line is closest to:

(A) 364 nm
(B) 486 nm
(C) 656 nm
(D) 820 nm

Detailed Solutions

Q1.

Solution

Concept: Torque on a Magnetic Dipole in a Uniform Field

The torque $\vec{\tau}$ on a magnetic dipole $\vec{M}$ placed in a uniform magnetic field $\vec{B}$ is:

$$\vec{\tau} = \vec{M} \times \vec{B} \quad \Longrightarrow \quad \tau = MB\sin\theta$$

Given: $M = 2\ \mathrm{A\,m^2}$, $B = 0.5\ \mathrm{T}$, $\theta = 30$

Calculation:

$$\tau = MB\sin 30 = 2 \times 0.5 \times \frac{1}{2} = 1.0 \times 0.5 = \mathbf{0.50}\ \mathrm{N\,m}$$

Why the other options are wrong:

- **(A)** $0.25\ \mathrm{N\,m}$: Would require $MB\sin\theta = 0.25$. This results if M is taken as $1\ \mathrm{A\,m^2}$ instead of $2\ \mathrm{A\,m^2}$, or if $\sin 30$ is confused with $\cos 30/2$.
- **(C)** $\frac{\sqrt{3}}{2} \approx 0.87\ \mathrm{N\,m}$: This equals $MB\sin 60$, i.e., the formula is correct but the angle used is 60 instead of the stated 30.
- **(D)** $1.00\ \mathrm{N\,m}$: This equals $MB\sin 90 = MB = 2 \times 0.5 = 1.0\ \mathrm{N\,m}$, the maximum torque occurring only when $\vec{M} \perp \vec{B}$, not at 30.

Answer: (B) Go Back to Q 1

Q2.

Solution

Concept: Maximum Height in Projectile Motion

For a projectile launched with speed u at angle θ, the maximum height is:

$$H = \frac{u^2\sin^2\theta}{2g}$$

Given: $u = 20\ \mathrm{m/s}$, $\theta = 45$, $g = 10\ \mathrm{m/s^2}$

Calculation:

$$\sin 45 = \frac{1}{\sqrt{2}} \quad \Longrightarrow \quad \sin^2 45 = \frac{1}{2}$$

$$H = \frac{(20)^2 \times \frac{1}{2}}{2 \times 10} = \frac{400 \times 0.5}{20} = \frac{200}{20} = \mathbf{10}\ \mathrm{m}$$

Why the other options are wrong:

- **(B)** 15 m**:** Arises from using $\sin^2 60 = 3/4$, giving $H = 400 \times (3/4)/20 = 15$ m—wrong angle.
- **(C)** 20 m**:** This equals $u^2/(2g) = 400/20 = 20$ m, which is the maximum height only for $\theta = 90$ (vertical throw); the $\sin^2\theta$ factor was omitted.
- **(D)** 25 m**:** No combination of the given values yields this result; likely a computational error where $g = 8$ m/s^2 is used inadvertently.

Answer: (A) Go Back to Q 2

Q3.

Solution

Concept: Rocket Propulsion — Thrust Force

By applying Newton's second law to a variable-mass system, the thrust force on the rocket equals the rate of momentum transfer from the ejected mass:

$$F_{\text{thrust}} = v_{\text{rel}} \left| \frac{dm}{dt} \right|$$

where v_{rel} is the exhaust speed relative to the rocket and $|dm/dt|$ is the mass ejection rate.

Given: $v_{\text{rel}} = 2000$ m/s, $|dm/dt| = 5$ kg/s

Calculation:

$$F_{\text{thrust}} = 2000 \text{ m/s} \times 5 \text{ kg/s} = \mathbf{10{,}000} \text{ N}$$

Why the other options are wrong:

- **(A)** 5000 N**:** Obtained by using $v_{\text{rel}} = 1000$ m/s (half the given value), or by incorrectly dividing instead of multiplying.
- **(B)** 8000 N**:** No standard application of the thrust formula with the given data produces 8000 N; this is a likely numerical or conceptual error.
- **(D)** $15{,}000$ N**:** Arises from using $v_{\text{rel}} = 3000$ m/s instead of 2000 m/s.

Answer: (C) Go Back to Q 3

Q4.

Solution

Concept: Transformer — Turns Ratio

For an ideal transformer, the voltage ratio equals the turns ratio:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \implies V_s = V_p \frac{N_s}{N_p}$$

Given: $N_p = 100$, $N_s = 500$, $V_p = 220$ V

Calculation:

$$V_s = 220 \times \frac{500}{100} = 220 \times 5 = \mathbf{1100} \text{ V}$$

Since $N_s > N_p$, this is a step-*up* transformer; the output voltage is higher than the input.

Why the other options are wrong:

- **(A)** 44 V**:** Uses the inverted ratio $V_s = V_p \times N_p/N_s = 220/5 = 44$ V, which would describe a step-down transformer with these windings.
- **(B)** 220 V**:** Assumes a 1:1 turns ratio (output = input), ignoring the different winding counts entirely.
- **(D)** 2200 V**:** Arises from mistaking the turns ratio as 10 (perhaps confusing $N_s - N_p = 400$ with the ratio), giving $220 \times 10 = 2200$ V.

Answer: (C) Go Back to Q 4

Q5.

Solution

Concept: Adiabatic Process — Temperature-Volume Relation

For a reversible adiabatic process with an ideal gas:

$$TV^{\gamma-1} = \text{const} \implies T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

Given: $\gamma = \frac{5}{3}$ (monatomic), $V_2 = 2V_1$

Calculation:

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = \left(\frac{V_1}{2V_1}\right)^{\frac{5}{3}-1} = \left(\frac{1}{2}\right)^{2/3} = \mathbf{2^{-2/3} \approx 0.63}$$

Since the gas expands (volume increases) adiabatically, it does work and cools:

$T_2 < T_1$, consistent with the negative exponent.

Why the other options are wrong:

- **(A)** $2^{-1/3}$**:** Uses $\gamma - 1 = \frac{1}{3}$, which corresponds to $\gamma = \frac{4}{3}$ — applicable to a different model, not a monatomic ideal gas ($\gamma = \frac{5}{3}$).
- **(C)** $2^{+1/3}$**:** A positive exponent implies $T_2 > T_1$, i.e., the gas heats during expansion. This violates energy conservation for an adiabatic process with no heat input.
- **(D)** $2^{+2/3}$**:** Arises from using V_2/V_1 instead of V_1/V_2 in the exponent; an inversion error.

Answer: (B) Go Back to Q 5

Q6.

Solution

Concept: Cyclotron — Frequency of Revolution

A charged particle of charge q and mass m moving with speed v in a perpendicular magnetic field B follows a circular path of radius:

$$r = \frac{mv}{qB}$$

The time period and frequency of revolution are:

$$T = \frac{2\pi r}{v} = \frac{2\pi m}{qB} \quad \Longrightarrow \quad f = \frac{1}{T} = \frac{qB}{2\pi m}$$

Key result: The cyclotron frequency $f = \dfrac{qB}{2\pi m}$ contains neither v nor r. It depends only on q, B, and m, all of which are fixed. Therefore the **frequency of revolution is independent of the particle's speed.**

This isochronous property is what makes the cyclotron work: particles of all speeds complete each orbit in the same time, staying in phase with the alternating dee voltage.

Why the other options are wrong:

- **(A) Radius:** $r = mv/(qB)$ — depends linearly on speed v; the faster the particle, the larger the orbital radius.
- **(B) Kinetic energy:** $K = \frac{1}{2}mv^2$ — depends on v^2; kinetic energy increases with each half-turn acceleration.

- **(D) Momentum:** $p = mv$ — proportional to speed; increases as the particle gains energy.

Answer: (C) Go Back to Q 6

Q7.

Solution

Concept: Compton Scattering — Wavelength Shift

The Compton wavelength shift formula gives the change in photon wavelength after scattering:

$$\Delta\lambda = \lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\phi) = \lambda_c(1 - \cos\phi)$$

where ϕ is the photon scattering angle and $\lambda_c = 2.43$ pm is the Compton wavelength.

For backscattering: $\phi = 180$, so $\cos 180 = -1$

Calculation:

$$\Delta\lambda = \lambda_c\big(1 - \cos 180\big) = 2.43\,(1 - (-1)) = 2.43 \times 2 = \mathbf{4.86}\ \text{pm}$$

This is the *maximum possible* Compton shift, achieved only at 180 backscattering.

Why the other options are wrong:

- **(A)** 0: Corresponds to $\phi = 0$ (forward scattering—photon passes through without energy transfer).
- **(B)** 1.21 pm: Would require $1 - \cos\phi = 0.5$, i.e., $\cos\phi = 0.5$, so $\phi = 60$—not the backscattering condition.
- **(C)** 2.43 pm: Correct value for $\phi = 90$ (right-angle scattering), where $\Delta\lambda = \lambda_c(1 - 0) = \lambda_c$—not 180.

Answer: (D) Go Back to Q 7

Q8.

Solution

Concept: Malus's Law — Polarization by a Polaroid

When plane-polarized light of intensity I_0 passes through a polaroid whose transmission axis makes angle θ with the polarization direction, the transmitted intensity is:

$$I = I_0 \cos^2\theta \qquad \text{(Malus's Law)}$$

Given: $\theta = 60$

Calculation:

$$I = I_0 \cos^2 60 = I_0 \left(\frac{1}{2}\right)^2 = \frac{I_0}{4}$$

Why the other options are wrong:

- **(A)** $I_0/2$**:** Follows from $I = I_0 \cos 60 = I_0/2$ (missing the square) or from using $\theta = 45$ ($\cos^2 45 = 1/2$)—both are errors.
- **(C)** $I_0/\sqrt{2}$**:** Equals $I_0 \cos 45$ (not squared), a common error of applying $\cos\theta$ instead of $\cos^2\theta$.
- **(D)** $3I_0/4$**:** Corresponds to $\cos^2 30 = 3/4$, i.e., $\theta = 30$ was used instead of 60—the complementary angle error.

Answer: (B) Go Back to Q 8

Q9.

Solution

Concept: Series LCR Circuit — Resonant Angular Frequency

In a series LCR circuit, resonance occurs when the inductive reactance equals the capacitive reactance:

$$X_L = X_C \implies \omega_0 L = \frac{1}{\omega_0 C} \implies \omega_0 = \frac{1}{\sqrt{LC}}$$

At resonance the impedance is purely resistive ($Z = R$, minimum) and the current is maximum.

Given: $L = 8$ H, $C = 50\ \mu\text{F} = 50 \times 10^{-6}$ F

Calculation:

$$LC = 8 \times 50 \times 10^{-6} = 400 \times 10^{-6} = 4 \times 10^{-4}\ \text{H}\cdot\text{F}$$

$$\sqrt{LC} = \sqrt{4 \times 10^{-4}} = 2 \times 10^{-2} \text{ s}$$

$$\omega_0 = \frac{1}{2 \times 10^{-2}} = \mathbf{50} \text{ rad/s}$$

Why the other options are wrong:

- **(B)** 100 rad/s: Corresponds to $L = 2$ H and $C = 50\ \mu$F ($LC = 10^{-4}$, $\omega_0 = 100$)—different inductance.
- **(C)** 200 rad/s: Requires $LC = 2.5 \times 10^{-5}$, obtainable from $L = 0.5$ H, $C = 50\ \mu$F—again not the given values.
- **(D)** 400 rad/s: Arises from computing $\omega_0 = 1/(LC) = 1/(4 \times 10^{-4}) = 2500$ rad/s (forgetting the square root), or from other arithmetic errors.

Answer: (A) Go Back to Q 9

Q10.

Solution

Concept: Total Internal Reflection — Critical Angle

Total internal reflection (TIR) occurs at the boundary when light travels from a denser medium (n_1) to a rarer medium ($n_2 < n_1$). At the critical angle θ_c, the refracted ray grazes the interface ($\theta_r = 90$). Applying Snell's law:

$$n_1 \sin \theta_c = n_2 \sin 90 = n_2 \implies \sin \theta_c = \frac{n_2}{n_1}$$

Given: $n_1 = \sqrt{3}$, $n_2 = 1.5$

Calculation:

$$\sin \theta_c = \frac{n_2}{n_1} = \frac{1.5}{\sqrt{3}} = \frac{3}{2\sqrt{3}} = \frac{3}{2\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{3\sqrt{3}}{6} = \frac{\sqrt{3}}{2}$$

$$\theta_c = \sin^{-1}\left(\frac{\sqrt{3}}{2}\right) = \mathbf{60}$$

Why the other options are wrong:

- **(A)** 30: $\sin 30 = 0.5$; this would require $n_2/n_1 = 0.5$, i.e., $n_2 = \sqrt{3}/2 \approx 0.87$. No real optical material has $n < 1$.
- **(B)** 45: $\sin 45 = 1/\sqrt{2} \approx 0.707 \neq \sqrt{3}/2 \approx 0.866$ for the given refractive indices.
- **(C)** 53: $\sin 53 \approx 0.8 = 4/5$, corresponding to $n_2/n_1 = 4/5$ (e.g., $n_1 = 1.5$,

$n_2 = 1.2$)—different values from those stated.

Answer: (D) Go Back to Q 10

Q11.

Solution

Concept: NAND Gate — Truth Table

A NAND gate implements the Boolean function: $\text{Output} = \overline{A \cdot B}$ (NOT of AND).

Input A	Input B	$A \cdot B$	NAND Output $\overline{A \cdot B}$
0	0	0	**1**
0	1	0	**1**
1	0	0	**1**
1	1	1	**0**

The output is **0 (LOW)** if and only if **both inputs are 1 (HIGH)**.

Why the other options are wrong:

- **(A) Both inputs are 0:** $\overline{0 \cdot 0} = \overline{0} = 1$ — output is HIGH, not LOW.
- **(C) Inputs are different:** $\overline{0 \cdot 1} = \overline{0} = 1$ — output is HIGH in all mixed-input cases.
- **(D) At least one input is 0:** All three rows with at least one 0 give output 1 (HIGH). Only the all-1s row gives 0. Option (D) describes the majority of cases, but for none of them is the output 0.

Answer: (B) Go Back to Q 11

Q12.

Solution

Concept: Beta-Minus (β^-) Decay

In β^- decay, a neutron inside the nucleus converts into a proton with the emission of an electron (e^-) and an electron antineutrino ($\bar{\nu}_e$):

$$n \rightarrow p + e^- + \bar{\nu}_e$$

Conservation laws applied to the nucleus:

- **Mass number** A: unchanged (neutron replaced by proton, both $A = 1$)
- **Atomic number** Z: increases by 1 (one new proton)

For ${}^{14}_{6}\mathrm{C}$**:** $Z = 6 \to 7$ (Carbon $\to$ Nitrogen), $A = 14$ (unchanged)

$$ {}^{14}_{6}\mathrm{C} \longrightarrow {}^{14}_{7}\mathrm{N} + e^{-} + \bar{\nu}_e $$

This is the decay used in radiocarbon dating.

Why the other options are wrong:

- **(A)** ${}^{14}_{5}\mathrm{B}$**:** Z decreased by 1 $(6 \to 5)$, which describes β^{+} decay or electron capture—not β^{-}.
- **(B)** ${}^{13}_{6}\mathrm{C}$**:** A changed from 14 to 13. Mass number is conserved in all β decays; only α decay reduces A.
- **(D)** ${}^{15}_{7}\mathrm{N}$**:** A increased from 14 to 15 and Z increased—neither change is consistent with β^{-} decay of C-14.

$\boxed{\textbf{Answer: (C)}}$ Go Back to Q 12

Q13.

Solution

Concept: Electromagnetic Wave — Relation between E_0 and B_0

In an electromagnetic wave propagating through vacuum, the electric and magnetic field amplitudes satisfy:

$$ \frac{E_0}{B_0} = c \quad \Longrightarrow \quad B_0 = \frac{E_0}{c} $$

where $c = 3 \times 10^{8}$ m/s is the speed of light.

Given: $E_0 = 6 \times 10^{5}$ V/m

Calculation:

$$ B_0 = \frac{E_0}{c} = \frac{6 \times 10^{5}}{3 \times 10^{8}} = 2 \times 10^{-3}\ \mathrm{T} = \mathbf{2}\ \mathrm{mT} $$

Why the other options are wrong:

- **(B)** 2×10^{-3} mT**:** The *numerical value* is the same but the unit is mT (millitesla), making it $2 \times 10^{-3} \times 10^{-3}$ T $= 2 \times 10^{-6}$ T—a factor of 10^{3} smaller than the correct answer. Unit confusion.
- **(C)** 6×10^{3} T**:** Arises from computing $B_0 = E_0 \cdot c$ (product instead of quotient), giving $6 \times 10^{5} \times 3 \times 10^{8} = 1.8 \times 10^{14}$ T—an enormous, unphysical value. Option

(C) likely arises from a similar inversion error.

- **(D)** 18×10^{13} T: Exactly $E_0 \times c = 6 \times 10^5 \times 3 \times 10^8 = 1.8 \times 10^{14}$ T—the formula was applied upside-down.

Answer: (A) Go Back to Q 13

Q14.

Solution

Concept: Newton's Law of Cooling

Newton's law of cooling (average-temperature approximation) states that the rate of temperature drop over a small interval is proportional to the average excess temperature above the surroundings:

$$\frac{\Delta T}{\Delta t} = k\left(\frac{T_i + T_f}{2} - T_0\right)$$

Step 1 — Find k from the first interval ($100\text{C} \to 80\text{C}$ in 5 min, $T_0 = 20\text{C}$):

$$\frac{20}{5} = k\left(\frac{100+80}{2} - 20\right) = k\,(90-20) = 70k \implies k = \frac{4}{70} = \frac{2}{35}\ \text{min}^{-1}$$

Step 2 — Second interval ($80\text{C} \to 60\text{C}$):

$$\frac{20}{t_2} = k\left(\frac{80+60}{2} - 20\right) = \frac{2}{35}(70-20) = \frac{2}{35} \times 50 = \frac{100}{35} = \frac{20}{7}$$

$$t_2 = 20 \div \frac{20}{7} = 20 \times \frac{7}{20} = \mathbf{7}\ \text{min}$$

Why the other options are wrong:

- **(A)** 5 min: Would be correct only if both intervals had the same average excess temperature. The second interval has average excess 50C vs. 70C for the first—the body cools more slowly.
- **(B)** 6 min: Likely from using an incorrect average temperature (e.g., 70C instead of the correct 50C excess for the second interval).
- **(D)** 8 min: An overestimate; arises from further underestimating the cooling rate in the second interval.

Answer: (C) Go Back to Q 14

Q15.

Solution

Concept: Hydrogen Spectrum — Balmer Series and Rydberg Formula

The wavelength of spectral lines in hydrogen is given by the Rydberg formula:

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

For the Balmer series $n_1 = 2$. The first line (H_α) has $n_2 = 3$.

Given: $R_H = 1.097 \times 10^7 \text{ m}^{-1}$, $n_1 = 2$, $n_2 = 3$

Calculation:

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{4} - \frac{1}{9} \right) = 1.097 \times 10^7 \times \frac{9-4}{36} = 1.097 \times 10^7 \times \frac{5}{36}$$

$$\frac{1}{\lambda} = \frac{5.485 \times 10^7}{36} = 1.524 \times 10^6 \text{ m}^{-1}$$

$$\lambda = \frac{1}{1.524 \times 10^6} \approx 6.56 \times 10^{-7} \text{ m} = \mathbf{656} \text{ nm}$$

This red line (H_α) is the brightest line in the Balmer series and lies in the visible region of the spectrum.

Why the other options are wrong:

- **(A)** 364 nm: This is the series limit of the Balmer series (transition $n = \infty \to n = 2$), giving $1/\lambda = R_H/4 \Rightarrow \lambda = 4/R_H \approx 364$ nm—not the first line.
- **(B)** 486 nm: This is the second Balmer line (H_β), corresponding to the $n = 4 \to n = 2$ transition—the next line in the series, not the first.
- **(D)** 820 nm: Falls in the near-infrared; no standard transition in the Balmer series produces this wavelength. This is a fabricated distractor.

Answer: (C) Go Back to Q 15

Answer Key

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