

CLASS 12

PHYSICS

EXTRA QUESTIONS

Class 12 Physics Chapter 12 Atoms – Extra Questions with Answers

These extra practice questions for Class 12 Physics Chapter 12 – Atoms go beyond the NCERT textbook exercises to reinforce Rutherford's atomic model, Bohr's postulates, and the hydrogen spectrum. Useful for board exam revision and quick concept checks.

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Very Short Answer Type Questions (1 Mark)

Q1. State Bohr's second postulate regarding the angular momentum of an orbiting electron.

Ans: An electron can only revolve in certain stable orbits for which its orbital angular momentum is an integer multiple of $h/2\pi$ (i.e. $L=n\hbar$, where $n=1,2,3,\dots$). Orbits with any other angular momentum are forbidden.

Q2. What is meant by the "ground state" of an atom?

Ans: The ground state is the lowest energy level an electron can occupy in an atom — the most stable configuration, corresponding to $n=1$ in the hydrogen atom, with energy -13.6eV .

Q3. Name the series of hydrogen spectral lines that lies in the visible region.

Ans: The **Balmer series** (transitions ending at $n=2$) lies in the visible region; the Lyman series (ending at $n=1$) lies in the ultraviolet, and the Paschen, Brackett, and Pfund series (ending at $n=3, 4, 5$) lie in the infrared.

Q4. Why couldn't Rutherford's model explain the stability of the atom?

Ans: Classical electromagnetic theory requires an accelerating (orbiting) charge to continuously radiate energy. An electron losing energy this way would spiral inward and collapse into the nucleus almost instantly, so Rutherford's purely classical model cannot explain why atoms are stable.

Short Answer Type Questions (2–3 Marks)

Q5. State Bohr's three postulates for the hydrogen atom.

Ans: (1) Electrons revolve in certain stable, non-radiating orbits around the nucleus, held there by Coulomb attraction providing the centripetal force. (2) Only orbits for which the electron's angular momentum is an integer multiple of $h/2\pi$ are permitted ($L=n\hbar$). (3) An atom radiates energy only when an electron jumps from a higher-energy orbit to a lower-energy one, emitting a photon of energy equal to the energy difference between the two orbits ($h\nu=E_i-E_f$).

Q6. Derive the general relationship between the energy of an orbit (E_n) and the quantum number n for a hydrogen atom.

Ans: Since $E_1=-13.6\text{eV}$ for the ground state, and total energy scales as $E_n=E_1/n^2$, this gives **$E_n = -13.6/n^2\text{eV}$** . This follows from combining Coulomb attraction providing centripetal force with Bohr's angular-momentum quantisation condition, which together fix both the orbit radius ($r_n=n^2r_1$) and the orbital speed ($v_n=v_1/n$) at each level.

Q7. Explain why the hydrogen emission spectrum consists of discrete, sharp spectral lines rather than a continuous band of colours.

Ans: Since electrons can only occupy specific quantised energy levels ($E_n=-13.6/n^2\text{eV}$), a transition between any two levels releases a photon of one exact, fixed energy (and hence one exact wavelength) rather than a continuous range. Since only a finite, discrete set of energy differences is possible between the various levels, only a finite, discrete set of spectral lines results.

Higher Order Thinking Skills (HOTS)

Q8. An electron in a hydrogen atom is in the $n=5$ level. It can eventually fall back to the ground

state through several possible paths (single jumps or step-by-step cascades). How many distinct spectral lines can be emitted in total as electrons across a large sample of such atoms de-excite from $n=5$ to $n=1$?

Ans: The number of possible spectral lines from level n falling to the ground state equals the number of ways to choose 2 levels out of n , given by $n(n-1)/2$. For $n=5$: $5 \times 4 / 2 = 10$ distinct spectral lines (corresponding to all possible pairs of levels: $5 \rightarrow 4$, $5 \rightarrow 3$, $5 \rightarrow 2$, $5 \rightarrow 1$, $4 \rightarrow 3$, $4 \rightarrow 2$, $4 \rightarrow 1$, $3 \rightarrow 2$, $3 \rightarrow 1$, $2 \rightarrow 1$).

Q9. Two hydrogen atoms are in different excited states: atom A is in $n=2$ and atom B is in $n=3$. Which atom is more tightly bound (has lower, more negative total energy), and which one would require more energy to fully ionise from its current state?

Ans: Using $E_n = -13.6/n^2 \text{ eV}$: $E_A(n=2) = -3.4 \text{ eV}$, $E_B(n=3) \approx -1.51 \text{ eV}$. **Atom A ($n=2$) is more tightly bound** (its energy is more negative). Ionisation energy from a given state equals the magnitude of its energy (bringing the electron to $E=0$ at infinite separation), so **atom A also needs more energy to ionise** (3.4 eV, versus only 1.51 eV for atom B) — a higher- n electron is already closer to being free, so less extra energy is needed to fully remove it.

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