

Atoms — CBSE Pattern Test 2

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Atoms · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- In Rutherford's model the electrons revolve around the nucleus in
 - circular orbits
 - straight lines
 - random paths
 - a cloud
- According to Thomson's model, the atom is
 - a sphere of positive charge with electrons embedded in it
 - mostly empty space
 - a nucleus with orbiting electrons
 - a plasma of ions
- Bohr's model could successfully explain the spectrum of
 - the hydrogen atom
 - the helium atom
 - multi-electron atoms
 - the nucleus
- The Lyman series of the hydrogen spectrum lies in the
 - ultraviolet region
 - visible region
 - infrared region
 - microwave region
- The wave number of a spectral line is given by
 - $R(1/n_1^2 - 1/n_2^2)$
 - $R(n_1^2 - n_2^2)$
 - $R(1/n_1 - 1/n_2)$
 - $R n_1 n_2$
- The ionisation energy of the hydrogen atom from the ground state is
 - 13.6 eV
 - 3.4 eV
 - 1.51 eV
 - 27.2 eV
- The de Broglie wavelength of an electron in the n th Bohr orbit is proportional to
 - n

(B) $1/n$ (C) n^2 (D) $1/n^2$

8. The de Broglie explanation of Bohr's postulate gives

(A) $2\pi r = n\lambda$ (B) $2\pi r = \lambda/n$ (C) $r = n\lambda$ (D) $2\pi r = n^2\lambda$

9. Which series of the hydrogen spectrum lies in the visible region?

10. State the de Broglie relation for a Bohr orbit.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. Find the energy of the electron in the third Bohr orbit of the hydrogen atom.

12. Calculate the energy required to ionise a hydrogen atom from its first excited state ($n = 2$).

13. Calculate the de Broglie wavelength of an electron in the ground state of the hydrogen atom.

14. Find the ionisation potential of the hydrogen atom.

Section C — Short Answer II ($4 \times 3 = 12$ marks)15. State the postulates of Bohr's model of the hydrogen atom and derive the expression for the energy of the electron in the n th orbit.

16. Using Bohr's theory, derive the expression for the wave number of the lines in the hydrogen spectrum and identify the different series.

17. Describe Thomson's model of the atom, state its limitations, and explain how Rutherford's experiment improved upon it.

18. Explain how de Broglie's hypothesis provides an explanation for Bohr's postulate of quantised angular momentum.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Draw a diagram of the energy levels of the hydrogen atom. Explain the origin of the Lyman, Balmer and Paschen series and calculate the wavelength of the first line of the Balmer series.

20. Using Bohr's postulates, derive the expressions for the radius and energy of the electron in the n th Bohr orbit, and hence calculate the ionisation energy of the hydrogen atom.**Answer Key (Marking Scheme)**

Q1 — (A) circular orbits. Q2 — (A) a sphere of positive charge with electrons embedded in it. Q3 — (A) the hydrogen atom. Q4 — (A) ultraviolet region.

Q5 — (A) $R(1/n_1^2 - 1/n_2^2)$. Q6 — (A) 13.6 eV. Q7 — (A) n . Q8 — (A) $2\pi r = n\lambda$.

Q9 — Balmer series.

Q10 — The circumference of a stationary orbit is an integral multiple of the de Broglie wavelength: $2\pi r = n\lambda$.Q11 — $E_3 = -13.6/9 \approx -1.51$ eV.Q12 — Ionisation from $n = 2$ needs 3.4 eV.Q13 — $\lambda = 2\pi r_1 \approx 3.32 \times 10^{-10}$ m.

Q14 — 13.6 V.

Q15 — See notes; $E_n = -13.6/n^2$ eV.

Q16 — $1/\lambda = R(1/n_1^2 - 1/n_2^2)$ with series as in notes.

Q17 — Thomson: positive sphere with embedded electrons, does not explain scattering; Rutherford's experiment revealed the nucleus.

Q18 — $2\pi r = n\lambda$ with $\lambda = h/mv$ gives $mvr = nh/2\pi$.

Q19 — Level diagram; transitions to $n = 1, 2, 3$ give Lyman, Balmer, Paschen; first Balmer line ≈ 656 nm.

Q20 — $r_n = n^2 h^2 \epsilon_0 / \pi m e^2$; $E_n = -13.6/n^2$ eV; ionisation energy = 13.6 eV.