

Atoms — CBSE Pattern Test 1

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

Test 1 — 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)

- Rutherford's alpha-particle scattering experiment established the existence of
 - the nucleus
 - the electron
 - the neutron
 - the photon
- The main defect of Rutherford's atomic model is that it
 - cannot explain the stability of the atom
 - has no nucleus
 - has no electrons
 - contradicts the photoelectric effect
- According to Bohr's postulate, the angular momentum of an electron in a stationary orbit is
 - an integral multiple of $h/2\pi$
 - an integral multiple of h
 - zero
 - continuous
- The radius of the n th Bohr orbit of hydrogen is proportional to
 - n^2
 - n
 - $1/n$
 - $1/n^2$
- The energy of the electron in the n th orbit of the hydrogen atom is proportional to
 - $-1/n^2$
 - $-n^2$
 - $1/n$
 - n
- The series of the hydrogen spectrum lying in the visible region is the
 - Balmer series
 - Lyman series
 - Paschen series
 - Brackett series
- The ground-state energy of the hydrogen atom is
 - -13.6 eV

- (B) -3.4 eV
- (C) -1.51 eV
- (D) 0 eV

8. According to de Broglie, the circumference of a Bohr orbit is equal to

- (A) an integral multiple of the wavelength
- (B) half the wavelength
- (C) the wavelength squared
- (D) zero

9. State Bohr's postulate about angular momentum.

10. Write the value of the ionisation energy of the hydrogen atom.

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

11. The radius of the first Bohr orbit of hydrogen is $0.53 \text{ \AA}$. Find the radius of the third orbit.

12. Calculate the wavelength of the first line of the Balmer series of hydrogen. ($R = 1.097 \times 10^7 \text{ m}^{-1}$)

13. Calculate the energy required to excite a hydrogen atom from the ground state to the first excited state.

14. Find the energy of the electron in the second Bohr orbit of the hydrogen atom.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. Describe Rutherford's alpha-particle scattering experiment and state the conclusions drawn from it.

16. State the postulates of Bohr's model and derive the expression for the radius of the n th orbit.

17. Draw a diagram of the energy levels of the hydrogen atom and explain the origin of the different spectral series.

18. Using de Broglie's hypothesis, derive Bohr's quantisation condition for the angular momentum of an electron.

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

19. State Bohr's postulates. Derive the expressions for the radius and the energy of the electron in the n th orbit of the hydrogen atom and hence obtain the expression for the wave number of the emitted radiation.

20. Describe Rutherford's alpha-particle scattering experiment, state its conclusions, and explain the drawbacks of Rutherford's model that led Bohr to propose his postulates.

Answer Key (Marking Scheme)

Q1 — (A) the nucleus. Q2 — (A) cannot explain the stability of the atom. Q3 — (A) an integral multiple of $h/2\pi$. Q4 — (A) n^2 .

Q5 — (A) $-1/n^2$. Q6 — (A) Balmer series. Q7 — (A) -13.6 eV. Q8 — (A) an integral multiple of the wavelength.

Q9 — Angular momentum $L = nh/2\pi$, where n is an integer.

Q10 — 13.6 eV.

Q11 — $r_3 = 0.53 \times 9 = 4.77 \text{ \AA}$.

Q12 — $1/\lambda = R(1/2^2 - 1/3^2)$ $\lambda \approx 656 \text{ nm}$.

Q13 — $\Delta E = 13.6 - 3.4 = 10.2$ eV.

Q14 — $E_2 = -13.6/4 = -3.4$ eV.

Q15 — Alpha particles scattered by a thin gold foil; most pass straight, some deflect strongly; implies a small dense nucleus.

Q16 — Postulates as in notes; $r_n = n^2 h^2 \epsilon_0 / \pi m e^2 = 0.53 n^2 \text{ \AA}$.

Q17 — Transitions to $n = 1$ (Lyman), $n = 2$ (Balmer), $n = 3$ (Paschen), etc.

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

Q19 — $r_n = n^2 h^2 \epsilon_0 / \pi m e^2$, $E_n = -13.6/n^2 \text{ eV}$; transition energy gives $1/\lambda = R(1/n_1^2 - 1/n_2^2)$.

Q20 — See Q15 and notes; Rutherford's model fails on stability and discreteness of spectra, motivating Bohr's postulates.