INDIAN SCHOOL AL WADI AL KABIR

Class: XII	Department: SCIENCE 2025-2026 Subject: PHYSICS	Date: 20.11.2025
Worksheet No:12(with answers)	Topic: ATOMS	Note: A4 FILE FORMAT
NAME OF THE STUDENT-	CLASS & SECTION	ROLL NO.

MULTIPLE CHOICE TYPE QUESTIONS

1. The transition of electron that gives rise to the formation of the second spectral line of the Balmer series in the spectrum of hydrogen atom corresponds to:

(A) $n_f = 2$ and $n_i = 3$ (B) $n_f = 3$ and $n_i = 4$
(C) $n_f = 2$ and $n_i = 4$ (D) $n_f = 2$ and $n_i = \infty$

2. Energy levels A, B and C of an atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$. Let λ_1, λ_2 and λ_3 be the wavelengths of radiation corresponding to the transitions C to B, B to A and C to A, respectively. The correct relation between λ_1, λ_2 and λ_3 is:

(A) $\lambda_1^2+\lambda_2^2 = \lambda_3^2$ (B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$ (C) $\lambda_1+\lambda_2+\lambda_3 = 0$ (D) $\lambda_1+\lambda_2=\lambda_3$

3. An alpha particle approaches a gold nucleus in Geiger-Marsden experiment with kinetic energy K. It momentarily stops at a distance d from the nucleus and reverses its direction. Then d is proportional to:

(A) $\frac{1}{\sqrt{K}}$ (B) $\sqrt{K}$ (C) $\frac{1}{K}$ (D) K

4. An electron makes a transition from n = 2 level to n = 1 level in the Bohr model of a hydrogen atom. Its period of revolution:

(A) increases by 87·5% (B) decreases by 87·5%
(C) increases by 43·75% (D) decreases by 43·75%

5. The radius (r_n) of nth orbit in Bohr model of hydrogen atom varies with n as.

(A) $r_n \propto$ n (B) $r_n \propto \frac{1}{n}$ (C) $r_n \propto n^2$ (D) $r_n \propto \frac{1}{n^2}$

6. In Bohr's model of hydrogen atom, the total energy of the electron in nth discrete orbit is proportional to

(A) n (B) $\frac{1}{n}$ (C) n^2 (D) $\frac{1}{n^2}$

7. In Balmer series of hydrogen atom, as the wavelength of spectral lines decreases, they appear,

(A) equally spaced and equally intense. (B) further apart and stronger in intensity.
(C) closer together and stronger in intensity. (D) closer together and weaker in intensity.

8. The energy of an electron in the ground state of hydrogen atom is - 13.6 eV. the kinetic and potential energy of the electron in the first excited state will be.

(A) – 13.6 eV, 27.2eV (B) – 6.8 eV, 13.6 eV (C) 3.4 eV, - 6.8 eV, (D) 6.8 eV, - 3.4 eV

9. Hydrogen atom initially in the ground state, absorbs a photon which excites it to n = 5 level. The wavelength of the photon is:

(a) 975 nm (b) 740 nm (c) 523 nm (d) 95 nm

10. The atomic number of an atom represents:

(a) number of neutrons in nucleus. (b) total number of protons and electrons in the atom.
(c) number of protons in nucleus. (d) total number of protons and neutrons in nucleus.

ANSWERS OF MCQs; -(1). (c), 2. (b), 3. (c), 4. (b), 5. (c),6. (d),7. (d), 8. (c), 9. (d), 10. (c),

Assertion and Reason type questions;

DIRECTIONS. In each of the following questions, read the two statements and choose if

(A) both Assertion and Reason are true and the Reason is correct explanation of the Assertion.
(B) both Assertion and Reason are true, but the Reason is not a correct explanation of the Assertion.

(C) Assertion is true and Reason is false.
(D) both, Assertion and Reason are false.
11. Assertion(A): - An alpha particle is moving towards a gold nucleus. The impact parameter is maximum for the scattering angle of 180°.
Reason(R): - The impact parameter in an alpha particle scattering experiment does not depend upon the atomic number of the target nucleus.
12. Assertion (A): Atoms consist of a nucleus surrounded by electrons.
Reason (R): The nucleus contains protons and neutrons, which are held together by the strong nuclear force.
13. Assertion (A): Electrons in an atom occupy specific energy levels.
Reason (R): Electrons can exist in any energy level based on their energy.
14. Assertion (A): The mass of an atom is mostly concentrated in its nucleus.
Reason (R) : Protons and neutrons have significantly more mass than electrons.
Answer: 11. (d), 12. (a), 13. (c), 14. (a).

SHORT ANSWER TYPE QUESTIONS: (2/3 marks)

1. (a) Two energy levels of an electron in hydrogen atom are separated by 2.55 eV. Find the wavelength of radiation emitted from the electron makes transition from higher energy label to the lower energy level.
(b) In which series of hydrogen spectrum this line shall fall?

(a) $E_2 - E_1 = \frac{hc}{\lambda}$

Given

$$E_2 - E_1 = 2.55 \times 1.6 \times 10^{-19} \text{ J}$$

$$\Rightarrow \quad \lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2.55 \times 1.6 \times 10^{-19}} = 487.5 \text{ nm}$$

(b) Balmer series

2. The Earth revolves around the sun in an orbit of radius 1.5 x 10^{11} m with orbital speed 30 km/s. Find the quantum number that characterizes its revolution using Bohr's model. In this case (mass of earth = 6.0 x 10^{24} kg).

Using Bohr's model

$$mvr = \frac{nh}{2\pi}$$

$$n = \frac{2\pi \times 6.0 \times 10^{24} \times 30 \times 10^3 \times 1.5 \times 10^{11}}{6.63 \times 10^{-34}}$$

$$n = 2.558 \times 10^{74}$$

3. Suppose you are given a chance to repeat the alpha-particle scattering experiment using a thin sheet of solid hydrogen in place of the gold foil. (Hydrogen is a solid at temperatures below 14 K.) What results do you expect?
Ans: - the mass of the scattering particle is more than the target nucleus (hydrogen). As a result, the α-particles would not bounce back if solid hydrogen is used in the α-particle scattering experiment.
4. A difference of 2.3 eV separates two energy levels in an atom. What is the frequency of radiation emitted when the atom makes a transition from the upper level to the lower level?

$$E = 2.3 \text{ eV}$$

$$= 2.3 \times 1.6 \times 10^{-19}$$

$$= 3.68 \times 10^{-19} \text{ J}$$

$$\therefore \nu = \frac{E}{h}$$

$$= \frac{3.68 \times 10^{-19}}{6.62 \times 10^{-32}} = 5.55 \times 10^{14} \text{ Hz}$$

4. The ground state energy of hydrogen atom is –13.6 eV. What are the kinetic and potential energies of the electron in this state?
Ans: - Kinetic energy is equal to the negative of the total energy.
Kinetic energy = − E = − (− 13.6) = 13.6 eV

Potential energy is equal to the negative of two times of kinetic energy.
Potential energy = − 2 × (13.6) = − 27 .2 eV

5. A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n = 4 level. Determine the wavelength and frequency of photon.

Ans: - energy in ground state = - 13.6 eV.
Energy in n = 4 = -13.6/16 = 0.85 eV
Amount of energy absorb by photon = $E_2 – E_1$ = 12.75 eV = 12.75 x 1.6 x 10^{-19} J = 2.04 x 10^{-18} J

$$\therefore \lambda = \frac{hc}{E} = \frac{6.6\times10^{-34}\times3\times10^{8}}{2.04\times10^{-18}} = 9.7\times10^{-8}\ \text{m} = 97\ \text{nm}$$

$$\nu = \frac{c}{\lambda} = \frac{3\times10^{8}}{9.7\times10^{-8}} \approx 3.1\times10^{15}\ \text{Hz}$$

6. (a) Using the Bohr's model calculate the speed of the electron in a hydrogen atom in the n = 1, 2, and 3 levels. (b) Calculate the orbital period in each of these levels.

As we have, $v_n = \frac{ze^2}{2\epsilon_0 nh}$

Hence, the speed in n = 1, n=2, and n=3 is 2.18 × 10^6m/s, 1.09 × 10^6 m/s, 7.27 × 10^5 m/s respectively.

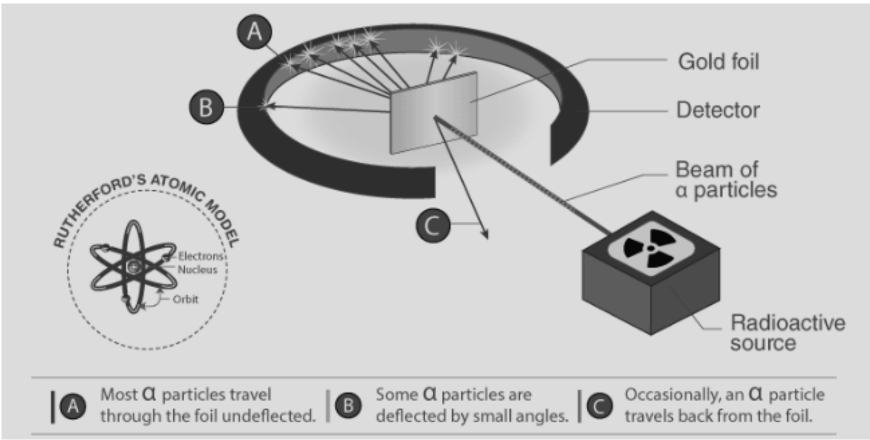
$$\therefore T_1 = \frac{2\pi r_1}{v_1} = \frac{2\pi\times(1)^2\times(6.62\times10^{-34})^2\times8.85\times10^{-12}}{2.18\times10^{6}\times\pi\times9.1\times10^{-31}\times(1.6\times10^{-19})^2} = 15.27\times10^{-17} = 1.527\times10^{-16}\ s$$

$$\therefore T_2 = \frac{2\pi r_2}{v_2} = \frac{2\pi\times(2)^2\times(6.62\times10^{-34})^2\times8.85\times10^{-12}}{1.09\times10^{6}\times\pi\times9.1\times10^{-31}\times(1.6\times10^{-19})^2} = 1.22\times10^{-15}\ s$$

$$\therefore T_3 = \frac{2\pi r_3}{v_3} = \frac{2\pi\times(3)^2\times(6.62\times10^{-34})^2\times8.85\times10^{-12}}{7.27\times10^{5}\times\pi\times9.1\times10^{-31}\times(1.6\times10^{-19})^2} = 4.12\times10^{-15}\ s$$

CASE STUDY BASED QUESTIONS:

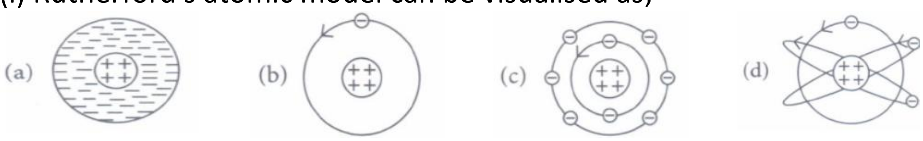
1. In 1911, Rutherford, along with his assistants, H. Geiger and E. Marsden, performed the alpha particle scattering experiment. H. Geiger and E. Marsden took radioactive source ($^{214}_{83}$Bi) for a-particles. A collimated beam of a-particles of energy 5.5 MeV was allowed to fall on 2.1 x 10^{-7} m thick gold foil. The α-particles were observed through a rotatable detector consisting of a Zinc sulphide screen and microscope. It was found that a-particles got scattered. These scattered a-particles produced scintillations on the zinc sulphide screen. Observations of this experiment are as follows.



(I) Most of the a-particles passed through the foil without deflection.
(II) Only about 0.14% of the incident a-particles scattered by more than 1°.
(III) Only about one a-particle in every 8000 a-particles deflected by more than 90°.

These observations led to many arguments and conclusions which laid down the structure of the nuclear model of an atom.

(i) Rutherford's atomic model can be visualised as;



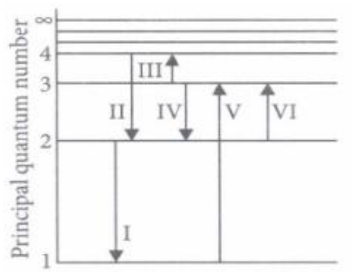
(ii) Gold foil used in Geiger-Marsden experiment is about 10^{-8} m thick. This ensures
(a) gold foil's gravitational pull is small or possible
(b) gold foil is deflected when a-particle stream is not incident centrally over it
(c) gold foil provides no resistance to passage of a-particles
(d) most a-particle will not suffer more than 1° scattering during passage through gold foil
(iii) In Geiger-Marsden scattering experiment, the trajectory traced by an a-particle depends on
(a) number of collision (b) number of scattered a- particles
(c) impact parameter (d) none of these
(iv) In the Geiger-Marsden scattering experiment, in case of head-on collision, the impact parameter should be
(a) maximum (b) minimum (c) infinite (d) zero

Or

(v) The fact only a small fraction of the number of incident particles rebound back in Rutherford scattering indicates that
(a) number of a-particles undergoing head-on-collision is small
(b) mass of the atom is concentrated in a small volume
(c) mass of the atom is concentrated in a large volume
(d) both (a) and (b).

Ans: (i) d, (ii) d (iii) c (iv) d (v) d

2. Bohr's model explains the spectral lines of hydrogen atomic emission spectrum. While the electron of the atom remains in the ground state, its energy is unchanged. When the atom absorbs one or more quanta of energy, the electrons moves from the ground state orbit to an excited state orbit that is further away. The given figure shows an energy level diagram of the hydrogen atom. Several transitions are marked as I, II, III and so on. The diagram is only indicative and not to scale.



(i) In which transition is a Balmer series photon absorbed?
(a) II (b) III (c) IV (d) VI
(ii) The wavelength of the radiation involved in transition II is
(a) 291 nm (b) 364 nm (c) 487 nm (d) 652 nm
(iii) Which transition will occur when a hydrogen atom is irradiated with radiation of wavelength 103 nm?
(a) I (b) II (c) IV (d) V
(iv) The electron in a hydrogen atom makes a transition from $n = n_1$ to $n = n_2$ state. The time period of the electron in the initial state is eight times that in the final state. The possible values of n1 and n2 are
(a) $n_1 = 4, n_2 = 2$ (b) $n_1 = 8, n_2 = 2$ (c) $n_1 = 8, n_2 = 3$ (d) $n_1 = 6, n_2 = 2$

Or

(v) The Balmer series for the H-atom can be observed
(a) if we measure the frequencies of light emitted when an excited atom falls to the ground state
(b) if we measure the frequencies of light emitted due to transitions between excited states and the first excited state.
(c) in any transition in a H-atom
(d) none of these.

Ans: (i) d, (ii) c (iii) d (iv) a (v) b

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