

NCERT Examples (ATOM) Ch 12

Ex. 1.

Given,

Radius of nucleus $r_n = 10^{-15} \text{ m}$

Radius of electron's orbit $r_e = 10^{-10} \text{ m}$

Radius of sun $R_s = 7 \times 10^8 \text{ m}$

Radius of earth's orbit $R_E = ?$

As dimensions ratio of solar system is same to atom's dimension, then

$$\frac{r_n}{r_e} = \frac{R_s}{R_E}$$

$$R_E = \frac{r_e \times R_s}{r_n}$$

$$= \frac{10^{-10} \times 7 \times 10^8}{10^{-15}}$$

$$= 7 \times 10^{-10+15+8}$$

$$R_E = 7 \times 10^{13} \text{ m}$$

In actual $R'_E = 1 \text{ A.U.} = 1.5 \times 10^{11} \text{ m}$

$$\frac{R_E}{R'_E} = 10^2$$

$$R_E = 10^2 \times \text{Actual } R_E$$
$$= 100 \text{ times}$$

i.e. An atom contains a much greater fraction of empty space than our solar system.

Ex.2 Given,

$$K = 7.7 \text{ MeV}$$

$$K = 7.7 \times 10^6 \times 1.6 \times 10^{-19} \text{ J}$$

By conservation of energy

$$K = U = \frac{k q_1 q_2}{r}$$

here $q_1 = 2e$, $q_2 = Ze$

$r \rightarrow d \rightarrow$ distance of closest approach

$$K = \frac{k(2e)(Ze)}{d}$$

$$K = \frac{k(2Ze^2)}{d}$$

$$\text{or } d = \frac{k \times 2Ze^2}{K}$$

$$= \frac{9 \times 10^9 \times 2 \times 79 \times (1.6 \times 10^{-19})^2}{7.7 \times 10^6 \times 1.6 \times 10^{-19}}$$

$$= \frac{18 \times 79 \times 16}{7.7} \times 10^{9-19-6}$$

$$= \frac{1422 \times 16}{77} \times 10^{-16}$$

$$= \frac{22752}{77} \times 10^{-16}$$

$$= 295.4 \times 10^{-16}$$

$$= 29.5 \times 10^{-15}$$

$$\approx 30 \times 10^{-15}$$

$$d = 30 \text{ fm} \quad [1 \text{ fm} = 10^{-15} \text{ m}]$$

But the actual radius of gold nucleus = 6 fm and $30 \text{ fm} \gg 6 \text{ fm}$. The reason of this discrepancy is electrostatic repulsion, due to which α particle reverses its motion without touching the nucleus of gold.

Ans

12.3 Given,

$$E = -13.6 \text{ eV}$$

$$E = -13.6 \times 1.6 \times 10^{-19} \text{ J}$$

$$R = ? , \quad \theta = ?$$

We have $E = \frac{-e^2}{8\pi\epsilon_0 R}$

$$E = \frac{-ke^2}{2R} \quad \left[k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 \text{e}^{-2} \right]$$

$$R = \frac{-ke^2}{2E}$$

$$= \frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{2 \times 13.6 \times (1.6 \times 10^{-19})}$$

$$R = \frac{9 \times 10^{-10}}{2 \times 13.6}$$

$$R = \frac{9 \times 10^{-10}}{17}$$

$$= \frac{90}{17} \times 10^{-11}$$

$$R = 5.3 \times 10^{-11} \text{ m} \quad \underline{\text{Ans}}$$

velocity

$$v^2 = \frac{e^2}{4\pi\epsilon_0 m r}$$

$$= \frac{k e^2}{m r} \quad \left[\frac{k e^2}{r} = 2E \right]$$

$$v^2 = \frac{2E}{m}$$

$$= \frac{2 \times 13.6 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}} \quad [m_e = 9.1 \times 10^{-31} \text{ kg}]$$

$$= \frac{272 \times 1.6 \times 10^{12}}{9.1}$$

$$= 3 \times 1.6 \times 10^{12}$$

$$\sqrt{484} \rightarrow 22$$

$$v^2 = 4.8 \times 10^{12}$$

$$v^2 = 480 \times 10^{10}$$

$$v = 22 \times 10^5$$

$$v = 2.2 \times 10^6 \text{ m/s}$$

Ans

12.4

We have for hydrogen atom

$$r = 5.3 \times 10^{-11} \text{ m}$$

$$v = 2.2 \times 10^6 \text{ m/s}$$

$$T = \frac{2\pi r}{v}$$

$$\text{or } v = \frac{v}{2\pi r} \quad \left[v = \frac{1}{T} \right]$$

$$= \frac{2.2 \times 10^6 \times 7}{20 \times 22 \times 5.3 \times 10^{-11}}$$

$$= \frac{7 \times 10^{17}}{106}$$

$$= \frac{700 \times 10^{15}}{106}$$

$$\nu \approx 6.6 \times 10^{15} \text{ Hz}$$

Ans

$$106 \overline{) 700} \quad (6 \cdot 60)$$

636

648

636

0400

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