NCERT Examples (ATOM)

Ex 1. Given,
Radius of nucleus $r_n = 10^{-15}$ m
Radius of electron's orbit $r_e = 10^{-10}$ m
Radius of sun $R_S = 7 \times 10^{8}$ m
Radius of earth's orbit $R_E = ?$
As dimensions ratio of solar system is same to atom's dimension, then

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

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

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

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

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

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

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

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

$= 100$ times

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

Ex.2 Given,

$K = 7.7\ MeV$

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

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

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

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

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

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

$$= \frac{18 \times 79 \times 1.6}{7.7} \times 10^{9-19-6}$$

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

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

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

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

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

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

But the actual radius of gold nucleus = 6 fm and 30 fm >> 6 fm. The reason of this discripancy is electrostatic repulsion due to which α particle reverses its motion without touching the nucleus of gold.

12.3 Given,

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

$r = ?$, $v = ?$

We have $E = \dfrac{-e^2}{8\pi\epsilon_0 r}$

$$E = \frac{-ke^2}{2r} \quad \left[k = \frac{1}{4\pi\epsilon_0} = 9\times10^9 Nm^2C^{-2}\right]$$

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

$$= \frac{-9\times10^9 \times (1.6\times10^{-19})^2}{-2\times13.6\times(1.6\times10^{-19})}$$

$$r = \frac{9\times1.6}{2\times13.6}\times10^{-10}$$

$$r = \frac{9\times10^{-10}}{17}$$

$$= \frac{90}{17}\times10^{-11}$$

$$r = 5.3\times10^{-11} \text{ m}$$

Velocity

$$v^2 = \frac{e^2}{4\pi\varepsilon_0 m r}$$

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

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

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

$$= \frac{272 \times 1.6 \times 10^{12}}{91}$$

$$= 3 \times 1.6 \times 10^{12} \qquad \sqrt{484} \rightarrow 22$$

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

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

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

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

12.4 We have for hydrogen atom

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

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

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

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

$$= \frac{2.2 \times 10^6 \times 7}{2 \times 22 \times 5.3 \times 10^{-11}}$$

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

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

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

Ans

$$106)\,700\,(6.60$$
$$636$$
$$640$$
$$636$$
$$0400$$