

## Some Important Points

**Impact parameter:** Perpendicular distance of initial velocity vector of  $\alpha$ -particles from the centre of the nucleus.

$$b = \frac{1}{4\pi\epsilon_0} \frac{Ze^2 \cot \theta/2}{\left(\frac{1}{2}mv^2\right)}$$

**Distance of closest approach:** Distance of a point from nucleus at which  $\alpha$ -particle is nearest to the centre of nucleus.

$$r_0 = \frac{1}{4\pi\epsilon_0} \frac{2Ze^2}{\left(\frac{1}{2}mv^2\right)}$$

**Bohr radius:** First orbit of hydrogen atom, called Bohr radius ( $a_0$ ).

**Ground state:** Lowest state of atom, called the ground state, is the state in which electron revolves in the orbit of smallest radius, the Bohr radius,  $a_0$ .

**Ionization energy:** Minimum energy required to free an electron from the ground state of hydrogen atom is called the ionization energy.

## BOHR'S MODEL

### Postulates

$$(a) \quad \frac{q^2}{4\pi\epsilon_0 r^2} = \frac{mv^2}{r}$$

$$(b) \quad mvr = \frac{nh}{2\pi}$$

$$(c) \quad E_i - E_f = h\nu = \frac{hc}{\lambda}$$

$$\text{Radius of } n\text{th orbit, } r_n = \frac{\epsilon_0 h^2 n^2}{\pi m e^2 Z} \Rightarrow r_n \propto \frac{n^2}{Z}$$

$$\text{Orbital speed, } v_n = \frac{nh}{2\pi m r_n} = \frac{Ze^2}{2\epsilon_0 hn} \Rightarrow v_n \propto \frac{Z}{n}$$

$$\text{Energy of } n^{\text{th}} \text{ orbit, } E_n = -\frac{me^4 Z^2}{8\epsilon_0^2 h^2 n^2} \Rightarrow E_n \propto \frac{Z^2}{n^2}$$

Note: Total energy of the  $e^-$  in an atom is negative, that implies it is bound.

Total Energy = -Kinetic Energy

Potential Energy =  $2 \times$  Total Energy

## Spectral Series

$$\frac{1}{\lambda} = RZ^2 \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

where,  $R$  = Rydberg's constant,  $R = \frac{me^4}{8\epsilon_0^2 h^3 c} = 1.09 \times 10^7 \text{ m}^{-1}$

- (i)  $n_1 = 1, n_2 = 2, 3, \dots$  for Lyman series (UV region)
- (ii)  $n_1 = 2, n_2 = 3, 4, \dots$  for Balmer series (visible region)
- (iii)  $n_1 = 3, n_2 = 4, 5, \dots$  for Paschen series (Infra-red region)
- (iv)  $n_1 = 4, n_2 = 5, 6, \dots$  for Brackett series (Infra-red region)
- (v)  $n_1 = 5, n_2 = 6, 7, \dots$  for Pfund series (Infra-red region)