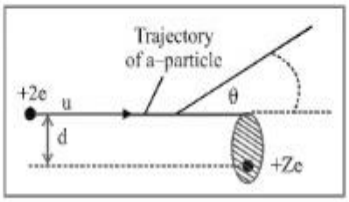
Impact Parameter of the alpha particle is defined as the perpendicular distance of the velocity vector of the alpha particle from the centre of the nucleus, when it is far away from the atom. It is denoted by b.

$$b = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2 \cot\theta/2}{1/2\, mu^2}$$



8.5 Discussion

The following interference can be drawn from the above equation:

1. If the impact parameter b is large, then cot θ/2 is also large i.e. the angle of scattering θ is small and vice-versa.

   Thus, if an α-particle has large impact parameter, it gets scattered through a very small angle and may practically go undeviated and if the α-particle has small impact parameter, it will be scattered through a large angle.

2. If the impact parameter b is zero, then cot θ/2 = 0 or θ/2 = 90° or θ = 180°.

9. PHOTON

A photon is a packet of energy. It possesses energy given by, $E = h\upsilon$

Where $h = 6.62 \times 10^{-34}$ Js is Plank's constant and υ is frequency of the photon. If λ is wavelength of the photon, then, $c = \upsilon\lambda$

Hence, $c = 3 \times 10^8$ ms^{-1} Js velocity of light. Therefore, $E = h\upsilon = hc/\lambda$.

Energy of a photon is usually expressed in electron volt (eV).

$1eV = 6 \times 10^{-19}$ J

The bigger units are keV and MeV.

$1keV = 1.6 \times 10^{-16}$ and $1\ MeV = 1.6 \times 10^{-13}$ J

10. BOHR ATOMIC MODEL

Bohr adopted Rutherford model of the atom & added some arbitrary conditions. These conditions are known as his postulates :

(i) The electron in a stable orbit does not radiate energy . i.e.

$$\frac{mv^2}{r} = \frac{kze^2}{r^2}$$

(ii) A stable orbit is that in which the angular momentum of the electron about nucleus is an integral (n) multiple of $\frac{h}{2\pi}$. i.e. $mvr = n\frac{h}{2\pi}$; $n = 1, 2, 3, \ldots\ldots (n \neq 0)$.

(iii) The electron can absorb or radiate energy only if the electron jumps from a lower to a higher orbit or falls from a higher to a lower orbit.

(iv) The energy emitted or absorbed is a light photon of frequency ν and of energy **E = hν**.

10.1 For hydrogen atom : (Z = atomic number = 1)

(i) L_n = angular momentum in the n^{th} orbit = $n\frac{h}{2\pi}$.

(ii) r_n = radius of n^{th} circular orbit = $(0.529\,A^\circ)\,n^2$; $(1A^\circ = 10^{-10}\,m)$; $r_n \propto n^2$.

(iii) E_n Energy of the electron in the n^{th} orbit = $\frac{-13.6\,eV}{n^2}$ i.e.

$$E_n \propto \frac{1}{n^2}.$$

Note

Total energy of the electron in an atom is negative, indicating that it is bound.

Binding Energy $(BE)_n = -E_n = \frac{13.6V}{n^2}$.

(iv) $E_{n_2} - E_{n_1}$ = Energy emitted when an electron jumps from n_2^{th} orbit to n_1^{th} orbit $(n_2 > n_1)$.

$$\Delta E = (13.6\ ev)\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right].$$

$\Delta E = h\nu$; ν = frequency of spectral line emitted .

$\frac{1}{\lambda} = \nu$ = wave no. [no. of waves in unit length (1m)]

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

Where R = Rydberg's constant for hydrogen = 1.097×10^7 m^{-1}.

(v) For hydrogen like atom/species of atomic number Z :

$$r_n = \frac{\text{Bohr radius}}{Z} n^2 = (0.529A^\circ)\frac{n^2}{Z};$$

$$E_n = (-13.6)\frac{Z^2}{n^2} ev$$

$R_y = RZ^2$ – Rydberg's constant for element of atomic no. Z.