Radioactivity: It is found that the nuclide of some elements having high atomic number (Z > 82) , break spontaneously into nuclide of lighter element by emitting α particle, β particle γ particle etc.

This spontaneous disintegration of nuclides is known as natural radioactivity.

Elements with higher nuclides such as $14C_6$ is also radioactive. Radioactivity is essentially a nuclear phenomenon and the orbital electrons do not play any role in the radioactive emission.

The particle, β particle & γ particle as Becquerel rays.

Law of radioactive decay: Soddy and Fagan gave the following two laws for radioactive Disintegration.

1. The rate of radioactive disintegration depends on the nature of the radioactive element and is different for different elements.
2. The rate of radioactive disintegration at any instant of time is proportional to the number of radioactive atoms present at that instant of time.

Let N_0 = The number of radio active atoms present in the sample at an instant of time t = 0

N = The number of radio active atoms present in the sample at an instant of time t

N - dN = N_0 = The number of radio active atoms present in the sample at an instant of time t + dt

dN = The number of radio active atoms disintegrating in time dt at an instant of time t

$$\therefore -\frac{dN}{dt} \propto N$$

$$\frac{dN}{dt} = -\lambda dt \rightarrow (1)$$

λ = constant of proportionality known as decay constant or disintegration constant.

$$\frac{dN}{N} = -\lambda dt$$

Integrating both sides:

$$\log_e N = -\lambda t + A \rightarrow (2)$$

Where A is constant of integration. At t = 0, N = N_0 from equation (2)

$$\log_e N_0 = -\lambda \times 0 + A$$

$$or\ A = \log_e N_0 \rightarrow (3)$$

Putting equation (3) in (2)

$$\log_e N = -\lambda t + \log_e N_0$$

$$\log_e \frac{N}{N_0} = -\lambda t$$

$$\frac{N}{N_0} = e^{-\lambda t}$$

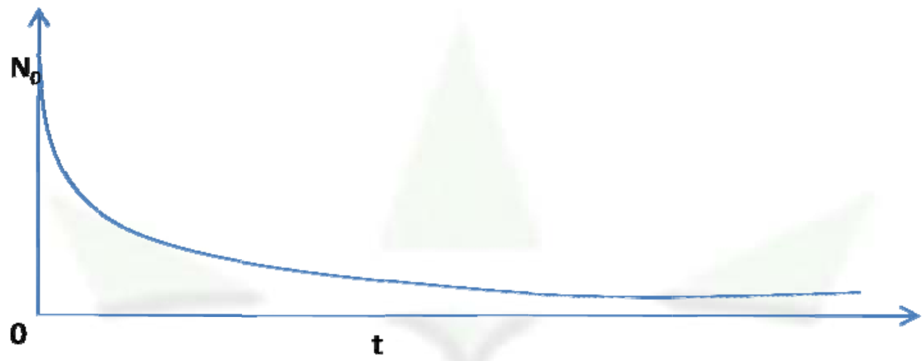
$$N = N_0 e^{-\lambda t} \rightarrow (4)$$

Using equation (4) the number of radio active atoms present at any instant t can be calculated.

Half life period: The number of radioactive nuclides present in the sample at any instant of time t is given by

$$N = N_0 e^{-\lambda t} \rightarrow (1)$$

From equation (1) we find that at $t = 0$, $N = N_0$ and $t = \infty$, $N = 0$



Thus all the radioactive nuclides disintegrate completely after infinite long time. Hence to get an idea about the longevity of the sample we define half life period.

"Half life period of a radioactive element is defined as the time during which half of the radioactive atoms present in the specimen disintegrated."

Let at $t = 0$, $N = N_0$ be the number of radioactive atoms present in the sample.

at $t = T$, $N = \frac{N_0}{2}$ = Half of the original radioactive atom present in the sample, then T is known as half life.

From equation (1) : $\frac{N_0}{2} = N_0 e^{-\lambda t}$

Taking log of both sides $-\log_e 2 = -\lambda T$

$$T = \frac{\log_e 2}{\lambda} = \frac{0.693}{\lambda} \rightarrow (2)$$

Equation (2) gives the half life period.