Types of radioactivity:

1. Natural radioactivity:

The Process in which highly penetrating radiations are emitted from heavy elements ($A > 206$) occurring in nature is called as natural radioactivity.

$$_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_{2}He^{4}$$

2. Artificial radioactivity:

The process in which radioactivity can be induced in a substance by artificial means (by bombardment with high-speed particles such as protons or neutrons) is called as artificial radioactivity.

$$_{0}n^{1} + {}_{7}N^{14} \longrightarrow {}_{6}C^{14} + {}_{1}H^{1}$$

Stable *Unstable*

$$_{6}C^{14} \longrightarrow {}_{7}N^{14} + {}_{-1}e^{0} + \bar{\nu} \qquad (Beta\ decay)$$

Decay Law and Decay Equation:

Let N_0 be the number of atoms present in the radioactive sample at time t = 0 and N be the number of atoms left after time t.

Then, the rate of disintegration, $\frac{dN}{dt}$ is proportional to N.

i.e., $\frac{dN}{dt} \propto N$

or, $\boxed{\frac{dN}{dt} = -\lambda N \ldots \ldots \ldots (1)}$

Where λ is a constant of proportionality called as disintegration constant or decay constant.

The negative sign indicates that N decreases as time increases.

The number of disintegrations per second, dN/dt is called the activity of the radioactive sample.

The equation (1) can be written as

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

Integrating the equation both sides, we get

or, $\int_{N_0}^{N} \frac{dN}{N} = -\lambda \int_{0}^{t} dt$

or, $[ln\, N]_{N_0}^{N} = -\lambda\, [t]_{0}^{t}$

or, $lnN - lnN_o = -\lambda t$

or, $ln\left(\frac{N}{No}\right) = -\lambda t$

$$\boxed{N = N_o\, e^{-\lambda t}}$$

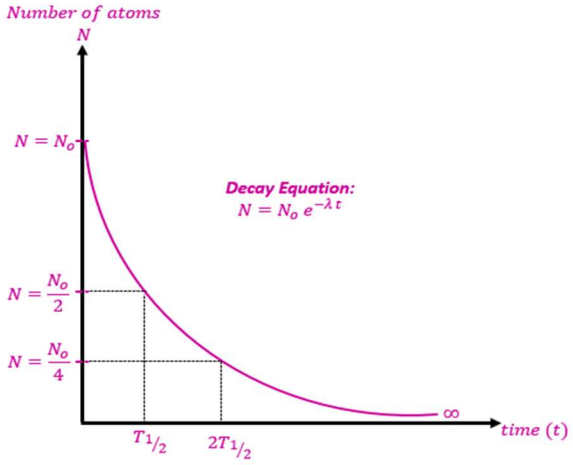

Figure: Decay Curve

This equation is known as decay equation.

It shows that number of atoms of a given substance decreases exponentially with time.

- Write the laws of radioactivity and hence establish decay equation. Interpret the law graphically.
- Why are gamma rays emitted only after the emission of alpha and beta rays?