Rate of radioactive decay.

"According to the law of radioactive decay, the quantity of a radioelement which disappears in unit time (rate of disintegration) is directly proportional to the amount present."

The law of radioactive decay may also be expressed mathematically.

Suppose the number of atoms of the radioactive element present at the commencement of observation, i.e. when $t = 0$ is N_0, and after time t, the number of atoms remaining unchanged is N_t, then the rate of decay of atoms is $-\frac{dN_t}{dt}$ (the word 'd' indicates a very-very small fraction; the negative sign shows that the number of atoms N_t decreases as time t increases)

Now since the change in number of atoms is proportional to the total number of atoms N_t, the relation becomes $\boxed{-\frac{dN_t}{dt} = \lambda N_t}$, where λ is a radioactive constant or decay constant.

- Rate of decay of nuclide is **independent** of temperature, so its energy of activation is zero.
- Since the rate of decay is directly proportional to the amount of the radioactive nuclide present and as the number of undecomposed atom decreases with increase in time, the rate of decay also decreases with the increase in time. Various forms of equation for radioactive decay are,

$$N_t = N_0 e^{-\lambda t};\ \log N_0 - \log N_t = 0.4343\ \lambda t\ ;\ \log \frac{N_0}{N_t} = \frac{\lambda t}{2.303}$$

$$\boxed{\lambda = \frac{2.303}{t} \log \frac{N_0}{N_t}}$$

Where $N_0 =$ Initial number of atoms of the given nuclide, i.e. at time 0

$N_t =$ Number of atoms of that nuclide present after time t.

$\lambda =$ Decay constant

Note: This equation is similar to that of first order reaction, hence we can say that radioactive disintegration are examples of first order reactions. However, unlike first order rate constant (K), the decay constant (λ) is independent of temperature.

Decay constant (λ): The ratio between the number of atoms disintegrating in unit time to the total number of atoms present at that time is called the decay constant of that nuclide.

Characteristics of decay constant (λ)**:**

- It is characteristic of a nuclide (not for an element).
- Its units are time^{-1}.
- Its value is always less than one.