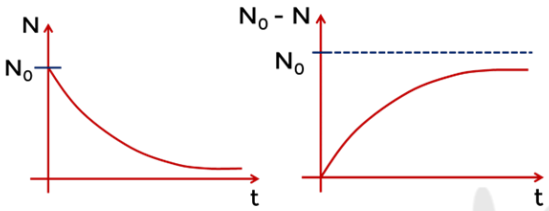
MIND MAP

Radioactivity

Law of Radioactivity

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

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



Number of nuclei decayed $= N_0 - N$

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

Spontaneous Decay

$A \xrightarrow{\lambda_1} B \quad A \xrightarrow{\lambda_2} C$

$$\frac{dN_A}{dt} = -(\lambda_1 + \lambda_2)N_A$$

$$N_A = N_0 e^{-(\lambda_1+\lambda_2)t}$$

$\lambda_1 \longrightarrow N_B \quad \frac{\lambda_1}{\lambda_1+\lambda_2} N_0(1 - e^{-(\lambda_1+\lambda_2)t})$

$\lambda_2 \longrightarrow N_C \quad \frac{\lambda_2}{\lambda_1+\lambda_2} N_0(1 - e^{-(\lambda_1+\lambda_2)t})$

Half Life ($T_{1/2}$)

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

$$N = \frac{N_0}{2^{\frac{t}{t_{1/2}}}}$$

Mean or Average Life (T_a)

$$T_{avg} = \frac{\text{Sum of ages of all nuclei}}{\text{Number of nuclei}}$$

$$T_a = \frac{1}{\lambda}$$

Spontaneous decay of unstable nuclei is called radioactivity.

$$A = \left|-\frac{dN}{dt}\right|$$

α- decay

$${}^{m_x}_{Z}X \longrightarrow {}^{m_y}_{Z-2}Y + {}^{m_{He}}_{2}He + \gamma - \text{rays}$$

Q-value $= (m_x - m_y - m_Z)\,c^2$

Q-value = KE of products + Energy of γ-rays

γ – Decay

${}^{A}_{Z}X \longrightarrow {}^{A}_{Z}X + \gamma - \text{rays}$

β⁻ Decay

${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \bar{\nu}$

Q value $= (m_x - m_y)\,c^2$

$0 < KE_{electron} < Q\text{-value}$

$0 \le E_{\bar{\nu}} < Q\text{-value}$

K-capture

${}^{A}_{Z}X + {}^{0}_{-1}e \rightarrow {}^{A}_{Z-1}Y + \nu$

Q-value $= (m_x - m_y)\,c^2$

β⁺-decay

${}^{m_x}_{Z}X \longrightarrow {}^{m_y}_{Z-1}Y + {}^{m_e}_{+1}e$

Q-value $= (m_x - m_y - 2m_e)\,c^2$

Nuclear Fission

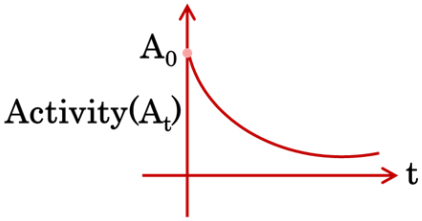
$${}^{235}U + {}^{0}_{1}n \rightarrow X + Y + \underbrace{(2 \text{ or } 3) \text{ neutrons}}_{\text{avg=2.5 neutrons}}$$

Nuclear Fusion

Light nuclei fuse (combine) together in nuclear fusion reaction. Energy released in fusion is much more than in fission per nucleon.

Activity

$$A = \lambda N$$



$$\Rightarrow A = \frac{A_0}{2^{t/t_{1/2}}} \qquad A = A_0 e^{-\lambda t}$$

SI unit is Becquerel (Bq)

1 becquerel (1 Bq)=1 decay/sec

Other unit is curie

1 Ci = 3.70×10^{10} decays/sec