Formulas

(Bq) (decay constant, s^{-1})

① $A = \lambda N$

Acitivity of nucleus when N number of nucleons are present

② $A = A_0 e^{-\lambda t}$

Activity after time, t

initial activity

③ $N = N_0 e^{-\lambda t}$

# of nucleons after time, t

initial nucleons.

④ $t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$

$\frac{\cancel{N_0}}{2} = \cancel{N_0} e^{-\lambda t_{\frac{1}{2}}}$

Binding energy

The energy required to seperate the nucleons to infinity

$$\underbrace{E}_{\text{Binding energy}} = \underbrace{\Delta m}_{\text{mass defect}} \underbrace{c^2}_{\text{speed of light}}$$

① Finding mass defect of a nucleus.

$$\Delta m = \text{Total mass} - (\underbrace{M_p}_{\text{mass of proton}} \underbrace{N_p}_{\text{number of proton}} + \underbrace{M_n}_{\text{mass of neutron}} \underbrace{N_n}_{\text{number of nutrons}})$$

* All the values of is used from a given table.

* Binding energy of a neutron/proton is 0, because it is not binded with any other particle

② finding energy released from a reaction.

Reactants $\longrightarrow$ Products

$\Delta M_{reaction} = \Delta M_{products} - \Delta M_{reactants}$

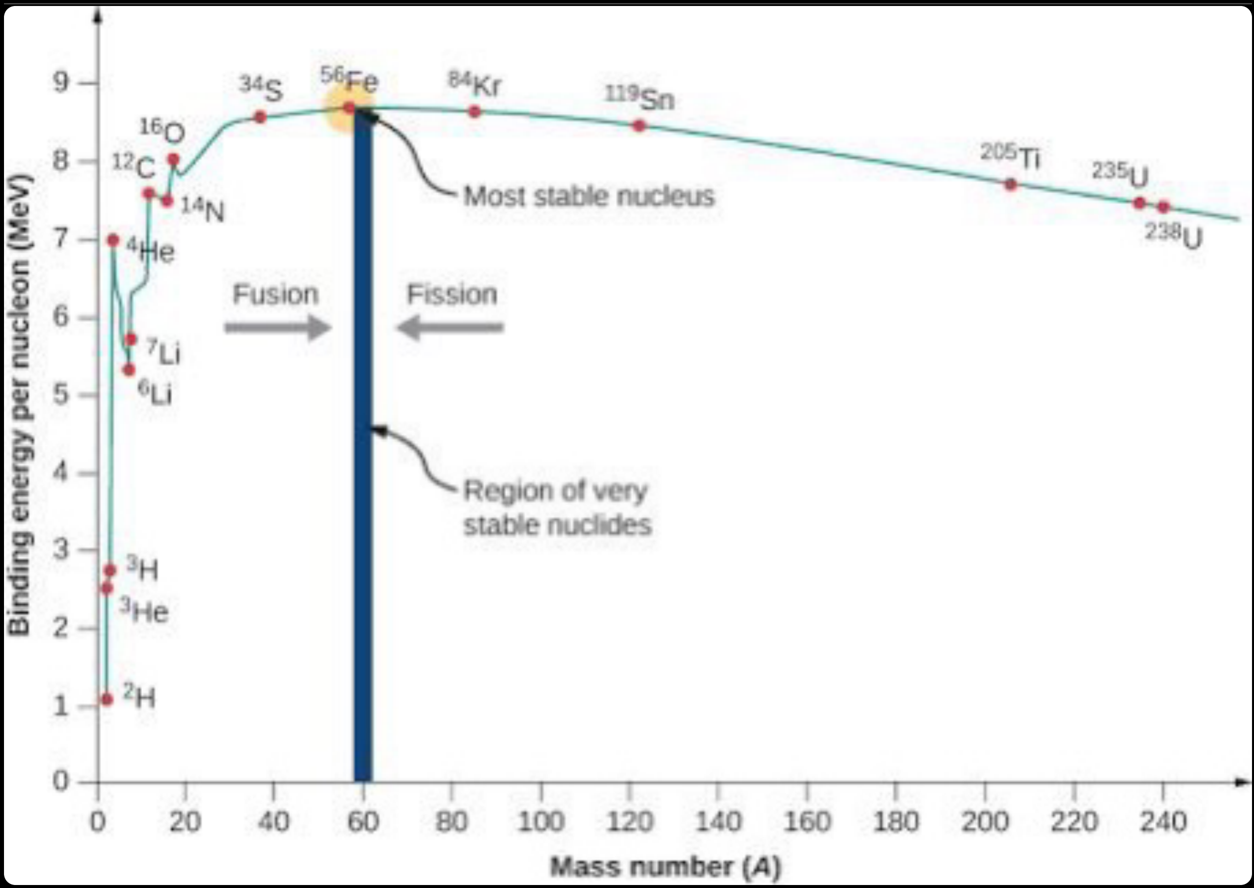
$\therefore$

$E = \Delta M_{reaction} \times c^2$

* Fusion : Two or more lighter nuclei combine together to form a heavier nucleus

* Fission : A heavier nucleus will decay into lighter nuclei's

Curve question



$\Delta m_{fission} = \Delta m_p - \Delta m_r > 0$

$\Delta m_{fusion} = \Delta m_p - \Delta m_r < 0$

Fig. 7.1

One particular fission reaction may be represented by the nuclear equation

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^{1}_{0}n.$$

(i) On Fig. 7.1, label the approximate positions of

1. the uranium ($^{235}_{92}U$) nucleus with the symbol U.
2. the barium ($^{141}_{56}Ba$) nucleus with the symbol Ba.
3. the krypton ($^{92}_{36}Kr$) nucleus with the symbol Kr.

[2]

$\Delta m_p - \Delta m_r > 0$

$BE_p - BE_r > 0$

$\boxed{BE_p > BE_r}$

(ii) The neutron that is absorbed by the uranium nucleus has very little kinetic energy. Explain why this fission reaction is energetically possible.

$B.E = A \cdot E_B$

A → Number of nucleus

E_B → B.E / nucleon

B.E of U < B.E of (Ba + Kr) [2]

Extra info:

Fission $\left\{ \text{BE of reactant} < \text{BE of product} \right.$

Fussion $\left\{ \text{BE of reactant} > \text{BE of product} \right.$

Decay Constant

Probability for a nucleus to undergo a decay per unit time.

Decay (by α, β, γ)

gamma

Spontaneous

- The process is not triggered by any environmental factor for eg. temp, pressure.

Random

- There is no way to tell which nucleus will decay and cannot predict when it will decay

Radioactivity, it is a spontaneous and random decay of an unstable nucleus, accompanied by emmission of energetic particles or photons

Half-life

- The time at which the nucleans becomes half of initial value.

when $N = \frac{N_0}{2}$

then $t = t_{1/2}$

$\therefore$ when $N = \frac{N_0}{2}$

$$N = N_0 e^{-\lambda t_{1/2}}$$

$$\frac{N_0}{2} = N_0 e^{-\lambda t_{1/2}}$$

$$\ln \frac{N_0}{2} = \ln N_0 - \lambda t_{\frac{1}{2}} \ln e$$

$$\ln \frac{N_0}{2} = \ln N_0 - \lambda t_{\frac{1}{2}}$$

$$\lambda t_{\frac{1}{2}} = \ln \frac{N_0}{\frac{N_0}{2}}$$

$$\lambda t_{1/2} = \ln 2$$

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