10th April Nuclear physics discussion solutions

(1) No. of neutrons release per fission = x.

x for U^{235} = 2.48

x for Pu^{239} = 2.92

As neutrons from fission escape from surface lesser the surface Area lesser the chances of escape from material.

Sphere has least surface Area for given volume.

x more means lesser the critical mass for given shape.

$\therefore$ Pu^{239} sphere has least critical mass.

Ans: 2.

plane sheet has largest surface Area $\therefore$ larger critical mass

(2) Nuclear forces are short range hence includes only neighbours. If electromagnetic forces were absent on a particular nucleon strong nuclear force after reaching certain value, remains constant.

$\therefore$ B.E/nucleon first increases then remain constant. Due to electromagnetic forces B.E/nucleon after reaching maximum, starts decreasing.

(3) $A \rightarrow B + C$ (free) to conserve momentum energy generates due to mass decrease.

$\therefore m_A > (m_B + m_C)$

If 'A' were bound in nucleus, m_A can be less than $m_B + m_C$ as internally energy changes can occur.

(4) Any radio active nucleus has life time zero to infinity.

Law of disintegration is valid only when sample contains large number.

(5) $R_1 = \lambda N_1 \Rightarrow N_1 = R_1/\lambda$

$R_2 = \lambda N_2 \Rightarrow N_2 = R_2/\lambda$

$\therefore$ No of disintegration (or) No of β^- (or) No. of $\bar{\nu}$ $= N_1 - N_2 = \frac{1}{\lambda}(R_1 - R_2)$

$= \frac{T}{\ln 2}(R_1 - R_2)$

(6) when no. of radio active nuclei reaches maximum

$P = \lambda N$

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

for N_{Max} $\frac{dN}{dt} = 0$

$N_{max} = P/\lambda$

upto that time Produced nuclei $= Pt$

$\therefore$ No of nuclei disintegrated $= Pt - P/\lambda$

$\therefore$ Total Energy released

$= P(t - 1/\lambda)E_0$

(7) M

$p = h/\lambda$ ← (●) m_d $p = h/\lambda$ ● → m_α

$KE_d = \frac{h^2}{2 m_d \lambda^2}$ $KE_\alpha = \frac{h^2}{2 m_\alpha \lambda^2}$

$$[M - (m_d + m_\alpha)] c^2 = \frac{h^2}{2\lambda^2}\left(\frac{1}{m_\alpha} + \frac{1}{m_d}\right)$$

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(8) Ans 2 & 3.

neutrino rest mass is negligibly small but not zero

for neutrino spin and momentum are in opposite directions but for $\bar{\nu}$ they are in same direction.

(9) $N_0 = \frac{m}{M} N_A$ $N = N_0 e^{-2} = N_0/e^2$

∴ Number of disintegration (No. of α particles emitted) $= N_0 - N = N_0(1 - 1/e^2)$

(10) If Activity ratio of α and β = x : y

Then probability of getting α and probability of getting β at an instant

i.e. are $\frac{x}{x+y}$ and $\frac{y}{x+y}$ respectively

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