S-II

(1) $$X^{200} \longrightarrow A^{110} + B^{90}$$

$\frac{BE}{nucleon}$ 7.4 MeV 8.2 MeV 8.2 MeV

total Energy exchange = $[7.4 \times 200] - [(110 \times 8.2) + (90 \times 8.2)]$

$\Rightarrow 1480 - 1640 = -160$ MeV

(2) Nuclear Reaction is :-

$${}^{2}_{1}H + {}^{2}_{1}H \longrightarrow {}^{4}_{2}He$$

$\frac{BE}{nucleon}$ 1.1 MeV 1.1 MeV 7 MeV.

total Energy exchange = $[(2 \times 1.1) + (2 \times 1.1)] - [7 \times 4]$

$\Rightarrow 4.4 - 28 \Rightarrow -23.6$ MeV.

(3) $${}^{a}_{c}X \longrightarrow {}^{b}_{d}Y + n_1 \alpha\, {}^{4}_{2}He + n_2 \times {}^{0}_{-1}e$$

$a = b + 4n_1$, $n_1 = \frac{a-b}{4}$

$c = d + 2n_1 - n_2$

$n_2 = d - c + 2\left(\frac{a-b}{4}\right)$

$n_2 = d + \frac{a-b}{2} - c$

Q4 Since after 10 sec, 50% of nuclie are decayed, therefore half life will be 10 sec.

(I) $t_{avg} = 1.44 \times t_{1/2} = 1.44 \times 10\,sec = 14.4\,sec.$

(II) Let undecayed nuclie $= N_0$,
Now we have to calculate the time by which it will further reduce to 6.25%, i.e from N_0 to $\frac{N_0}{16}$ (rest amount of nuclie after t time)

$$\lambda = \frac{\ln 2}{10} = \frac{1}{t} \ln \frac{N_0}{N_t}$$

$$\frac{\ln 2}{10} = \frac{1}{t} \ln \frac{N_0}{N_0/16}$$

$$t = \frac{\ln 16 \times 10}{\ln 2} = 40\,sec.$$

Q5

$$t_{1/2} = 40\text{ year}$$

$$\frac{N_0}{N_t} = \frac{W_0}{W_t}$$

$$\lambda = \frac{1}{t} \ln \frac{W_0}{W_t}$$

$$\frac{\ln 2}{t_{1/2}} = \frac{1}{20} \ln \frac{1}{W_t}$$

$$\frac{\ln 2}{40} = \frac{1}{20} \times \ln \frac{1}{W_t}$$

$$\frac{\ln 2}{2} = \ln \frac{1}{w_t}$$

$$\ln 2^{1/2} = \ln \frac{1}{w_t}$$

$$w_t = \frac{1}{\sqrt{2}} = 0.707 \text{ microgram.}$$

$$w_t = 7.07 \times 10^{-7} \text{ gm}$$

(6) $${}^{232}_{90}Th \longrightarrow {}^{208}_{82}Pb + 6\,{}^{4}_{2}He + 4\,{}^{0}_{-1}e$$

$t=0$, $928g$

$\Rightarrow 4 \text{ mol}$

$4-a \qquad a \qquad 6a$

$$4a = \frac{9.3 \times 10^{24}}{6 \times 10^{23}}$$

$$a = \frac{93}{6 \times 4} = 3.875$$

from I^{st} order Kinetics

$$\lambda = \frac{1}{t} \ln \frac{N_0}{N_t}$$

$$\frac{\ln 2}{T} = \frac{1}{t} \ln \frac{4}{4-a}$$

$$\frac{t}{T} = \frac{1}{\ln 2} \times \ln \frac{4}{4-3.875}$$

$$\frac{t}{T} = \frac{1}{\ln 2} \times \ln 32 = 5$$

Q 7

$$\frac{N_0}{N_t} = \frac{A_0}{A_t}$$

$$\lambda = \frac{1}{t} \times \ln \frac{A_0}{A_t}$$

$$\frac{\ln 2}{5770} = \frac{1}{t} \ln \frac{\cancel{15}\,5}{\cancel{12}\,4}$$

$$t = \frac{(\ln 5 - 2\times\ln 2)}{\ln 2} \times 5770$$

$$t = \frac{(1.6 - 0.7\times 2)}{0.7} \times 5770$$

$t = \underline{1648.6}$ year

Q 8 18 gm of H_2O has 2N hydrogen atoms in it and $H^3 : H^1$ is $8\times10^{-18} : 1$.

i.e 18 gm of H_2O contains $(8\times10^{-18} \times 6.023\times10^{23}\times2)$ H^3 atoms.

So 10 gm of H_2O contains $\left(8\times10^{-18}\times 6.023\times10^{23}\times\frac{2\times10}{18}\right)$ H^3 atom initially

$$t = \frac{1}{K} \ln \frac{N_0}{N}$$

$$3\cancel{36} = \frac{12}{\ln 2} \ln \frac{8\times10^{-18}\times 6.023\times10^{23}\times 2\times 10}{18\times N}$$

$$\ln 2^3 = \ln \frac{5.35\times10^6}{N}$$

$$N = \frac{5.35}{8}\times10^6 = 6.67\times10^5$$

Q9

$$Ac^{227} \xrightarrow{2\%} Th^{227}$$
$$Ac^{227} \xrightarrow{98\%} Fr^{223}$$

λ

$t_{1/2} = 22$ year

λ_1 = fraction of $Th^{227} \times \lambda$

$$= \frac{2}{100} \times \frac{\ln 2}{22} = 6.3 \times 10^{-4}\ yr^{-1}$$

$$\lambda_2 = \frac{98}{100} \times \frac{\ln 2}{22} = 3.087 \times 10^{-2}\ yr^{-1}$$

Q10

$$U \xrightarrow{\lambda_1} Th \xrightarrow{\lambda_2} Ra \xrightarrow{\lambda_3} Rn$$

$$\lambda_2 \times N_{Th} = 2(\lambda_3 \times N_{Ra})$$

$$\frac{\ln 2}{80,000} \times N_{Th} = 2 \times \frac{\ln 2}{1600} \times N_{Ra}$$

$$\frac{N_{Th}}{N_{Ra}} = \frac{160000}{1600} = \frac{100}{1}$$

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