Sem 1 (2009/2010) : Nuclear Reactions

Q3 (a) How does nuclear fission differ from nuclear fusion?

In nuclear fission, the atomic nuclei breaks appart into smaller nuclei.

eg. $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{94}_{36}Kr + {}^{139}_{56}Ba + 3\,{}^{1}_{0}n + \text{energy}$

Usually a smaller nuclei ($^{1}_{0}n$) is used to bombard a heavy nuclei ($^{235}_{92}U$). This results in the breaking up of the large/heavy nuclei into smaller daughter nuclei (ie $^{94}_{36}Kr$ & $^{139}_{58}Ba$ – daughter nuclei) and releasing energy in the process.

In nuclear fussion, small unstable nuclei join together to form a larger and more stable nuclei and releasing energy in the process.

eg. $^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{Energy}$

tritium deuterium

Q3 (b) (i) $^{131}_{53}I \longrightarrow {}^{131}_{54}Xe + {}^{0}_{-1}\beta + \gamma$

(ii) $\ln \frac{N_0}{N_t} = kt \quad ; \quad k = \frac{\ln 2}{t_{1/2}}$

$N_0 = 100$
$N_t = 10$
$t_{1/2} = 8.7$ day

$\ln\left(\frac{100}{10}\right) = \left(\frac{\ln 2}{8.7}\right) t$

$t = 28.89$ days

$t = 28.9$ days

Q3 (c) (i) Circulatory system:

$^{24}_{11}Na \longrightarrow {}^{0}_{-1}\beta + {}^{24}_{12}Mg$

Imaging tumors:

$^{0}_{-1}\beta + {}^{111}_{49}In \longrightarrow {}^{111}_{48}Cd$

(1½)

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Q3(c)(ii) Total time, $t = (50 + 12)$ hours
$= 62$ hours

$t_{1/2} = 15h$
$t = 62h$
$\frac{N}{N_0} = ?$

$$\ln\left(\frac{N_0}{N}\right) = kt$$
$$= \left(\frac{\ln 2}{15h}\right)(62h)$$
$$= 2.865$$
$$\frac{N_0}{N} = 17.59$$
$$\therefore \frac{N}{N_0} = 0.0570 \text{ (Ans)}$$

Q3c (iii) Production of $^{18}_{9}F$

$$^{18}_{8}O + {}^{1}_{+1}p \longrightarrow {}^{18}_{9}F + {}^{1}_{0}n$$

Decay of $^{18}_{9}F$

$$^{18}_{9}F \longrightarrow {}^{0}_{1}\beta + {}^{18}_{8}O$$

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