## Sem 1 (2005/2006): Nuclear Reactions

**Q4(a)**

$$^{238}_{92}U \longrightarrow ^{234}_{90}Th + ^{4}_{2}He$$

$$^{234}_{90}Th \longrightarrow ^{234}_{91}Pa + ^{0}_{-1}e$$

$$^{234}_{91}Pa \longrightarrow ^{234}_{92}U + ^{0}_{-1}e$$

**Q4(b)(i)**

| Atom | n | P |
|---|---|---|
| C | 6 | 6 |
| N | 9 | 7 |
| Ne | 9 | 10 |
| S | 16 | 16 |

(ii) S-32 is a stable nuclei because the $n:p = 1:1$

(iii) For N-16 : $n:p = 9:7 = 1.286:1$
It is above the belt of stability

(iv) Since the $n:p = 1.286$, therefore the N nuclei will undergo $\beta$ emission. This will decreases N (no. of and increases Z (no. of protons)

$$^{16}_{7}N \longrightarrow ^{16}_{8}O + ^{0}_{-1}e + \bar{\nu}$$

$\frac{n}{p} = 1.286$ $\quad$ $\frac{n}{p} = 1.0$ (stable)

The $\beta$-emission converts the N-16 into a O-16 nuclei in which the $n/p = 1.0$ (stable nuclei)

**Q4(c)**

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

$(2.01355 + 3.01550)g$ $\quad$ $(4.00150 + 1.00867)g$

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Q4(c)

$$\Delta m = m_{reactants} - m_{products}$$

$$= (2.01355 + 3.01550)g - (4.00150 + 1.00867)g$$

$$= 5.02905 - 5.01017 = 0.01888\ g$$

$$= (0.01888 \times 10^{-3})kg$$

$$\Delta E = (\Delta m)c^2$$

$$= (1.888 \times 10^{-5} kg)(3 \times 10^{8} ms^{-1})^2$$

$$\Delta E = 1.699 \times 10^{12}\ J$$

$$= 1.699 \times 10^{9}\ kJ$$ ← for 5.02905 g of reactants (H-2, H-3)

∴ The energy released per gram of reactants

$$= \left(\frac{1.699 \times 10^{9}}{5.02905}\right) kJg^{-1}\ \text{reactants}$$

$$= 3.3740 \times 10^{8}\ kJg^{-1}\ \text{reactants (Ans)}$$

Q4(d)(i) The balanced equation for the decay process is:

$$^{131}_{53}I \longrightarrow\ ^{131}_{54}Xe +\ ^{0}_{-1}e + \bar{\nu}$$

(ii) Given: $t_{1/2} = 8.05$ days ; $N_0 = 25.0$ mg ; $t = 30$ days, $N_t = ?$

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

$$\ln N_t = -kt + \ln N_0$$

$$= -\left(\frac{\ln 2}{t_{1/2}}\right)t + \ln N_0$$

$$\ln N_t = -\left(\frac{0.6931}{8.05d}\right)(30d) + \ln(25.0)$$

$$\ln N_t = -2.58298 + 3.2189 = 0.63592$$

$$\therefore N_t = 1.89\ mg\ \text{(Ans)}$$

After 30 days, 1.89 mg of the salt will remain in the body.

*Prepared by*
*V.Manoharan*
vmano@usm.my
manovv1955@yahoo.com
04-6533888 ext 3566