TD: 9

Exercice 1:

$A_0 = 50\ GBq = 5 \times 10^{10}\ Bq$, $T = 6h = 21600s$

1) $A_0 = \lambda N_0 = \frac{\ln 2}{T} N_0 \Rightarrow N_0 = \frac{A_0 . T}{\ln 2}$

$$N_0 = \frac{5 \times 10^{10} \times 21600}{\ln 2} = 1,558 \times 10^{15} \text{ noyaux}$$

2) $N_0 - N = N_0 - N_0 e^{-\frac{\ln 2}{T} . t} = N(1 - e^{-\frac{\ln 2}{T} . t})$

$$= 1,558 \times 10^{15} (1 - e^{-\frac{\ln 2}{6} \times 12})$$

$$= 1,168 \times 10^{15} \text{ noyaux}$$

3) $A_c = A_0 e^{-\frac{\ln 2}{T} . t} \Rightarrow \frac{A_c}{A_0} = e^{-\frac{\ln 2}{T} . t} \Rightarrow \frac{A_0}{A_c} = e^{+\frac{\ln 2}{T} . t}$

$$\frac{\ln 2}{T} . t = \ln \frac{A_0}{A_c} \Rightarrow t = \frac{\ln \left(\frac{A_0}{A_c}\right)}{\ln 2} \times T$$

$$t = \frac{\ln \left(\frac{50}{1}\right)}{\ln 2} \times 6 = 33,863\ h$$

B-1) $m_K = 400\,mg$, $m_{^{40}K} = \frac{0,011}{100} \times 400 = 0,044\,mg = 4,4 \times 10^{-5}$

$T = 1,3 \times 10^9$ ans , $M_K = 39\,g/mol$

On a : $m_K = N_K \cdot \frac{M_K}{N_A} \Rightarrow N_K = \frac{m_K}{M_K} N_A = \frac{0,4}{39} \times 6,023 \times 10^{23}$

$N_K = 6,177 \times 10^{21}$ noyaux

2) $^{40}_{19}K \longrightarrow {}^{40}_{20}Ca + {}^{0}_{-1}e + \bar{\nu}$

3) $m_0 = \frac{A_0 \cdot A \cdot T}{N_A \cdot \ln 2} \Rightarrow A_0 = \frac{m_0 \times N_A \times \ln 2}{A \cdot T}$

$A_0 = \frac{4,4 \times 10^{-5} \times 6,023 \times 10^{23} \times \ln 2}{40 \times 1,3 \times 10^9} = 3,53 \times 10^8$ dés/an

4) La diminution de l'activité de ^{40}K commence à la mort de la personne.

Exercice 2:

$T = 8,1\,j$, $A_0 = 2,6 \times 10^9\,Bq$, ^{131}I

1) $m_0 = \frac{A_0 \cdot A \cdot T}{N_A \cdot \ln 2} = \frac{2,6 \times 10^9 \times 131 \times 8,1 \times 24 \times 3600}{6,023 \times 10^{23} \cdot \ln 2}$

$m_0 = 5,7 \times 10^{-7}\,g$

2) $t = 30\ j$, $A_i = 4 \times 10^6\ Bq$

$$A_c = A_0 e^{-\frac{\ln 2}{T} \cdot t} = 2{,}6 \times 10^9 \times e^{-\frac{\ln 2}{8{,}1} \times 30} \simeq 2 \times 10^8\ Bq$$

$$n = \frac{A_c}{A_i} = \frac{2 \times 10^8}{4 \times 10^6} = 5 \text{ injections.}$$

3) $T_b = 30\ j$

$$\frac{1}{T_{eff}} = \frac{1}{T_{ph}} + \frac{1}{T_b} \Rightarrow T_{eff} = \frac{1}{\frac{1}{T_{ph}} + \frac{1}{T_b}} = \frac{1}{\frac{1}{8{,}1} + \frac{1}{30}}$$

$$T_{eff} = 6{,}378\ j.$$

Par rapport au patient $A_0 = 4 \times 10^6\ Bq$, $t = 1an = 365\ j$

$$A_c = A_0 e^{-\frac{\ln 2}{T_{eff}} \cdot t} = 4 \times 10^6 e^{-\frac{\ln 2}{6{,}378} \times 365} = 2{,}37 \times 10^{-11}\ Bq$$

Exercice 3 :

$T_1 = T_{M_0} = 66\ h$, $T_2 = T_{^{m}T_c} = 6\ h$

$$M_0 \xrightarrow[T_1]{} {}^{99m}T_c \xrightarrow[T_2]{} {}^{99}T_c$$

1) $\lambda_1 = \frac{\ln 2}{T_1} = \frac{\ln 2}{66} = 1{,}05 \times 10^{-2}\ h^{-1}$

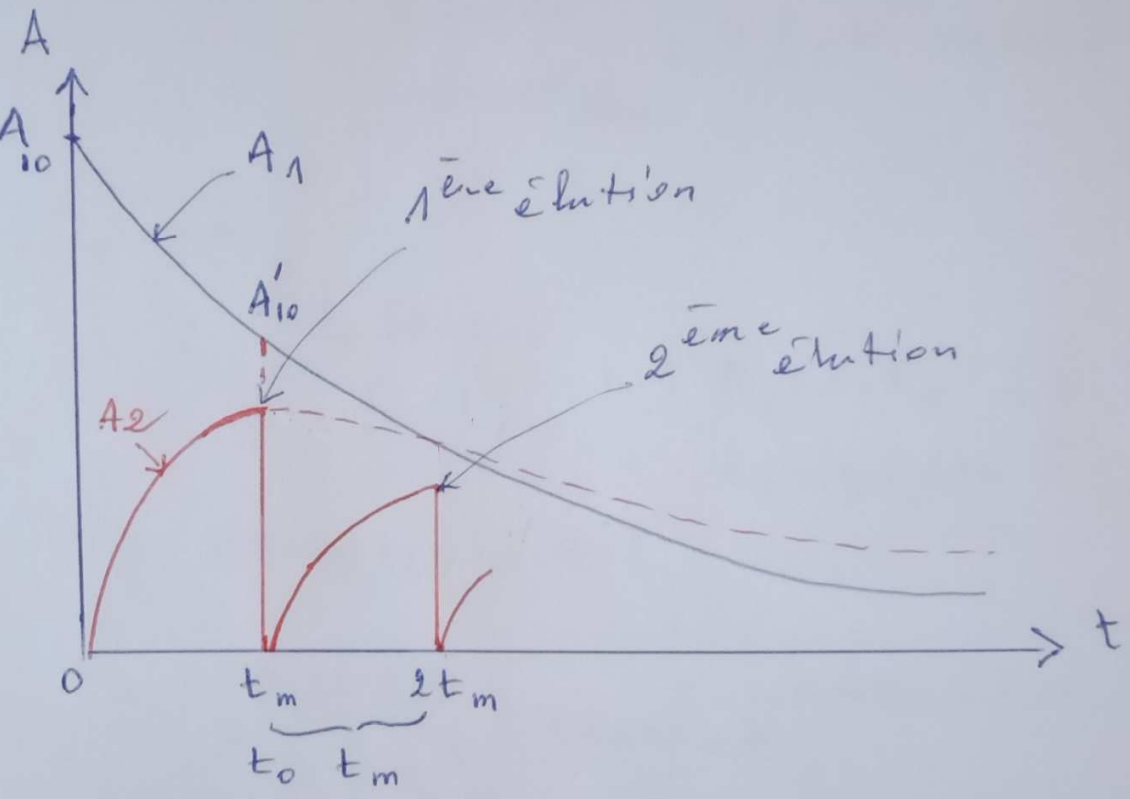
$\lambda_2 = \frac{\ln 2}{T_2} = \frac{\ln 2}{6} = 0{,}1155\ h^{-1}$

On a : $A_{10} = 4 \times 10^9$ Bq

2) Pour recueillir le maximum de noyaux $^{99m}_{43}Tc$ on fait l'élution lorsque l'activité de ce dernier est maximale. Donc lorsque : $t = t_{max}$

$$t_{max} = \frac{\ln\left(\frac{\lambda_2}{\lambda_1}\right)}{\lambda_2 - \lambda_1} = \frac{\ln\left(\frac{0,1155}{1,05 \times 10^{-2}}\right)}{0,1155 - 1,05 \times 10^{-2}} = 22,837 \text{ h}$$

3) $T_2 < T_1$



$$A_2 = \frac{\lambda_2}{\lambda_2 - \lambda_1} A'_{10} \left(e^{-\lambda_1 (t - t_0)} - e^{-\lambda_2 (t - t_0)} \right)$$

$t = 2t_m$, $t_0 = t_m \Rightarrow t - t_0 = t_m = 22,837$ h

$$A'_{10} = A_{10} e^{-\lambda_1 t} = 4\times10^{9} \times e^{-0,1155\times 22,837} = 2,86\times10^{8}\ Bq$$

$$A_2 = \frac{0,1155}{0,1155-1,05\times10^{-2}} \times 2,86\times10^{8}\left(e^{-1,05\times10^{-2}\times 22,837} - e^{-0,1155\times 22,837}\right)$$

$$A_2 = 2,25\times10^{8}\ Bq$$

4) $$N'_{10} = \frac{A'_{10}}{\lambda_1} = \frac{2,86\times10^{8}}{1,05\times10^{-2}/3600} = 9,8\times10^{13}\ \text{noyaux}$$

5) $t = 48\ h$

$$A'_2 = A_2 e^{-\lambda_2 (t-t_0)}$$

: $t_0 = 2\times t_m = 2\times 22,837$

$t_0 = 45,674\ h$

$t - t_0 = 48 - 45,764 = 2,326\ h$

$$A'_2 = A_2 e^{-\lambda_2 (t-t_0)} = 2,25\times10^{8} \times e^{-0,1155\times 2,326}$$

$$A'_2 = 1,72\times10^{8}\ Bq$$

Dans la solution à $t = t_0$ il n'y a que des noyaux de $^{99m}_{43}Tc$