38J c) Limiet 1 mSv/jr

Bij 10 mA en 1 min is de dosis 9,2 mGy/min

Dus per mA: 0,92 mGy mA^{-1} min^{-1}

Per jaar: W = 10000 mA/min/wk · 50 wk/jr

= $5 \cdot 10^5$ mA min/jr

U = 0,5

T = 1

dan: 0,92 mGy mA^{-1} min^{-1} · $5 \cdot 10^5$ mA min/jr · 0,5

= $2,3 \cdot 10^5$ mGy/jr ≙ $2,3 \cdot 10^5$ mSv/jr

$$T = \frac{1 \text{ mSv/jr}}{2,3 \cdot 10^5 \text{ mSv/jr}} = 4,3 \cdot 10^{-6}$$

Fig 43 → 20,9 $4,3 \cdot 10^{-6} = 9,1 \cdot 10^{-5}$ → 52 cm beton.

4.1) 1,0 MBq ^{198}Au in de lever

a) $$U_s = \int_0^{50j} A_s(0)\, e^{-\lambda^{eff} t}\, dt = \frac{A_s(0)}{-\lambda} e^{-\lambda^{eff} t} \Big|_0^{50j}$$

$$\approx - \frac{A_s(0)}{\lambda^{eff}} (0 - 1) = \frac{A_s(0)}{\lambda^{eff}}$$

$$\lambda^{eff} = \lambda^{fys} + \lambda^{biol}$$

$$\lambda^{fys} = \frac{\ln 2}{T_{1/2}^{fys}} = \frac{\ln 2}{2{,}696d} = 0{,}2571\, d^{-1}$$

$$\lambda^{biol} = \frac{\ln 2}{T_{1/2}^{biol}} = \frac{\ln 2}{3d} = 0{,}23\, d^{-1}$$

$$\Big\} \lambda^{eff} = 0{,}49\, d^{-1}$$

$$\Rightarrow U_s = \frac{1{,}0 \cdot 10^6\ Bq}{0{,}49 \cdot \frac{1}{24 \cdot 3600}\, s^{-1}} = 1{,}8 \cdot 10^{11}\ Bq\, s$$

b)

$$E(50) = \sum_T{}' w_T \sum_S{}' U_S \; SEE(T \leftarrow S)$$

$$SEE(T \leftarrow S) = \sum_R{}' w_R Y_R E_R \, SAF(T \leftarrow S)_R$$

$$SAF(T \leftarrow S) = \frac{1}{m_T} AF(T \leftarrow S)$$

$m_{lever} = 1800 g$

$AF(T \leftarrow S) = 1$ als $T = S$ voor β-straling

dus $SAF(T \leftarrow S) = \frac{1}{1800 g} \cdot 1 = 5{,}6 \; 10^{-4} \; g^{-1}$

Fig 1: listed β, ce en Auger: $\sum_i{}' y_i E_i = 0{,}326$ MeV

Voor de fotonen geldt:

$E_{\gamma_1} = 0{,}4118$ MeV $y_i E_i = 0{,}393$ MeV

$E_{\gamma_2} = 0{,}6759$ "   " $7{,}16 \cdot 10^{-3}$ MeV

$E_{\gamma_3} = 1{,}088$ "   " $2{,}49 \cdot 10^{-3}$ MeV

Fig 48 doel = bron = lever

AF = SAF · 1800 g

411,8 keV	SAF: $8{,}84 \cdot 10^{-5}\ g^{-1}$	0,159
675,9	8,58	0,154
1088	7,96	0,143

$$\bar{E}_\gamma = \sum_i y_i E_i AF_i = 0{,}159 \cdot 0{,}393 + 0{,}154 \cdot 7{,}16 \cdot 10^{-3} + 0{,}143 \cdot 2{,}49 \cdot 10^{-3} = 0{,}063\ MeV$$

Dus: $\bar{E} = \bar{E}_\beta + \bar{E}_\gamma = 0{,}326\ MeV + 0{,}063\ MeV = 0{,}389\ MeV$

c) $SEE(\text{lever} \leftarrow \text{lever}) = \sum_R w_R Y_R E_R\, SAF(\text{lever} \leftarrow \text{lever})_R$

$SEE = 1 \cdot 0{,}389\ MeV / 1800\ g = 2{,}16 \cdot 10^{-4}\ MeV/g$

↑ $w_R = 1$

d) $H_T(Sv) = U_S \cdot SEE$

$$= 1{,}8\,10^{11}\ Bqs \cdot 2{,}16 \cdot 10^{-4}\ MeV/g$$

$$= 3{,}9 \cdot 10^{7}\ MeV/g$$

$$= 3{,}9 \cdot 10^{7} \cdot 1{,}6\,10^{-19} \cdot 10^{6}\ J/_{10^{-3}\,kg}$$

$$= 6{,}2 \cdot 10^{-3}\ J/kg = 6{,}2\ mSv$$

42) a) $A = \lambda N$ $1 g\ Rb = \frac{6{,}02 \cdot 10^{23}}{85{,}5} \cdot 27{,}8\% = 1{,}957 \cdot 10^{21}$ atomen ^{87}Rb

$A = \frac{\ln 2}{T_{1/2}} N = \frac{\ln 2}{4{,}7 \cdot 10^{10} \cdot 365 \cdot 24 \cdot 3600\,s} \cdot 1{,}957 \cdot 10^{21} g^{-1}$

$= 915\ Bq/g.$

b) Jaarlijkse inname:

$2{,}2 \cdot 10^{-3}\ g/d \cdot 365\ d/j \cdot 915\ Bq/g = 735\ Bq/j$

c) Effectieve jaardosis:

$735\ Bq/j \cdot \cancel{1{,}25}\ 1{,}5 \cdot 10^{-9}\ Sv/Bq = \cancel{0{,}919}\ 1{,}1\ \mu Sv/j$

d) $\frac{dA}{dt} = P - \lambda A = 0$ bij evenwicht.

$A = P/\lambda = \frac{915\ Bq/g \quad 2{,}2 \cdot 10^{-3}\ g/d}{\ln 2 / 44 d} = 128\ Bq$

↑ fig 14

e) U_s (1 jaar) $= 128\ s^{-1} \cdot 3600 \cdot 24 \cdot 365 = 4{,}04 \cdot 10^{9}$ desintegraties

f) $SEE = \frac{Y_B\ \bar{E}_B}{m} = \frac{1.0 \cdot \frac{1}{3} E_{max}}{70 kg} = \frac{1.0 \cdot \frac{1}{3} \cdot 0{,}3 MeV}{70 kg} = 0{,}00143 \cdot 10^{-3}$ MeV/g

g) $H(50) = 1{,}6 \cdot 10^{-10}\ \mathcal{U}_S \cdot w_R \cdot SEE$

$w_R = 1$

$= 1{,}6 \cdot 10^{-10} \cdot 4{,}04 \cdot 10^{9} \cdot 0{,}00143 \cdot 10^{-3} = 0{,}92\ \mu Sv.$

NB: dit is de uitwerking van een verouderde opgave, en wijkt dus af van het antwoord/

43] Uitscheiding via urine $T_{1/2} = 0{,}25\,d$

Fig 4 → biologische halveringstijden:

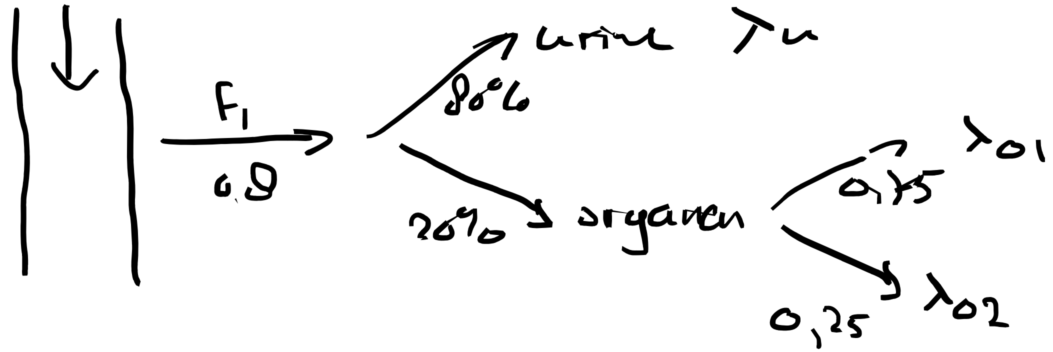
fractie 0,75 $T_{1/2} = 20\,d$

0,25 $= 2000\,d$

Fig 4 → ingestie zwavelverbinding $f_1 = 0{,}8$

Fig 4 → 80% directe uitscheiding

20% wordt verdeeld over alle organen.



$$\lambda_u = \lambda^{fys} + \lambda^{bio} = \frac{\ln 2}{87{,}44\,d} + \frac{\ln 2}{0{,}25\,d} = 2{,}78\,d^{-1}$$

$$\lambda_{01} = \frac{\ln 2}{87{,}44\,d} + \frac{\ln 2}{20\,d} = 4{,}26 \cdot 10^{-2}\,d^{-1}$$

$$\lambda_{02} = \text{"} + \frac{\ln 2}{2000\,d} = 8{,}27 \cdot 10^{-3}\,d^{-1}$$

$$\lambda^{eff} = 0{,}8\,\lambda_{LI} + 0{,}2\,(0{,}75\,\lambda_{o1} + 0{,}25\,\lambda_{o2}) = 2{,}23\,d^{-1}$$

$$U_S = F_1 \frac{A_0}{\lambda^{eff}} = 0{,}8 \cdot \frac{1\ Bq}{2{,}23\,d^{-1}} = 0{,}359\ Bq\,d = 3{,}10 \cdot 10^{4}\ Bq\,s$$

b) $$SEE(T \leftarrow S) = \sum_R w_R Y_R E_R\, SAF(T \leftarrow S)_R$$

$$SAF(T \leftarrow S) = \frac{AF(T \leftarrow S)}{m}$$

$$SAF = \frac{1}{63000\,g} = 1{,}59 \cdot 10^{-5}\ g^{-1}$$

$$SEE = 49 \cdot 10^{-3}\ MeV \cdot 1{,}59 \cdot 10^{-5}\ g^{-1} = 7{,}8 \cdot 10^{-7}\ MeV/g.$$

c) $$E(50) = U_S\, SEE = 3{,}10 \cdot 10^{4}\ Bq\,s \cdot 7{,}8 \cdot 10^{-7}\ MeV/g$$

$$= 2{,}41 \cdot 10^{-2}\ MeV/g$$

$$= 3{,}86 \cdot 10^{-12}\ Sv \text{ per } Bq$$

d) $$e_{ing}(50) = 1{,}4 \cdot 10^{-10}\ Sv/Bq.$$

verschil wordt veroorzaakt door 20% die via het maag-darm kanaal wordt uitgescheiden.