The University of Jordan / Physics Department
Solutions for Extra Suggested Problems
Giancoli / Seventh edition / chapter 31

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Q47] $AD = 4.5\,kGy = 4.5 \times 10^{3}\,\frac{J}{kg}$ (allowed limit)

$E_{e^-} = 1.6\,MeV = 1.6 \times 10^{6} \times 1.6 \times 10^{-19}\,J$.

$E_{total} = 4.5 \times 10^{3}\,\frac{J}{kg} \times 5\,kg$ (allowed total energy)

$= 22.5 \times 10^{3}\,J$.

$\therefore$ number of e^- (to reach allowable limit) $= \frac{E_{tot}}{E_{e^-}} \simeq 8.79 \times 10^{16}$

Q48] a) ${}^{131}_{53}I \longrightarrow {}^{131}_{54}Xe + \beta^- + \bar{\nu}$ (you are not expected to know this decay equation. But you should know the changes in Z and N for β decay).

b) $N = 0.05\,N_0$

$\frac{N}{N_0} = 0.05 = e^{-\lambda t}$

$0.05 = e^{-\frac{\ln 2}{t_{1/2}} t} \Rightarrow \ln(0.05) = -\frac{\ln 2}{t_{1/2}}\,t$

$t = -\frac{\ln(0.05)}{\ln 2}\,t_{1/2} = \frac{-\ln(0.05)}{\ln 2}(8) \simeq 34.6$ days.

L2

(c) $A = \lambda N \Rightarrow N = \frac{A}{\lambda} = \frac{A}{\left(\frac{\ln 2}{t_{1/2}}\right)} = \frac{A\, t_{1/2}}{\ln 2}$

$\therefore N = \frac{(1\times10^{-3}\times3.7\times10^{10}\ s^{-1})(8\times24\times60\times60\ s)}{\ln 2}$

$N = 3.6896\times10^{13}$ nuclei

$n = \frac{N}{N_A} = 6.129\times10^{-11}$ moles.

↑ number of moles

mass = $n \times$ molar mass

$= 6.129\times10^{-11}$ moles $\times 131 \frac{\text{grams}}{\text{mole}} = 8\times10^{-9}$ grams

= 8 ngrams
↑ nano $= 10^{-9}$

Q71] All three sources have the same activity

$A = 35\ mCi = 35\times10^{-3}\times3.7\times10^{10}\ s^{-1}$.

$A = 1295\times10^{6}\ s^{-1}$ (or decays/s)

To determine their relative danger of the three sources we should compare their relative effective doses.

Remember $ED = AD \times RBE$

for source A

$$ED_A = \underbrace{\left(\frac{A\,E_\gamma}{m}\right)}_{\text{AD per second}} \times RBE$$

$$ED_A = \frac{A}{m} \times 1\,MeV \times 1 = \left(\frac{A}{m} \cdot MeV\right) \quad \left(\text{in units of } Sv/s\right)$$

$$ED_B = \frac{A}{m} \times 2\,MeV \times 1 = 2\left(\frac{A}{m} \cdot MeV\right)$$

$$ED_C = \frac{A}{m} \times 2\,MeV \times 20 = 40\left(\frac{A}{m} \cdot MeV\right)$$

$\Rightarrow$ $ED_C : ED_B : ED_A$

$40 : 2 : 1$

$\Rightarrow$ In order of <u>increasing</u> danger we have

$A \rightarrow B \rightarrow C$ ← most dangerous

(A ← least dangerous)