The University of Jordan / Physics Department

Solutions for suggested Problems

Giancoli / seventh edition / Chapter 31

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Q38] $ED_{\alpha} = ED_{x\text{-rays}}$

$AD_{\alpha}\, RBE_{\alpha} = AD_{x}\, RBE_{x}$

$350 \times 20 = AD_{x} \times 1$

$\Rightarrow AD_{x\text{-ray}} = 7000$ rad.

Q40] $AD = 2.5\ Gy = 2.5 \times 1\frac{J}{kg} = 2.5\ J/kg.$

$m = 65$ kg $\Rightarrow$

Absorbed energy $= 2.5\frac{J}{kg} \times 65\ kg = 162.5\ J.$

Q41] $E_p = 1.2\ MeV = 1.2\times10^6\times1.6\times10^{-19}\ J$

tumer mass = 0.20 kg.

a) $ED = AD \times RBE \Rightarrow 1.0\ rem = AD \times (1)$

$\Rightarrow AD = 1.0\ Rad\ (= 0.01\ Gy)$.

b) absorbed energy by tumer E_{tumer}

$$E_{tumer} = M_{tumer} \times AD$$
$$= 0.2\,kg \times 0.01\ J/kg$$
$$= 0.002\ J.$$

$\Rightarrow$ number of absorbed protons is n

$$n = \frac{E_{tumer}}{E_p} = \frac{0.002\ J}{1.2\times10^6\times1.6\times10^{-19}\ J/proton}$$

$\therefore n \approx 1.04\times10^{10}$ protons.

Q44] $A = 1.6\ mCi$

$= 1.6 \times 10^{-3} \times 3.7 \times 10^{10}\ Bq$

$= 5.92 \times 10^{7}\ Bq \quad (1\ Bq = 1\ decay/s)$

Need to administer 32 Gy to a tumer.

$1\ mCi \longrightarrow 10\ mGy/min$

$1.6\ mCi \longrightarrow X$

$$\therefore X = \frac{1.6\ mCi}{1\ mCi} \times 10\ mGy/min$$

$= 16\ mGy/min$

$\Rightarrow$ a 1.6 mCi delivers 16 mGy/min

required time t is given by

$$t = \frac{32\ Gy}{16\ mGy/min} = \frac{32\ Gy}{16 \times 10^{-3}\ Gy/min}$$

$= 2000\ min \approx 33.3\ hrs \approx 1.4\ days.$

Q46] $^{57}_{27}Co$ emits 122 keV γ-rays.

energy of each γ is $E_\gamma = 122 \times 10^{3} \times 1.6 \times 10^{-19}$ J

$A = 1.55 \mu Ci = 1.55 \times 10^{-6} \times 3.7 \times 10^{10}$ Bq
$= 57350$ decays/s (Bq)

Radiated energy per second E is given by

$E = A E_\gamma$ (in units of J/s)

Absorbed energy by person per second is

$E_{absorbed} = 0.5 E$ (J/s)
↳ since only 50% of γ-rays interact with the body.

Absorbed energy per day $E_{tot} = E_{absorbed} \times 24 \times 60 \times 60$

$\therefore E_{tot} = 0.5 (A E_\gamma \frac{J}{s})(24 \times 60 \times 60 \frac{s}{day})$

$= 0.5 A E_\gamma \times 24 \times 3600 \frac{J}{day} =$

$\Rightarrow AD = \frac{E_{tot}}{m} = \frac{E_{tot}}{65} \simeq \frac{4.836 \times 10^{-5} \text{ J/day}}{65 \text{ kg}}$

$\simeq \frac{7.44}{10^7} \frac{J}{kg} \times \frac{1}{day} = 7.44 \times 10^{-7} \frac{Gy}{day}$ (J/kg = Gy)