Ch 2. {2, 4, 6, 8, 10, 15}

2.2 From fig 2.7, a 5 MeV proton has a range of about 225 μm in Si. If we assume a linear E loss - somewhat accurate for the first 100 μm - then one would predict $\frac{E_{lost}}{5} = \frac{100}{225}$; $E_{lost} = \frac{20}{9}$ MeV = 2.2 MeV lost

so 5 - 2.2 = 2.8 MeV remaining

Another method gives:

$R_1 = 225\ \mu m$ (Full range of photon at 5 MeV)

$R_2 = R_1 - t = 125\ \mu m$ (range of photon exiting Si)

Again using fig 2.7, a photon w/ range 125 μm has $\boxed{E = 3.5\text{ MeV}}$

2.4 From fig 2.4, the range of 1 MeV e^- can be deduced from the mass thickness plot which places a 1 MeV e^- at about 0.5 g/cm^2 = range x density. Using a value of 2.70 $g/cm^3 = \rho_{Al}$, we can solve for the range.

$$R = 0.5\ g/cm^2 \times \left(\frac{1\ cm^3}{2.70\ g}\right) = \boxed{0.185\ cm}$$

2.6 $\tau \approx c \times \frac{Z^n}{E_\gamma^{3.5}}$ is the photoelectric absorption probability, where $Z_{Si} = 14$; $Z_{Ge} = 32$. In book n is between 4 & 5 so

$\frac{\tau_{Si}}{\tau_{Ge}} = \frac{14^n}{32^n}$. $\boxed{\text{For: } n = 4,\ \frac{\tau_{Si}}{\tau_{Ge}} = 0.0366,\quad n = 5,\ \frac{\tau_{Si}}{\tau_{Ge}} = 0.016}$

2.8 If s.g. = 3.67, $\rho = 3.67\ g/cm^3$. Chart shows cm^2/g, or $\frac{1}{\rho \times range}$. Mean free path of all interactions is ∝ to avg dist of 0.001, 0.0035, 0.025, 0.0275, 0.03, 0.06, 0.06

avg = 0.065 cm^2/g

(a) so $0.065\ cm^2/g = \left(\frac{1\ cm^3}{3.67\ g}\right) \times \left(\frac{1}{\text{mean free path}}\right)$ $\boxed{\text{path} = 4.19\ cm}$

(b) $\frac{\tau}{\rho} = 0.01\ cm^2/g$; $\rho_{NaI} = 3.70\ g/cm^3$ $\tau = 0.01 \frac{cm^2}{g}\left(3.7 \frac{g}{cm^3}\right)(1\ cm)$

$\boxed{\tau = 0.037 \text{ or } 3.7\%}$

2.10 $\left(\frac{\mu}{\rho}\right)_{H_2O} = \sum_i w_i \left(\frac{\mu}{\rho}\right)_i$; $\frac{\mu}{\rho}_H = 0.26\ cm^2/g$; $\frac{\mu}{\rho}_O = 0.14\ cm^2/g$

$w_H = 1/9$ $w_O = 8/9$

so... $\left(\frac{\mu}{\rho}\right)_{H_2O} = \frac{1}{9}(0.26) + \frac{8}{9}(0.14) = 0.1533\ cm^2/g$

$$\lambda_{H_2O} = 1/[(0.1533\ cm^2/g)(1.0\ g/cm^3)] = \boxed{6.5\ cm}$$

2.15 Eff Dose equivalent for individual

- 8 hr day
- 5 m from 3 μg ^{252}Cf fast neutron source

$H = DQ$ $\quad H_{eff} = h_E \Phi$

$\Phi = \frac{N}{4\pi d^2}$

We have $\sim 2.30 \times 10^6$ neutrons/second per μg of sample

For 3 μg, this yields 6.90×10^6 n/s

$$N = \frac{8\ hr}{} \left| \frac{3600\ s}{hr} \right| \frac{6.90 \times 10^6\ n}{s} = 1.987 \times 10^{11} \text{ neutrons}$$

$$\Phi = \frac{1.987 \times 10^{11}}{4\pi (5\ m)^2} = 6.325 \times 10^8 \ n/m^2$$

$H_E = h_E \Phi$ for fast neutrons from ^{252}Cf, $h_E \approx 1.0 \times 10^{-10}$ Sv cm^2

$$H_E = (1.0 \times 10^{-10}\ Sv \cdot \cancel{cm^2})(6.325 \times 10^8\ \frac{n}{\cancel{m^2}})\left(\frac{1\ \cancel{m^2}}{10000\ \cancel{cm^2}}\right) = \boxed{6.325 \times 10^{-6}\ Sv}$$

OR 1 Sievert = 100 rem

so $6.325 \times 10^{-6}\ Sv \left(\frac{100\ rem}{1\ Sv}\right) = \boxed{6.325 \times 10^{-4}\ rem}$