Lamarsh Solutions

Chapter-3 Part-2

3.26

(a) $E^{'} = \frac{E}{(A+1)^2}[\cos\theta + \sqrt{A^2 - \sin^2\theta}]^2 = 0.846Mev$

(b) $E_A = E - E^{'} = 0.154Mev$

(c) conservation of momentum:

$$mv = mv^{'}\cos\theta + MV^{'}\cos\varphi$$
$$0 = mv^{'}\sin\theta - MV^{'}\sin\varphi$$

Cons. of energy: $0.5mv^2 = 0.5mv^{'2} + 0.5MV^{'2}$ and finally,

$$\varphi = \arccos(\sqrt{0.5(\frac{1}{A}+1)}) = 42.61^0$$

3.30

(a)

$\xi = 1 - \frac{(A-1)^2}{2A}\ln(\frac{A+1}{A-1})$ and $\xi^H = 1$ and knowing that,

<# of collisions>= $\frac{\Delta U}{\xi} = \frac{\ln(\frac{2e6ev}{1ev})}{1} = 14.5collisions$

(b)

$\xi^C = 0.158$ and <# of collisions>= $\frac{\Delta U}{\xi} = \frac{\ln(\frac{2e6ev}{1ev})}{0.158} = 91.82collisions$

3.39

$\sigma_s = \sigma_e + \sigma_i = 5.4b \Rightarrow \sigma_t = \sigma_s + \sigma_a = 6.7b$

$\sigma_\gamma = \sigma_a - \sigma_f = 0.1 \Rightarrow \alpha = \frac{\sigma_\gamma}{\sigma_f} = 0.0833$

3.49

(a)Actually in here we are asked the burnup rate from Lamarsh eq. 3.57

Burnup rate=1.05P g/day=1.05 x 2758=2906.4 g/day

(b) $cons.rate = fis.ratex\frac{\sigma_a}{\sigma_f} = fis.ratex\frac{\sigma_f + \sigma_c}{\sigma_f} = fis.ratex(1+\alpha)$

Cons.rate=1.05P x (1+0.169)=3397.6 gr-U235/day

3.58

$$\frac{\mu}{\rho} = 1.84cm^2/gr \quad \rho_{Pb} = 11.34gr/cm^3$$

$$I(x) = I_0 e^{-\mu x} \text{ or } I(x) = I_0 e^{-\frac{\mu}{\rho}\rho x}$$

$$\text{and then } \ln(\frac{I_0}{I(x)}) = \frac{\mu}{\rho}\rho x \text{ this gives that } x = \frac{\ln(1000)}{1.84x11.34} = 0.331cm$$

3.61

Cross sections are given in terms of "per electron";so we can find both for Al and water the total cross sections as $\sigma_c = \sigma_c^e xZ$ and $\sigma_{ca} = \sigma_{ca}^e xZ$ and using these cross sections we'll find the total cross sections or attenuation coefficients as $\mu = Nx\sigma$ .And finally using the appropriate coefficients and $W = ExIx\mu$,will find the deposited energies.Notice that we'll not use the total compton cross section for this calculation ,0.4929b, but use the compton abs. cross section for energy absorbtion due to compton ; for energy abs. due to photelectric effect we'll use the total mass attenuation coefficient at energy 0.1 Mev to find the total photoel. absorption coefficient

(a) Compton scattering.

(i)For Al, $\sigma_{ca} = 0.0685e-24cm^2 x13 = 0.8905e-24cm^2$ and

$$\mu_{ca} = 0.06024e24atoms/cm^3 x0.8905e-24cm^2 = 0.05363cm^{-1}$$

$$W = ExIx\mu = 0.1Mevx5e6x0.05363 = 4.2949e-9\frac{W}{cm^3}$$

(ii)For water, $\sigma_{ca} = 0.0685e-24cm^2 x(8+2) = 0.685e-24cm^2$ and

$$\mu_{ca} = 0.03342e24atoms/cm^3 x0.685e-24cm^2 = 0.0228cm^{-1}$$

$$W = ExIx\mu = 0.1Mevx5e6x0.0228 = 1.834e-9\frac{W}{cm^3}$$

(b)Photoelectric Effect,

(i)For Al,

$$\mu_{Al,tot} = (\frac{\mu}{\rho})_a @ 0.1Mevx\rho = 0.0373x2.699 = 0.1006cm^{-1}$$

$$\mu_{Al,photoel} = \mu_{Al,tot} - \mu_{Al,compton} = 0.1006 - 0.0536 = 4.707e-2cm^{-1}$$

And finally deposited energy is,

$$W = ExIx\mu = 0.1Mevx5e6x4.707e-2 = 3.7703e-9\frac{W}{cm^3}$$

(ii)For water,

$$\mu_{water,tot} = (\frac{\mu}{\rho})_a @ 0.1Mevx\rho = 2.53e-2cm^{-1}$$

$$\mu_{water,photoel} = \mu_{water,tot} - \mu_{water,compton} = 2.53e-2cm^{-1} - 2.2897e-2cm^{-1} = 2.403e-3cm^{-1}$$

And finally deposited energy is,

$$W = ExIx\mu = 0.1Mevx5e6x2.403e-3cm^{-1} = 1.9248e-10\frac{W}{cm^3}$$

WARNING!!!!!: In energy calculation ,you finally found the unit in Mev ,so you must convert it into joule to find Watt.In here this is left to the student!!!