Radiation Biology, Protection and Applications

(PHYS-450)

Quiz No. 4

Week 13

Problem 1:

The density of an NaCl crystal is 2.17 g/cm^3. Compute the atom densities of Na and Cl. *(The atomic weight of the Na and Cl are 22.990 and 35.453, respectively).*

Solution :

$$N = \frac{2.17 * 6.022 * 10^{23}}{58.443}\ cm^{-3} \cong 2.24 \times 10^{22}\ cm^{-3}$$

Since there is one atom each of *Na* and *Cl* per « molecule », it follows that this is also equal to the atom density of each atom.

$$N = N^{Na} = N^{Cl} \cong \mathbf{2.24 \times 10^{22}\ cm^{-3}}$$

Problem 2:

What is the intensity of gamma rays from a 10 curie source of ^{22}Na surrounded by 5 cm of lead ? *(The build-up factor is 2.1 ; the ^{22}Na gamma energy is 1.28 MeV and the corresponding total linear absorption coefficient is 0.66 cm^{-1}).*

Solution :

(1 Ci = 3.7 x 10^{10} Bq)

$$I = \frac{10 * (3.7\times10^{10}) * (2.1) * e^{-(0.66)*(5)}}{4 * \pi * (5)^2}\ \frac{\gamma}{(cm^2.s)} \cong \mathbf{9.03 \times 10^{7}\ cm^{-2}.s^{-1}}$$

Problem 3:

Calculate the mass attenuation coefficient of UO_2 for 1MeV γ-rays. *(The density of UO_2 is about 10 g/cm^3. For 1 MeV γ-rays μ/ρ is 0.0757 cm^2/g and 0.0636 cm^2/g for uranium and oxygen, respectively).*

Solution :

(considering ^{238}U in UO_2)

$$M_{UO_2} \cong 238 + (2\times16) = 270\ g/mol$$

Thus,

^{238}U	O_2
$\frac{238}{270} \cong 88.1\%$	*(100 - 88.1)% = 11.9%*

$$\frac{\mu}{\rho} \cong (0.881 \times 0.0757) + (0.119 \times 0.0636)\ \frac{cm^2}{g} \cong 0.0743\ \frac{cm^2}{g}$$

$$\mu \cong (10 \times 0.0743)\ cm^{-1} = \mathbf{0.743\ cm^{-1}}$$