

22.01 “Introduction to Ionizing Radiation”

Fall 2006

Problem Set #7

Due Date: Tuesday December 5, 2006

1. Pure crystalline silicon ingots are irradiated in the MIT reactor to produce n-type semiconductor material for industry. Describe the nuclear reaction that occurs in silicon to produce the “doped” silicon. Be specific.
2. For cells that show a linear dose response relationship when plotted as log survival vs dose, explain why D_0 is considered to be the “mean lethal dose”.
3. Calculate the effective dose to an individual who has received the following exposures:
 - 5 mGy alpha to the lung
 - 10 mGy thermal neutron, to the skin
 - 5 mGy gamma, whole body
 - 100 mGy beta to the thyroid.
4. If the absolute risk of lung cancer from radon exposure is 5×10^{-3} /person-year/Sv, calculate the annual number of lung cancer cases expected in a population of 150×10^6 persons from exposure to 4 pCi/L of indoor radon. The dose conversion factor for lung epithelial cells is 0.75 Gy/WLM. State any assumptions you need to make.
5. Given the following cell survival data:

<u>X rays</u>		<u>α-particles</u>	
Dose (cGy)	Surviving fraction (%)	Dose (cGy)	Surviving fraction (%)
0	100	0	100
330	60	100	45
620	28	200	15
826	12	400	2.5
1239	1.7	600	0.45
1653	0.11	800	0.06
2479	0.0009	1200	0.0015

- a. Estimate the RBE of the α -particles relative to the x-rays. Explain how you determined the RBE.
 - b. Estimate the D_0 value for the alpha particles and the x-rays.
 - c. What is the extrapolation number, n , for the x-rays?
 - d. Is the RBE higher or lower at 10% survival than at 1% survival? Give an explanation for this.
6. A 50 cm^3 sample of water is given a dose of 2 Gy from 2 MeV protons. If the yield of OH radicals is $G = 1.44$ per 100 eV, how many OH radicals are produced in the sample?