

22.55 Spring 2004

Professor Coderre

February 13, 2004

Due: February 20, 2004

Paper due for class discussion on Feb 25.

Problem Set 2

Literature search; “Clustered Damage” i.e., closely spaced damage sites in DNA caused by high-LET radiation. Also known as “multiply damaged sites” or “locally multiply damaged sites”.

Search example:

Go to PubMed: <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>

Enter: clustered AND damage

Go to “History”

Enter: #1 AND radiation

Find a paper that looks interesting, be prepared to give a 5 minute summary in class of the paper. E.g., What was the objective, the methods used, the main finding, the significance.

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Problems:

1. Consider three particles: 1 keV protons, 10 MeV protons and 8400 MeV iron nuclei (${}_{26}^{56}\text{Fe}$).

You are a NASA engineer faced with shielding astronauts from these particles. Compare water, aluminum and lead. Calculate the velocities of the three particles. Calculate the stopping power of water, aluminum and lead for these three particles. Calculate the ranges of the protons and the iron particles in water, aluminum and lead.

2) A narrow beam of 10^8 photons per second is normally incident on a 6 mm aluminum sheet. The beam consists of equal numbers of 200 keV photons and 2 MeV photons.

a) Calculate the number of photons per second of each energy that are transmitted without interaction through the sheet.

b) Calculate the transmitted intensities for the same two photon beams striking a lead sheet of the same thickness.

c) Calculate the atomic cross sections of aluminum and lead for the 200 keV and the 2 MeV photons.

3) If the G value for the OH radicals produced by 20 keV electrons is 1.10, how many of them are produced, on the average, when a 20 keV electron stops in water?

4) 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?

5) How far can a hydroxyl radical and a hydrogen radical diffuse in 10^{-6} sec?

6) Estimate the average time it takes for an OH radical to diffuse 400 Å in water.