22.55 Spring 2004
Professor Coderre
February 6, 2004
Due: February 13, 2004

Problem Set 1

1. Calculate the stopping powers (-dE/dx) of water for a 1.2 MeV proton and a 30.5 MeV alpha particle. What are the ranges of the 1.2 MeV proton and the 30.5 MeV alpha particle in water? Calculate the maximum energy transferred by each in a collision with an orbital electron (assume that the electron is free and at rest). Calculate the range in water of these delta ray electrons.

2. When it decays, cobalt-60 releases a 1.17 MeV gamma photon. Assume that this photon collides with an orbital electron in a maximum energy transfer geometry ($\theta = 180°$). What is the energy of the Compton electron? What is the energy of the scattered photon? If the scattering angle, θ, is 30°, calculate the energies of the Compton electron and the scattered photon.

3. You are preparing for an experiment at an accelerator facility that can produce protons, alpha particles and carbon ions. Calculate the maximum energy that can be transferred to an orbital electron for each of these three particles when accelerated to the following energies: 0.1, 0.5, 1.0, 5.0, 10, 50 MeV. Graph the results on appropriate coordinate paper.

4. An electron emerges normally from a 4-mm-thick Lucite slab (density 1.19 g cm^{-3}) with an energy of 2.5 MeV. What was its energy when it entered the slab?

5. You have at your disposal an accelerator capable of accelerating any ion up to a maximum energy of 1000 MeV per nucleon. You want to do a cell irradiation experiment with $^{12}_{6}C$ and $^{56}_{26}Fe$ ions **both having the same stopping power** (-dE/dx). You can pick any stopping power you want, but both ions must be able to penetrate the cell target, i.e., have a range of > 20 micrometers in water. Is this experiment possible? Why or why not?

6. Define "sister chromatids". At what point in the cell cycle would you expect to find sister chromatids?