22.01 Introduction to Ionizing Radiation
Fall 2003
Problem Set # 8

Due Date: Friday, November 14, 2003

1. Given what you know about primordial radionuclides and the biological effects of high-LET radiation, explain how the decay of ^{238}U in the soil underneath a house could ultimately cause a lung cancer in one of the occupants of the home. Be thorough, citing all the relevant steps, and give an indication of the time scales involved.

2. Define RBE (relative biological effectiveness). List three factors that can influence the value of RBE and demonstrate or describe how each factor affects the value of RBE.

3. A working chamber in a uranium mine measures 15 meters x 10 meters x 2.5 meters. The air inside contains the nuclide inventory shown below.

Nuclide	Activity Concentration
^{222}Rn	180 pCi/L
^{218}Po	170 pCi/L
^{214}Pb	140 pCi/L
^{214}Bi	120 pCi/L
^{214}Po	125 pCi/L

a) Calculate the working level (WL) concentration.
b) Calculate the total potential alpha particle energy (PAEC) in the chamber in J/m^3.
c) If a person spends an average of 8 hours per day, 5 days per week, 12 months per year in the mine chamber, what is the exposure in WLM, after one year of activity?
d) If the dose conversion factor for lung epithelial cells is 1.5 mGy/WLM, what are the physical dose and the effective dose per year to the lung epithelium? What is the equivalent dose per year? (consider the dose to the lung epithelium as the lung dose).

4. Describe the major sources of radiation in space. Discuss the radiation environment in low-earth orbit and in interplanetary space. Describe factors or events that can affect the radiation levels in these two areas.