

**22.01 “Introduction to Ionizing Radiation”  
Fall 2006  
Problem Set #2**

***Due Date: Tuesday, September 26, 2006***

Show all work. Provide units on all answers.

Problems in Turner:

Chapter 3: Problems 3.12, 3.17, 3.26

Also:

1. (a) Calculate the  $Q$  value for K orbital-electron capture by the  ${}_{18}^{37}\text{Ar}$  nucleus, neglecting the electron binding energy.  
(b) Repeat (a), including the binding energy, 3.20 keV, of the K-shell electron in argon.  
(c) What becomes of the energy released as a result of this reaction?
2. The radioisotope  ${}^{224}\text{Ra}$  decays by  $\alpha$  emission primarily to the ground state of  ${}^{220}\text{Rn}$  (94% probability) and to the first excited state 0.241 MeV above the ground state (5.5% probability). What are the energies of the two associated  $\alpha$  particles?
3. The radionuclide  ${}^{41}\text{Ar}$  decays by  $\beta^-$  emission to an excited level of  ${}^{41}\text{K}$  that is 1.293 MeV above the ground state. What is the maximum kinetic energy of the emitted  $\beta^-$  particle?
4. The radioisotope  ${}^{64}\text{Cu}$  decays by three different mechanisms:  $\beta^-$  decay (39.0%), electron capture (EC) (43.1%) and  $\beta^+$  decay (17.4 %). The  $Q$  value for the  $\beta^-$  decay is 578.7 keV. The  $Q$  value for the  $\beta^+$  decay is 653.1 keV. In addition, there is a gamma emission (0.5% probability) at 1.345 MeV. Sketch the energy level diagram for the decay scheme.

Extra NOT graded problem: Turner 3.28

Good practice on a slightly challenging decay scheme. We will go over it in recitation on Friday.