PHYS420 (Spring 2002)
Riq Parra

Homework # 8
(due Monday, April 8th, 2002)

Problems

1. The name *nuclide* is a general term for any isotope for any element. Using a table of nuclides, find all the possible *naturally occurring* isotopes of xenon (**Xe**) and cesium (**Cs**) along with their relative abundances. *An online table of nuclides can be found in the class website under 'Resources'.*

2. Starting with the law of radioactive decay, $N(t) = N_0 e^{-\lambda t}$ where λ is the decay constant, and using the definition of half-life ($T_{1/2}$), show that $\boldsymbol{T_{1/2} = ln2 / \lambda}$.

3. *The **decay rate** R, defined as the number of decays per unit time in a given radioactive sample, is given by* $R = \left|\frac{dN}{dt}\right|$. *The decay rate of a sample is often referred to as its **activity** and frequently uses units of **curies** (Ci), defined as* $1Ci \equiv 3.7x10^{10}\, decays/s$. A sample of the isotope I^{131}, which has a half-life of 8.04 days, has an activity of 5 mCi at the time of shipment. Upon receipt of the I^{131} in a medical laboratory, its activity is 4.2 mCi. How much time has elapse between the two measurements?

4. The Actinium Series begins with the isotope $_{92}U^{235}$; each atom sends out in succession the following particles: α, β, α, β, α, α, α, α, β, β, α. From this information and by consulting the periodic table, write out an account of the Actinium Series (i.e. $_{\mathbf{92}}\mathbf{U}^{\mathbf{235}} \xrightarrow{\alpha} ? \xrightarrow{\beta} ?$ …) complete with the necessary symbols and the figures for atomic mass and atomic number. *Use the notation $_ZX^A$, where Z is the atomic number, X is the element name and A is the atomic weight to the nearest integer.*

5. **Carbon-14 dating**. *Carbon-14 is a radioactive isotope (half life of 5730 years), created in the atmosphere by cosmic rays, that combines with oxygen to create carbon dioxide that is then absorbed by plants (and eventually makes it into plant eating organisms). Even though C^{14} is always decaying, it is continually being replenished in living things so that the ratio of C^{14} to normal carbon (C^{12}) is nearly constant. Once the organism dies, the C^{14} is no longer replenished and simply decays away. This decay can be used to determine how long ago the organism died.* The dirt floor of the Shanidar Cave in the northern part of Iraq has been examined. Below the layer of soil that contained arrowheads and bone awls was a layer of soil that yielded flint tools and pieces of charcoal. When the charcoal was examined it was discovered that in 1 kg of carbon, approximately $9.4x10^2$ carbon-14 nuclei decayed each second. It is known that in 1 kg of carbon from living material, $1.5x10^4$ disintegrations of carbon-14 occur each second. Use this data to calculate when people of the Stone Age culture occupied the cave.

6. **SMM, Chapter 3, problem 14.**
7. **SMM, Chapter 3, problem 15.**
8. **SMM, Chapter 3, problem 16.**
9. **SMM, Chapter 3, problem 17.**