Activity: Radioactive Decay Cards

Objective: to determine the natural decay of U-238

Background: Nuclear stability and radioactive decay are important concepts to understanding nuclear chemistry, the size of the nucleus, and the energy that holds it together. Radioactive decay also plays an important role in society in the form of energy, medical tracers, and weapons. The radioactive decay of uranium isotopes has been extensively studied due to its abundance in nature and the important role uranium plays in nuclear power and weapons. The uranium -238 isotope is the predominant species (99.3%) found in nature and undergoes a slow radioactive decay to lead-206. Natural uranium also contains 0.7% U-235. When bombarded with neutrons, ruranium-235 will undergo nuclear fission and break into two lighter elements, releasing substantial amounts of energy. This is the principled behind the nuclear power industry and nuclear weapons.

Alpha Particle, α: a helium atom produced ruing radioactive decay. Represented by $^{4}_{2}He$. α-particle production is a very common mode of decay for heavy radioactive isotopes.

Beta Particle, β: an electron produced in a radioactive decay. Represented by $^{0}_{-1}e$. Beta decay is the most common type of decay and the net effect is to change a neutron into a proton.

Half-Life ($t_{1/2}$): the time required for one-half of the nuclides to undergo radioactive decay.

Nuclear Fission: the splitting of a heavy nucleus by a neutron into tow lighter nuclei, accompanied by a large release of energy.

Nuclide: a unique atom, represented by the symbol $^{A}_{Z}X$, where X is the chemical symbol of the element, A is the mass number and Z is the atomic number.

Materials:

- stack of radioactive decay cards (15 elements, 6 β, 8 α)
- graph paper

Overview: U-238 decays to Pb-206. There are thirteen nuclide species between U-238 and Pb-206. Each decay will emit an alpha or a beta particle.

Procedure:

1. Arrange the element cards in order of the natural radioactive decay with either an alpha or beta particle between each element.

Analysis:

1. Write the series of reactions in your lab book. Each reaction should be on a separate line.

2. How many decays are alpha decays? How many beta?

3. Make a graph of mass number (y-axis) vs. atomic number (x-axis) for each element in the series. Write the elements symbol at its point on the graph and connect the appropriate points in order of decay with an arrow. You can do this on graph paper or on Excel, if you have the program at home.