Project #68 – Modeling Activity

Modeling Radioactive & Stable Atoms

(Source: ReActions Newsletter, Volume 19, September 2003)

Use this as a demonstration or as a hands-on activity for students.

Introduction:

A zip-close plastic bag represents the nucleus of an atom and holds representation for protons and neutrons. If the atom is stable, zip the bag closed. If atom is radioactive, bag is left open to emit ionizing radiation (alpha particles, beta particles and/or gamma rays).

Materials:

large marshmallows
fine point permanent marker
toothpicks
mini-marshmallows
Periodic Table of the elements
white school glue
quart size zip-close plastic bags
pipe cleaners (optional)
Chart of the nuclides (optional)

Directions:

1) Mark 7 large marshmallows with a positive (+) sign. They represent protons.

2) Select 7 unmarked large marshmallows to represent neutrons.

3) From the group above, select 2 protons and 2 neutrons ; use toothpicks and glue to join these into a group of four . This represents an alpha particle.

4) Mark the sides of a mini-marshmallow with a negative (-) sign; it represents an electron. Stick, but do not glue, a toothpick into this mini-marshmallow. Glue the other end of the toothpick into the side of a proton (so the positive sign is partially covered). This now represents a neutron.

5) Put the alpha particle from step #3 into an empty zip-close bag. Add 4 protons and 4 unmarked marshmallows (neutrons). Zip bag closed.

The closed bag represents the nucleus of a stable atom. The binding energy can contain all the protons and neutrons within the nucleus; atom is stable.

Q1. *How many positively charged marshmallows (protons) are in the bag? (Do not count the one whose positive sign is partially covered by the mini-marshmallow!) This is the atomic number of the atom.*

Q2. *What element is represented by this model?*

*Q3. How many neutral particles are in the bag? (You **do count** the particle where positive and negative charges cancel each other out!)*

Q4. What is the atomic mass of this atom? (Each large marshmallow equals 1 atomic mass unit, regardless of charge.)

6) Open the bag. Add two neutrons. Leave the bag unzipped; excess neutrons have now made it unstable.

7) To become stable, the nucleus will emit a beta particle. Find the neutron you made in step #4. Pull off the mini-marshmallow (now it is a beta particle) and toss it about 1-2 feet from you. Leave the remaining proton in the bag and zip it closed. The atom has changed and is stable again.

Q6. What is the atomic number of the atom now?

Q7. What element does the atomic model represent now?

Q8. What is the atomic mass of the atom now?

Summary:

- Radioactive atoms emitting beta particles will change into the element which is one atomic number higher, but they will have the same atomic mass as before.

- To show another radioactive atom that emits an alpha particle to become stable, place an alpha particle in an empty zip bag. Add 2 protons and 2 neutrons. This represents the nucleus of Beryllium-8. The atom emits an alpha particle, which will pick up two electrons to become a stable atom of Helium-4. The result is two atoms of Helium-4.

- Represent a Gamma ray emission by shining a flashlight through the bag. Although gamma rays are really not visible, you can use this to model the fact that gamma rays are not particles; they are a form of electromagnetic radiation. All three types of radiation (alpha, beta, gamma) are ionizing radiation; they have enough energy to remove electrons from ordinary atoms. These ions allow us to detect radiation using a Geiger counter, photographic film, or an electroscope.

If desired, you can add pipe cleaners onto the bag to represent the orbits or shells where electrons would be present; mini-marshmallows with a negative (-) sign on them can be attached to the pipe cleaners to represent orbital electrons.