Isotope Revolution:
Isotopes for Radiometric Dating

<u>Teacher Instructions</u>

Materials:

1. beads (2 colors) 1000 of each (depends on the number of bags you make and the total number of beads you put in each bag)
2. zip lock sandwich bags
3. permanent marker
4. cash register tape

Preparation:
Lay out a length of cash register tape that will run the length of 3 sides of your room. Leave the front of the room open. Mark one end of the tape "Present" and the other end 4.6 billion years ago (4.6Ga). Half way between mark 2.3 Ga and then halfway between the "present" and 2.3 Ga mark 1.2 Ga. Half way between 4.6 Ga. and 2.3 Ga mark 3.5 Ga. This is you time line. Run it around three sides of your room.

Make up bags of beads that have the following numbers of beads.

Light-dark

A. 1-99
B. 50-50
C. 71-29
D. 75-25
E. 84-16
F. 25-75
G. 6-94
H. 12-88
I. 35-65
J. 100-0
K. 65-35
L. 18-82

You can make up more bags that have other ratios of beads. It is best to have one bag for each student. Light + dark must add up to 100. For higher level students you can change the total number of beads in each bag and have the students calculate the % decay. We are using 100 beads to make the % decay more obvious.

Label the bags with a permanent marker- A,B,C… We are using letters to avoid confusion with the numbers used in counting the beads.

The light beads are the parent atoms and the dark beads are the daughter atoms.

Activity:

1. Give each student a bag of beads.
2. Have the students count the beads of each color in the bag.
3. Ask the students to calculate the % of isotope decay in their bag.
4. Identify the parent and daughter atoms and tell them the half life for the parent-daughter pair. (see below)
5. Place the bag with 100 adult atoms at the end of the timeline marked "Present".
6. Tell the students to stand under the position on the time line that corresponds to the age of their rock.

Discuss with the class, while they are standing on the time line, where each person (% decay) should be. One common mistake is at the half way point to the 1st half-life. Many students will think the ratio should be 75/25 but since the regression is not linear it is actually about 71/29. That is why one of the bags has 25 dark and 75 light and another has 29 dark and 71 light.

For the 1st trial the parent daughter pair should be Uranium-235 and Lead-207 because it has a half life of 713 million years (Ma) and with this half life all of the students will be on the timeline.

For the 2nd trial the parent daughter pair can be Carbon-14 and Nitrogen-14 which has a half life of 5730 years. With this pair all of the students will be crowded to the front of the timeline.

Another trial can be done using the parent daughter pair Uranium-238 and Lead-206 which has a half-life of 4.5Ga (billion years). In this trial some of the students will see that they are in the future and don't have a place on the timeline.

Another discussion about the appropriate uses for each parent daughter pair could be held while the students are on the timeline. Students will see that carbon-14 would not work for dating the earth and that Uranium-238 would not work well for dating fossils that are only thousands of years old.

Students can graph the collective data of all the bags. They can graph the percent of parent atoms remaining against time. The time can be in years or half-lives. The graph will show the rate of decay is not linear.

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Student Instructions: Half-life Activity

You will be given a bag of beads. This bag represents a rock. This rock has a mineral in it that contains an element that is radioactive, which means that it will decay into another element. The original atom is called the parent atom and the element that is left after the radioactive decay is the daughter atom. The dark beads in the bag represent the parent atom and the light beads represent the daughter atom.

1. Count and record the number of each color of beads in the bag, without opening the bag, provided by your teacher.
2. The dark beads are the parent atoms and the light beads are the daughter atoms. Calculate the percent of daughter to parent atoms. This is the percent of decay for your parent atom.
3. Ask your teacher to tell you the half-life for this atom.
4. Calculate how long ago your rock formed.
5. Find the spot on the time line, which is on the classroom wall that corresponds to the forming of your rock.

Your teacher is now going to change the parent and daughter atoms in your rock. This new parent –daughter pair will have a different half-life. Your teacher will tell you the new half-life.

6. Calculate the age of this rock.
7. Find the spot on the time line that corresponds to the age of your rock.

Your teacher will now change the parent-daughter pair and half-life again.

8. Calculate the age of this rock.
9. Find the spot on the time line that corresponds to the age of your rock.

Discuss with your class or group:

A. The differences in the bags of old and new rocks.
B. The appropriate use of each parent-daughter pair in the dating of rocks or artifacts.

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Student Work Page: Half-life Activity

The following data table can be used to help guide students through the Half-life Activity.

Beads/atom	Number	Percent	Age Trial 1	Age Trial 2	Age Trial 3
Light					
Dark					

1. Identify which radioactive element you would use to date the following items and explain why you made that choice.
   A. A fossilized bone.
   B. A core sample taken from near the Mid-Atlantic Ridge.
   C. The oldest rock on the earth.

2. You have found a rock that has a mineral in it that contains the parent –daughter combination Samarium-Neodymium. Research and find the half-life of the parent atom. Determine the age of the rock if 75% of the parent atom has decayed. (your teacher may tell you the half-life or you may have to research it yourself.)

3. You find a rock that earth scientists believe to be 4 billion years old. Approximately what percentage of the following parent atoms would you expect to find. Explain your answers.

   A. ^{238}U
   B. ^{14}C

4. If you as a scientist are using radioactive decay to date a rock what assumptions do you have to make?