

## Get a Life and a Half!

### Concept Development

**Challenge:** What is a half-life of a radioactive isotope?

**Materials:** 100 pennies  
plastic container with lid

### Let's Dig In:

#### Part 1:

- Place 100 pennies in the plastic container “heads up” in the box. It doesn't matter if the coins overlap. Place the lid on the container.
- Shake the box the designated number of seconds. Your teacher will assign you to shake for 1 second, 5 seconds, or 15 seconds.
- Count the number of coins that are “heads up” after the shaking.
- Record and calculate the percent of coins that are “heads up” see (Go Figure Question 1)
- Share your percent with one other group which shook a different length of time and compare your answers (see Go Figure Question 2)

#### Part 2:

- Make a data table to record the data for up to 12 shakes and the percent parent isotope left after each shake.
- Record the number of “heads up” on your first shake in the data table you just made.
- Remove from the container all pennies that landed “heads up” and set them aside.
- Repeat the shaking, recording, and removing until you have no pennies “heads up” left. You may not need 12 shakes to accomplish this.
- Graph your results. Be sure to label both axes and make a title.

### Go Figure:

#### Part 1

1. Record the percent “heads up” pennies after shaking the box the designated amount of time.
2. How does your percent compare with the other group?
3. What percent would you expect to get after the 1 shake?
4. The shaking time does not have an impact on the expected percent for “heads up”. Why?

#### Part 2

5. State the isotope assigned by your teacher and state how many years is one half-life?
6. How many half-lives did it take before you have no measurable parent isotope left?
7. If a fossil containing your isotope was analyzed and found to have about 25% of the parent isotope left. How old is the fossil?
8. If a fossil containing your isotope was analyzed and found to have about 6% of the parent isotope left. How old is the fossil?
9. Why would a scientist choose different isotopes to analyze a fossilized dinosaur bone from the Mesozoic era or a saber-tooth tiger bone from the Pleistocene Era? Explain your answer.



Teacher Notes  
**Get a Life and a Half!**  
 Concept Development

**GEOMES Topic:** Geologic History – Fossils and Ancient Life

<b>Lab setup:</b>	none	<u>easy</u>	moderate	difficult
<b>Reasoning level:</b>	easy	<u>moderate</u>	difficult	
<b>Time required:</b>	20-40 minutes	<u>40-60 minutes</u>	60-90 minutes	
<b>Process skills:</b>	<u>observing</u>	<u>collecting data</u>	<u>communicating</u>	

**Objectives:** In this activity students will learn how a radioactive isotope acts as a measure of time.

**National Science Education Standards:**

Content Standard: Earth and Space Science: Energy in the earth system  
 Unifying Concepts and Processes: Evidence, models, and explanation

**Materials:** 100 pennies per student group  
 plastic container with lid

**Teaching Strategies:**

The purpose of this activity is to formulate the concept of radioactive isotope decay and how this can be used to measure time. This works best with pairs of students rather than larger groups. Pennies can be substituted with M & M's® or Skittles® since these candies have writing on only one side. You can also use 50 pennies instead of 100 to conserve supplies.

After Part 1, hold a class discussion to make sure students understand the idea of the probability being 50% when tossing a coin. This is also the time for you to introduce the terms parent isotope and daughter isotope. In this activity, the parent isotope is represented by the “heads up” coin and the daughter isotope is represented by the “tails up” coin. Each toss should result in a 50% reduction of the parent isotope.

After Part 2, assign different groups different radioactive isotopes. Below is a chart of common isotopes used to absolute date fossils.

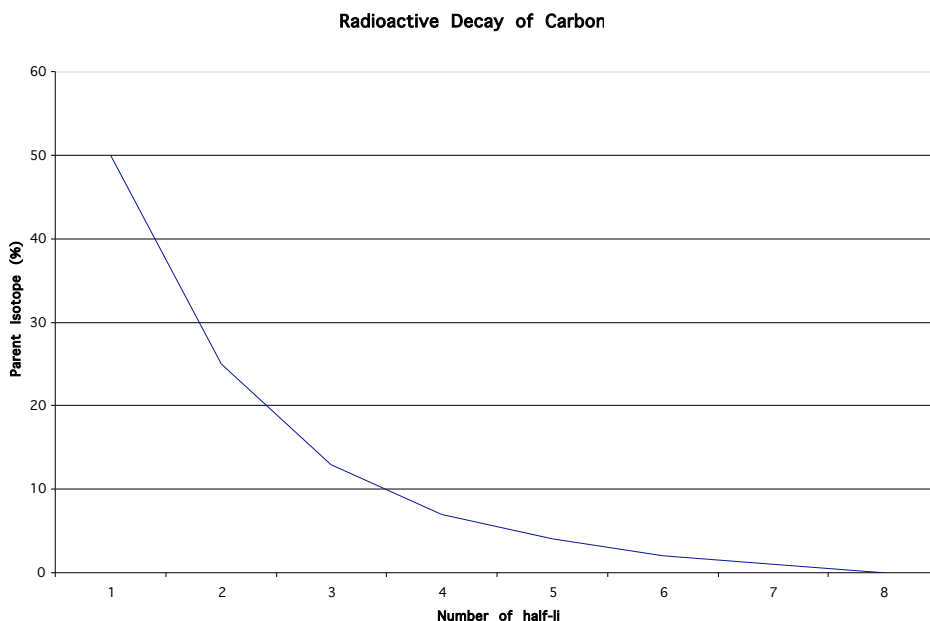
**Table 1: Common Isotopes Used for Radiometric Dating**

Parent Isotope	Half-life of parent (yrs)	Daughter Isotope	Dating Range (years)	Datable items
Rubidium-87	47 billion	Strontium-87	10 million-4.6 billion	Igneous & Metamorphic Rock
Uranium-238	4.5 billion	Lead -206	10 million – 4.6 billion	Igneous & Metamorphic Rock
Potassium-40	1.3 billion	Argon-40	100,000-4.6 billion	Igneous & Metamorphic Rock
Carbon-14	5,730	Nitrogen-14	100-100,000	Bone, wood, shells, charcoal, cloth, paper, animal droppings, water, ice, cave deposits

Uranium-235	713 million	Lead-207	10 million-4.6 billion	Igneous & Metamorphic rocks
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You may need to remind students of graphing skills depending on the skill level of your students.

### Sample Data and Observations:



### Sample Responses to Go Figure:

1. Probability says students should get 50%, but you may see some variation since student groups are just doing one trial.
2. There could be quite a range of responses since you are taking just one shake. Students should say their response was the same, higher or lower than the other group.
3. We would expect the percent to be 50.
4. The shaking time does not impact the results because each shake has the same probability of heads or tails, 50%.
5. Answers will vary depending on which isotope was assigned. See Table 1.
6. Student answers will vary from 8-12 half-lives.
7. If a student had Carbon 14, with a half-life of 5,730 years. Here is the solution:  

$$5730 \text{ years} \times 2 = 11,460 \text{ years}$$
8. If a student was assigned Uranium-235 with a half-life of 713 million years. Here is the solution:  $713 \text{ million years} \times 4 = 2852 \text{ million years}$
9. Different isotopes are used for different objects because they can only date objects for a portion of a half-life up to about 9 half-lives. There has to be enough detectable isotope of

the parent or daughter to measure with some accuracy. The fossilized dinosaur bone would be best analyzed by using potassium-40, Uranium-238, or Uranium-235. The saber-tooth tiger bone would have been analyzed using Carbon-14.