Name: ____ TOC#____

Radioactive Decay
Half Life Simulation

Background

It was not until the end of the 1800's that scientists found a method for determining the actual age of rocks, minerals and fossils. They found that *isotopes,* or radioactive elements *decay*, or change to other elements. This occurs when particles and energy are released at a constant, measurable rate. Scientists found that each radioactive element decays at a fixed rate. This rate is not affected by pressure, temperature, or the outside environment. The decay process is so regular that it can literally be used to determine the passage of time, like the ticking of a clock.

In this activity, you will use a mathematical model to study the process of radioactive decay. You will examine how scientists can use this model to determine the age of ancient earth materials - particularly fossils. It will be helpful to remember that the term *"half-life"* refers to the time required for half of the atoms of a given mass of substance to decay to a stable end product.

Focus Questions and Pre-lab Questions

By the end of this lab you should be able to answer the following questions:

- What are half-life and radioactive decay and how are they connected?
- What is the relationship between specific elements and their half-lives?
- How can radioactive decay and half-life be used to calculate the *absolute age* of fossils?

Before you Begin, Please answer these questions:

1. What is the purpose of today's lab?

2. What is radioactive decay and how does that relate to an isotope?

3. Define half-life.

Procedures and Flow Chart

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1. Obtain the necessary materials for your lab group from the supply table. This should include a cardboard shoebox with a lid and 100 popcorn kernels.

2. Count the popcorn kernels to be certain there are exactly 100 kernels in your box. Also check to be sure that each side on the inside of the box is numbered 1, 2, 3, or 4.

3. Cover the box. Hold it level and give it a sharp, single shake.

4. Open the box and remove all the kernels that have the small end pointed toward side 1. Count and record the removed corn. Subtract the removed number from the number in the box before the shake (100). Then record the number of remaining kernels in the proper place on the data table. Do **not** return the removed corn kernels to the box.

5. Replace the lid, shake the box again, and once more remove the corn kernels pointing toward side 1. Count and record the removed corn. Subtract this figure from the number remaining from the previous shake. Record this new figure in the data table under corn remaining.

6. Repeat this process until all of the corn kernels have been removed from the box.

7. Return all 100 pieces of corn to the box, cover it and repeat the above procedure except, this time, after each shake, remove the kernels that are pointed toward **both side 1 and side 2**. Count the corn remaining and record each of your observations in the data table.

8. Continue this procedure until all of the corn has been removed from the box.

9. Finally, return all of the corn to the box and repeat the entire procedure for a third time, except this time remove **the kernels that are facing sides 1, 2 <u>and</u> 3.** Count the corn remaining and record each of your observations in the data table. Repeat until all the corn has been removed from the shoebox.

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<td>Create your flow chart here. Remember-this should include all the steps-but should be a summary!</td>
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Data/Results

Radioactive Decay Simulation - Data Table

Starting Corn Count: _________

Shake #	Side 1 Test		Side 1 and 2 Test		Side 1, 2 and 3 Test	
	corn removed	corn remaining	corn removed	corn remaining	corn removed	corn remaining
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Analysis and Conclusions

1. Construct a graph to illustrate your data by comparing the number of shakes vs. number of corn kernels remaining. The graph should include the data from all three trials as recorded in each column of your data table. (Remember, bar graphs are used for discontinuous data, line graphs for continuous data.)

2. Write brief paragraph summarizing the data illustrated in your graph.

3. a) For the first data set (side 1 only) how many shakes were required before half of the kernels were remaining in the box?

   b) For the second data set (sides 1 and 2) how many shakes were required before half of the kernels were remaining in the box?

   c) For the third data set (sides 1, 2 and 3) how many shakes were required before half of the kernels were remaining in the box?

4. Complete the following table, indicating what each of the components of the lab were simulating with respect to radioactive decay.

Component In Simulation	What It Represents
Corn kernels in box before simulation begins	
Corn kernels pointing towards any side (to be removed)	
Corn kernels remaining after any given shake	
A single shake	
The change from removing only side one kernels to either sides 1 and 2 or sides 1, 2, and 3	
Shoebox	
	Half Life

Use your new understanding of radioactive decay and half-life to perform the following calculations.

5. Suppose a radioactive element has a half-life of 30 days.
   a. How much of a 4 gram sample will be unchanged (still radioactive) after 60 days? (Show your work.)

   b. After 90 days? (Show your work.)

   c. After 120 days? (Show your work.)

6. Suppose a radioactive element has a half-life of 10,000 years.
   a. What percent of the material will be unchanged (still radioactive) after 20,000 years? (Show your work.)

   b. After 30,000 years? (Show your work.)

7. Create a graphic (which could be as simple as a data table) that demonstrates the following: Ten pounds of a radioactive element, with a half life of 2 million years, after 10 million years.

8. What are half-life and radioactive decay and how are they related?

9. Why might the half-lives of different elements differ?

10. Describe how radioactive decay and half-life can be used to calculate the *absolute age* of fossils?