# Pre-Lab Information

Purpose Explore the process of radioactive decay (half-life) through simulation.

Time Approximately 45 minutes

Question What does half-life “look like” for a radioactive substance?

Hypothesis If an element is radioactive, then the fraction of radioactive atoms remaining after *n*   
half-life cycles should be approximately 0.5*n*, because approximately half of the atoms’ nuclei will decay during each cycle.

Summary You will first predict the decay pattern of 100 atoms of a fictional radioactive element “Lincolnium,” which decays to “Memorium.” Then you will simulate and analyze   
that pattern.

# Procedure

1. **Compute 0.5*n* for *n* = 1 to 8**

Recall that your hypothesis is that these values are the fraction of atoms that are still radioactive after *n* half-life cycles. Record in the data table.

1. **Predict the Number of Radioactive Atoms at Each Half-Life**

Using the values from Step 1, predict the pattern for the decay of 100 atoms over the course   
of eight half-life cycles. Round to the nearest whole number of atoms. Record in the data table.

1. **Simulate 100 Radioactive Atoms for Eight Half-Life Cycles**

Record the number of radioactive atoms remaining at the end of each cycle in the data table. Use everyday objects such as pennies. If you use pennies, let “heads” represent an atom with   
a radioactive nucleus. Let “tails” represent an atom with a nucleus that has decayed (no longer radioactive). If you don’t have 100 pennies, you can use other objects, such as candy with letters on one side or even slips of paper with the letters “L” (for Lincolnium) and “M” (for Memorium).

Count out 100 pennies and lay them all on the table so that they all show heads, representing 100 radioactive atoms. Then repeat the following eight times**:** Pick up all the pennies showing heads. Shake them in your hands (or in a cup) and then spread them onto the table next to the nonradioactive atoms (pennies still showing “tails”). Count the number of radioactive atoms (“heads”) and record in the data table.

1. **Compare Predicted and Simulated Results**

Write a few sentences comparing the predicted and simulated data.

1. **Create a Graph and Regression Equation for the Simulated Results**
   1. Make a scatterplot with the variables below in an appropriate viewing window.

*x* = Time (half-life cycles)

*y* = Radioactive atoms (simulated)

* 1. Use a calculator to compute the exponential regression equation that best fits.

1. **(Optional) Act Out the Decay in Real Time**
   1. Start with 100 radioactive atoms. (If representing the atoms with pennies, spread them   
      out, heads up.)
   2. Make radioactive atoms decay, trying to match the timing shown in the data table. As you   
      flip coins to make the atoms decay, count downward aloud (99, 98, 97, …) to represent the number of radioactive atoms remaining. Have a classmate record the numbers you say at 30-second intervals.
   3. How accurately were you able to make the exponential decay happen? If you were not   
      very accurate, try again, keeping in mind the rate of exponential decay.

# Data

Record your data either in your lab notebook or in the space below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Time** | | **0.5*n*** | **Radioactive Atoms** | | |
| **Minutes** | **Half-Life Cycles, *n*** | **Predicted** | **Simulated** | **Acted out** |
| 0.0 | Initial = 0 | 1 | 100 | 100 | 100 |
| 0.5 | 1 |  |  |  |  |
| 1.0 | 2 |  |  |  |  |
| 1.5 | 3 |  |  |  |  |
| 2.0 | 4 |  |  |  |  |
| 2.5 | 5 |  |  |  |  |
| 3.0 | 6 |  |  |  |  |
| 3.5 | 7 |  |  |  |  |
| 4.0 | 8 |  |  |  |  |