LAB 2 Laboratory Activity

Radioactive Decay—A Simulation

Certain elements are made up of atoms whose nuclei are naturally unstable. The atoms of these elements are said to be radioactive. The nucleus of a radioactive atom will decay into the nucleus of another element by emitting particles of radiation. It is impossible to predict when the nucleus of an individual radioactive atom will decay. However, if a large number of nuclei are present in a sample, it is possible to predict the time period in which half the nuclei in the sample will decay. This time period is called the half-life of the element.

Radioactive materials are harmful to living tissues. Their half-lives are difficult to measure without taking safety precautions. To eliminate these problems, you will simulate the decay of unstable nuclei by using harmless materials that are easy to observe. In this experiment you will use dried split peas to represent the unstable nuclei of one element. Dried lima beans will represent the stable nuclei of another element. Your observations will allow you to make a mental model of how the nuclei of radioactive atoms decay.

Strategy

You will simulate the decay of a radioactive element.
You will graph the results of the simulated decay.
You will determine the half-life of the element.

Materials

small bag of dried split peas
250-mL beaker
large pizza or baking tray
bag of dried lima beans

Procedure

1. Count out 200 dried split peas and place them in a beaker.
2. Record the number of split peas in Table 1 as Observation 0.
3. Place the pizza or baking tray on a flat surface.
4. Hold the beaker over the tray and sprinkle the split peas onto the tray. Try to produce a single layer of split peas on the tray.
5. Remove all the split peas that have NOT landed on the flat side down. Count the split peas that you have removed and return them to the bag. Replace the number of peas that you have removed from the tray with an equal number of lima beans. Count the number of peas and the number of lima beans on the tray. Record these values in Table 1 as Observation 1.
6. Scoop the peas and beans from the tray and place them into the beaker.
7. Predict how many split peas you will remove if you repeat steps 4 and 5. Enter your predictions in the Data and Observations section.
8. Repeat steps 4 through 6, recording your data in the data table as Observation 2.
9. Predict how many observations you will have to make until there are no split peas remaining. Enter your prediction in the Data and Observations section.
10. Repeat steps 4 through 6 until there are no split peas remaining.

Laboratory Activity 2 (continued)

Data and Observations

Table 1

Observation	Time (minutes)	Split peas	Lima beans

Prediction of number of split peas removed:

Prediction of number of observations until there are no split peas remaining:

Laboratory Activity 2 (continued)

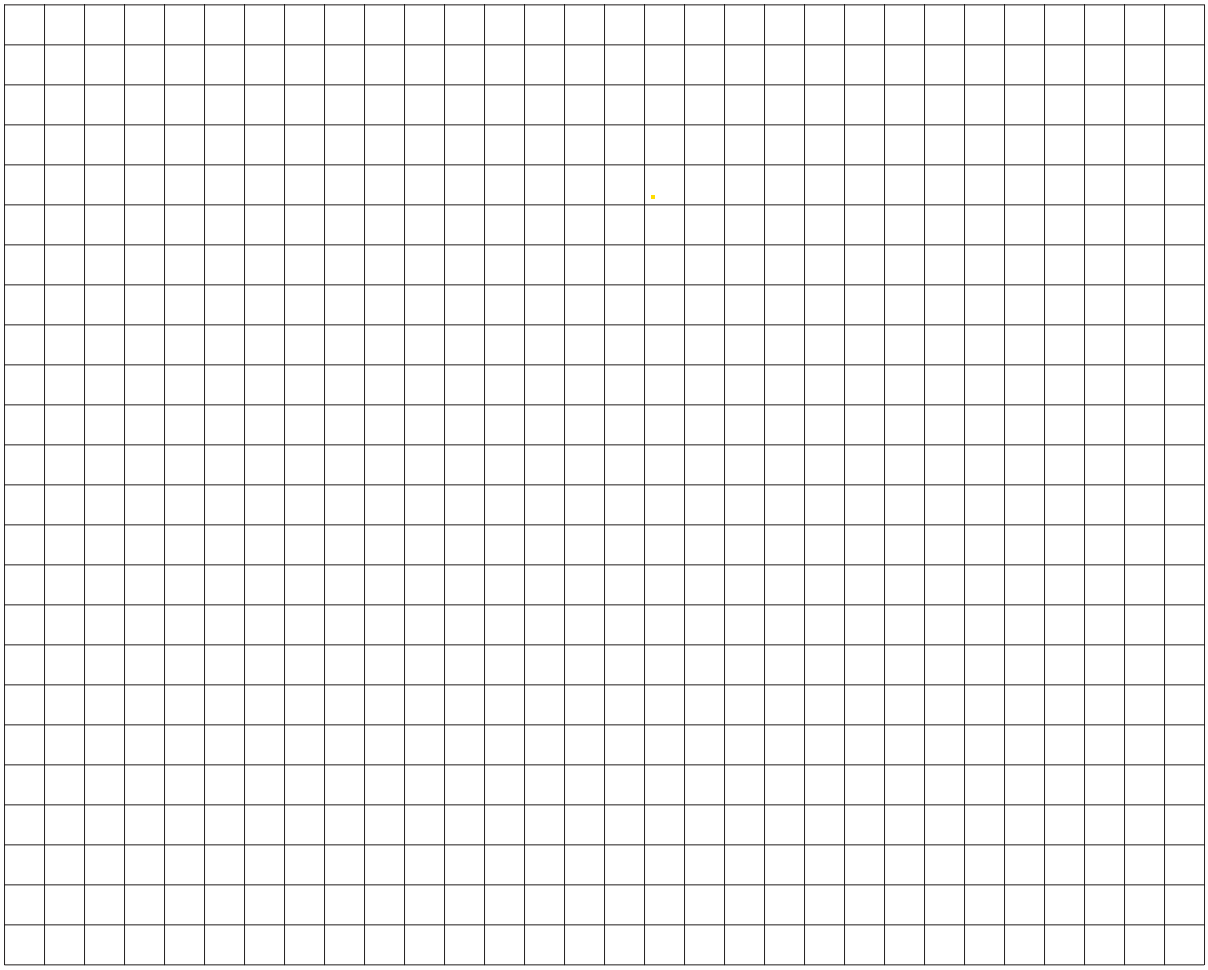
Analysis

In this experiment each split pea represents the nucleus of an atom of radioactive element A. A split pea that has landed flat side down represents the nucleus of an atom of radioactive element A that has not yet decayed. Each split pea that has NOT landed flat side down represents the nucleus of element A that has decayed. Each lima bean represents the nucleus of an element B that was formed by the decay of the nucleus of an element A .

Assume that the time period between each observation was 5 minutes. Observation 1 will have been made at 5 minutes, observation 2 at 10 minutes, and so on. Complete the time column in Table 1.

1. Use Graph 1 below to graph the results of your experiment. Plot on one axis the number of the nuclei of element A atoms remaining after each observation. Plot the time of this observation on the other axis. Determine which variable should be represented by each axis.
2. Use Graph 1 to construct another graph. Plot on one axis the number of nuclei of element B atoms remaining after each observation. Plot the time of the observation on the other axis.
3. Determine the appropriate half-life of element A from your graph.

Graph 1



Laboratory Activity 2 (continued)

Questions and Conclusions

1. What is the approximate half-life of element A?

2. Use your graph to determine the number of element A nuclei remaining after 2 half-lives, and after 3 half-lives.

3. Why did you replace split peas but not lima beans during this experiment?

4. The two graphs that you constructed look like mirror-images. Explain why this is so.

5. Suppose you were given 400 dried split peas to do this experiment. Explain which of the following questions you could answer before starting this experiment.

a. Can you identify which split peas will fall flat side up?

b. Can you predict when an individual split pea will fall flat side up?

c. Can you predict how many split peas will remain after 3 observations?

Strategy Check

_____ Can you simulate the decay of a radioactive element?

_____ Can you graph the results of the simulated decay?

_____ Can you determine the half-life of the element?