Radiation and Half-Life
Lesson Plan

Grade Level: 9-12 | **Curriculum Focus:** Inorganic Chemistry | **Lesson Duration:** One class period

Student Objectives

- Learn about the discovery of radium and radioactivity.
- Understand the process of radioactive decay.
- Perform an experiment to better understand half-life

Materials

- Discovery School video on *unitedstreaming*: *Invention: Elements and Compounds*
  Search for this video by using the video title (or a portion of it) as the keyword.

  Selected clips that support this lesson plan:

  - Marie Curie: Radioactivity and the Discovery of Radium

For each pair or group:

- Shoebox with cover
- One hundred items that have distinguishable tops and bottoms (e.g., M&Ms or coins)

Procedures

1. Ask students if they can define the term *radioactivity*. Make sure they understand that radioactivity is technically defined as the property of some elements or isotopes of spontaneously emitting particles of energy by the disintegration of their atomic nuclei.
2. Go on to explain the following concepts before proceeding with the activity:
   - The disintegration of the atomic nuclei of radioactive materials is known as *radioactive decay*.
   - As a sample of radioactive material decays, it becomes stable and nonradioactive.
   - The amount of time it takes for half a sample of radioactive material to decay into a stable substance is called its *half-life*.
   - The half-lives of different radioactive materials can be anywhere from billions of years to a few seconds long.

3. Have your students demonstrate radioactive half-life by using a shoebox containing 100 items. The items should have distinguishable "heads" and "tails," as do coins or M&Ms (letters on one side, blank on the other).
4. Instruct students, working individually, in pairs, or in small groups, to put their 100 items into the shoebox with the same side facing up.
5. Have students put the cover on the box and shake the box up and down (not sideways) five times.
6. They should then open the lid and remove any of the items that now have the chosen side facing down. (If one item is on top of another, students should move the item on top to an empty space in the box without changing its orientation.)
7. Have students count the number of items remaining in the box and record the results for the first five shakes.
8. Students should repeat the process until no items are left in the box, recording data as they work (number of items remaining after the second five shakes, third five shakes, and so on).
9. Have students graph the data they have recorded, with "number of items remaining" on the vertical axis and "number of five-shake tries" on the horizontal axis.
10. Students can now determine the "half-life" for their items by calculating how many five-shake tries were necessary to remove 50 of the items.
11. Invite students to share their results. Was the number consistent throughout the class? Why, or why not? What factors may have influenced the results? Are similar factors present in measuring the half-life of an element or isotope? Why, or why not?

Discussion Questions

1. Compare and contrast the radioactive elements on the periodic table. What do they have in common with each other in terms of their chemical structure?
2. The Curies risked their health to make what turned out to be an important scientific discovery: the element known as radium. Scientists today continue to work hard to create new elements in laboratories all over the world, but they usually take extensive safety precautions, which sometimes slow down the pace of their research. With safety in mind, what kinds of risks should scientists take in their research? Who should determine whether an experiment is genuinely safe?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Students' data clearly and correctly recorded; graphs carefully prepared.
- 2 points: Students' data recorded; graphs prepared.
- 1 point: Students' data poorly recorded and graphed.

Vocabulary

aspirin

Definition: A white crystalline derivative of salicylic acid used for relief of pain and fever.

Context: As anyone who's ever had an ache or a fever knows, aspirin has remarkable properties.

leukemia

Definition: An acute or chronic disease in humans and other warm-blooded animals characterized by an abnormal increase in the number of white blood cells in the tissues and often in the blood.

Context: Both Marie Curie and her daughter died from leukemia caused by their exposure to radioactive elements.

osmosis

Definition: Movement of a solvent through a semipermeable membrane into a solution of higher solute concentration that tends to equalize the concentrations of solute on the two sides of the membrane.

Context: Osmosis is used to purify salt water in desalinization plants.

radioactivity

Definition: The property possessed by some elements or isotopes of spontaneously emitting energetic particles by the disintegration of their atomic nuclei.

Context: Marie Curie discovered that the mineral pitchblende, which contains radium, was a source of radioactivity.

radium

Definition: An intensely radioactive brilliant white metallic element that resembles barium chemically, occurs in combination in minute quantities in minerals, emits alpha particles and gamma rays to form radon, and is used chiefly in luminous materials and in the treatment of cancer.

Context: Radium is a highly radioactive metallic element, discovered by Marie Curie, which was used in cancer radiation therapy.

semipermeable

Definition: Partially but not freely or wholly permitting liquids or gases to pass through.

Context: A semipermeable membrane is important in the filtering of seawater.

Academic Standards

Mid-continent Research for Education and Learning (McREL)
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit

http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Physical Science: Understands the sources and properties of energy.
- Science—Physical Science: Understands the structure and properties of matter.
- Science—Nature of Science: Understands the nature of scientific knowledge.
- Science—Nature of Science: Understands the nature of scientific inquiry.

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site:
http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Physical Science: Properties and changes of properties in matter

---

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html