

Activity 2: Time, Distance and Shielding

Objectives

Students will investigate how time, distance and shielding can reduce exposure risks.

Next Generation Science Standards

The concepts in this activity can be used to support the following science standard:

- PS4. Waves and Electromagnetic Radiation.

Common Core State Standards (CCSS)

The concepts in this activity align with the following CCSS English Language Arts Standards for Literacy in History/Social Studies, Science, & Technical Subjects:

- Comprehension and Collaboration: CCSS.ELA-LITERACY.SL.6-12.1
- Text Types and Purposes: CCSS.ELA-LITERACY.WHST.6-12.2
- Research to Build and Present Knowledge: CCSS.ELA-LITERACY.WHST.6-12.7

The concepts in this activity align with the following CCSS Mathematics Standards:

- CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.
- CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.
- CCSS.MATH.CONTENT.6.SP.B.5. Summarize numerical data sets in relation to their context, such as by:
 - CCSS.MATH.CONTENT.6.SP.B.5.B. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
- CCSS.MATH.CONTENT.7.EE.B.4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.
- CCSS.MATH.CONTENT.HSN.Q.A.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Materials and Resources

- *Radiation Protection: Teacher Background Information.*
- *Vocabulary Materials.*
- *Radiation Protection Worksheet* (one per student, pair or group).
- *Applying Time, Distance and Shielding Worksheet* (one per student, pair or group).
- Option A (per group or class based on supplies available):
 - Geiger counter and radioactive source (e.g., commercially purchased source, Fiesta dinnerware, luminescent clock or watch face, or gas camping lantern with a thorium mantel).
 - Alternative to Geiger counter: Heat source (e.g., hot plate or heat lamp).
 - Measuring device (ruler, measuring stick or tape measure).
 - Clock with a second hand or a stopwatch.
 - A thermometer (if using a heat source).
 - Shielding sources (e.g., piece of glass, clothing or aluminum foil; or sheet of paper or metal).

- Option C:
 - Student computers with Internet access or printed resources for students with information about protection measures taken in nuclear reactor incident(s).

Time

45-60 minutes depending on the activity option chosen. Students may also complete the activity outside of class and discuss their findings in the next class period.

Vocabulary

- Geiger counter
- Ionizing radiation
- Radiation
- Radiation exposure
- Radiation protection

Directions

1. Start with a vocabulary activity if students are not familiar with radiation and the terms used in this activity, or provide students with the terms and definitions.
2. Explain that there are situations in which we may or may not have control over our exposure to ionizing radiation. Ask students:
 - When do we not have control over our exposure to radiation? We do not have control over our exposure to some naturally occurring (background) radiation, and we may not have control over our exposure to undetected sources of radiation.
 - When do we have control over our exposure to radiation? Examples may include when evaluating whether to have an x-ray or medical procedure (using radiation), when testing for and fixing radon levels in your home, or when following warnings or emergency response directives and staying away from radioactive areas.
 - Why might we want to limit our exposure to radiation when possible? Radiation can deposit energy in body tissue and can damage or kill cells.
3. Select and prepare an activity option:
 - **Option A:** Have students use a Geiger counter and a radioactive source or heat source and thermometer to conduct an experiment and test possible radiation protection methods. Provide time, distance and shielding materials that are listed in Materials and Resources.
 - **Option B:** Have students predict what steps they can or might take to reduce their exposure to radiation (e.g., if living near a radioactive area like an abandoned uranium mine, if finding an orphan radioactive source, or in the event of a nuclear explosion or accident).
 - **Option C:** Have students research what radiation protection concepts are, and have been, used in radiological emergencies (e.g., Japan's Fukushima nuclear power plant incident or other historical nuclear power plant incidents).
 - **Option D:** Have students interview a person who practices radiation protection at work to determine what radiation practices are followed according to the source(s) of radiation used. Interviewees may include medical, dental or veterinary staff; x-ray equipment or environmental inspectors; people who test and resolve radon issues; Department of Health staff who deal with radiation issues; truck drivers who haul radioactive materials; emergency responders; researchers; power plant workers; radon mitigation workers; and construction workers who use moisture and density nuclear gauges.

4. Explain to students that their task is to hypothesize and test (or research) ways people can limit their exposure to ionizing radiation.
5. Introduce the three main concepts of radiation protection. Determine how much information you want to provide about these concepts before students complete the activity and investigate the concepts. For instance if using Option A, you may want students to identify these concepts through the activity and review the concepts afterwards. Information on the concepts (time, distance and shielding) can be found in the *Radiation Protection: Teacher Background Information*.
6. Distribute the *Radiation Protection Worksheet* (if using Option A) or the *Time, Distance and Shielding Worksheet* (if using Options B through D). Have students work in pairs or small groups to conduct the activity and complete the worksheet. Students should determine that one can limit their exposure by:
 - Limiting their time spent near a radiation source.
 - Increasing the distance from a radiation source.
 - Using shielding to provide a barrier between themselves and a radiation source.
7. Have students share the radiation protection concepts they identified in their experiment or research and how they help reduce or eliminate a person's exposure to radiation. Prompt students to consider how using two or more forms of protection might affect a person's exposure level. NOTE: You may want to extend Activity Option A and have students hypothesize and test how using two or more forms of protection might affect a person's exposure level if they did not already do so.

Radiation Protection Worksheet

Name: _____

Date: _____

Conduct an experiment to test the ways in which you and others can limit your radiation exposure when you have control over the situation.

1. State the problem or question.

2. Conduct research and state your hypothesis.

3. List any materials or resources used to test your hypothesis.

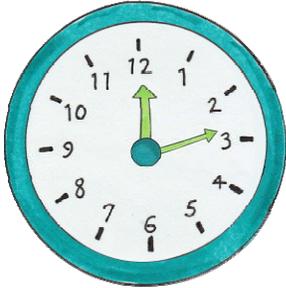
4. Describe the procedure(s) to test your hypothesis.

5. Collect the data on the back of this sheet or a separate sheet of paper and present the results in tables or graphs, if applicable.

6. State your conclusions.

Applying Time, Distance and Shielding Worksheet

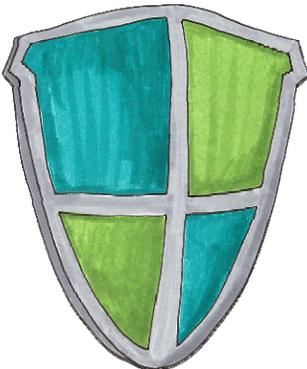
Describe how you and others can use time, distance and shielding to limit your radiation exposure when you have control over the situation.



Time



Distance



Shielding