Activity 1: Ground Up

Objectives

Students will:

- Predict whether they live in an area where the potential average indoor radon levels are low, moderate or high.
- Investigate why indoor radon levels vary.
- Conduct experiments to investigate the movement of radon through the ground.

Next Generation Science Standards

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

- ESS2. Earth's Systems.
- ESS3. Earth and Human Activity.

Materials and Resources

- *Radon: Teacher Background Information*.
- *Vocabulary Materials*.
- *Radon Zones Map* and state radon zones map (display with computer and projector, copy for students, or allow them to access the maps with student computers):
  - EPA Map of Radon Zones: http://www2.epa.gov/radon/find-information-about-local-radon-zones-and-radon-programs#radonmap
- *Ground Up Worksheet* (one per student, pair or group) and teacher answer key.
- *Ground Up Data Sheet* (one per student, pair or group).
- Containers, such as small, clear plastic tubs or clear plastic cups (at least one per pair or group or one for each type of rock and soil per pair or group).
- Rocks and soil representative of the local geology (enough of each type so pairs or groups can partially fill the tubs or cups).
- Straws (at least one per student).
- Beakers (one per pair or group).
- Water.
- Droppers (one per pair or group).

Time

45-60 minutes, not including optional activities or extensions.

Vocabulary

- Ionizing radiation
- Radiation
- Radioactive atom
- Radioactive decay
- Radon
- Uranium

Directions

1. Start with a vocabulary activity if students are not familiar with radon and the vocabulary words used in this activity.

2. Explain that radon is a naturally occurring radioactive gas that comes from the decay of uranium found in rocks and soils. Human activities, such as uranium mining, can increase the risk of radon exposure. During the mid-1940s to 1970s, the U.S. was in a race with the Soviet Union to develop and test nuclear weapons. Nuclear power was also introduced during this time. Thousands of uranium mines were in operation, primarily in the Western part of the U.S., and nuclear testing was taking place in the West and in Alaska. When the demand for uranium decreased, uranium mines and testing areas were abandoned; leaving contaminated soil and water with high radon levels that has affected Native Americans and Alaska Natives.

   Radon is a threat to health because it tends to collect indoors in homes and buildings, sometimes to very high levels, and can cause lung cancer.

3. Ask students to predict whether they live in an area where the potential average indoor radon levels are low, moderate or high and explain their reasoning.

4. Display or provide students with a copy of the *Radon Zones Map* and their state map. State maps are web-accessible through http://www2.epa.gov/radon/find-information-about-local-radon-zones-and-radon-programs#radonmap. Explain that the maps show potential average indoor radon levels by three zones: Zone 1 (red) is predicted to have high indoor radon levels, Zone 2 (orange) moderate indoor radon levels, and Zone 3 (yellow) low indoor radon levels.

5. Ask students to hypothesize why certain areas (or the area where they live) have greater potential for higher indoor radon levels or why two houses side by side can have very different radon levels. **This is due to the geology below the individual homes. It may be that the rock and soil has a higher uranium (and therefore, radon) content or that the type of rock and soil and presence of cracks and fissures that might allow radon to move up more easily through the ground. How well the homes are built, including how well floors, walls and gaps are sealed or how ventilated the home is, may be other factors.**

6. Distribute the *Ground Up Worksheet*. Provide rock and soil samples of the local geology and identify each. Direct students to answer the questions.

7. Distribute the *Ground Up Data Sheet.* Direct students in completing the experiments and documenting their findings.

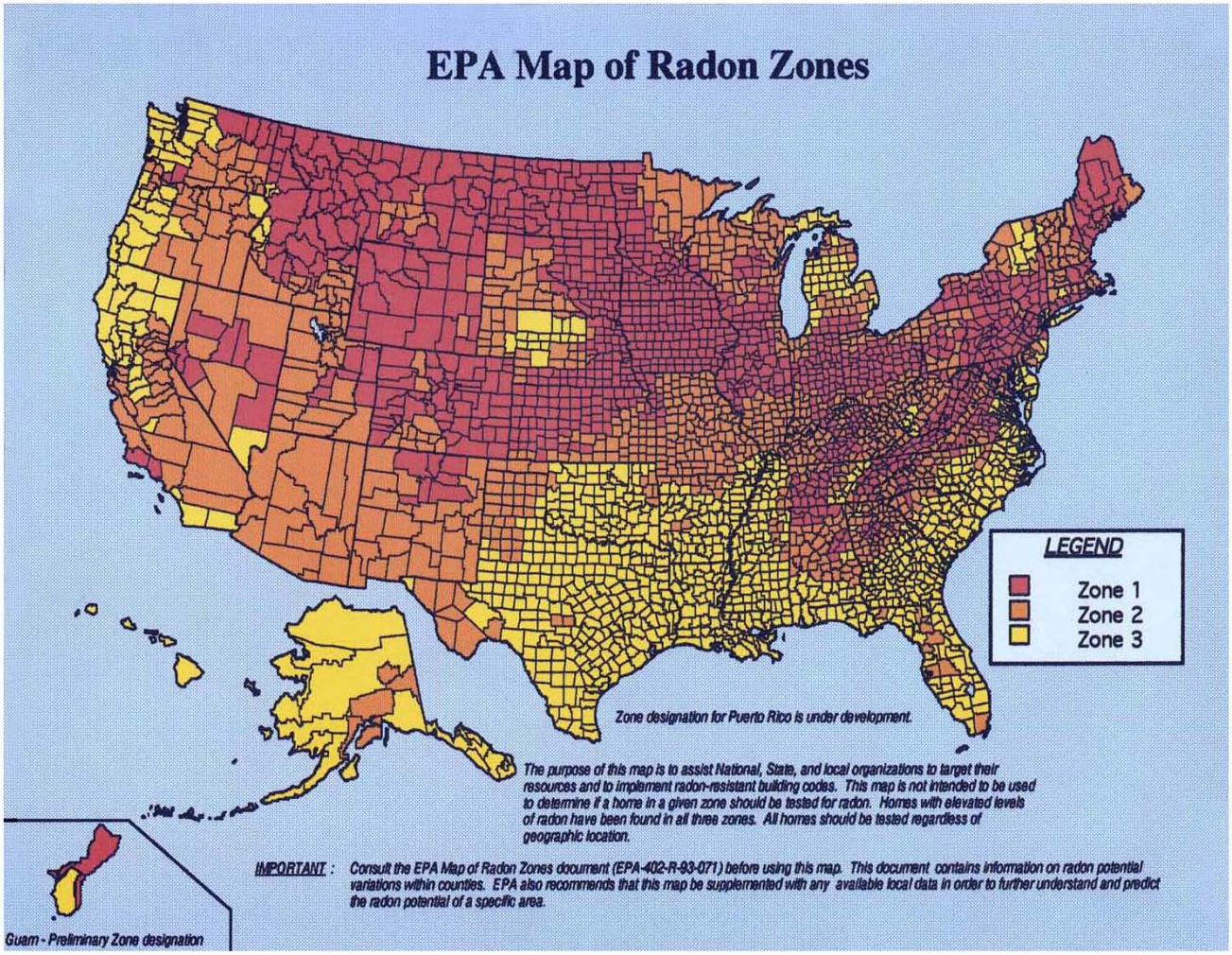
8. Review students' findings and conclusions when complete. *The Ground Up Teacher Answer Key* may serve as a guide.

9. Conclude by asking students if they should rely solely on radon maps to determine whether they should test their home for radon. **Students should recognize the importance of testing all homes because uranium exists in nearly all rock and soil and the movement of radon can vary greatly based on the formation of the earth or the presence of cracks and fissures below individuals' homes.**

10. Optional activities or extensions: Have students:
    - Investigate how scientists collect soil air samples to determine the radon content.
    - Investigate local soil air data (check with your state's radon program), chart the data and identify areas of concern.
    - Examine the local rock and soil types. Plot on a map the geological breakdown of the area with low, medium and high radon potential. Have students test different areas using short-term test kits. Plot the results on the map, determine which results correlate with the radon potential of area and provide possible explanations if the data doesn't correlate.

Radon Zones Map

The U.S. Environmental Protection Agency (EPA) created this map to identify areas with the potential for elevated indoor radon levels. The EPA Map of Radon Zones helps national, state, and local organizations implement radon-resistant building codes. The map should not be used to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones. All homes should be tested for radon.



What do the colors mean?

	Zone 1 (red zones)	Highest potential; average indoor radon levels may be greater than 4 pCi/L (picocuries per liter)
	Zone 2 (orange zones)	Moderate potential; average indoor radon levels may be between 2 and 4 pCi/L
	Zone 3 (yellow zones)	Low potential; average indoor radon levels may be less than 2 pCi/L

Ground Up Worksheet

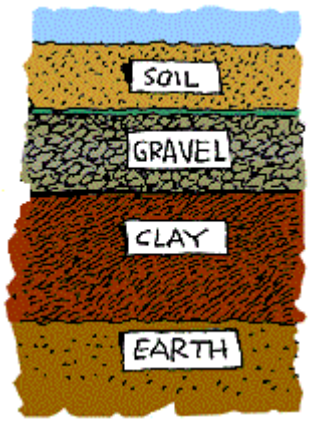
Name: _____ Date: _____

Radon is a radioactive gas that comes from the decay of uranium found in nearly all rock and soil types. Radon moves from the ground up into homes and other buildings.

Read the following questions. Form a hypothesis in response to each question.

1. How does radon move up through rock and soil?

   _____
   _____
   _____



2. Examine rock and soil samples that are representative of the local geology. Which rock and soil types might slow or block radon's movement?

   _____
   _____
   _____

3. How might ground water or the moisture content of soil affect radon's movement?

   _____
   _____
   _____

Ground Up Teacher Answer Key

1. How does radon move up through rock and soil?
   Students should find that radon can move through porous or permeable rocks, spaces between rocks and gravel, and cracks in rocks and soil. Sandstone tends to be permeable, and uranium is generally found in sandstone deposits.

2. Examine the rock and soil samples that are representative of the local geology. Which rock and soil types might slow or block radon's movement?
   Students should find that radon may be blocked by less permeable rock and soil types like clay, slate and granite. Radon that is trapped in the soil will decay to form lead.

3. How might ground water or the moisture content of soil affect radon's movement?
   Students should find that ground water or moist soil slows radon movement.

Ground Up Data Sheet

Name: _____ Date: _____

Follow the directions and record your observations and conclusions.

Directions	Observations and Conclusions
1. Fill one or more container(s) one-half to three-quarters full of individual types of rock and soil. 2. Insert a straw so it nearly touches the bottom of the container and blow. Take note of how easy or hard it is to blow air in the straw and how gas might travel through the soil. 3. Record your observations. 4. Form a conclusion about how radon, a radioactive gas, might move up through the different types of rock and soil.	
5. Fill a beaker with water. 6. Fill a dropper with water from the beaker. 7. Place several drops of water on the individual types of rock and soil. Observe whether the rock and soil absorb the water. Permeable rocks and soil allow liquids and gases to pass through them. 8. Record your observations. 9. Form a conclusion about which types of rock and soil might slow or block radon's movement.	
10. Fill a beaker with water. 11. Pour the water over the different types of rock and soil in the container. 12. Insert a straw so it nearly touches the bottom of the container and blow. Take note of how easy or hard it was to blow air in the straw and how the gas might travel through the soil. 13. Record your observations. 14. Form a conclusion about how ground water might impact radon's movement up through the ground.	