Activity 1: Uranium, Radium and Radon

Objectives

Students will:

- Determine the atomic structures of uranium, radium and radon.
- Describe the characteristics of each.
- Examine the benefits and risks of each.

NOTE: Students should have an understanding of the periodic table and how to use the information to determine the atomic structure of elements.

Next Generation Science Standards

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

- PS1. Structure and Properties of Matter.
- ESS3. Earth and Human Activity.

Materials and Resources

- *Uranium: Teacher Background Information*.
- *Vocabulary Materials*.
- *Uranium Past and Present* images (one per student, pair or group or display with a computer and projector).
- *Uranium, Radium and Radon Worksheet* (one per student, pair or group) and *Uranium, Radium and Radon Teacher Answer Key*.
- *Periodic Table of Elements* (one per student, pair or group).
- Student computers with Internet access or provide print versions for students (optional):
    - RadTown: www3.epa.gov/radtown
    - Nuclear Power Plants: www3.epa.gov/radtown/nuclear-plant.html
    - Uranium Mines: www3.epa.gov/radtown/uranium-mines.html
    - Radionuclide Basics: Uranium: http://www2.epa.gov/radiation/radionuclide-basics-uranium
    - Radionuclide Basics: Radium: http://www2.epa.gov/radiation/radionuclide-basics-radium
    - Radionuclide Basics: Radon: http://www2.epa.gov/radiation/radionuclide-basics-radon

Time

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

Vocabulary

- Atom
- Electron
- Neutron
- Nuclear energy
- Proton
- Radiation
- Radioactive atom
- Radioactive decay
- Radium
- Radon
- Uranium
- Uranium mining

Directions

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

2. Share the *Uranium Past and Present* images. Explain that a uranium mining boom took place in the U.S. from the mid-1940s to 1970s. During this period thousands of uranium mines were in operation, primarily in the Western part of the U.S.

3. Ask students why uranium was mined and how it is used today. Uranium was mined primarily for the development of nuclear weapons and then for power generation. The images show the industrial uses today include:
   - A nuclear power plant: Nuclear power plants produce electricity through a heat-generating process known as "fission" in which neutrons split uranium atoms to produce large amounts of energy.
   - A nuclear-powered supercarrier: A small nuclear reactor powers submarines, supercarriers, icebreakers and other ships. In the defense industry, depleted uranium metal is used for armor plating and armor-piercing projectiles.

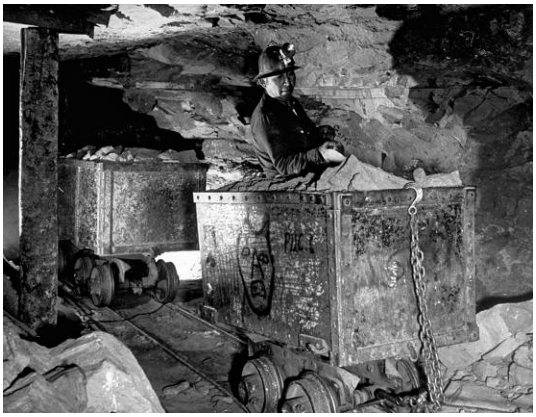
4. Distribute the *Uranium, Radium and Radon Worksheet*. Direct students to use the *Periodic Table of Elements* to complete the activity. The atomic number will provide students with the number of protons and electrons. They can calculate the neutrons by subtracting the atomic number from the atomic mass. Resources may include information from the Environmental Protection Agency (EPA) webpages listed in the Materials and Resources section.

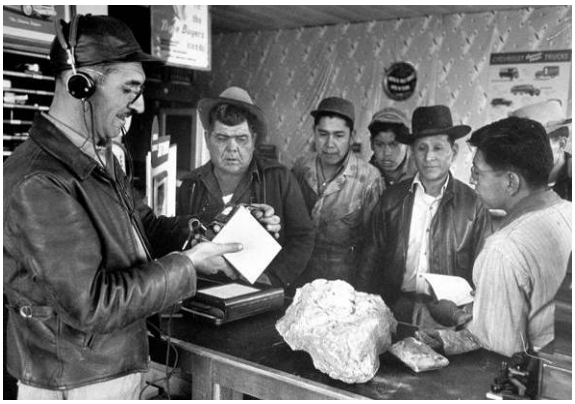
5. Review student responses as a class using the *Uranium, Radium and Radon Teacher Answer Key*. Conclude by asking students to share at least one thing they learned about uranium, radium or radon.

6. Optional activities or extensions: Have students examine:
   - The atomic structure and physical characteristics of each element.
   - The types of radiation each emits (alpha particles, beta particles and gamma rays), the potential exposure pathways (direct exposure, ingestion and inhalation), the potential health effects and the potential protection measures people can take to avoid exposure to these elements. Information about uranium, radium and radon can be found online at: http://www2.epa.gov/radiation/radionuclides.
   - Explore how the uranium to lead decay chain can be used in radioactive dating to calculate the age of rocks or organic material.

Uranium Past and Present

Uranium Mining Boom: 1947 to 1970





Uranium miner (left) and prospectors with a large uranium ore (right).
Source: National Institute of Environmental Health Sciences

Industrial Uses Today

Energy

Defense
Source: White House photo by David Bohrer

Uranium, Radium and Radon Worksheet

Name: _____ Date: _____

Use a periodic table to complete the following table and determine the number of protons, electrons and neutrons.

Element	Symbol	Atomic Number	Atomic Mass	Atomic Structure	Group/Family and Properties
Uranium				Protons: Electrons: Neutrons:	
Radium				Protons: Electrons: Neutrons:	
Radon				Protons: Electrons: Neutrons:	

1. How are we exposed to these elements?

   Natural (background) sources:

   _____

   _____

   Man-made sources:

   _____

   _____

2. What is the connection between these elements?

   _____

   _____

3. Explain how the elements' atomic structures relate to their radioactive properties.

   _____

   _____

   _____

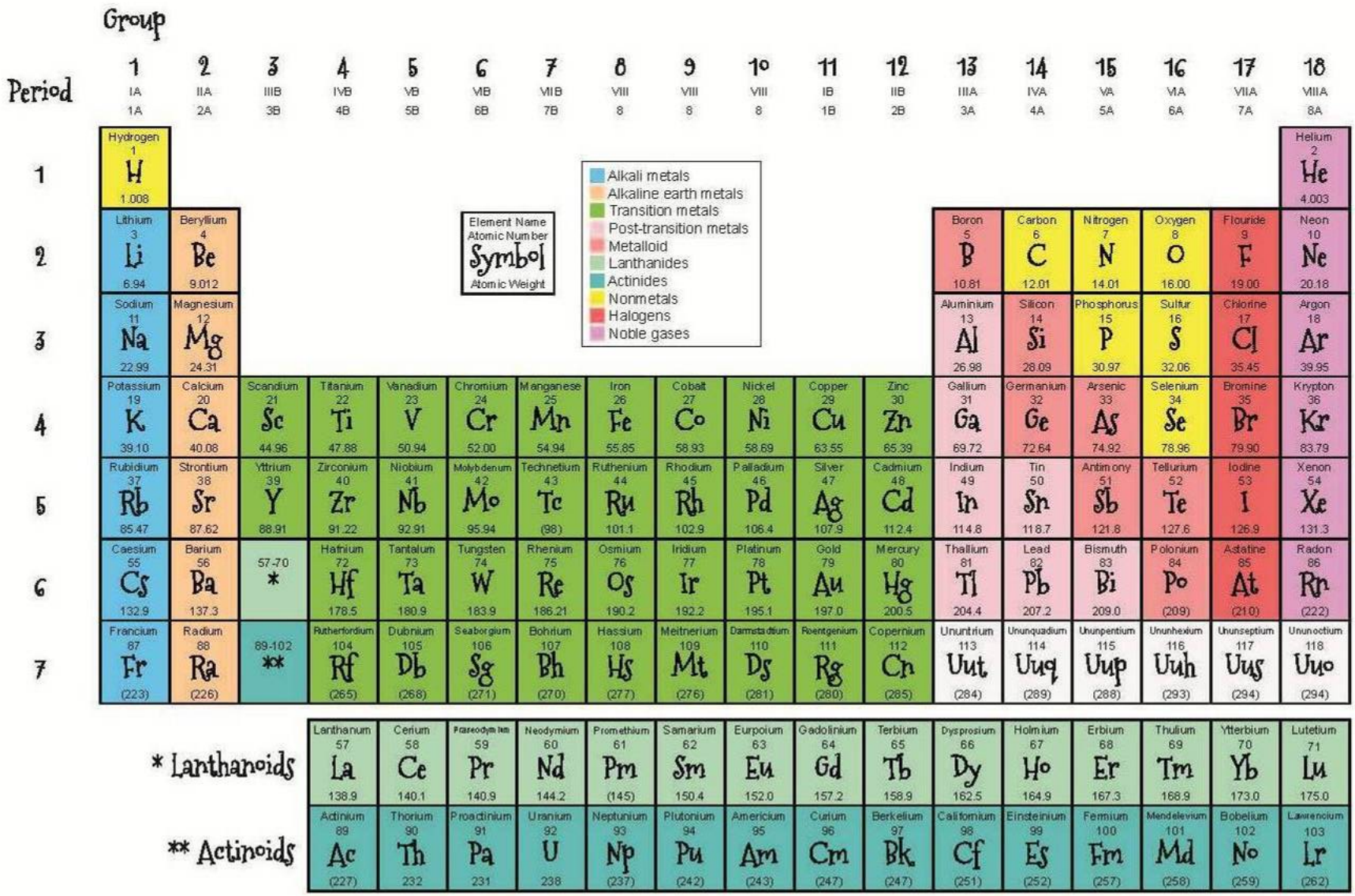
4. Why is exposure to these elements a concern?

   _____

   _____

   _____

Periodic Table of Elements



Uranium, Radium and Radon Teacher Answer Key

Element	Symbol	Atomic Number	Atomic Mass	Atomic Structure	Group/Family and Properties
Uranium	**U**	**92**	**238**	**Protons: 92 Electrons: 92 Neutrons: 330**	**Part of the actinide series; silvery white, weakly radioactive metal**
Radium	**Ra**	**88**	**226**	**Protons: 88 Electrons: 88 Neutrons: 138**	**Alkaline earth metal; naturally radioactive, silvery-white metal that blackens when exposed to air**
Radon	**Rn**	**86**	**222**	**Protons: 86 Electrons: 86 Neutrons: 136**	**Noble gas; colorless, odorless, and tasteless radioactive element**

1. How are we exposed to these elements?

   Natural (background) sources: **Uranium, radium and radon are naturally occurring radioactive elements found in soil, rock and water.**
   Man-made sources: **Man-made activities, like digging and mining, can bring these elements to the surface. These elements may also be found in radioactive waste from human activities like mining, milling and nuclear power generation.**

2. What is the connection between these elements?
   Uranium decays to form radium and radon. Exposure to radon can cause lung cancer.

3. Explain how the elements' atomic structures relate to their radioactive properties.
   An atom is unstable (radioactive) if the forces among the particles that make up the nucleus are unbalanced from an excess of either neutrons or protons. Unstable nuclides of any element can exist. However, almost all elements that are heavier than bismuth, which has 83 protons, have an unstable nucleus; they are radioactive and are known as "heavy nuclides."

4. Why is exposure to these elements a concern?
   These elements tend to pose more of a concern when they exist in high concentrations (e.g., in radioactive waste) rather than in their natural state. Concentrations of these elements can contaminate the soil, water and air. People and animals may also be contaminated by or exposed to these elements. Exposure to these elements may pose health effects. For example, radon can cause lung cancer.