

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

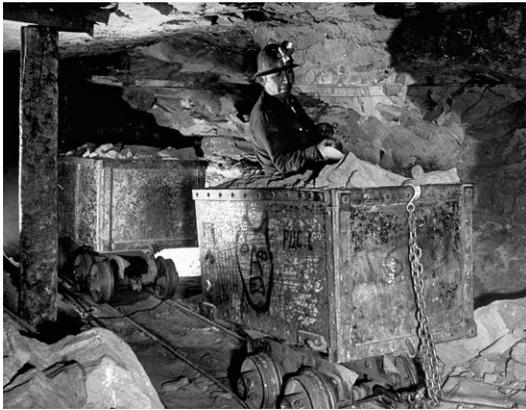
- Atom
- Electron
- Neutron
- Nuclear energy
- Proton
- Radiation
- Radioactive atom
- Radioactive decay
- Radium
- Radon
- Uranium
- Uranium mining

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

Period	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18	
1	Hydrogen 1 H 1.008																	Helium 2 He 4.003	
2	Lithium 3 Li 6.94	Beryllium 4 Be 9.012												Carbon 6 C 12.01	Nitrogen 7 N 14.01	Oxygen 8 O 16.00	Fluorine 9 F 19.00	Neon 10 Ne 20.18	
3	Sodium 11 Na 22.99	Magnesium 12 Mg 24.31												Silicon 14 Si 28.09	Phosphorus 15 P 30.97	Sulfur 16 S 32.06	Chlorine 17 Cl 35.45	Argon 18 Ar 39.95	
4	Potassium 19 K 39.10	Calcium 20 Ca 40.08	Scandium 21 Sc	Titanium 22 Ti 47.88	Vanadium 23 V 50.94	Chromium 24 Cr 52.00	Manganese 25 Mn 54.94	Iron 26 Fe 55.85	Cobalt 27 Co 58.93	Nickel 28 Ni 58.69	Copper 29 Cu 63.55	Zinc 30 Zn 65.39		Gallium 31 Ga 69.72	Germanium 32 Ge 72.64	Arsenic 33 As 74.92	Selenium 34 Se 78.96	Bromine 35 Br 79.90	Krypton 36 Kr 83.79
5	Rubidium 37 Rb 85.47	Strontium 38 Sr 87.62	Yttrium 39 Y	Zirconium 40 Zr 91.22	Niobium 41 Nb 92.91	Molybdenum 42 Mo 95.94	Technetium 43 Tc (98)	Ruthenium 44 Ru 101.1	Rhodium 45 Rh 102.9	Palladium 46 Pd 106.4	Silver 47 Ag 107.9	Cadmium 48 Cd 112.4		Indium 49 In 114.8	Tin 50 Sn 118.7	Antimony 51 Sb 121.8	Tellurium 52 Te 127.6	Iodine 53 I 126.9	Xenon 54 Xe 131.3
6	Cesium 55 Cs 132.9	Barium 56 Ba 137.3	* 57-70	Hafnium 72 Hf 178.5	Tantalum 73 Ta 180.9	Tungsten 74 W 183.9	Rhenium 75 Re 186.21	Osmium 76 Os 190.2	Iridium 77 Ir 192.2	Platinum 78 Pt 195.1	Gold 79 Au 197.0	Mercury 80 Hg 200.5		Thallium 81 Tl 204.4	Lead 82 Pb 207.2	Bismuth 83 Bi 208.98	Polonium 84 Po (209)	Astatine 85 At (210)	Radon 86 Rn (222)
7	Francium 87 Fr (223)	Radium 88 Ra (226)	** 89-102	Rutherfordium 104 Rf (261)	Dubnium 105 Db (268)	Seaborgium 106 Sg (271)	Bhombium 107 Bh (270)	Hassium 108 Hs (277)	Mitlerium 109 Mt (276)	Darmstadtium 110 Ds (281)	Roggenium 111 Rg (280)	Copernicium 112 Cn (285)		Ununtrium 113 Uut (284)	Ununquadium 114 Uuq (289)	Ununpentium 115 Uup (286)	Ununhexium 116 Uuh (293)	Ununseptium 117 Uus (294)	Ununoctium 118 Uuo (294)
			* Lanthanoids																
			** Actinoids																

Element Name	Atomic Number	Symbol	Atomic Weight
Alkali metals			
Alkaline earth metals			
Transition metals			
Post-transition metals			
Metalloid			
Lanthanides			
Actinides			
Nonmetals			
Halogens			
Noble gases			

Element Name	Atomic Number	Symbol	Atomic Weight
Hydrogen	1	H	1.008

* Lanthanoids

** Actinoids

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.