Activity 1: Types of Radiation

Objectives

Students will:

- Differentiate between non-ionizing and ionizing radiation.
- Explore real-world sources of each.
- Gain an increased awareness of their everyday exposure to radiation.

Next Generation Science Standards

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

- PS4. Waves and Electromagnetic Radiation.

Materials and Resources

- *Radiation Exposure: Teacher Background Information*.
- *Vocabulary Materials.*
- *Radiation Types and Sources Worksheet* (one per student, pair or group or group).
- *Electromagnetic Spectrum* image (included in the *Radiation Exposure: Teacher Background Information* or the *Vocabulary Materials*); display with computer and projector.
- *Radiation Worksheet* (one per student, pair or group or group) and *Radiation Worksheet Teacher Answer Key*.
- Marbles — approximately eight to ten marbles per group. Use unique sizes or colors with one marble representing the nucleus, five marbles representing electrons and the remaining two to four marbles representing radiation (e.g., one white, five blue and two to four red marbles).
- *Radiation Sources in Our Community Worksheet* (one per student, pair or group) and *Radiation Sources in Our Community Teacher Answer Key* (optional activity or extension).
- Student computers with Internet access (optional).

Time

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

Vocabulary

- Atom
- Electromagnetic spectrum
- DNA
- Gamma rays
- Ionizing radiation
- Non-ionizing radiation
- Radiation
- X-rays

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. Ask students to hypothesize whether all sources of radiation are the same or different. For example, have students explain whether there is a difference between the radiation from a cellphone, the radiation from the sun, and the radiation used in x-ray machines.

3. Distribute the *Radiation Types and Sources Worksheet*. Explain that radiation is energy that travels in the form of waves or high speed particles (photons) and makes up the electromagnetic spectrum in the form of non-ionizing and ionizing radiation. The energy of the radiation shown on the spectrum increases from left to right as the frequency rises.

4. Direct students to cut out the radiation source images and place them under the matching type of radiation on the electromagnetic spectrum. Alternatives:
   - Have students label each source image with the matching type of radiation.
   - Have eight students write a type of radiation on a sheet of paper (extremely low frequency radiation to gamma rays) and line up in the order of the electromagnetic spectrum. Provide nine other students with a radiation source image (use those provided or larger images of these items) and have them line up accordingly with the students representing the electromagnetic spectrum.

5. Display the *Electromagnetic Spectrum* image (included in the *Radiation Exposure: Teacher Background Information* or the *Vocabulary Materials*) so students can use it to check their work.

6. Distribute the *Radiation Worksheet* and direct students to complete the demonstrations and record their observations. Students should complete the critical thinking questions following the demonstrations. A *Radiation Worksheet Teacher Answer Key* has been provided.
   - Demonstration A shows that non-ionizing radiation can cause atoms to vibrate and move. A potential effect is heat generated from the vibration or movement. You can prompt students to think about how we use microwaves to heat our food or how cell phones get warm with use.
   - Demonstration B shows that ionizing radiation can change the structure of an atom by breaking chemical bonds in molecules or removing tightly bound electrons from atoms and creating charged molecules or atoms (ions). A potential effect is cell or DNA damage when this occurs.

7. Have students share their responses.

8. Conclude by explaining that people often view ionizing radiation as harmful. However, it is all around us and has been present since the birth of our planet. As a result, our bodies are adapted to some degree of radiation exposure and have developed mechanisms for repairing cell damage from radiation exposure. Health risks and the amount of cell damage depends on the type of radiation, the exposure pathway, the radiation's energy and the total amount of radiation absorbed.

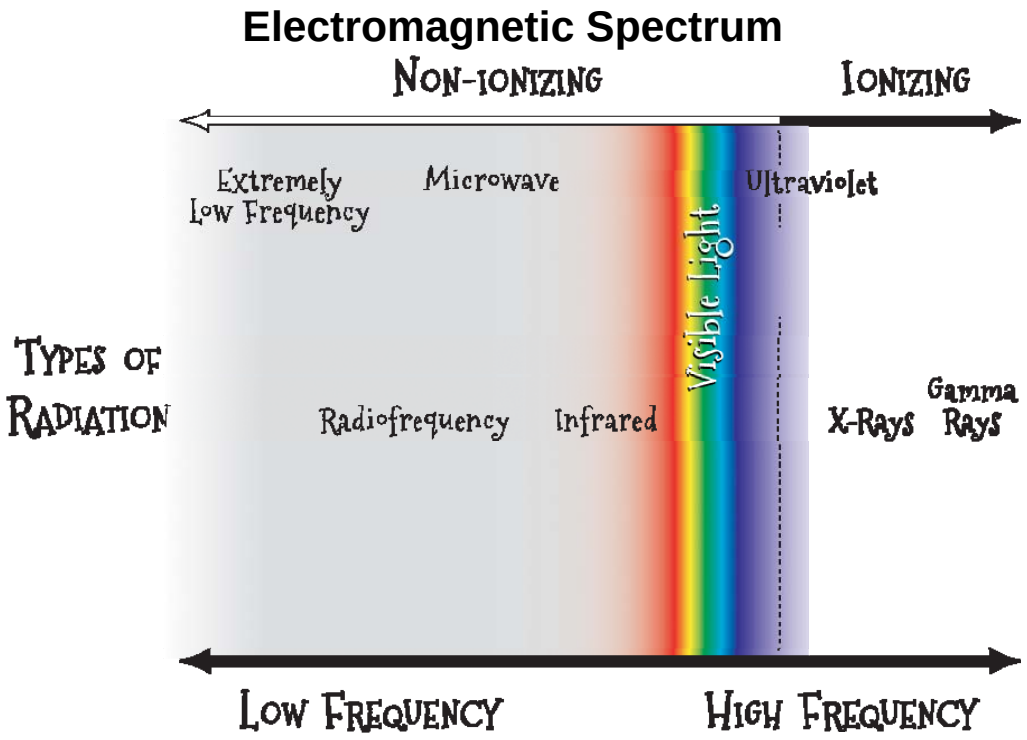
9. Optional activities or extensions: Direct students to identify sources of radiation in their community and determine whether they are sources of non-ionizing and/or ionizing radiation.

- Provide students with the *Radiation Sources in Our Community Worksheet*. Direct them to identify the location of the radiation sources and indicate whether they are a source of non-ionizing radiation, ionizing radiation or both. Students can refer to the RadTown USA website (www3.epa.gov/radtown). A *Radiation Sources in Our Community Teacher Answer Key* is provided.
- Direct students to tour their school, home and/or community and identify sources of radiation. Have them generate the list of identified sources by energy range (e.g., radio, microwave, ultraviolet or x-ray) in the electromagnetic spectrum and type (e.g., non-ionizing radiation, ionizing radiation or both).
- Have students research and debate the effects of non-ionizing radiation (e.g., use of microwaves and cellphones).

Radiation Types and Sources Worksheet

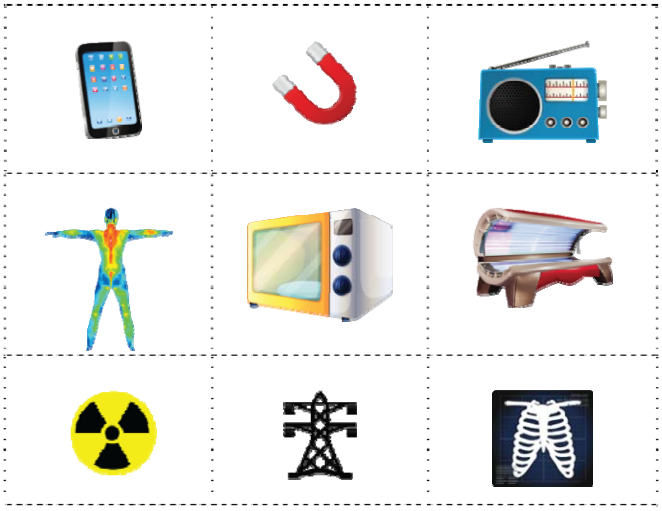
Name: _____ Date: _____

Radiation is energy that travels in the form of waves or high speed particles (photons) and makes up the electromagnetic spectrum. Radiation within the electromagnetic spectrum is divided into two major categories: ionizing radiation and non-ionizing radiation.



Sources of Radiation

Cut out the sources of radiation images. Place them on the electromagnetic spectrum under the appropriate type of non-ionizing or ionizing radiation. Some types of radiation may have more than one source image.

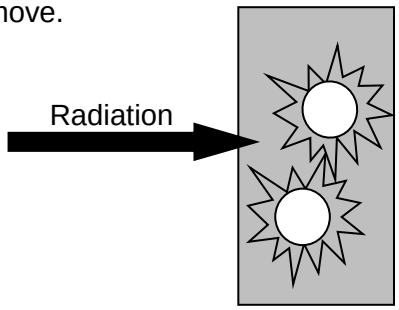


Radiation Worksheet

Name: _____ Date: _____

The images and demonstrations represent the effects of radiation when it is absorbed by atoms (represented by the white circles). Complete the demonstrations, record your observations and answer the questions.

Image A: This type of radiation can cause atoms to vibrate and move.



Demonstration A:

1. Place your hands together. Your hands represent atoms.
2. Rub them against each other for 10 to 20 seconds.
3. Observe and record what happens to the "atoms" and the potential effects.

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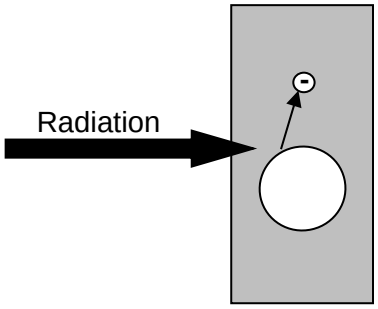
Image B: This type of radiation can change the structure of an atom by removing tightly bound electrons from atoms.



Demonstration B:

Equipment: 8 to 10 marbles. Select one marble to represent an atom nucleus. Select five marbles to represent electrons that surround the atom nucleus. Select two to four marbles to roll at the atom.

1. Place one marble (representing the nucleus of an atom) on a level surface.
2. Place five marbles tightly around the "nucleus" marble. The five marbles represent electrons. You now have a marble atom.
3. Roll one marble at a time at the "atom" and try to move, or knock away, an "electron."
4. Observe and record what happens to the atom nucleus and the potential effects.

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Questions:

1. Does image and demonstration A represent the effects of non-ionizing or ionizing radiation? Consider the effects you observed and what you know about these types of radiation in the electromagnetic spectrum. How might this type of radiation affect our bodies?

   _____

   _____

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2. Does image and demonstration B represent the effects of non-ionizing or ionizing radiation? Consider the effects you observed and what you know about these types of radiation in the electromagnetic spectrum. How might this type of radiation affect our bodies?

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3. Why do you need to be aware of and understand the difference between non-ionizing and ionizing radiation and their effects?

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Radiation Worksheet Teacher Answer Key

1. Does image and demonstration A represent the effects of non-ionizing or ionizing radiation? Consider the effects you observed and what you know about these types of radiation in the electromagnetic spectrum. How might this type of radiation affect our bodies? **Non-ionizing radiation. Low frequency sources of non-ionizing radiation are not known to present health risks. High frequency sources of ionizing radiation (such as the sun and ultraviolet radiation) can cause burns and tissue damage with overexposure.**

4. Does image and demonstration B represent the effects of non-ionizing or ionizing radiation? Consider the effects you observed and what you know about these types of radiation in the electromagnetic spectrum. How might this type of radiation affect our bodies? **Ionizing radiation. It can damage living tissue by changing cell structure and damaging DNA. Children are more sensitive to ionizing radiation than adults because children are still in the process of growing. There are more cells dividing and a greater opportunity for radiation to disrupt the growth process.**

2. Why do you need to be aware of and understand the difference between non-ionizing and ionizing radiation and their effects?
   Answers may vary, but students should be aware that ionizing radiation can affect atoms in living things and pose a health risk. Therefore, we may need to take measures to limit our exposure to ionizing radiation. Non-ionizing radiation does not typically pose a health risk. However, higher frequency forms of non-ionizing radiation such as the sun and ultraviolet lights can burn our skin or damage our eyes.

Radiation Sources in Our Community Worksheet

Name: _____ Date: _____

Review the following sources of radiation and indicate where you might encounter them, such as outdoors, in specific buildings or in certain work settings. Indicate whether the source is non-ionizing radiation, ionizing radiation or both.

Sources of Radiation	Locations	Non-Ionizing, Ionizing Radiation or Both
Ultraviolet (UV) light		
Security scanners		
Computed tomography (CT) scanners		
Cosmic radiation		
Electric and magnetic fields (EMF)		
Antique clocks and watches that glow in the dark		
Radon		
Tritium exit signs		
Ionizing smoke detectors		
Radioactive waste from abandoned uranium mines		
Wireless technology		
Nuclear moisture and density gauges		
Cigarettes/radiation in tobacco		

Radiation Sources in Our Community Teacher Answer Key

Sources of Radiation	Location(s)	Non-Ionizing and/or Ionizing Radiation
Ultraviolet (UV) light	**Outdoors, hospitals, tanning salons and certain jobs (e.g., welding or research)**	**Sun, medical uses and certain jobs: Both Tanning beds: Non-ionizing**
Security scanners	**Airports, courthouses and other buildings**	**Ionizing**
Computed tomography (CT) scanners	**Hospitals, clinics, medical/digital imaging diagnostic labs, and some veterinary offices**	**Ionizing**
Cosmic radiation	**Airplanes and outdoors**	**Ionizing**
Electric and magnetic fields (EMF) from power lines	**Near power lines and in all buildings with electrical devices and electrical outlets**	**Non-ionizing**
Antique clocks and watches that glow in the dark	**Homes, antique stores and flea markets**	**Ionizing**
Radon	**Outdoors and in some buildings; radon may also be encountered through drinking water and soil**	**Ionizing**
Tritium exit signs	**Many commercial and public buildings, as well as landfills**	**Ionizing**
Ionizing smoke detectors	**Many homes, schools and commercial and public buildings**	**Ionizing. Ionizing smoke detectors use a small amount of radioactive material to detect smoke. Photoelectric smoke detectors use a light source.**
Radioactive waste from abandoned uranium mines	**Water, buildings, soil and the air may be contaminated by radioactive waste**	**Ionizing**
Wireless technology	**Many homes, commercial and public buildings**	**Non-ionizing**
Nuclear moisture and density gauges	**Construction sites**	**Ionizing**
Cigarettes/radiation in tobacco	**Homes or designated smoking areas**	**Ionizing; naturally-occurring radioactive minerals accumulate on tobacco leaves**