Activity 2: Sources of Annual Radiation Exposure

Objectives

Students will:

- Predict and graph Americans' annual exposure to natural (background) and man-made radiation sources.
- Compare their predictions to data from the National Council on Radiation Protection and Measurements (NCRP).
- Define and classify sources of radiation exposure.

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.*
- *Annual Radiation Exposure — 1987 and 2009* pie charts; display using computer and projector.
- *Annual Sources of Radiation Exposure Pie Chart* (one per student, pair or group).
- Colored pens, pencils or markers.
- *NCRP Sources of Radiation Exposure — 2009* pie chart (optional).
- *Relative Doses from Radiation Sources* diagram (optional).
- Student computers with Internet access (optional)

Time

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

Vocabulary

- Cosmic radiation
- Dose (optional)
- Ionizing radiation
- Man-made radiation
- Natural (background) radiation
- Radiation
- Radon
- Rem (optional)
- Terrestrial radiation

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 whether we can control our exposure to radiation? **The answer is both "no" and "yes." Radiation can come from natural and man-made sources. Natural (background) radiation is all around us and has been since the earth formed. We cannot control our exposure to natural cosmic (from space) radiation and terrestrial (from the ground) radiation. When made aware of the presence of radiation through testing or monitoring results, warning signs, labels and notices, we can make choices that limit our exposure. For example, people can fix high radon levels in homes, distance themselves from radioactive sources, and wear protective equipment and follow regulations when handling or being near a radiation source.**

3. Explain that the word "radiation" generally brings to mind nuclear power plants, nuclear weapons, or medical procedures, tests and treatments. However, radiation is part of our daily lives. Our bodies are well adapted to handle some exposure to radiation. We can also benefit from some sources of radiation in moderation, such as the sun. There are benefits from the use of x-ray machines that can tell us if something is wrong within our body and other medical radiation sources used to treat diseases like cancer.

4. Share the *Annual Radiation Exposure — 1987* pie chart. Explain to students that are unfamiliar with a pie chart that pie charts are circular graphs divided into sections that represent parts of the whole. Explain that the pie chart is based on data the NCRP collected in 1987. The chart shows that Americans' average annual exposure to radiation in 1987 came from 82 percent of natural (background) radiation and 18 percent of man-made radiation. The pie chart is further broken down to show exposure by more specific sources of natural and man-made radiation.

5. Provide students with the *Annual Sources of Radiation Exposure Pie Chart*. Review the example provided and the directions. Answer any questions. NOTE: Students can include the different types of natural and man-made radiation in the pie chart for more complexity if desired.

6. Display students' pie charts and the *Annual Radiation Exposure — 2009* pie chart. Have students compare their pie charts to the 2009 pie change and discuss:
   - How their pie chart compares to or differs from their classmates' pie charts and the NCRP's 2009 pie chart.
   - Reasons for any large differences.

7. Conclude by having students answer the following questions (verbally or in writing):
   - What differences do you see between the 1987 and 2009 pie charts? What do you think are the reasons for those differences?
   - What information was most surprising to you?
   - Did this activity confirm or change your perceptions and beliefs about radiation exposure? Explain your response.

8. Optional activities or extensions:
   - Explain that, in the United States, radiation exposure is usually expressed in units called rems or millirems (mrem). (1000 mrem = 1 rem). In 1987, the NCRP found that

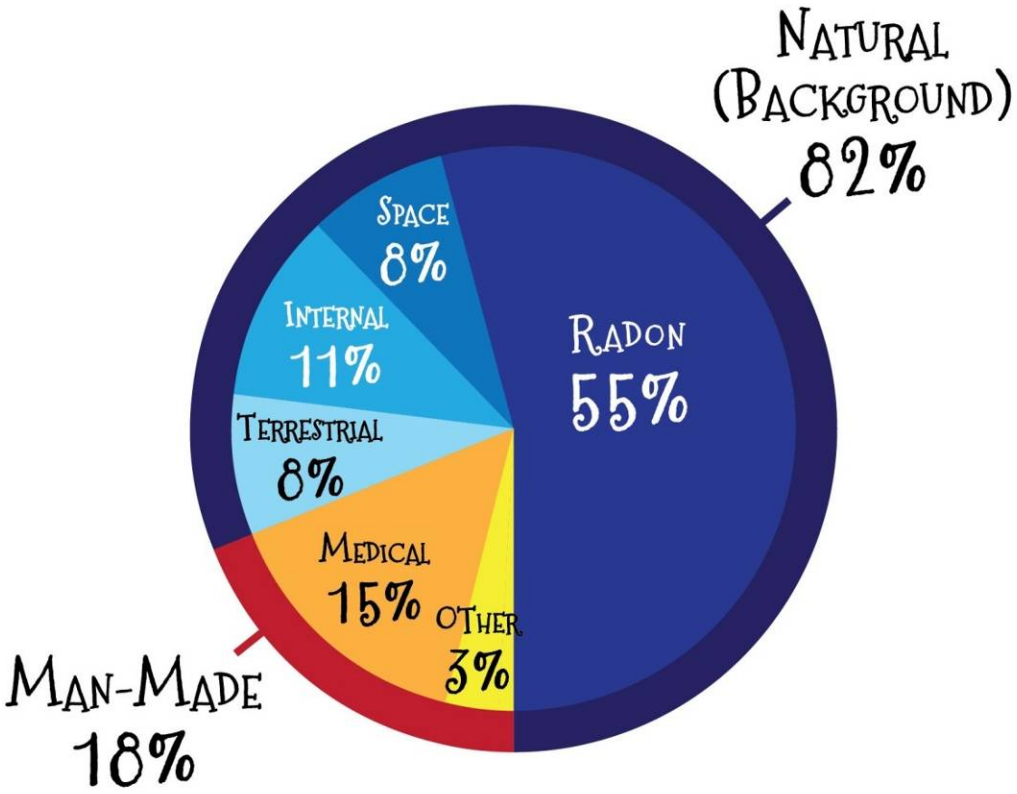
Americans were exposed to 320 mrem per year from all sources of radiation. In 2009 the exposure rate increased to 620 mrem per year. Have students:

- Examine the *Relative Doses from Radiation Sources* diagram. Identify potential sources that can increase a person's exposure to radiation (e.g., certain medical procedures or living in areas with higher than average radon levels).
  - Have students examine the *Annual Radiation Exposure – 1987, Annual Radiation Exposure – 2009* and *NCRP Sources of Radiation Exposure—2009* pie charts and discuss the changes that have led to the average increase in radiation exposure from 320 to 620 mrem per year. Note the significant increase in medical radiation and the types of medical radiation used.
- Consider the increased use of medical radiation to detect and treat diseases and discuss whether the benefits outweigh the potential risks of exposure.

- Have students complete a pie chart based on their prediction of Americans' exposure to natural (background) and man-made radiation in the next 10 or 20 years.

Annual Radiation Exposure — 1987

Based on data from NCRP Report No. 93, 1987, with permission of the National Council on Radiation Protection and Measurements, NCRPonline.org.



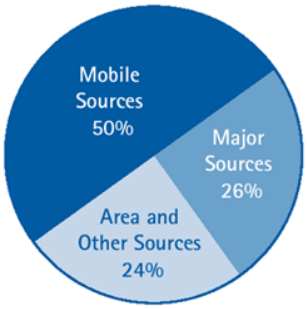
Annual Sources of Radiation Exposure Pie Chart

Name: _____ Date: _____

Pie charts show data in the form of sections, or parts, of a whole. The pie chart example shows three parts (50%, 26% and 24%) that add up to the whole (100%).

In 2009 the National Council on Radiation Protection and Measurements (NCRP) examined Americans' annual exposure to radiation. Hypothesize the amount of natural and man-made radiation Americans were exposed to by dividing the pie chart into two parts. Label each part according to its percentage of the whole. Make sure the two slices total 100%. Color each part (and the corresponding box in the legend) with a different color or pattern.

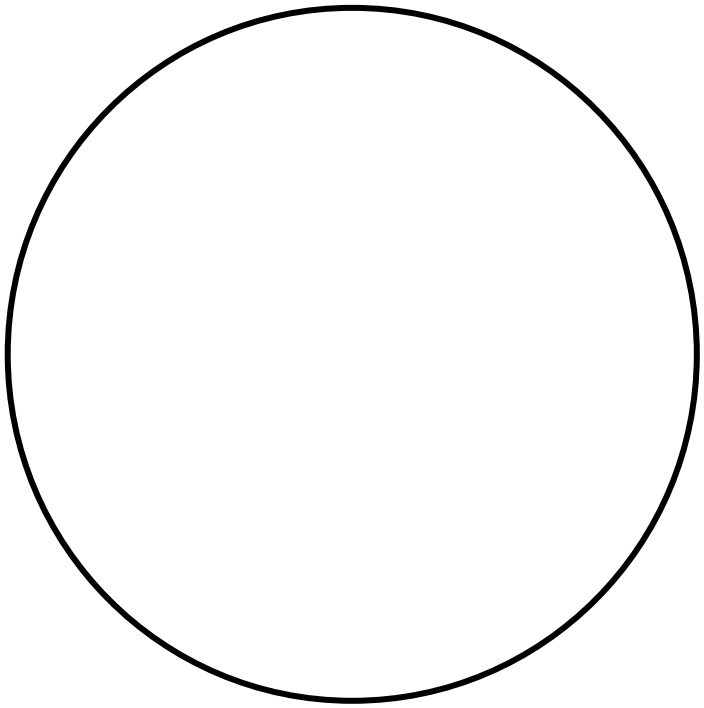
Pie Chart Example



Pie Chart Legend

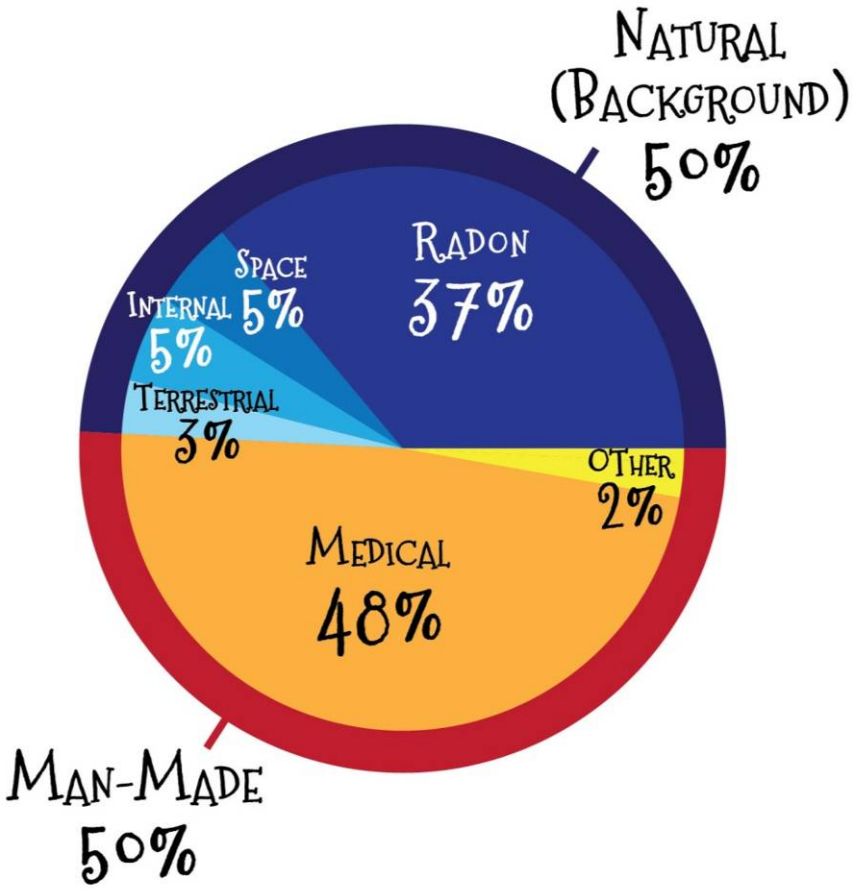
☐ Natural (Background) Radiation

☐ Man-Made Radiation



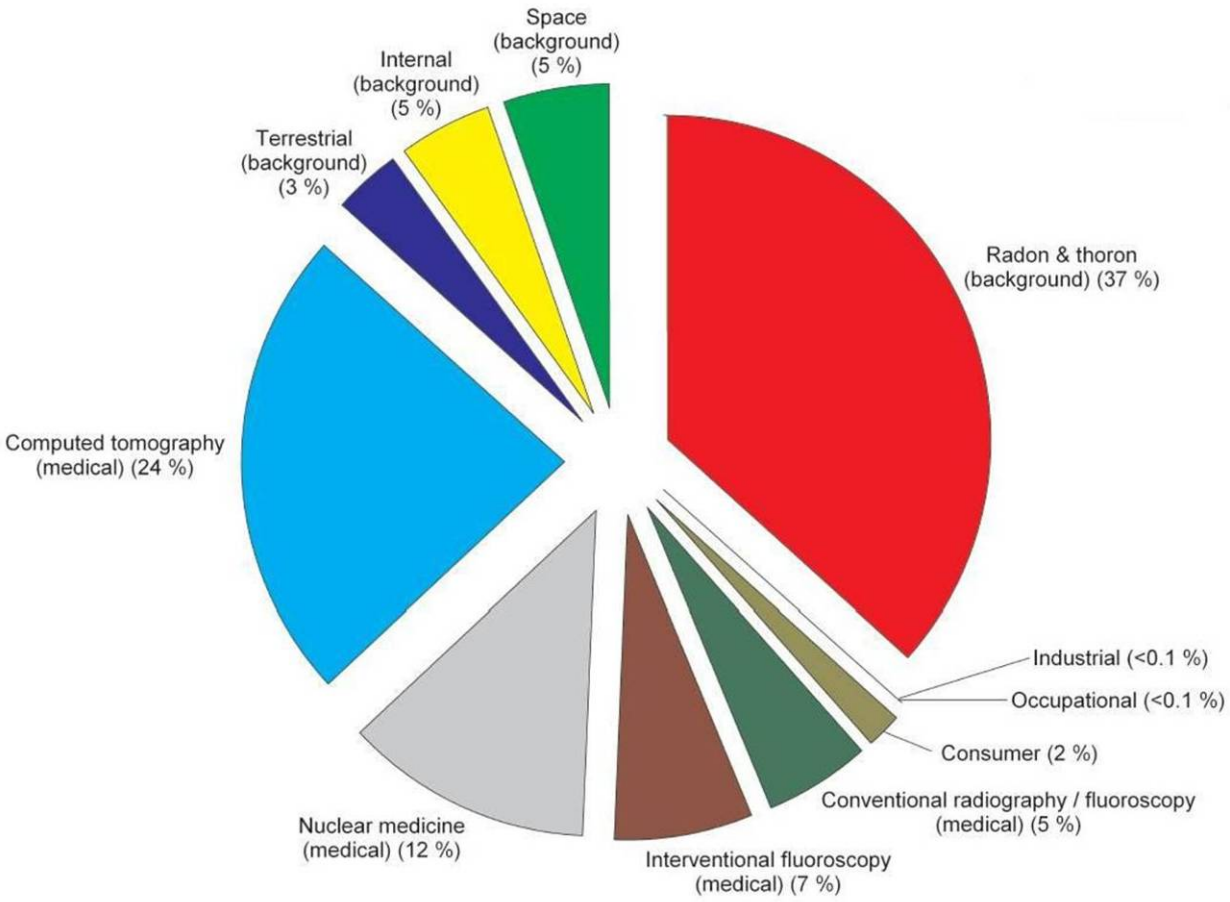
Annual Radiation Exposure — 2009

Based on data from NCRP Report No. 160, 2009, with permission of the National Council on Radiation Protection and Measurements, NCRPonline.org.



NCRP Sources of Radiation Exposure—2009

Reprinted from: NCRP Report No. 160, 2009, with permission of the National Council on Radiation Protection and Measurements, NCRPonline.org.



Description of Medical Terms:

- **Computed tomography (CT):** A medical imaging procedure that uses x-rays to show cross-sectional images of the body. Also called computerized axial tomography (CAT) scanning.
- **Interventional fluoroscopy:** The use of ionizing radiation to guide small instruments such as catheters through blood vessels or other pathways in the body.
- **Conventional radiography and fluoroscopy:** Radiography is the use of x-ray machines by doctors and dentists to view the human body. Fluoroscopy is a medical technique used by doctors to take real-time moving images of internal structures in the body by placing a patient between a fluorescent screen and an x-ray source.
- **Nuclear medicine:** Radioactive elements or tracers that are given intravenously or orally. A gamma camera detects gamma rays emitted by the tracer. These data are fed into a computer where they are used to produce images and other information about the body's organ system.

Relative Doses from Radiation Sources

From: www.epa.gov/radiation/understand/perspective.html