Radioactive Dating

Key Concepts

- What happens during radioactive decay?
- What can be learned from radioactive dating?
- What is the probable age of Earth?

Rocks are a form of matter. All the matter you see, including rocks, is made of tiny particles called **atoms.** When all the atoms of a particular type of matter are the same, the matter is an **element.** Most elements are stable. They do not change under normal conditions. But some elements exist in forms that are unstable. Over time, these elements break down, or decay, by releasing particles and energy in a process called **radioactive decay.** These unstable elements are said to be radioactive. **During the process of radioactive decay, the atoms of one element break down to form atoms of another element.**

Radioactive elements occur naturally in igneous rocks. For an igneous rock, its "birthday" is when it first hardens to become rock. As a radioactive element within the igneous rock decays, it changes into another element. Therefore, the composition of the rock changes slowly over time. The amount of the radioactive element decreases. But the amount of the new element increases. The rate of decay of each radioactive element is constant—it never changes. This rate of decay is the element's half-life. The **half-life** of a radioactive element is the time it takes for half of the radioactive atoms to decay.

Radioactive dating is used to determine the absolute ages of rocks. In radioactive dating, scientists first determine the amount of a radioactive element in a rock. Then they compare that amount with the amount of the stable element into which the radioactive element decays. Scientists often use potassium-40 to date rocks. This form of potassium decays to form the stable element argon-40 and has a half-life of 1.3 billion years. The long half-life of potassium-40 makes it useful in dating the most ancient rocks.

All plants and animals contain some carbon-14, a radioactive form of carbon. Carbon-14 is useful in dating materials from plants and animals that lived as far back as 50,000 years ago. Because carbon-14 has a half-life of only 5,730 years, it can't be used to date more ancient fossils or rocks.

Scientists have not found it easy to figure out the age of planet Earth. Most of the matter that made up early Earth has been destroyed or changed. Radioactive dating shows that the oldest rocks ever found on Earth are about 4.0 billion years old. But scientists hypothesize that Earth formed even earlier than that. Scientists have used moon rocks and meteorites to estimate the age of Earth. **Radioactive dating shows that the oldest moon rocks are about 4.6 billion years old. Scientists infer that Earth is only a little older than those moon rocks—roughly 4.6 billion years old.** The oldest living things are about 3.5 billion years old.

8. Look carefully at Figure 6, "Unconformity," in your textbook. Then describe how an unconformity can form.

Sedimentary rocks form in horizontal layers. Folding tilts the rock layers. Surface is eroded. New sediment is deposited, forming new rock layers. Unconformity is the boundary where the rock layers meet, new layers meet old layers at the eroded surface

9. A rock contains inclusions. Which of the following is older? _____

   a. the rock
   b. the inclusions

Using Fossils to Date Rocks (pp. 276–277)

10. Geologists use index fossils to match rock layers in different locations.

11. Circle the letter of each sentence that is true about index fossils.

   a. Index fossils must be found in many different areas.
   b. Index fossils must represent an organism that lived for a very long time.
   c. Index fossils tell the absolute ages of the rock layers in which they occur.
   d. A type of ammonite that is different from other ammonites is a useful index fossil.

The Relative Age of Rocks *(continued)*

The Position of Rock Layers (p. 273)

3. According to the law of superposition, the oldest layer is at the bottom. Each higher layer is younger than the layers below it.

4. Is the following sentence true or false? The deeper one travels into the Grand Canyon, the younger the rocks become. false

Determining Relative Age (pp. 274–275)

5. Complete the table below about the clues that geologists use to find the relative ages of rocks.

Clues to the Relative Ages of Rocks		
Clue	**How It Forms**	**What Clue Tells Geologists**
Extrusion	**a.**	**b.**
Intrusion	**c.**	**d.**
Fault	**e.**	**f.**

6. A fault cuts through an extrusion. Which is older? the extrusion

7. What is an unconformity?
A gap in the geologic record where new rock layers form above a much older rock surface.

The Relative Age of Rocks (pp. 272–277)

This section explains how scientists determine whether a rock is older or younger than other rocks and how geologists use index fossils.

Use Target Reading Skills

As you read, take notes on the main ideas and supporting details. Consider the Key Concepts and Key Terms. Use the graphic organizer below to help you take notes.

Relative Age

Questions	Notes
What does the position of rock layers reveal?	The position of rock layers shows . . .

Introduction (p. 272)

Match the term with its definition.

Term	Definition
b 1. relative age	a. The number of years since the rock formed
a 2. absolute age	b. The age of a rock compared to the ages of other rocks