

relative dating:
ordering events or
objects in time
without assigning
actual ages or dates

absolute dating:
determining an actual
age for an object or a
date of occurrence for
an event

radiometric dating:
a method of absolute
dating in which the
amount of a
radioactive element
that remains in a
material after it has
begun to decay is
measured

Using radiometric dating, Earth has been dated at 4.5 billion years old. The planet's oldest rocks were formed about 3.8 billion years ago, but meteorites in our solar system have been dated at 4.5 billion years old. Earth and the meteorites would have formed at the same time—with the formation of our solar system—so they should be approximately the same age.

Dendrochronology is the use of a tree's growth rings to determine the age of a tree and what the environmental conditions were like during its lifetime.

How can scientists determine the age of objects and events from Earth's past?

Antiques dealers can use style, workmanship, and materials as clues to date a piece of furniture or a vase. It's quite a bit more complex for scientists to assign an age to a fossil, a piece of rock, a tree limb, or even a geological event. Like an expert in antiques, a paleontologist or geologist will gather clues about an object. Then, he or she will use the information to determine the object's age. Over the years, methods of dating have improved and allow most materials to be dated with accuracy.

Relative dating was used before a reliable method of absolute dating was discovered. It allowed scientists to determine the order of events or tell whether one object was older than another. For example, using the law of superposition—one of the principles of relative dating—a geologist knows that the oldest beds of rock form the bottom layers in a series, while the most recent are on top.

When methods of absolute dating became possible, scientists could assign an actual age to objects and events, instead of just ordering them in time. Radiometric dating, developed after radioactivity was discovered in 1896, is one of the best-known methods. It's based on the theory that radioactive elements decay at predictable rates.

Carbon dating is frequently used to date organic remains. It's based on the fact that there is always a specific percentage of all carbon that exists as the isotope carbon-14. Those unstable carbon-14 isotopes steadily break down and turn into nitrogen-14. Other processes ensure there is always the same percentage of carbon-14. However, when the organism dies, the percentage will not stay at its stable amount. Over a period of 5,730 years, half the carbon in a dead plant, for example, will have changed to nitrogen. This is called the *half-life* of carbon-14. In another 5,730 years, half the remaining carbon will have changed to nitrogen. By measuring how much carbon-14 there is in the organic material, scientists can tell how old it is.

One problem with using carbon dating is that it's useful only to date things that are less than about 40,000 years old because carbon's half-life isn't very long. Other radioactive elements can be used for some types of dating, but like carbon, they also have limits.

One type of dating isn't superior to another. In fact, scientists generally use more than one method when possible. This allows them to double-check their conclusions and be sure that they are as accurate as possible.



Write your answers on the lines below.

1. How could a natural event, like an earthquake, make it difficult to use the law of superposition?

2. Sam is the oldest in his group of friends. Amira is five years younger than Sam, Lea is between Sam and Amira in age, and Marcus is the youngest. Arrange the names of the friends in order from youngest to oldest.

3. Explain whether you used absolute or relative dating in the previous item and why you were able to use one method but not the other.

4. Why would a radioactive element need to have a known rate of decay in order for it to be useful as a dating tool?

5. Why is the use of carbon-14 dating limited?

6. Describe a scenario in which a scientist might use both relative and absolute methods of dating.

Unifying Concepts and Processes

When paleontologists dated the Burgess shale fossils to the Cambrian period because trilobites were found among them, were they using relative dating or absolute dating?
