

Chapter: Clues to Earth's Past

Read each question thoroughly. The Science Coach boxes will help you apply the skills and concepts you need to answer the questions.

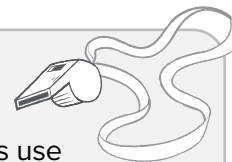
1. During a field studies course, Aaliyah and Xavier visit a canyon in Utah. Their teacher asks them to determine the relative order of geologic events based on patterns of rock layering in the canyon.

What is a common way to determine the relative ages of the rock layers in the canyon?

- (A) A common method is to use radiocarbon dating to determine their precise ages.
- (B) A common method is to identify the absolute ages of the layers using index fossils.
- (C) A common method is to interpret the ages of the layers in comparison to each other.
- (D) A common method is to classify the rock types to determine the layers' numerical ages.

Science Coach

Think about the **methods** scientists use to **measure the age of rock layers**. Think about what it means to find the **relative age** of a rock layer. What is a common method used to determine relative age?



2. Scientists studying a rock from the Ocala limestone formation found xenon-129 in the sample. The table shows some of the radioisotopes scientists use to date fossils, rocks, and artifacts.

Table 1: Radioactive Isotopes

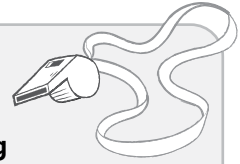
Parent Isotope	Half-Life	Daughter Product
Carbon-14	5,730 years	nitrogen-14
Thorium-230	75,380 years	lead-206
Iodine-129	16.14 million years	xenon-129
Uranium-235	704 million years	lead-207
Potassium-40	1.25 billion years	argon-40

What parent isotope did the rock originally contain?

- ☐ F carbon-14
- ☐ G iodine-129
- ☐ H uranium-235
- ☐ I potassium-40

Science Coach

Think about **radioactive dating methods**, and study the table carefully. What is a parent isotope? What does the information that xenon-129 has been found in a rock tell you about the isotopes the rock originally contained?



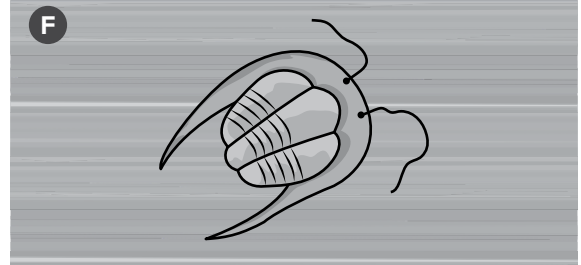
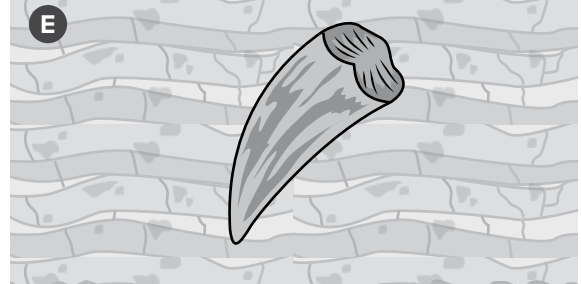
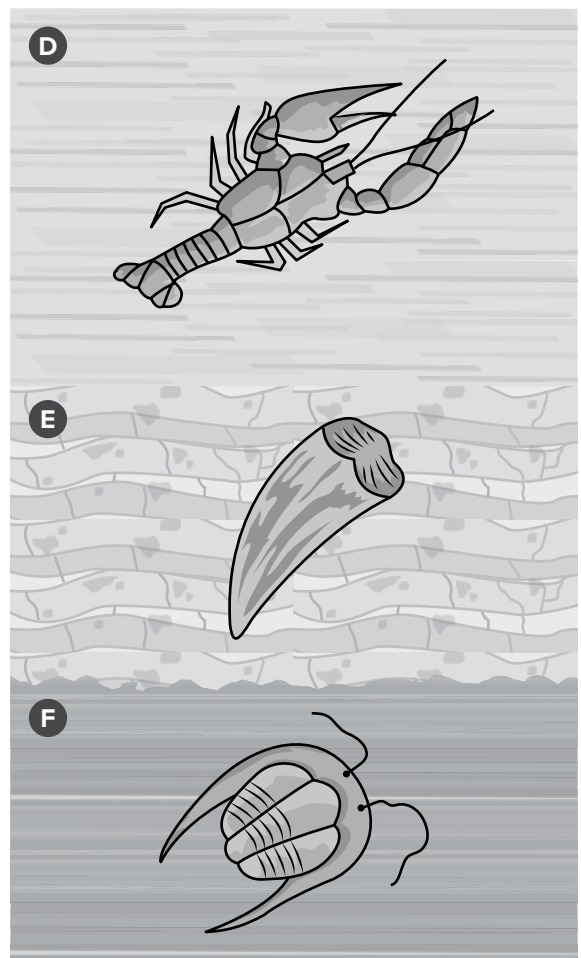
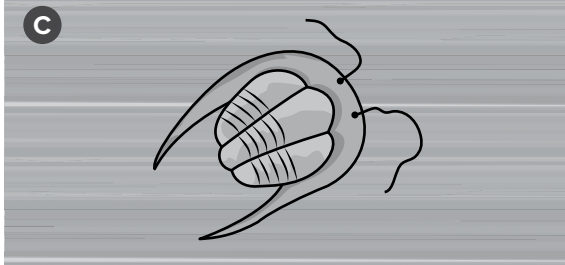
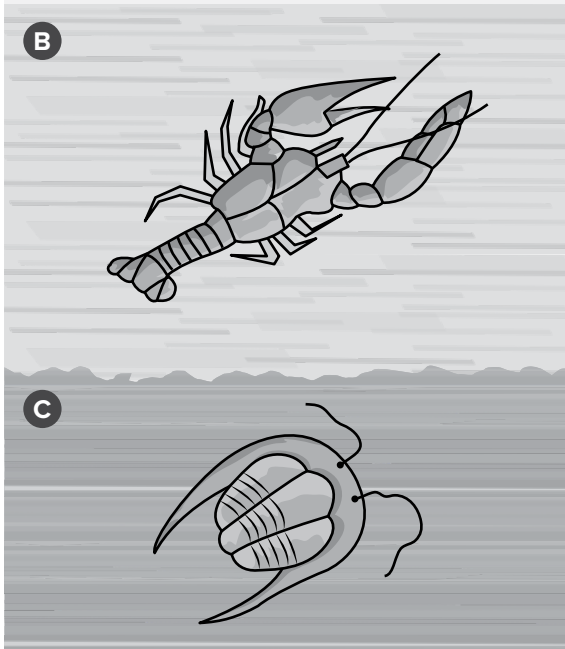
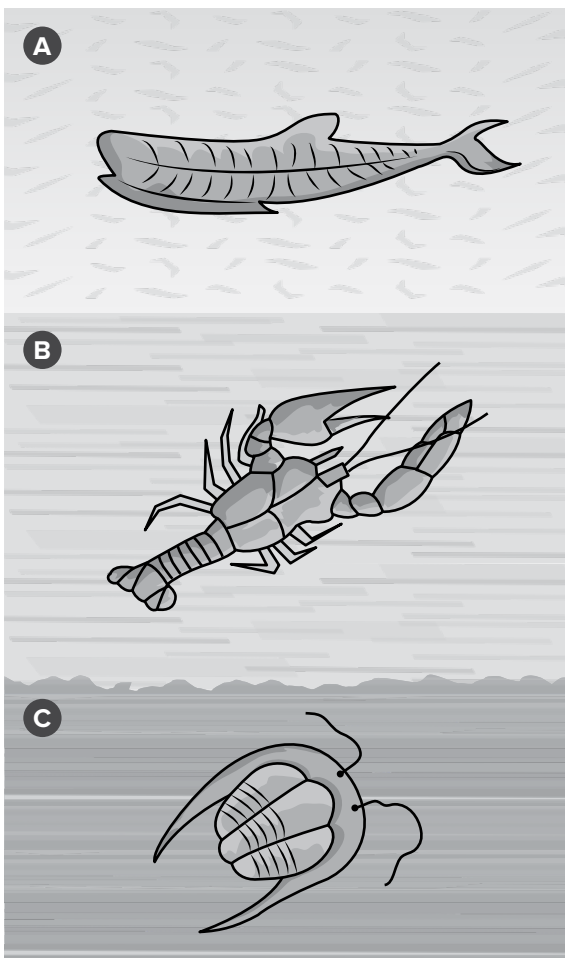
For questions 3, 4, and 5, refer to the following passage and illustration.

In this group of questions, you will use your knowledge about relative-age dating to answer three questions.

Dating Rock Layers

Two teams of geologists are studying rock formations in two different locations thousands of miles apart. Both rock formations contain several types of index fossils. Index fossils are useful in determining the relative ages of rock layers. Scientists can infer that rock layers containing the same index fossil are of the same age. Not all fossils make good index fossils. How long an organism lived, where it lived, and how common it was are all factors that determine a good index fossil. The two teams sketch the rock layers and fossils found at their locations, as shown.

Comparison of Rock Layers and Fossils

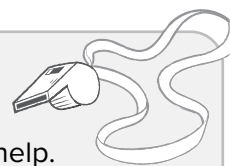


3. Which statement **best** describes a useful index fossil?

- (A) Certain ammonite species- they existed for a relatively short time, were abundant, and lived in many locations.
- (B) All horseshoe crabs- they have existed for a long time and are abundant in some regions.
- (C) Two species of coelacanths- they have existed for a long time and are rare.
- (D) An early species of bird- it was found in a small region of China.

Science Coach

Consider how **index fossils** can help. What **evidence** do index fossils provide? What characteristics define index fossils?

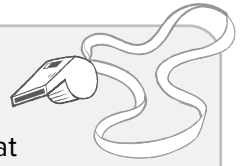


4. What method are the geologists relying on to establish the relative age of these two rock layers?

- Ⓕ correlation
- Ⓖ inclusion
- Ⓗ radioactive decay
- Ⓘ unconformity

Science Coach

Pretend you are the geologist! What **methods** do geologists rely on to determine the **relative ages of rock layers** that are far apart?

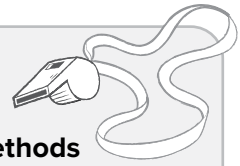


5. Which statement **most accurately** describes the rock layers?

- (A) Layer A is the oldest.
- (B) Layer F is the newest.
- (C) Layer C is older than Layer F.
- (D) Layer A is newer than Layer C.

Science Coach

Study the **graphic** carefully. What **methods** can you use to determine the **relative ages of the rock layers**? Put the layers in order from oldest to newest.



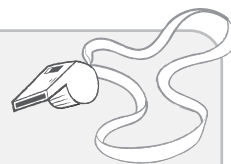
6. Scientists have found many prehistoric items in Florida. The table shows some fossils and artifacts recovered as well as their approximate age.

Table 2: Florida Fossils And Artifacts

Item recovered	Approximate age
Arrowhead	64,000 years old
Ceramic bowl	2,000 years old
Mammoth bones	13,000 years old
Megalodon tooth	5 million years old

Science Coach

Carbon dating is also referred to as **radiocarbon dating**. What characteristics does an item need to have for carbon dating to work? Recall that carbon-14 has a half-life of 5,730 years. What is the maximum age of an item beyond which radiocarbon dating is no longer useful?



Which of the items recovered could be carbon-dated?

- ☐ F arrowhead
- ☐ G ceramic bowl
- ☐ H mammoth bones
- ☐ I megalodon tooth

7. Gabriel and Ella visit the natural science museum. An exhibit contains a sample of sedimentary rock from the Mesozoic Era. A sign next to the exhibit lists examples of index fossils from youngest to oldest.

Table 3: Index Fossils

Period	Index Fossil
Jurassic	<i>Nerinea trinodosa</i>
Triassic	<i>Tropites subbullatus</i>
Permian	<i>Leptodus americanus</i>
Pennsylvanian	<i>Dictyoclostus americanus</i>
Mississippian	<i>Prolecanites gurleyi</i>

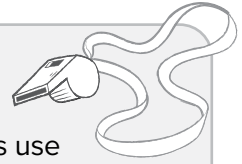
Ella notices that one rock layer contains fossils of *Tropites subbullatus*. The rock layer directly above contains fossils of *Leptodus americanus*. Gabriel claims a major geologic event, such as mountain building, must have disturbed the order of the layers.

What evidence supports Gabriel's claim?

- (A) According to the principle of superposition, the oldest rocks are on the bottom of an undisturbed sequence of sedimentary rock.
- (B) According to radioactive decay rates, fossils of *Leptodus americanus* should be found below fossils of *Tropites subbullatus*.
- (C) According to the principle of lateral continuity, the order of the layers does not change even if they encounter a barrier.
- (D) According to the principle of original horizontality, rock layers might tilt, but they were first deposited horizontally.

Science Coach

Think about the **principles** scientists use to **compare the ages of rock layers**. How do scientists know when these layers have been disturbed? Can disturbed rock layers still provide valuable evidence? If so, how?

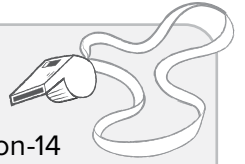


8. The carbon-14 content of an ancient piece of wood is about 25% of that in living trees. If carbon-14 has a half-life of 5,730 years, approximately how old is the piece of wood?

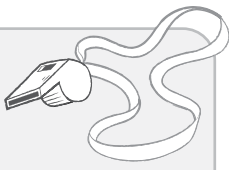
- (F) about 3,000 years old
(G) about 6,000 years old
(H) about 11,500 years old
(I) about 23,000 years old

Science Coach

Recall that the **radioisotope** carbon-14 has a half-life of 5,730 years. How long would it take for 75% of the parent isotope to decay?



9. How do geologists determine the absolute age of a sedimentary rock layer?
- (A) They combine the position of index fossils with radiocarbon dating.
 - (B) They use uranium-235 trapped inside the grains that make up sedimentary rocks.
 - (C) They combine radiometric dating of nearby igneous rock and relative dating techniques.
 - (D) They use the principle of superposition to correlate sedimentary rocks from different locations.

Science Coach

Consider the rock cycle. How are sedimentary rocks formed? How does this affect the **methods** scientists use to **gather evidence** to determine the actual age of the sedimentary rock layer?

Chapter: **Clues to Earth's Past**

Answer the questions that follow.

1. Why are most of the rocks found on Earth younger than Earth itself?
 - (A) The half-life of uranium-238 is only 4.5 billion years.
 - (B) Some rocks are from the Moon, and others are from meteorites.
 - (C) Old rocks are constantly being destroyed through the rock cycle.
 - (D) Earth's oldest rocks are too deep for scientists to ever find them.

2. Mariah and Luis created a model of one of the principles of relative-age dating. They poured several layers of sand into a large container. Each layer was a different color. They challenged their classmates to analyze the layers and identify which colors represented the oldest and youngest layers.

What principle of relative-age dating is being modeled, and how would the students know?

- ☐ F Lateral continuity; it describes how sediments deposit in layers.
- ☐ G Inclusions; small particles, like sand, must have several inclusions.
- ☐ H Cross-cutting relationships; the sand colors must mix across layers.
- ☐ I Superposition; it deals with the order in which the layers are deposited.

3. How do scientists approximate the age of Earth?

- (A) They collect the absolute age of all Earth rocks and take an average.
- (B) They collect evidence from multiple unconformities found on different continents.
- (C) They collect the relative age of index fossils and then use the principle of superposition.
- (D) They collect evidence from radiometric dating of Earth rocks, Moon rocks, and meteorites.

4. Angel and Eva are studying index fossils. They created a table of index fossils from youngest to oldest.

Table 1: Index Fossils

Period	Index Fossil
Permian	<i>Leptodus americanus</i>
Pennsylvanian	<i>Dictyoclostus americanus</i>
Mississippian	<i>Prolecanites gurleyi</i>
Devonian	<i>Mucrospirifer mucronatus</i>
Silurian	<i>Hexamoceras hertzeri</i>
Ordovician	<i>Bathyrurus extans</i>
Cambrian	<i>Paradoxides pinus</i>

Which statement **best** explains how a rock layer could be relatively dated to the Pennsylvanian Period?

- (F) The rock layer could contain *Leptodus americanus*.
- (G) The rock layer could contain *Dictyoclostus americanus*.
- (H) The rock layer could have *Bathyrurus extans* in the rock layer below.
- (I) The rock layer could have *Hexamoceras hertzeri* in the rock layer above.

5. How can scientists determine the relative age of a layer of rock above the layer with an index fossil?
- Ⓐ Scientists can infer that the presence of an index fossil means the layers are the same age.
 - Ⓑ Scientists can infer that the rock layer containing the index fossil is younger than the rock layer above.
 - Ⓒ Scientists can infer that the rock layer above the index fossil is younger than the rock layer containing the fossil.
 - Ⓓ Scientists can infer that the absence of the index fossil in the layer above means that the rock layer is older than the layer containing the fossil.

6. A geologist is studying a collection of rocks found in the university laboratory. The table shows the age of each rock sample.

Table 2: Age of Rock Samples in University Collection

Sample	Age (millions of years)
A	300
B	175
C	200
D	250

If the geologist had found the rocks in a natural rock formation, which rock sample would most likely have been found closer to the surface?

- ☐ F sample A
- ☐ G sample B
- ☐ H sample C
- ☐ I sample D

For questions 7, 8, and 9, refer to the following passage and table.

In this group of questions, you will use your knowledge about absolute-age dating to answer three questions.

Radiometric Dating

Zoe and Leah are visiting their local science center. They explore three exhibits about rocks and artifacts found in Florida.

- **Dugout Canoes:** Florida has the highest number of prehistoric dugout canoes in the world. Florida's Seminole Tribe made most of their canoes from logs of yellow pine or cypress wood. Uncovered canoes have been dated to a few hundred to over 6,000 years old.
- **The Avon Park Formation:** The Avon Park Formation contains the oldest rocks exposed at the surface in Florida. Pollen grains lodged in the rock have been dated to about 45 million years old.
- **The Ocala Limestone:** The Ocala Limestone formation formed during the late Eocene. Parts of it are exposed at the surface near Silver Springs.

The table shows some radioisotopes scientists use to date fossils, rocks, and artifacts.

Table 3: Radioisotopes

Parent Isotope	Half-Life	Daughter Product
Carbon-14	5,730 years	nitrogen-14
Thorium-230	75,380 years	lead-206
Iodine-129	16.14 million years	xenon-129
Uranium-235	704 million years	lead-207
Potassium-40	1.25 billion years	argon-40

7. Which radioisotope would be the **most** useful in dating a dugout canoe?

- Ⓐ carbon-14
- Ⓑ thorium-230
- Ⓒ uranium-235
- Ⓓ potassium-40

8. Could scientists use the same radioisotope to date a dugout canoe and the pollen grains?
- (F) Yes; both the dugout canoes and the fossilized pollen grains are about the same relative age.
 - (G) Yes; both the dugout canoes and the fossilized pollen grains are made up of organic material.
 - (H) No; the dugout canoes were made from organic material, and the fossilized pollen grains are no longer organic.
 - (I) No; the dugout canoes were made from organic material, and the fossilized pollen grains were never organic.

9. Scientists studying the Ocala Limestone formation found a rock that contains 75% lead-206.

According to the radioactive dating process, how old is the rock?

- (A) about 75,380 years old
- (B) about 150,760 years old
- (C) about 704 million years old
- (D) about 1,408 million years old