Answer Key

Directed Reading A

SECTION: EARTH'S STORY AND THOSE WHO FIRST LISTENED

1. C
2. D
3. A
4. E
5. B
6. D
7. A
8. C
9. Scientists believe that catastrophes sometimes play an important role in shaping Earth's history.
10. Huge craters have been found where asteroids and comets are thought to have struck the Earth.
11. A
12. C
13. B
14. D

SECTION: RELATIVE DATING: WHICH CAME FIRST?

1. B
2. C
3. B
4. The disruptions make it difficult for scientists to determine the relative age of the rocks.
5. The geologic column is an ideal sequence of rock layers that contains all the known fossils and rock formations on Earth.
6. Geologists use the geologic column to interpret rock sequences and to identify the layers in puzzling rock sequences.
7. The crosscutting feature is always younger because the rock layers had to exist before anything could cut across them.
8. C
9. A
10. E
11. B
12. D
13. unconformity
14. The layer was never present, or the layer was removed.
15. nondeposition
16. erosion
17. C
18. B
19. A
20. Geologists use their knowledge of the events that disturb or remove rock-layer sequences to help them solve rock-layer puzzles.

SECTION: ABSOLUTE DATING: A MEASURE OF TIME

1. The purpose of absolute dating is to determine the age of an object by determining the number of years it has existed.
2. isotopes
3. stable
4. unstable
5. radioactive decay
6. Scientists use the relative amounts of stable and unstable isotopes present in an object to determine the object's age.
7. parent
8. daughter
9. older
10. half-life
11. radiometric dating
12. Half the parent material has decayed and become daughter material.
13. D
14. A
15. B
16. C

SECTION: LOOKING AT FOSSILS

1. B
2. C
3. A
4. A
5. B
6. C
7. B
8. B
9. A
10. C
11. Animal tracks can tell how big an animal was and how fast it was moving

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12.A coprolite can tell about the habits and diet of the animal that left it.
13. A
14. C
15. Geologists know where the rock layer fits into the geologic column, so they can give the rock layer an accurate date.
16. The rock surrounding a *Tropites* is between 230 and 208 million years old.
17. The rock surrounding a *Phacops* is about 400 million years old.

SECTION: TIME MARCHES ON

1. C
2. C
3. Geologists created the geologic time scale to make it easier to study the 4.6 billion years of Earth's history by dividing it into distinct intervals of time.
4. B
5. D
6. A
7. C
8. The boundaries between geologic time intervals represent shorter intervals in which visible changes took place on Earth.
9. 2, 3, 4, 1
10. Extinction is the death of every member of a species.
11. Global climate change and asteroid impacts are catastrophic
12. At the beginning of the Paleozoic era, marine life flourished. A great diversity of life made its home in the oceans.
13. The Paleozoic era ended with the largest mass extinction in Earth's history. Nearly 90% of all marine species became extinct.
14. The Mesozoic era is called the Age of Reptiles because reptiles, including the dinosaurs, lived in the water and on land.
15. The Cenozoic era is called the Age of Mammals because mammals flourished. The mass extinction of so many other species at the end of the Mesozoic era made it easier for mammals to find enough food and habitat.
16. A global climate change probably caused the extinction of dinosaurs.
17. Mammals are able to regulate their body temperature. Also, baby mammals develop inside the mother's body.

Directed Reading B

SECTION: EARTH'S STORY AND THOSE WHO FIRST LISTENED

1. C
2. D
3. C
4. A
5. C
6. D
7. C
8. paleontologists
9. fossils

SECTION: RELATIVE DATING: WHICH CAME FIRST?

1. B
2. C
3. B
4. B
5. C
6. B
7. B
8. A
9. D
10. C
11. unconformity
12. nondeposition
13. erosion
14. B
15. B
16. D
17. C
18. B

SECTION: ABSOLUTE DATING: A MEASURE OF TIME

1. C
2. A
3. C
4. C
5. D
6. D
7. radiometric dating
8. half-life
9. B
10. B reserved.
12. C
13. A

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SECTION: LOOKING AT FOSSILS

1. B
2. C
3. D
4. A
5. B
6. C
7. B
8. B
9. A
10. C
11. A
12. C
13. B
14. B
15. C
16. D

SECTION: TIME MARCHES ON

1. C
2. C
3. B
4. D
5. B
6. A
7. D
8. C
9. B
10. C
11. D
12. A
13. C
14. C
15. A
16. C
17. B
18. D
19. B

Vocabulary & Section Summary

SECTION: EARTH'S STORY AND THOSE WHO FIRST LISTENED

1. uniformitarianism: a principle that states that geologic processes that occurred in the past can be explained by current geologic processes
2. catastrophism: a principle that states that geologic change occurs suddenly
3. paleontology: the scientific study of fossils

SECTION: RELATIVE DATING: WHICH CAME FIRST?

1. relative dating: any method of determining whether an event or object is older or younger than other events or objects
2. superposition: a principle that states that younger rocks lie above older rocks if the layers have not been disturbed
3. geologic column: an arrangement of rock layers in which the oldest rocks are at the bottom
4. unconformity: a break in the geologic record created when rock layers are eroded or when sediment is not deposited for a long period of time

SECTION: ABSOLUTE DATING: A MEASURE OF TIME

1. absolute dating: any method that measures the age of an object or event in years
2. isotope: an atom that has the same number of protons (or the same atomic number) as other atoms of the same element do but that has a different number of neutrons (and thus a different atomic mass)
3. radioactive decay: the process in which a radioactive isotope tends to break down into a stable isotope of the same or another element
4. radiometric dating: a method of determining the age of an object by estimating the relative percentages of a radioactive (parent) isotope and a stable (daughter) isotope
5. half-life: the time required for half of a sample of a radioactive substance to undergo radioactive decay

SECTION: LOOKING AT FOSSILS

1. fossil: the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock.
2. trace fossil: a fossilized mark that is formed in soft sediment by the movement of an animal
3. mold: a mark or cavity made in a sedimentary surface by a shell or other body part
4. cast: a type of fossil that forms when sediments fill in the cavity left by a decomposed organism
5. index fossil: a fossil that is found in the rock layers of only one geologic age and that is used to establish the age of the rock layers

SECTION: TIME MARCHES ON

1. geologic time scale: the standard method used to divide the Earth's long natural history into manageable parts
2. eon: the largest division of geologic time
3. era: a unit of geologic time that includes two or more periods
4. period: a unit of geologic time into which eras are divided

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5. epoch: a subdivision of a geologic period
6. extinction: the death of every member of a species

Section Review:

SECTION: EARTH'S STORY AND THOSE WHO FIRST LISTENED

1. Sample answer: Uniformitarianism is the idea that the same gradual, uniform geologic processes that shape the Earth today have been at work throughout Earth's history. Catastrophism is the idea that all geologic processes that have shaped the Earth throughout Earth's history have been sudden and catastrophic. Paleontology is the scientific study of Earth's history using the remains of organisms preserved by geologic processes.
2. D
3. The principle of uniformitarianism states that all geologic processes that shape the Earth are gradual and uniform. The principle of catastrophism states that all geologic processes that shape the Earth are sudden and catastrophic.
4. Catastrophism dominated geologic thinking until it was replaced by Hutton and Lyell's uniformitarianism in the 1800s. Modern geology is based on uniformitarianism, but modern geology recognizes the role of catastrophism in geologic history.
5. Sample answer: One example of catastrophic global change would be a global climate change caused by an asteroid striking Earth.
6. Vertebrate paleontologists study fossils of animals that have backbones. Invertebrate paleontologists study fossils of animals without backbones. Paleobotanists study plant fossils.
7. area = $(85\text{km})^2 = 3.1416 \times 85\text{ km} \times 85\text{ km} = 22{,}698\text{ km}^2$
8. Uniformitarianism is considered to be the foundation of modern geology because most geologic change is gradual and uniform rather than sudden and catastrophic.
9. Answers may vary. Sample answer: An example of a type of recent catastrophe is the eruption of Mount Pinatubo in the Philippines in 1991.

SECTION: RELATIVE DATING: WHICH CAME FIRST?

1. Sample answer: Relative dating is a method of determining whether an event or object is older or younger than other events or objects. Superposition is a principle that states that younger rocks lie above older rocks in undisturbed rock sequences. The geologic column is an ideal sequence of rock layers that contains all known rock and fossil formations on Earth, arranged from oldest to youngest.
2. C
3. Two events that can disturb rock layers are folding and tilting. Two features that disturb rock layers are faults and intrusions.
4. Geologists can use their knowledge of how physical features form to determine the order in which events occurred and thereby determine relative ages.
5. The geologic column is an ideal sequence of all the rock formations and fossils on Earth. No single location contains all of Earth's rock formations and fossils.
6. Disconformities represent a gap in the geologic column. If part of the column is missing from the layers, then the geologist could be observing a disconformity.
7. an angular unconformity

SECTION: ABSOLUTE DATING: A MEASURE OF TIME

1. Sample answer: Absolute dating is the process of establishing the age of an object by determining the number of years it has existed. An isotope is an atom that has the same number of protons as other atoms of the same element do but that has a different number of neutrons. A half-life is thetime it takes one-half of a radioactive sample to decay.
2. C

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3. Radioactive decay occurs as a radioactive isotope breaks down into a stable isotope. This happens as the isotope loses an electron and a neutron becomes a proton.
4. Radioactive decay occurs at a constant rate. By determining the ratio between the parent material and the daughter material in an object, scientists can determine how old an object is.
5. potassium-argon, uranium-lead, strontium-rubidium, and carbon-14
6. One-eighth of the parent material will be left. After one half-life, 1/2 of the sample is left. After two half-lives, 1/4 of the sample is left. After three half-lives, 1/8 of the sample is left.
7. If decay rates were inconsistent, scientists would not have a specific half-life number to compare with an object's ratio of parent material to daughter material. Therefore, a precise age could never be determined.
8. Carbon-14 would be the best method to date artifacts from Effigy Mounds. This is because carbon-14 has a relatively short half-life of 5,730 years.

SECTION: LOOKING AT FOSSILS

1. mold
2. Index fossils
3. D
4. Three types of trace fossils are tracks, burrows, and coprolites.
5. Because index fossils are organisms that lived during a relatively short, well-defined time span and are found in rock layers throughout the world, index fossils can be used to obtain relative dates for rock layers.
6. The fossil record is incomplete because most organisms, such as organisms with soft body parts, did not become fossils, and many fossils have yet to be discovered.
7. Scientists can examine fossils of plants and animals in different rock layers to see how these organisms or their environment have changed over time.
8. Scientists can infer that the plant existed sometime between 400 million to 230 million years ago.
9. Answers may vary. The desert was once an aquatic environment, such as an ocean, lake, or stream.
10. Scientists know more about organisms that had hard body parts than organisms that had soft body parts. Scientists also know more about organisms that lived in environments that favored fossilization than in environments that did not favor fossilization.

SECTION: TIME MARCHES ON

1. Sample answer: Eras are divisions of geologic time that are divided into periods, and periods are units of geologic time that are divided into epochs.
2. B
3. The major time intervals represented by the geologic time scale are eons, eras, periods, and epochs.
4. Geologic time is recorded in rock layers by the differences in the fossils they contain.
5. Environmental changes that cause mass extinctions include global climate change, changes in ocean currents, and possible asteroid strikes.
6. Answers may vary. Sample answer: a major change in the Earth's climate
7. A decrease in the competition between species allows species to move into new parts of the environment and to adapt to use new resources.
8. 25×6.4 million years = 160 million years; 7×6.4 million years = 44.8 million years; 160 – 44.8 million years = 115.2 million years

Chapter Review

1. Sample answer: Superposition is the principle that states that younger rocks lie above older rocks in undisturbed sequences. The geologic column is an ideal sequence of rock layers that contains all the known fossil and rock layers on Earth, arranged from oldest to youngest. The geologic time scale is a scale that divides Earth's 4.6 billion year history into distinct intervals of time.

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. 2. Sample answer: Uniformitarianism is the theory that gradual geologic processes that we observe in the present were also active in the past. This theory argues that slow gradual change shapes the Earth. Catastrophism is the theory that past episodes of sudden and drastic change are responsible for the major geologic features that change the Earth.
3. Sample answer: Relative dating is a method of comparing rocks or fossils to each other to determine which ones are older. Absolute dating is a method of determining the age of something in years.
4. Sample answer: A trace fossil is any naturally preserved evidence of animal activity. And index fossil is a fossil of an organism that lived during a relatively short, well-defined geologic time span that is used to establish the age of rock layers.
5. D
6. B
7. D
8. C
9. B
10. C
11. C
12. A
13. Sample answer: Fossils are formed by the process of petrifaction, in which minerals replace an organism's tissue. Fossils are formed when organisms become trapped in hardened tree sap, or amber. Fossils are formed by sediment that slows decay.
14. Uniformitarianism is the guiding principle in Earth science. The same geologic processes shaping the Earth today have been at work throughout Earth's history.
15. Radioactive decay occurs as an unstable isotope breaks down into a stable isotope. This happens as the isotope loses an electron and a neutron becomes a proton.
16. Paleontologists use fossils to reconstruct past climates and to determine water depth in the oceans.
17. Paleontologists piece together the history of life on Earth using fossils as their data.
18. An answer to this exercise can be found at the end of the Teacher Edition
19. Changes in environmental conditions can change or eliminate a species' habitat, so a species cannot meet its basic needs. Both global climate changes and changes in ocean currents can cause the extinction of species.
20. Hard-bodied organisms are more easily preserved, so more of these organisms have been studied.
21. The tree is not made of wood because the wood tissue in the tree was completely replaced by minerals.
22. younger
23. an angular unconformity
24. Intrusion A is younger than fault 10 because the intrusion is not disturbed by the fault.
25. folding; Folding occurred, and then the fault occurred. After erosion and deposition of layers X and Y, the intrusion occurred.

Reinforcement

WELCOME TO THE GEOLOGY ROCKS CAFÉ

a. rye bread
b. pickles
c. tomatoes
d. provolone cheese
e. turkey
f. mustard
g. sourdough bread
h. onions
i. lettuce
j. Cheddar cheese
k. ham
l. mustard
m. sourdough bread
n. relish
o. provolone cheese
p. turkey
q. mayonnaise
r. sourdough bread
s. pickles
t. tomatoes
u. lettuce
v. ham
w. mustard
x. rye bread

Dessert bonus: disconformity

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Critical Thinking

ADIÓS ALAMOSAURUS

1. a.Answers may vary. Sample answer: Like one current theory, Dr. Garza's hypothesis states that the extinction of the dinosaurs was due partly to the impact of a huge asteroid.
   b.Answers may vary. Sample answer: One current theory states that the asteroid struck the Earth, causing the dinosaurs to die from a lack of sunlight. Dr. Garza's hypothesis states that the asteroid crashed into the ocean, and that the dinosaurs died as a result of the destruction of their habitat.
2. Answers may vary. Sample answers: asteroid impact: tsunamis, debris in the air, blockage of sunlight, forest fires, death of plants and animals; massive earthquake: tsunamis, flooding, destruction of habitat; drought: death of plants and animals
3. Answers may vary. Sample answer: Dr. Garza should look for disconformities in rock layers and extra thick layers of sediment due to heavy deposition. Sediment layers should contain large numbers of fossilized plants and animals that were buried and preserved in sediment after the flood.
4. Answers may vary. Sample answer: Yes, these discoveries support Dr. Garza's hypothesis. Flowing water would cause dinosaur skeletons in low-lying areas to be disrupted. Skeletons on high ground would not be affected by flooding, so they would remain intact.

Section Quizzes

SECTION: EARTH'S STORY AND THOSE WHO FIRST LISTENED

1. A
2. E
3. B
4. D
5. F
6. C
7. C
8. B
9. A
10. D

SECTION: RELATIVE DATING: WHICH CAME FIRST?

1. D
2. A
3. B
4. C
5. F
6. E
7. C
8. B
9. B
10. A

SECTION: ABSOLUTE DATING: A MEASURE OF TIME

1. C
2. F
3. A
4. B
5. E
6. D
7. C
8. B
9. A

SECTION: LOOKING AT FOSSILS

1. B
2. A
3. D
4. F
5. C
6. E
7. B
8. D
9. A
10. C

SECTION: TIME MARCHES ON

1. B
2. E
3. A
4. F
5. D
6. C
7. A
8. B
9. C
10. B

Chapter Test A

1. B
2. C
3. A
4. B
5. A
6. B
7. A
8. D
9. D
10. D
11. B
12. C
13. D
14. B
15. A
16. A
17. B
18. C
19. A
20. B
21. B
22. B
23. D
24. A
25. C

Chapter Test B

1. uniformitarianism
2. mold
3. relative dating
4. eons
5. unconformities
6. B

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7. A
8. D
9. D
10. D
11. B
12. Answers may vary. Sample answer: Scientists found that some types of fossils are found in the rock layers of only one geologic age. Using this information, they can date the rock layers where these fossils are found.
13. Answers may vary. Sample answer: Paleontology is the study of past life. Understanding how and where things lived in the past can help us to reconstruct past ecosystems and conditions in which organisms lived.
14. The geologic column is an ideal rock-layer sequence that contains all the known fossils and rock formations on Earth arranged from oldest to youngest. Geologists create this reference column by merging data collected from rock sequences all over the world.
15. 20 days is equivalent to 5 half-lives (20÷4 4 = 5). The progression would be 32g→16g→8g →4g→2g→1g of radon remaining after 20 days.
16. Sequence: C, D, A, E, B Folding has occurred between pictures A and B. By picture C, the folded layers have broken, and one side has dropped down. Picture D shows erosion of the rock layers exposed by movement along the fault surface. In picture E, sediments have been deposited on top of the eroded surface.
17. Answers may vary. Sample answer: While many geologic processes happen slowly, some occur suddenly. For example, an asteroid strike may have caused the extinction of the dinosaurs.
18. a. eons
    b. Archean
    c. Phanerozoic
    d. Paleozoic
    e. Cenozoic
    f. reptiles
    g. mammals

Chapter Test C

1. C
2. C
3. C
4. C
5. B
6. C
7. C
8. A
9. B
10. D
11. A
12. C
13. B
14. A
15. D
16. C
17. fossils
18. radioactive decay
19. radiometric dating
20. index fossils

Standardized Test Prep

Reading

Passage 1

1. B
2. G
3. C

Passage 2

1. C
2. F
3. B

INTERPRETING GRAPHICS

1. B
2. H
3. D

MATH

1. B
2. G
3. A
4. G
5. C

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Vocabulary activity

1. isotopes
2. catastrophism
3. Radiometric dating
4. Superposition
5. nonconformities
6. trace fossil, coprolite
7. half-life
8. Absolute dating
9. radioactive decay
10. mineral replacement
11. geologic column
12. eons, eras, periods, epochs
13. relative dating
14. index fossil
15. mold, cast
16. Uniformitarianism
17. Paleontology
18. extinction
19. Nonconformities
20. geologic time scaleSciLinks Activity

SciLinks Activity

1. Drawings may vary, but should obviously represent a *Pterygotus*, or sea scorpion. Features that may be labeled include large eyes, big claws, 8 legs, and a tail.
2. Drawings may vary, but should obviously represent an *Archaeopteryx*. Features that may be labeled include bird-like head, large eyes, prominent beak, teeth, long feathered tail, hind legs with 3 claws, and wings.
3. Drawings may vary, but should obviously represent a quagga, recent ancestor of horses and zebras. Features that should be shown are the yellowish-brown body with stripes on the head, neck, and forebody.

Performance-Based Assessment

PROCEDURE

1. Questions 1-4 Answers may vary according to the type of tablet the student uses.
4.

Time (Minutes)	Whole Tablet (g)	Half Tablet (g)
0 (start)	1.50	0.75
1	1.25	0.62
2	1.05	0.52
3	0.87	0.43
4	0.72	0.36
5	0.60	0.30

5. Answers may vary according to information in the student's chart.

ANALYSIS

6. The tablet represents the amount of parent material for an element.
7. Answers may vary. Sample answer: Both tablets dissolve.
8. Answers may vary. Sample answer: A half-life is the time it takes for one-half of a radioactive sample to decay. The whole tablet and the half tablet were both halfway dissolved after 3 minutes.
9. Answers may vary. Sample answer: No; the mass of the starting material does not affect the rate of dissolving. The tablets did not have the same mass, but they dissolved at the same rate.
10. Answers may vary. Sample answer: The same amount of material tablet did not dissolve from each tablet during the first "half-life." About twice as much parent material dissolved from the whole tablet than from the half tablet. However, both tablets lost 50 percent of their mass.

How Do You Stack Up?

ANALYZE THE RESULTS

1. There are 12 layers in this part of the geologic column.
2. The conglomerate that contains rectangles and X fossils is the oldest. The siltstone that contains circle fossils is the youngest.
3. The relative age of the fossils from oldest to youngest is rectangles, X's, diamonds, triangles, spirals, squares, and circles.
4. In Outcrop 2, part of the siltstone and all of the dark shale are missing. This information can be determined by comparing the outcrop with the geologic column.

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DRAW CONCLUSIONS

5. Index fossils include the spirals in the limestone and the rectangles in the conglomerate. These fossils are considered index fossils because they existed for a short range of geologic time. To determine the absolute age of the fossils, you would need to use radiometric dating.

Make a Fossil

PROCEDURE

4. Answers may vary. A cast could be formed by filling the mold with a substance such as plaster of Paris.

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