Answer Key

Directed Reading A

SECTION: INSIDE THE EARTH

1. layers
2. C
3. Answers may vary. Sample answer: Heavier elements are pulled to the center of the Earth by gravity; elements of lesser mass are farther from the center.
4. crust, mantle, core
5. oxygen, silicon, aluminum
6. iron, calcium, magnesium
7. magnesium
8. Magma from the mantle flows out of active volcanoes on the ocean floor.
9. silicon
10. iron
11. one-third
12. B
13. A
14. D
15. E
16. C
17. C
18. Each plate fits together with other plates.
19. oceanic and continental
20. The plates cover the surface of the asthenosphere; the plates touch each other; larger plates displace more of the asthenosphere than smaller plates.
21. D
22. C
23. Answers may vary. Sample answer: slower; The speed of seismic waves depends on the density and composition of material they pass through.

SECTION: RESTLESS CONTINENTS

1. D
2. A
3. C
4. Answers may vary. Sample answer: Fossils help support Wegener's hypo thesis. Fossils of the same species are found on different sides of the Atlantic.
5. Similar fossils, similar kinds of rocks, and evidence of the same ancient climactic conditions were found on several continents.
6. Pangaea
7. Laurasia
8. the present continents
9. From the calculated strength of the rocks, it did not seem possible for the crust to move this way.
10. new oceanic lithosphere forms
11. C
12. B
13. D
14. A
15. magnetic reversal

SECTION: THE THEORY OF PLATE TECTONICS

1. plate tectonics
2. B
3. B
4. A
5. The continental crust pushes upward.
6. B
7. C
8. A
9. divergent
10. transform
11. A
12. B
13. thermal
14. C
15. A
16. B
17. D
18. B

SECTION: DEFORMING THE EARTH'S CRUST

1. C
2. C
3. A
4. D
5. large mountain ranges
6. tension
7. B
8. B
9. C
10. A
11. C
12. A
13. C
14. D

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15. footwall
16. normal fault
17. reverse fault
18. C
19. A
20. B
21. C
22. B
23. C
24. A
25. A
26. C
27. B
28. Answers may vary. Sample answers: The farther the lithosphere is from the ridge, the cooler and denser the lithosphere becomes. Because the lithosphere takes up less volume, the ocean floor subsides.
29. rift zone

Directed Reading B

SECTION: INSIDE THE EARTH

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

SECTION: RESTLESS CONTINENTS

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

SECTION: THE THEORY OF PLATE TECTONICS

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

SECTION: DEFORMING THE EARTH'S CRUST

1. A
2. A
3. compression
4. convergent
5. tension
6. divergent
7. B
8. A
9. C
10. B
11. C
12. B
13. A
14. normal fault
15. reverse
16. sedimentary rock
17. strike-slip fault
18. C
19. A
20. B
21. C
22. A
23. B
24. D
25. A
26. C

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Vocabulary and Section Summary

SECTION: INSIDE THE EARTH

1. crust: the thin and solid outermost layer of the Earth above the mantle
2. mantle: the layer of rock between the Earth's crust and core
3. core: the central part of the Earth below the mantle
4. lithosphere: the solid, outer layer of the Earth that consists of the crust and the rigid upper part of the mantle
5. asthenosphere: the soft layer of the mantle on which the tectonic plates move
6. mesosphere: the strong, lower part of the mantle between the asthnosphere and the outer core
7. tectonic plate: a block of lithosphere that consists of the crust and the rigid, outermost part of the mantle

SECTION: RESTLESS CONTINENTS

1. continental drift: the hypothesis that states that the continents once formed a single landmass, broke up, and drifted to their present locations
2. sea-floor spreading: the process by which new oceanic lithosphere forms as magma rises toward the surface and solidifies

SECTION: THE THEORY OF PLATE TECTONICS

1. plate tectonics: the theory that explains how large pieces of the Earth's outermost layers, called *tectonic plates*, move and change shape
2. convergent boundary: the boundary formed by the collision of two lithospheric plates
3. divergent boundary: the boundary between two tectonic plates that are moving away from each other
4. transform boundary: the boundary between tectonic plates that are sliding past each other horizontally

SECTION: DEFORMING THE EARTH'S CRUST

1. compression: stress that occurs when forces act to squeeze an object
2. tension: stress that occurs when forces act to stretch an object
3. folding: bending of rock layers due to stress
4. fault: a break in a body of rock along which one block slides relative to another
5. uplift: the rising of the regions of the Earth's crust to higher elevations
6. subsidence: the sinking of regions of the Earth's crust to lower elevations

Section Review

SECTION: INSIDE THE EARTH

1. Sample answer: The crust is the thin, outermost layer of the Earth. It is made mainly of less dense compounds and is less than 1% of the Earth's mass. The mantle is a thick layer beneath the crust. The mantle is made of dense compounds and is 67% of the Earth's mass.
2. Sample answer: The lithosphere is rigid and is divided into tectonic plates. The asthenosphere is a layer of soft mantle material that flows very slowly.
3. C
4. B
5. The crust is made mainly of the elements oxygen, silicon, and aluminum. The mantle has more magnesium and less aluminum and silicon than the crust has; the core is made mostly of iron.
6. The lithosphere is the outermost, rigid layer of the Earth. Beneath the lithosphere is the asthenosphere, a plastic layer of the mantle on which the lithosphere moves. The mesosphere is the strong, lower part of the mantle. The outer core is the liquid layer of the Earth's core that lies between the mantle and the inner core. The solid, dense center of our planet is the inner core.
7. A tectonic plate is a large piece of the Earth's lithosphere that moves slowly on the top of the asthenosphere.

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Tectonic plates are composed of continental crust, oceanic crust, and both continental and oceanic crust.

8. Scientists can measure the speeds at which seismic waves travel through different parts of the Earth. This measurement helps them calculate the density and thickness of each layer the waves pass through.
9. According to the wave speeds in the table, the mesosphere and the inner core are the two densest physical layers. (In reality, the outer core and inner core are the two densest layers. Because the outer core is liquid, wave speed through the outer core is slower than it is in the mesosphere.)
10. The crust is the thin, outermost layer of the Earth that is compositionally different than the mantle. The lithosphere is a thick layer containing both the crust and upper mantle but which is rigid compared to the underlying asthenosphere.
11. Seismic waves travel through solid rock faster than they do through water because solid rock is denser than water.

SECTION: RESTLESS CONTINENTS

1. Sample answer: Continental drift is the hypothesis developed by Alfred Wegener to explain why the continents are in their present locations. Sea-floor spreading is a process in which magma rises to the surface at a mid-ocean ridge, solidifies, and forms new oceanic lithosphere.
2. B
3. Magma rises to the surface at a mid-ocean spreading center and solidifies to form new oceanic lithosphere.
4. A magnetic reversal is a change in the polarity of Earth's magnetic field.
5. *rate = time ÷ 4 distance*
   50 km ÷ 5,000,000 y = .00001 km/y
   = 10 mm/y
6. As oceanic crust spreads away from a mid-ocean ridge, the crust carries a sequence of bands of rock that shows magnetic reversals. The similar sequence of magnetic reversals on both sides of the ridge, even at a large distance from the ridge, indicates that the sea floor is spreading away from a center at which new oceanic lithosphere is forming.
7. The rate of sea-floor spreading on opposite sides of a mid-ocean ridge occurs at a similar rate, so bands indicating magnetic reversals will have a similar width.
8. Answers may vary. Students may suspect that older rocks re-enter the rock cycle at plate boundaries.

SECTION: THE THEORY OF PLATE TECTONICS

1. Sample answer: Plate tectonics is the theory that the lithosphere is divided into tectonic plates that move slowly across the asthenosphere.
2. B
3. Three possible driving forces of tectonic plate movement are ridge push, slab pull, and convection. Ridge push occurs when an oceanic plate slides down the boundary between the lithosphere and asthenosphere because of gravity. Slab pull occurs when the sinking edge of an oceanic plate pulls the rest of the plate down with it into the subduction zone. Convection occurs when hot mantle material in the asthenosphere convects and causes the tectonic plate to move sideways.
4. In the GPS process, radio signals are beamed from satellites to ground stations. The distance between the satellite and a ground station is recorded. Over time, these distances change slightly. Scientists can measure the rate at which tectonic plates move by recording the time it takes for ground stations to move a given distance.
5. $(4 \times 3.1416 \times 30^2) = 11{,}310\ cm^2$
6. During the convection process in the mantle, cooler material sinks because it is denser than warmer material.
7. Oceanic crust sinks beneath continental crust at convergent boundaries because oceanic crust is denser than continental crust

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SECTION: DEFORMING THE EARTH'S CRUST

1. Sample answer: Compression is stress that occurs when forces act to squeeze an object. Tension is stress that occurs when forces act to stretch an object.
2. Sample answer: Uplift is the rising of Earth's crust to higher elevations. Subsidence is the sinking of Earth's crust to lower elevations.
3. D
4. The three types of folds include anticlines, which are upward-arching folds; synclines, which are downward-arching folds; and monoclines, in which rock layers are folded so that both ends of the fold are horizontal.
5. The three types of faults include normal faults, in which the hanging wall moves down relative to the footwall; reverse faults, in which the hanging wall moves up relative to the footwall; and strike-slip faults, in which opposing forces cause rock to break and move horizontally.
6. The most common types of mountains are folded mountains, fault-block mountains, and volcanic mountains.
7. Rebound is a process in which Earth's crust slowly springs back to its original elevation.
8. Rift zones are a set of deep cracks in the Earth's crust that form when two tectonic plates pull away from each other. As tectonic plates pull apart, stress builds up between the plates. This stress causes strain in the Earth's crust, and a series of faults form along the rift zone.
9. A reverse fault is likely to form because both reverse faults and folding occur in areas where compression takes place.
10. No, you would be more likely to see volcanic mountains or fault-block mountains where magma is rising along the mid-ocean ridge spreading center.
11. a reverse fault
12. a convergent boundary

Chapter Review

1. Sample answer: Scientists divide the Earth into the crust, mantle, and core based on the chemical elements that make up each of these layers.
2. continental drift
3. asthenosphere
4. Tension
5. uplift
6. B
7. C
8. B
9. D
10. A
11. C
12. Scientists can measure the differences in the speeds of seismic waves that travel through the Earth's interior to calculate the density and thickness of each of the Earth's physical layers.
13. As oceanic crust spreads away from a mid-ocean ridge, the crust carries bands that contain minerals that were aligned with Earth's magnetic field when the crust formed. The similar sequence of bands on both sides of a mid-ocean ridge, even at a large distance from the ridge, indicates that the sea floor is spreading away from acenter point.
14. As new crust forms at mid-ocean ridges, plates on either side of the ridge move away from the ridge. Therefore, continents on those plates also move.
15. Compression and tension are two types of stress that deform rock. Compression squeezes rock at convergent plate boundaries; tension stretches rock at divergent plate boundaries.
16. The global positioning system is a system of satellites that orbit the Earth. Radio signals are continuously beamed from these satellites to ground stations. The distance between satellites and ground stations is recorded. By recording the time it takes for ground stations to move a given distance, scientists can measure the rate at which tectonic plates move.
17. An answer to this exercise can be found at the back of the Teacher Edition.

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18. Answers may vary. The lithosphere at a subduction zone is denser than at a mid-ocean ridge. Convection causes oceanic lithosphere to move away from the mid-ocean ridge. Oceanic lithosphere is also higher at a mid-ocean ridge, so oceanic lithosphere moves down toward the subduction zone because of gravity.
19. Answers may vary. The amount of crust formed is roughly equal to the amount of crust destroyed. If this were not true, the Earth would either be expanding or shrinking.
20. At the time they formed, the folded mountains must have been on the edge of a tectonic plate. New material was later added to the tectonic plate, causing the folded mountains to be located closer to the center of the continent.
21. 50 km
22. 150 km + 250 km + 2,550 km = 2,950 km
23. between 50 km and 150 km
24. 150 km + 250 km + 2,550 km + 2,200 km = 5,150 km

Reinforcement

THE LAYERED EARTH

1. crust
2. mantle
3. outer core
4. inner core
5. crust
6. asthenosphere
7. mesosphere
8. tectonic plate
9. outer core; inner core

A MOVING JIGSAW PUZZLE

1. divergent
2. transform
3. convergent

Critical Thinking

1. Answers may vary. Sample answer: Athena may have a liquid center surrounded by a solid, flexible outer layer.
2. Answers may vary. Sample answer: Athena's top layer must be made of a material less rigid and more flexible than the rock of Earth's crust. Otherwise, it would probably crack due to the stress.
3. The color of the sky and the smell of the air probably do not indicate anything about the planet's inner structure.
4. Answers may vary. Sample answer: If there are events like earthquakes on the planet, they could use seismographs to measure the speed and angles of any seismic waves produced. They also might try to drill into the planet's surface in order to see the layers.
5. Answers may vary. Sample answer: They should discuss their findings with other scientists in the field first. They should then make sure that no other hypotheses can be supported by their data.

Section Quizzes

SECTION: INSIDE THE EARTH

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

SECTION: RESTLESS CONTINENTS

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

SECTION: THE THEORY OF PLATE TECTONICS

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

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SECTION: DEFORMING THE EARTH'S CRUST

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

Chapter Test A

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

Chapter Test B

1. asthenosphere
2. mesosphere
3. outer core
4. continental drift
5. uplift
6. sea-floor spreading
7. B
8. A
9. A
10. D
11. C
12. D
13. Folded mountain ranges form when two tectonic plates with continental crust collide. The crust is forced upward at the point of collision, which forms mountains over a long period of time.
14. The asthenosphere is a layer made of solid rock that flows very slowly. The tectonic plates float, or move very slowly on top of the asthenosphere.
15. When rocks are pulled apart by tension, hanging walls tend to slip below the footwall. When rocks are pushed together by compression, hanging walls tend to push above the footwall.
16. Answers may vary. Sample answer: Molten rock at mid-ocean ridges has magnetized minerals that align with Earth's magnetic field. When the Earth's magnetic field reverses, the magnetized minerals align in the opposite direction. The record of magnetic reversals is carried away from each side of the spreading center of a mid-ocean ridge, showing that the molten rock is creating new lithosphere.
17. Answers may vary. Sample answer: When tectonic plates slide past each other, the movement may cause earthquakes, which might injure people or damage property in a community.
18. Answers may vary. Sample answer: Continental crust: Continental crust is thicker than ocean crust, but much less dense and therefore easier to drill through because it contains less dense minerals. Oceanic crust: Although it is denser than continental crust, oceanic crust is much thinner than continental crust and therefore would take less time to drill through.
19. a. Pangaea; b. Gondwana; c. Laurasia; d. North America; e. South America

Chapter Test C

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

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14. A
15. D
16. B
17. C
18. normal
19. convergent
20. reverse
21. magnetic reversals
22. sea-floor spreading
23. divergent

Standardized Test Preparation

READING

Passage 1

1. C
2. H
3. B

Passage 2

1. C
2. I
3. B

INTERPRETING GRAPHICS

1. C
2. G

MATH

1. B
2. H
3. B
4. H

Vocabulary Activity

1. sea-floor spreading
2. fault
3. mesosphere
4. convergent boundary
5. core
6. folding
7. uplift
8. divergent boundary
9. reverse fault
10. asthenosphere
11. plate tectonics
12. compression
13. lithosphere
14. subduction zone
15. subsidence
16. normal fault
17. mantle
18. strike-slip fault
19. continental drift
20. tension
21. crust
22. transform boundary
23. tectonic plates
24. stress

SciLinks Activity

1. Answers may vary. Sample answer: Philippine Plate, Scotia Plate, Juan de Fuca Plate
2. The Great Global Rift is a deep canyon that runs through the Mid-Ocean Ridge.
3. Answers may vary. Sample answer: The Mediterranean Sea will disappear, connecting Africa and Europe; India will continue pushing into the southern Asian continent, pushing the Himalayas higher; Los Angeles will move north to join with San Francisco; the Atlantic Ocean will continue to expand, while the Pacific Ocean will shrink.

Performance-Based Assessment

ANALYSIS

4. Points A, B, I, L, M, and N have moved toward the top of the map. The points on the right side of the map have not moved from their original position.
5. The fault is a strike-slip fault because the movement described is lateral only and shows no change in elevation.
6. Answers may vary. Sample answer: I would need a cross-sectional view that showed the elevation and the angle of the fault.

Convection Connection

ANALYZE THE RESULTS

1. Based on the motion of the food coloring, the warmer water rises and the cooler water sinks. Therefore, as the water warms, the craft sticks should move in a direction away from the center of the pan.

DRAW CONCLUSIONS

2. The hot water flowed outward from the center of the pan. This movement pushed the sticks away from each other and toward the edges of the pan.

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3. Convection currents within Earth's mantle may move tectonic plates in the same way that the convecting water moved the craft sticks. The convection currents in this model were created by the hot plates warming the water. In the mantle, convection currents are caused by thermal energy from deep within Earth.
4. Answers may vary but should include a description of how convection may be at least partially responsible for the movement of tectonic plates.

APPLYING YOUR DATA

Suggestions for improving the model may vary. Students may suggest increasing the size of the model or using model tectonic plates that have differing sizes and densities. Students may also suggest incorporating the processes of ridge push or slab pull into the model.

Tectonic Ice Cubes

PROCEDURE

5. All pieces of ice have the same density. Large, irregularly shaped pieces of ice have a greater weight and will therefore displace more water than smaller pieces of ice do.

Modeling Strike-Slip Faults

PROCEDURE

4. Sample answer: A strike-slip fault forms when opposing tectonic forces cause blocks of crust to move horizontally past each other. The blocks of clay modeled blocks of crust along a strike-slip fault.

Oh, the Pressure!

ANALYZE THE RESULTS

1. The first block got shorter and taller. The layers of clay became folded due to compression.
2. One of the pieces (the hanging wall) slid above the other piece (the footwall) due to compression.
3. One of the pieces (the footwall) moved up relative to the other piece (the hanging wall) as tension was released.

DRAW CONCLUSIONS

4. The conclusion should be a complete summary of this activity, indicating the direction of pressure at each step. Any diagrams should be correctly labeled, and students should demonstrate a good understanding of the terms fold, fault, anticline, syncline, hanging wall, footwall, tension, and compression.

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