Answer Key

Directed Reading A

SECTION: WHAT ARE EARTHQUAKES?

1. Seismology is the branch of Earth science devoted to studying earthquakes.
2. seismologists
3. Most earthquakes take place near the edges of tectonic plates.
4. tectonic plates
5. faults
6. Earthquakes happen along faults because of the sliding of the blocks of Earth's crust.
7. C
8. A
9. D
10. B
11. Rocks deform in response to the stress caused by the pushing, pulling, and slipping of tectonic plates.
12. The rock breaks, and elastic rebound occurs.
13. an earthquake
14. C
15. C
16. B
17. A
18. Most earthquakes happen in the earthquake zones along tectonic plate boundaries.
19. B
20. A
21. B
22. D
23. C
24. C
25. A
26. B
27. B
28. It depends on the kind of material the wave travels through.
29. Answers may vary. Accept either P waves, pressure waves, or primary waves.
30. Answers may vary. Accept either S waves, shear waves, or secondary waves.
31. Answers may vary. Sample answer: Surface waves travel along the surface of Earth and body waves travel inside Earth. Surface waves travel more slowly and are more destructive.
32. B
33. C
34. A

SECTION: EARTHQUAKE MEASUREMENT

1. C
2. A
3. B
4. D
5. Answers may vary but should include two of the following: calculating when an earthquake began, finding an earthquake's epicenter, determining an earthquake's strength.
6. S-P time method
7. seismograms
8. epicenter
9. Answers may vary. Sample answer: I could draw a circle around each station. The radius of the circle is the distance from each station to the epicenter. The point at which the three circles intersect is the epicenter of the earthquake.
10. D
11. C
12. A
13. C
14. B
15. D
16. A
17. The Richter scale measures the ground motion from an earthquake and adjusts for distance to find its strength.
18. Intensity values are usually highest near the epicenter.

SECTION: EARTHQUAKES AND SOCIETY

1. Earthquake hazard is a measurement of how likely an area is to have damaging earthquakes in the future.

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2. Answers may vary but should include the West Coast or California.
3. Answers may vary. Sample answer: Stronger earthquakes occur less often.
4. gap hypothesis
5. seismic gaps
6. aftershocks
7. gap hypothesis
8. D
9. C
10. B
11. A
12. B
13. flexible pipes
14. A common way to retrofit an older home is to securely fasten it to its foundation.
15. Sensors in an active tendon system notify a computer that a building is moving. Then the computer signals a large weight to shift in order to counteract the movement of the building.
16. Answers may vary. Sample answer: I can put heavier objects on lower shelves so they don't fall. I can talk to my parents about having our home strengthened.
17. Answers may vary. Sample answer: I can find safe places in each room of the home. I can also find safe places outside. I can plan with others to meet in a safe place after the earthquake is over.
18. Answers may vary. Sample answer: I can store things like water, nonperishable food, a fire extinguisher, a flashlight with batteries, a portable radio, medicines, and a first-aid kit in a place I can get to after an earthquake.
19. Answers may vary. Sample answer: The best thing to do is to crouch or lie face down under a table or desk in the center of a room.
20. Answers may vary. Sample answer: The best thing to do is to lie face down away from buildings, power lines, and trees and to cover my head with my hands.

Directed Reading B

SECTION: WHAT ARE EARTHQUAKES?

1. C
2. A
3. D
4. B
5. C
6. elastic rebound
7. plastic deformation
8. deformation
9. elastic deformation
10. B
11. C
12. A
13. A
14. B
15. C
16. D
17. C
18. B
19. seismic waves
20. body waves
21. surface waves
22. C
23. A
24. C
25. B
26. D
27. D
28. A
29. B
30. A

SECTION: EARTHQUAKE MEASUREMENT

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

SECTION: EARTHQUAKES AND SOCIETY

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

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7. A
8. D
9. D
10. A
11. active tendon system
12. flexible pipe
13. cross brace
14. base isolator
15. A
16. C
17. C
18. B
19. B
20. D

Vocabulary and Section Summary

SECTION: WHAT ARE EARTHQUAKES?

1. seismology: the study of earthquakes
2. deformation: the bending, tilting, and breaking of the Earth's crust; the change in the shape of rock in response to stress
3. elastic rebound: the sudden return of elastically deformed rock to its undeformed shape
4. seismic wave: a wave of energy that travels through the Earth, away from an earthquake in all directions
5. P wave: a seismic wave that causes particles of rock to move in a back-and-forth direction
6. S wave: a seismic wave that causes particles of rock to move in a side-to-side direction

SECTION: EARTHQUAKE MEASUREMENT

1. seismograph: an instrument that records vibrations in the ground and determines the location and strength of an earthquake
2. seismogram: a tracing of earthquake motion that is created by a seismograph
3. epicenter: the point on Earth's surface directly above an earthquake's starting point, or focus
4. focus: the point along a fault at which the first motion of an earthquake occurs

SECTION: EARTHQUAKES AND SOCIETY

1. gap hypothesis: a hypothesis that is based on the idea that a major earthquake is more likely to occur along the part of an active fault where no earthquakes have occurred for a certain period of time
2. seismic gap: an area along a fault where relatively few earthquakes have occurred recently but where strong earthquakes have occurred in the past

Section Review

SECTION: WHAT ARE EARTHQUAKES?

1. Deformation
2. P waves
3. B
4. The majority of earthquakes occur near the edges of tectonic plate boundaries.
5. Earthquakes are caused by elastic rebound—the return of elastically deformed rock to its original state. When enough stress is applied to an elastically deformed rock, the rock along a fault slips and releases energy. Some of the energy travels as seismic waves, which cause an earthquake.
6. Sample answer: Convergent plate motion occurs where two plates are pushed together. It creates reverse faults. Divergent plate motion occurs where two plates pull away from each other. It creates normal faults. Transform motion occurs where two plates slip past each other. It creates strike-slip faults.
7. An earthquake zone is an area of Earth's crust where a large number of faults are located.
8. 480 km ÷ 8 km/s = 60 s = 1 min
9. Sample answer: Some earthquakes are stronger than others because a greater amount of energy is released when elastically deformed rock slips.
10. Sample answer: Surface waves are more destructive than P waves and S waves because surface waves produce ground motion in the upper few kilometers of the Earth's crust.

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11. Sample answer: At tectonic plate boundaries, different types of plate motion all cause faulting.

SECTION: EARTHQUAKE MEASUREMENT

1. Sample answer: An epicenter is the point on Earth's surface above the focus. A focus is the point along a fault where an earthquake starts.
2. A seismograph is the instrument used to record seismic waves. A seismogram is the tracing of earthquake motion created by a seismograph.
3. Earthquakes are detected by seismographs located at or near the Earth's surface.
4. Seismologists collect seismograms of an earthquake from at least three seismograph stations and place them on a time-distance graph. The distance of each station from the epicenter can then be found. These distances are used to draw circles around seismograph stations. The radius of each circle is the distance of the seismograph from the earthquake's epicenter. The point of intersection of these circles is the earthquake's epicenter.
5. Because the effects of an earthquake can vary from place to place, an earthquake can have more than one intensity value. Higher intensity values are more likely to be seen near the epicenter of an earthquake.
6. An earthquake of magnitude 7.0 will produce 1,000 times ($10 \times 10 \times 10$) more ground motion than an earthquake of magnitude 4.0.
7. An earthquake of magnitude 6.0 is much more destructive than an earthquake of 5.0 because an earthquake of magnitude 6.0 produces 10 times more ground motion.
8. Answers may vary. Sample answer: Intensity is a more important measure of earthquakes because the damage caused by an earthquake is something people can see.
9. Sample answer: A moderate earthquake might produce high intensity values near the epicenter of the earthquake.

SECTION: EARTHQUAKES AND SOCIETY

1. Sample answer: According to the gap hypothesis, strong earthquakes are likely to occur along sections of active faults that have had relatively few earthquakes. A seismic gap is an area along an active fault where relatively few earthquakes have occurred.
2. C
3. The earthquake hazard level of a particular area is determined by the amount of past and present seismic activity that has occurred in the area.
4. Sample answer: According to the strength and frequency method, earthquake strength is related to how often earthquakes occur. The gap hypothesis predicts an earthquake's strength and location by finding out the parts of an active fault where no earthquakes have recently occurred.
5. Sample answer: A common way of making a home more earthquake resistant is to securely fasten it to its foundation.
6. Answers may vary. Sample answer: Flexible pipes that are able to twist and bend during earthquakes prevent water and gas lines from breaking. A base isolator made of rubber and steel wrapped around lead absorbs seismic waves. A mass damper placed in the roof of a building counteracts the movement of the building during an earthquake. Cross braces placed between floors in a building counteract pressure that pushes and pulls at the side of a building.
7. Answers may vary. Sample answer: nonperishable food, a flashlight, a portable radio, a fire extinguisher, and a first-aid kit
8. $140 \div 420{,}000 \times 100 = .03\%$
9. The hypothesis is not incorrect because there was only a 20% probability an earthquake would fill the seismic gap.
10. Aftershocks follow a large earthquake because the earthquake causes elastically deformed rock along other nearby faults to break.

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Chapter Review

1. Sample answer: A seismic wave is released when elastically deformed rock along a fault slips. A P wave is the fastest seismic wave and can move through all parts of the Earth. An S wave moves rock from side to side as the wave travels through the Earth.
2. Sample answer: A seismograph is an instrument that is used to record seismic waves. A seismogram is the tracing of earthquake motion created by a seismograph.
3. Sample answer: A focus is the point along a fault where an earthquake starts. An epicenter is the point on Earth's surface above the focus.
4. Sample answer: The gap hypothesis states that strong earthquakes are likely to occur along sections of active faults that have had relatively few earthquakes. Seismic gaps are areas along active faults where relatively few earthquakes have occurred.
5. B
6. B
7. D
8. B
9. B
10. D
11. No, a minimum of three seismograph stations are needed to find an earthquake's epicenter using the S-P time method.
12. The Richter magnitude scale measures the ground motion from an earthquake and adjusts for distance to find earthquake strength. The Modified Mercalli Intensity Scale measures the degree to which an earthquake is felt by people and the amount of damage caused by an earthquake.
13. With each step down in earthquake strength or magnitude, the number of earthquakes per year is greater.
14. P waves move rock back and forth, squeezing and stretching the rock. S waves stretch rock sideways as well as back and forth. Surface waves move rock up, down, and around or, in a back-and-forth motion.
15. Answers may vary. Sample answer: You should protect yourself and your property against earthquakes by storing items you may need after a strong, damaging earthquake. You should put heavy items closer to the floor so that they do not fall during earthquakes. You should find safe places within each room of your home or outdoors in the event there is an earthquake.
16. An answer to this exercise can be found at the end of the Teacher Edition.
17. Answers may vary. Sample answer: Based on the average number of earthquakes of different magnitudes that happen annually, a light earthquake would be more likely to happen along a major fault where there have not been many major earthquakes.
18. Because most earthquakes occur at tectonic plate boundaries, the earthquake-hazard level in Japan would be high.
19. Answers may vary. Sample answer: You might want to leave your car if it was stranded on or beneath a highway overpass.
20. A gelatin model is limited because it does not have the same properties as rock, such as density and hardness.
21. 4
22. 100 mm – 10 mm = 90 mm
23. Students should recognize that seismogram heights increase at a greater rate with each increase in earthquake magnitude. The relationship is logarithmic, not linear.

Reinforcement

COMPLETE A SEISMIC STORY

seismologist
fault
seismology
fault
deformation
plastic deformation
elastic deformation
seismograph
elastic rebound
seismogram
seismologist
epicenter
epicenter
focus
focus

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Critical Thinking

1. Answers may vary. Sample answer: Based on their descriptions in the letter, the earthquakes probably measure about a 3 or a 4 on the Richter scale.
2. Answers may vary. Sample answer: No; although a major earthquake is always possible, frequent major ones are not. There is an inverse relationship between earthquake frequency and strength. The more frequently earthquakes occur, the less intense the quakes are and the less damage they cause.
3. Answers may vary. Sample answer: I would offer them building materials and specialized designs that could help prevent structural damage to their buildings. For example, I could send flexible pipes, steel cross braces, mass dampers, base isolators, and active tendon systems. I could also help them develop an earthquake strategy.
4. Answers may vary. Sample answer: Citizens: Fear not; you face no dire threat. In fact, the frequent small earthquakes may mean fewer stronger quakes. Should large quakes hit, they will be few and far between.

Section Quizzes

SECTION: WHAT ARE EARTHQUAKES?

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

SECTION: EARTHQUAKE MEASUREMENT

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

SECTION: EARTHQUAKES AND SOCIETY

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

Chapter Test A

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

Chapter Test B

1. seismograph
2. focus
3. seismic gaps
4. deformation
5. seismic waves
6. B
7. A
8. C
9. C
10. A
11. Answers may vary. Sample answer: By studying seismic waves, seismologists can learn the strength of an earthquake and locate an earthquake's epicenter and focus.
12. Answers may vary. Sample answer: P waves squeeze and stretch rock, moving it back and forth. S waves shear rock side to side. P waves move faster than S waves. P waves can travel through liquid, but S waves cannot.
13. Answers may vary. Sample answer: The Richter magnitude scale measures the strength of an earthquake. The scale compares earthquakes based on the amount of ground motion generated. The Modified Mercalli Intensity Scale measures the intensity

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of an earthquake in a given location by using a scale that describes the amount of damage caused and the degree to which people felt the earthquake.

14. Answers may vary. Sample answer: I would draw a circle around each station. The center of each circle would be the station. The radius of each would be the distance from the epicenter to the station. The epicenter would be the spot where the three circles intersect.
15. Answers may vary. Sample answer: The S waves generated by an earthquake would be much stronger than those from the explosion.
16. Answers may vary. Sample answer: I can see no remaining effects of the earthquake in the first location. Any damage would be too small or would be repaired. In the second location, many buildings are in shambles. Many underground pipes burst and there is fire damage. The damage from this quake is both great and widespread.
17. Answers may vary. Sample answer: Part I (Before the Shaking): I will make sure my room is safe by moving the fish tank from the top of my bookshelf to the bottom. Next I'll find the safest places in every room of the house. Last I'd make sure that all my family knew exactly where to meet after an earthquake so we could each know the others are safe. Part II (When the Shaking Starts): I would take cover under the oak desk in the den. Part III (After the Shaking Stops): I would check around my house to make sure it was safe and clean up broken glass and tell my parents if I saw any downed power lines.
18. a.seismic waves
    b.focus
    c.epicenter
    d.body waves
    e.surface waves
    f.P waves
    g.waves

Chapter Test C

1. C
2. B
3. C
4. C
5. A
6. C
7. C
8. C
9. B
10. C
11. B
12. A
13. C
14. B
15. D
16. C
17. A
18. seismic waves
19. elastic deformation
20. base isolator
21. mass damper
22. P waves
23. body waves
24. S waves
25. surface waves

Standardized Test Preparation

READING

Passage 1

1. B
2. H
3. D

Passage 2

1. C
2. G
3. D

INTERPRETING GRAPHICS

1. A
2. H
3. B

MATH

1. B
2. H
3. D
4. H
5. C

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Vocabulary Activity

ACROSS

3. fault
4. seismology
5. focus
8. epicenter
10. P waves
11. S waves
12. gap hypothesis
13. seismogram

DOWN

1. deformation
2. elastic rebound
6. seismic waves
7. seismograph
9. seismic gap

SciLinks Activity

1. Answers may vary. Sample answer: The earthquake occurred in Eastern New Guinea.
2. Answers may vary. Sample answer: The earthquake happened on October 22, 2003, at 11:45 AM.
3. Answers may vary. Sample answer: The magnitude of the earthquake was 6.3.
4. Answers may vary but should include a description appropriate to the magnitude of the earthquake. Sample answer: This earthquake would definitely have been felt by people and probably caused quite a bit of damage to buildings that were not earthquake-resistant. There may be some cracking of the ground in the area, and there were probably some broken underground pipes.

Performance-Based Assessment

FORM A HYPOTHESIS

6. Sample hypothesis: I could inflate and seal the plastic bags to use them as shock absorbers.

ANALYZE THE RESULTS

9. The first design kept the box in the same place when the book was gently shaken.
10. Answers may vary. Sample answer: Our design was good for gentle shaking, but a lot of shaking caused the structure to fall apart.

DRAW CONCLUSIONS

11. a. Answers may vary. Sample answer: The inflated bags worked well as shock absorbers for very gentle shaking.
    b. Answers may vary. Sample answer: The slick surface between the plastic bags and the textbooks caused the books and the box to slide off.
12. Answers may vary. Sample answer: Rubber bands could be placed on the top and bottom of the plastic bags to add traction and to prevent the books and the box from sliding off.

Quake Challenge

ANALYZE THE RESULTS

1. Answers may vary. Sample answer: Structures that had a wide base generally withstood the earthquake. Structures that used triangles in the design also were successful.
2. Answers may vary. Sample answer: By experimenting with different design shapes, such as cubes or triangles, we could find the most stable structure.

DRAW CONCLUSIONS

3. Buildings designed in earthquake zones areas should have wide and flexible foundations. The building should also be reinforced to prevent collapse.
4. Answers may vary. Accept all reasonable answers. Sample answer: Rocks and gelatin have very different physical properties, such as hardness and density. Seismic waves may have different effects on rock than shaking does on gelatin.
5. Answers may vary. Accept all reasonable answers. Sample answer: By changing the design of our marshmallow-and-toothpick building, we can come up with better designs for buildings.

Modeling Seismic Waves

MATERIALS

4. P waves are represented in step 2; S waves are represented in step 3.

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Earthquake Waves

PROCEDURE

3. Austin: 150 s; Bismarck: 168 s; Portland: 120 s

ANALYZE THE RESULTS

1. San Diego, California
2. Sample answer: Seismologists require at least three intersecting circles to determine the epicenter of an earthquake. The first two circles intersect in two places. When a third circle is used, all three circles intersect in only one place near the epicenter.

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