Answer Key

Directed Reading A

SECTION: ROCKET SCIENCE

1. 165
2. rocket
3. A
4. C
5. A
6. B
7. C
8. D
9. B
10. Von Braun and his research team surrendered to the Americans near the end of WWII, giving the United States the best German rocket scientists.
11. in response to Soviet advances in space
12. National Aeronautics and Space Administration
13. D
14. B
15. C
16. A
17. because they are under extreme pressure
18. There is little or no oxygen in space, and oxygen is needed to burn fuel.
19. A
20. D
21. C
22. D
23. orbital velocity
24. It will fall back to Earth.
25. It will travel beyond Earth's orbit.

SECTION: ARTIFICIAL SATELLITES

1. any human-made object placed in orbit around a body in space, such as Earth
2. continuous updates on movement of gases in the atmosphere so that we can predict weather on Earth
3. communications satellites
4. remote-sensing
5. B
6. A
7. D
8. C
9. B
10. D
11. C
12. low Earth orbit (LEO)
13. geostationary
14. so that TV programs and other communications will not be interrupted
15. A
16. C
17. A
18. D
19. C
20. A
21. B
22. B
23. GEO
24. communications satellites
25. remote sensing
26. Landsat
27. change
28. EOS
29. satellites

SECTION: SPACE PROBES

1. space probe
2. Earth
3. They can complete missions that would be very dangerous and expensive for humans to undertake.
4. B
5. D
6. A
7. C
8. *Venera 9*
9. surface temperature and atmospheric pressure
10. Earth rocks
11. that Venus has a severe greenhouse effect
12. *Magellan*
13. It has features that suggest plate tectonics, and it has volcanoes.
14. Viking
15. that Mars was once much warmer and wetter than it is now
16. Pathfinder
17. floods
18. It traveled across the surface of Mars for almost three months, collecting data and recording images.
19. C

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20. B
21. B
22. D
23. A
24. that two moons have magnetic fields and one, Europa, may have an ocean of liquid water under its icy surface
25. Titan
26. whether it is like Earth's early atmosphere and clues about how life developed on Earth
27. A
28. B
29. D

SECTION: PEOPLE IN SPACE

1. orbit
2. A
3. B
4. C
5. B
6. A
7. D
8. C
9. expensive
10. space shuttle
11. *Columbia*
12. the orbiter, liquid-fuel tank, and solid-fuel booster rockets
13. orbitor
14. airplane
15. It exploded after takeoff.
16. *Columbia*
17. It will fly like a normal airplane, but it will have rocket engines for use in space
18. They may lower the cost by 90%
19. space vehicles
20. space station
21. C
22. A
23. B
24. D
25. perform space-science experiments and test new technologies
26. cooperation
27. resources and living space
28. It could be used to manufacture materials in low gravity or in a vacuum. It could help bring space resources to Earth. It would be a base for exploring the rest of the solar system.
29. It has expanded our knowledge and resulted in life-saving technologies.
30. space-age spinoffs
31. hand-held cameras

Directed Reading B

SECTION: ROCKET SCIENCE

1. D
2. A
3. A
4. C
5. D
6. B
7. C
8. C
9. motion
10. reaction devices
11. thrust
12. pressure
13. D
14. A
15. A
16. D
17. orbital velocity
18. suborbital velocity
19. escape velocity

SECTION: ARTIFICIAL SATELLITES

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

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SECTION: SPACE PROBES

1. C
2. B
3. A
4. D
5. A
6. B
7. moon
8. frozen water
9. human colony
10. C
11. B
12. A
13. D
14. *Magellan*
15. volcanoes
16. Viking
17. warmer
18. Pathfinder
19. *Sojourner*
20. Mars
21. B
22. A
23. B
24. C
25. A
26. B
27. C
28. D
29. A
30. B
31. D

SECTION: PEOPLE IN SPACE

1. D
2. A
3. A
4. C
5. C
6. D
7. B
8. A
9. D
10. Saturn V rocket
11. space shuttle
12. *Columbia*
13. orbiter
14. *Challenger*
15. *Columbia*
16. SpaceShipOne
17. C
18. C
19. A
20. B
21. A
22. C
23. B
24. D
25. A

Vocabulary and Section Summary

SECTION: ROCKET SCIENCE

1. rocket: a machine that uses escaping gas from burning fuel to move
2. NASA: the National Aeronautics and Space Administration
3. thrust: the pushing or pulling force exerted by the engine of an aircraft or rocket

SECTION: ARTIFICIAL SATELLITES

1. artificial satellite: any human-made object placed in orbit around a body in space
2. low Earth orbit: an orbit less than 1,500 km above the Earth's surface
3. geostationary orbit: an orbit that is about 36,000 km above the Earth's surface and in which a satellite is above a fixed spot on the equator

SECTION: SPACE PROBES

1. space probe: an uncrewed vehicle that carries scientific instruments into space to collect scientific data

SECTION: PEOPLE IN SPACE

1. space shuttle: a reusable space vehicle that takes off like a rocket and lands like an airplane
2. space station: a long-term orbiting platform from which other vehicles can be launched or scientific research can be carried out

Section Review

SECTION: ROCKET SCIENCE

1. Sample answers: A rocket is a vehicle that uses thrust provided by escaping gas to move. Thrust is the the force that accelerates a rocket. NASA was established in 1958 to combine the efforts of rocket development teams in the United States.
2. B

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3. Tsiolkovsky is known as the father of rocket theory because he proved, in theory, that rockets could be used to reach space. Robert Goddard is known as the father of modern rocketry because he developed and tested hundreds of rocket designs, and he built the first liquid-fuel rocket.
4. Answers may vary. Rocket engines use the pressure of expanding gas to generate thrust. Newton's third law of motion explains why rockets move in a direction opposite to the direction of the escaping gas.
5. Orbital velocity is the speed and direction an object must travel to stay in orbit around a body in space. Escape velocity is the speed and direction that an object must travel to break away from a planet's or moon's gravitational attraction.
6. Answers may vary. World War II led to an arms race between the United States and the Soviet Union, which encouraged competition between the two superpowers to achieve superiority in space.
7. 165 days × 24 h/day = 3,960 h; 3,960 h × 60 mi/h = 237,600 mi
   (Students may note that the moon's distance from the Earth varies and that the average distance is about 239,000 mi. To travel this distance at the rate described would take nearly 166 days.)
8. Rockets accelerate in space using Newton's third law of motion.
9. Escape velocity varies because the surface gravity of each planet depends on both the mass of the planet and the distance of the rocket from the center of the planet.

SECTION: ARTIFICIAL SATELLITES

1. Sample answer: Artificial satellites are used for communications and for studying the Earth. Because the satellite was placed in low Earth orbit, it could make very detailed images of the Earth's surface. Communications satellites are placed in geostationary orbits.
2. C
3. Sputnik I
4. Answers may vary. Students could note that satellites relay communications, help make accurate weather forecasts, and study environmental change using remote sensing.
5. Explorer 1 was the first satellite launched by the United States.
6. Answers may vary. LEO is much closer to the Earth than GEO is. Satellites in LEO are often used for studying the Earth in detail. Satellites in GEO are often used for communications and navigation.
7. The Global Positioning System uses a network of 27 satellites that send signals to the Earth. A GPS receiver interprets the signals from four satellites and determines the location of the user based on the amount of time it takes the signals to reach the receiver. Using that information, the receiver can determine the position of the user using triangulation.
8. Answers may vary. Students should note that a signal is sent to a satellite in GEO. Then, the satellite transmits the signal back to a ground station on Earth.
9. 8,000 m/s × 3,600 s/h = 28,800,000 m/h
10. The Hubble Space Telescope will orbit faster than a satellite in GEO because objects in LEO orbit at a much faster speed than objects in GEO orbit.
11. If you knew your distance from two points on a map, you could be in two possible locations.

SECTION: SPACE PROBES

1. *Clementine* or *Lunar Prospector*
2. *Magellan*
3. *Deep Space 1*
4. C

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5. Sample answer: The Viking missions sent images of dry water channels on the surface of Mars. *Venera* 9 recorded information about the surface and atmosphere of Venus. *Galileo* discovered that two of Jupiter's moons have magnetic fields.
6. Venus and Mars have surface features that are similar to Earth's. In addition, the high levels of CO_2 in Venus's atmosphere produce a severe greenhouse effect. This may help us understand the greenhouse effect on Earth. The atmosphere of Titan may be similar to Earth's early atmosphere. Studying Titan's atmosphere may provide clues about how life developed on Earth.
7. 299,793 km/s × 60 s/min = 17,987,580 km/min
   17,987,580 km/min × 60 min/h = 1,079,254,800 km/h
   1,079,254,800 km/h × 12 h = 12,951,057,600 km
8. Answers may vary. Students should note that the conditions on Mars and Europa are extreme and that the danger and expense of sending humans there is great. These places are also too distant to be seen clearly by a telescope on Earth's surface or in orbit around Earth.
9. Sample answer: The Discovery program seeks to produce results quickly and inexpensively. The disadvantages may be that missions may fail because of cost-cutting. Also, probes in the Discovery program may not gather as much data as larger probes do.
10. *Deep Space* 1 accelerates by expelling very small charged particles at a high speed. The probe reacts by moving forward.

SECTION: PEOPLE IN SPACE

1. Sample answer: NASA has completed more than 100 successful space shuttle missions. The International Space Station is being built with the help of many nations.
2. C
3. Answers may vary. Students should note that Cold War tensions greatly accelerated the space programs of the United States and the Soviet Union.
4. Answers may vary. Students can describe any of the space-age spinoffs that are described in the text or in Table 1.
5. Answers may vary. Space stations will serve as refueling, construction, and research stations.
6. Answers may vary. The United States was mainly focused on space shuttle development, while the Soviet Union was focused on space station development.
7. 2 million kg × 0.80 = 1.6 million kg
8. Answers may vary. After the Apollo program, the United States focused on developing a reusable space shuttle.
9. Answers may vary. Accept any well-supported answer. Students may describe the technology that has come from the space program to support increasing NASA funding. Students may also support a position to decrease funding based on the expense of the space program and the tragedies that have occurred.

Chapter Review

1. Sample answer: A geostationary orbit is about 36,000 km above the Earth's surface. In order to maintain GEO, satellites must orbit at a speed that exactly matches the speed of Earth's rotation. LEO is less than 1,500 km above the Earth's surface. To remain in LEO, satellites must travel much faster than the Earth rotates.
2. Sample answer: A space probe is a vehicle that carries scientific instruments to planets or other bodies in space. Space probes do not carry people. A space station is a long-term orbiting platform with scientific research labs and living quarters for astronauts.
3. Sample answer: An artificial satellite is any human-made object placed in orbit around a body in space. A moon is a natural satellite of a planet.

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4. thrust
5. oxygen
6. C
7. C
8. D
9. B
10. A
11. C
12. C
13. D
14. D
15. C
16. Answers may vary. Sample answer: Newton's third law of motion states that for every action, there is an equal reaction in the opposite direction. As the gases escape through the rocket nozzle, the rocket reacts by moving in the opposite direction.
17. Answers may vary. One disadvantage of LEO is that a satellite cannot maintain constant communication with a ground station.
18. Answers may vary. One reason the United States developed the space shuttle was to have a reusable space vehicle that would be less expensive than the Apollo rockets.
19. Answers may vary.
20. An answer to this exercise can be found at the end of the Teacher Edition.
21. Speed is a measure of how fast an object travels. Velocity is the speed and direction an object travels.
22. Rockets must carry oxygen with them because there is no oxygen in outer space. Without oxygen, rocket fuel cannot burn.
23. Answers may vary. Students should note that space research has helped develop many areas of human knowledge, including medicine, physics, engineering, biology, geology, and astronomy. The space program is also a challenge to human courage and can promote international cooperation and peace. Students may also mention space-age spinoffs. Finally, space probes enable us to study the atmospheres and surfaces of other bodies in the solar system. Scientists use these data to understand changes in Earth's environment.
24. no
25. 60 s/min×60 min/h 3 24 h/day× 3days= 25 200s
    259,200 s× 3 11 km/s= 5 2,851,200 km
26. 11 km/s – 8 km/s 5 × km/s
    A rocket traveling in orbital velocity would need to travel 3 km/s faster to reach escape velocity.
27. If a planet's velocity was 9 km/s, the planet's mass would be less than the mass of Earth.

Reinforcement

RONNIE ROCKET

rocket; fuel; oxygen; combustion; pressure; bottom; thrust; third; gravity; escape

PROBING SPACE

Earth's moon: *Luna* 9, U.S.S.R.; *Clementine*, U.S.; Sample answer: Craters of the moon may contain water left by comet impacts. Venus: *Venera* 9, U.S.S.R.; *Magellan*, U.S.; Sample answers: Venus has a very high surface temperature and atmospheric pressure; in many ways, the geology of Venus is similar to Earth's. Mars: *Viking* 2, U.S.; *Pathfinder*, U.S.; Sample answers: There is no hard evidence of life on Mars; images of dry water channels suggest that massive floods once flowed across the surface of Mars. Jupiter: *Pioneer* 10, U.S.; *Voyager* 2, U.S.; *Galileo*, U.S.; Sample answer: Jupiter's moon Europa may have an ocean of water under its icy surface.

Critical Thinking

1. a. A probe travels to other bodies in space. A satellite remains in Earth's orbit.
   b. A satellite requires orbital velocity to reach Earth's orbit. A probe requires escape velocity to break away from Earth's gravitational pull.
2. satellite in LEO: movement of dolphins and close up views of weather patterns; satellite in GEO: triggers leading to severe weather conditions and images of pollution patterns in a specific location; probe: rock samples of other moons and planets and images from distant planets
3. Answers may vary. Sample answer: My spacecraft would be a satellite in LEO

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4. Answers may vary. Sample answer: My spacecraft would track the availability of water resources in specific areas of the world.
5. Answers may vary. Sample answer: By monitoring water availability in specific areas, my spacecraft would enable Earthlings to plan for population increases in those areas.

Section Quizzes

SECTION: ROCKET SCIENCE

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

SECTION: ARTIFICIAL SATELLITES

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

SECTION: SPACE PROBES

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

SECTION: PEOPLE IN SPACE

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

Chapter Test A

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

Chapter Test B

1. space shuttle
2. space probe
3. geostationary orbit
4. space station
5. rocket
6. B
7. A
8. A
9. A
10. D
11. Satellites gather information by remote sensing. They measure light and other forms of energy that come from the Earth. Some satellites use radar. Radar sends radio waves that bounce off the surface of Earth and send back signals.
12. Answers may vary. Sample answer: The goals of the *International Space Station* include promoting cooperation among the United States, Russia, and other countries to build a space station where they can perform space-science experiments and test new technologies.
13. A space probe is a vehicle that carries scientific instruments to planets or to other bodies in space. It does not carry people. A space shuttle is a reusable vehicle that takes off like a rocket and lands like an airplane. It carries people and does not travel farther than Earth's orbit.
14. Answers may vary. Sample answer: The United States developed the space shuttle because it is reusable and less expensive.
15. Answers may vary. Sample answer: Two rockets may be traveling at the same speed but have different velocities because velocity is dependent on both speed and direction. A rocket traveling at orbital velocity moves in one direction in order to orbit the Earth, while a rocket traveling at escape velocity moves in a different direction in order to break away from the Earth's gravitational pull

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16. Answers may vary. Sample answer: Newton's third law states that for every action, there is an equal reaction in the opposite direction. A rocket's combustion chamber contains gases that are under extreme pressure. As the gases escape downward through the rocket's bottom, the rocket reacts by moving in the opposite direction.
17. Answers may vary. Sample answer: One disadvantage of LEO is that a satellite cannot maintain constant communication with a ground station because it is orbiting faster than the Earth rotates.

CONCEPT MAPPING

18. a. Venus, b. Jupiter, c. Mars, d. volcanoes, e. faint rings, f. dry water channels

Chapter Test C

1. C
2. B
3. D
4. B
5. C
6. A
7. D
8. D
9. B
10. C
11. D
12. A
13. B
14. A
15. C
16. B
17. thrust
18. orbital velocity
19. escape velocity
20. GEO
21. NASA
22. GPS
23. remote sensing
24. space probes
25. space station

Standardized Test Preparation

READING

Passage 1

1. C
2. H
3. B

Passage 2

1. B
2. H

INTERPRETING GRAPHICS

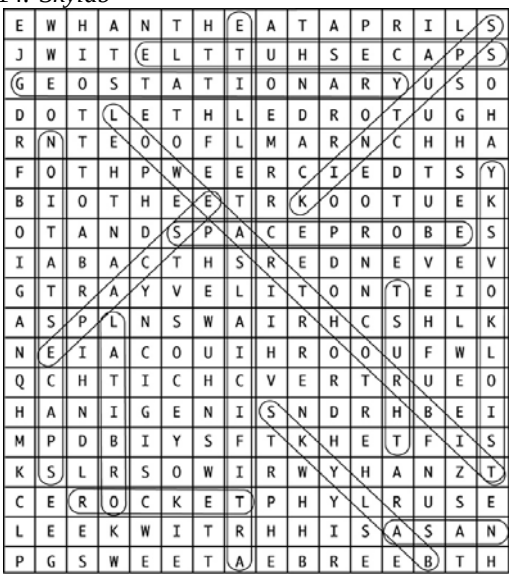
1. B
2. H
3. C
4. H

MATH

1. D
2. H
3. B
4. G

Vocabulary Activity

1. low Earth orbit
2. rocket
3. *Sputnik*
4. space probe
5. escape
6. artificial satellite
7. space shuttle
8. Tsiolkovsky
9. Thrust
10. geostationary
11. space station
12. Orbital
13. NASA
14. *Skylab*



SciLinks Activity

Response will vary. Students should mention doing research and experiments in their stories.

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Performance-Based Assessment

PROCEDURE

4. Sample answer: The cylinder (Earth) is blocking my view of S1.

ANALYSIS

8. A television signal cannot be transmitted around the world without being relayed between satellites because the signal does not curve to follow Earth's surface.
9. These lines represent paths along which television signals can be transmitted between Earth and the communication satellite.
10. three; With two satellites, the program could be transmitted from position A to two other positions, but the Earth would block transmittal of the program to the fourth position. A third satellite is needed to broadcast the program to all four positions round the globe.
11. Sample answer: A signal could be sent from C to S2, from S2 to S1, then from S1 to A.

Water Rockets Save the Day!

ANALYZE THE RESULTS

1. Answers will vary. Fins might help stabilize the rocket when it is in flight.
2. Answers will vary. Students should note that the water in the bottle was under pressure. When the rocket was released, the water escaped out of the opening. The bottle reacted by moving in the opposite direction—upward.
3. Answers will vary. Water is the propellant for the rocket. Pressurized air provides the force to launch the rocket. The amount of water in a rocket determines how much space air can occupy. The ideal rocket should expel all of the water at the maximum pressure.

DRAW CONCLUSIONS

4. Answers will vary. Modifying the fins, adjusting the water-to-air ratio, increasing the air pressure inside the rocket, and changing the amount of modeling clay used should affect the duration of the rocket's flight.
5. Answers will vary.
6. Answers will vary.

Modeling LEO and GEO

5. Penlights in GEO illuminated more of the globe.
6. GEO is better for communications satellites. LEO is better for spy satellites.

Reach for the Stars

ANALYZE THE RESULTS

1. Answers will vary. Students may have loosened the paper brads.
2. Answers will vary. Altering the paper-clip loop on the ball or changing the shape of the hook on the arm could make the task easier.

DRAW CONCLUSIONS

3. Answers will vary. Students may suggest using different materials, changing the length of different arm segments, or mounting the arm on a secure base.
4. Answers will vary. This device could help astronauts manipulate objects outside a spacecraft without having to go on a spacewalk. Also, if the arm were mechanized, it could allow astronauts to move massive objects with precision.

APPLYING YOUR DATA

Answers will vary.

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