

Study Guide

Interactive Textbook

- Complete student edition
- Section and chapter self-assessments
- Assessment reports for teachers

Help Students Read

Building Vocabulary

Word Forms Students may have seen several of the key terms for this chapter used in different contexts. Help them relate these familiar meanings to section content. Ask:

What form might shuttles take in a city?

(Buses and vans that move people between buildings or to and from an airport are sometimes referred to as shuttles.)

What is a satellite medical facility?

(A facility, such as a clinic, that is associated with a larger facility, such as a hospital)

Ask students to relate how the objects described by these terms are similar to the objects described by the terms in space science.

Paraphrasing Ask students to write the key terms on a sheet of paper. Instruct students to write a definition, in their own words, for each term. Then ask them to compare each of their own definitions with the definition given in the text. Tell students to revise their definitions, if necessary.

Connecting Concepts

Concept Maps Help students develop one way to show how the information in this chapter is related. Space exploration uses many technologies that benefit people on Earth and provide knowledge about our solar system and the universe. Have students brainstorm to identify the key concepts, key terms, details, and examples. Then ask students to write each item on a self-stick note, and attach the note at random on chart paper or on the board.

Point out that this concept map will be organized in hierarchical order. Tell students to begin at the top with the key concepts. To guide students to categorize the information on the self-stick notes, ask these questions:

1 The Science of Rockets

Key Concepts

- Rocket technology originated in China hundreds of years ago and gradually spread to other parts of the world.
- A rocket moves forward when gases shooting out the back of the rocket push it in the opposite direction.
- The main advantage of a multistage rocket is that the total weight of the rocket is greatly reduced as the rocket rises.

Key Terms

rocket
thrust
velocity
orbital velocity
escape velocity

2 The Space Program

Key Concepts

- The space race began in 1957 when the Soviets launched the satellite *Sputnik I* into orbit. The United States responded by speeding up its own space program.
- The American effort to land astronauts on the moon was named the Apollo program.

Key Term

satellite



3 Exploring Space Today

Key Concepts

- NASA has used space shuttles to perform many important tasks. These include taking satellites into orbit, repairing damaged satellites, and carrying astronauts and equipment to and from space stations.
- A space station provides a place where long-term observations and experiments can be carried out in space.
- Space probes contain a power system to produce electricity, a communication system to send and receive signals, and scientific instruments to collect data and perform experiments.

Key Terms

space shuttle
space station
space probe
rover



4 Using Space Science on Earth

Key Concepts

- Conditions in space that differ from those on Earth include the near vacuum, temperature extremes, and microgravity.
- The space program has developed thousands of products that affect many aspects of modern society, including consumer products, new materials, medical devices, and communications satellites.
- Satellites are used for communications and for collecting weather data and other scientific data.

Key Terms

vacuum
microgravity
space spinoff
remote sensing
geosynchronous orbit

What was the Apollo program? How are spacecrafts launched into space? What are space spinoffs?

Prompt students by using connecting words or phrases, such as “can be done using” and “can lead to,” to indicate the basis for the organization of the map. The phrases should form a sentence that connects a set of concepts.

Answer Accept logical presentations by students.

All in One Teaching Resources

- [Key Terms Review: Exploring Space](#)
- [Connecting Concepts: Exploring Space](#)

Organizing Information

Comparing and Contrasting Copy the graphic organizer onto a separate sheet of paper. Then complete it and add a title. (For more on Comparing and Contrasting, see the Skills Handbook.)

Astronaut	Year	Spacecraft	Accomplishment
Yuri Gagarin	1961	a. ___?	First human in space
Alan Shepard	b. ___?	Freedom 7	c. ___?
d. ___?	1962	Friendship 7	e. ___?
Neil Armstrong	f. ___?	g. ___?	First human to walk on the moon

Reviewing Key Terms

Choose the letter of the best answer.

- A device that expels gas in one direction to move in the opposite direction is a
 - rocket.
 - space probe.
 - space station.
 - rover.
- To fly beyond a planet's gravitational pull, a spacecraft must reach
 - velocity.
 - orbital velocity.
 - escape velocity.
 - geosynchronous orbit.
- Any object that revolves around another object in space is called a
 - vacuum.
 - space station.
 - satellite.
 - rocket.
- A spacecraft that can carry a crew into space, return to Earth, and then be reused for the same purpose is a
 - rover.
 - space shuttle.
 - space station.
 - space probe.
- Acquiring information about Earth and other objects in space without being in direct contact with these worlds is called
 - microgravity.
 - spinoff.
 - thrust.
 - remote sensing.

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

- The reaction force that propels a rocket forward is called microgravity.
- The velocity a rocket must reach to establish an orbit in space is escape velocity.
- A large artificial satellite on which people can live for long periods is a space station.
- An item that has uses on Earth, but was originally developed for use in space is called a space shuttle.
- A satellite in geosynchronous orbit stays over the same place on Earth all the time.

Writing in Science

Descriptive Paragraph Imagine that you are a scientist planning the first human expedition to Mars. In a detailed paragraph, list some of the major challenges that such a mission would face and provide possible solutions. Think about the physical stresses of space travel and how the crew's basic needs will be met.



Organizing Information

- Vostok 1
- 1961
- First American in space
- John Glenn
- First American to orbit Earth
- 1969
- Apollo 11 or Eagle

Reviewing Key Terms

- a
- c
- c
- b
- d
- thrust
- orbital velocity
- true
- space spinoff
- true

Writing in Science

Writing Mode: Description

Scoring Rubric

- Exceeds criteria by including descriptive detail of challenges and providing novel solutions to the problems
- Meets all criteria, but description lacks interest
- Includes some challenges and solutions, but includes inaccurate information
- Is incomplete and inaccurate



Exploring Space

Show the Video Assessment to review chapter content and as a prompt for the writing assignment Discussion questions: **Describe the first manned space flight.** (In 1961, Yuri Gagarin orbited once around Earth and returned to Earth 1 hour and 48 minutes later.) **What makes a crewed trip to Mars a challenge?** (Scientists are not yet sure of the long-term effects of extended space travel. Scientists are also working on the logistics of taking long space journeys, which include growing a sustainable food supply, recycling water, and producing oxygen to breathe.)

All in One Teaching Resources

- [Transparency J21](#)
- [Chapter Test](#)
- [Performance Assessment Teacher Notes](#)
- [Performance Assessment Teacher Worksheet](#)
- [Performance Assessment Scoring Rubric](#)

Review and Assessment

Checking Concepts

11. Solid fuels and liquid fuels are used to power most rockets. Some rockets use gas ions to produce thrust.
12. Neil Armstrong said, “That’s one small step for man, one giant leap for mankind.”
13. The crew of the space shuttle takes satellites into orbit, repairs damaged satellites, and carries equipment to and from space.
14. The purpose of a space station is to provide a place where long-term observations and experiments can be carried out in space.
15. Possible answer: Computer-aided imaging techniques are a medical spinoff. Athletic shoes that contain shock-absorbing material are a materials spinoff. A joystick controller is a consumer spinoff.

Thinking Critically

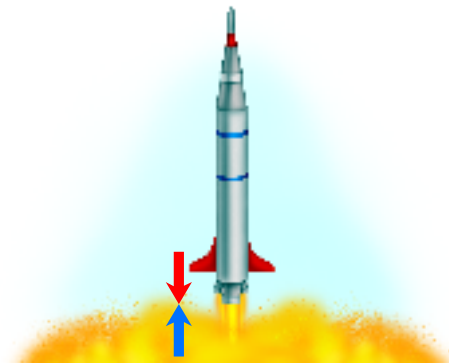
16. The downward red arrow represents the action force of gas propelled out of the back of a rocket. The upward blue arrow represents the reaction force of the thrust that propels the rocket forward.
17. Yes. A rocket expels gas in one direction to move the device in the opposite direction.
18. Possible answer: The educators made that decision to ensure that U.S. students—the country’s future scientists—understood and could contribute to space exploration and other areas of technological achievement.
19. Possible answer: Yes. The benefits outweighed the costs because we have learned much about the origins of Earth and the moon. We have also benefited from many space spinoffs.
20. Orbital velocity is the velocity a rocket must achieve to establish an orbit. Escape velocity is the velocity a rocket must reach to fly beyond a planet’s gravitational pull. Escape velocity is much greater than orbital velocity.
21. Possible answer: Astronauts are conducting a variety of experiments on the International Space Station. This research may produce technological breakthroughs and a greater understanding of the effects of microgravity that will help the subsequent exploration of the solar system.

Checking Concepts

11. What are the two main types of rocket fuels?
12. What did Neil Armstrong say when he first set foot on the moon?
13. Describe some tasks carried out by the crew of the space shuttle.
14. What is the purpose of a space station?
15. Name a space spinoff in each of the following categories: medical devices, materials, and consumer products.

Thinking Critically

16. **Applying Concepts** The diagram below shows a rocket lifting off. What does each of the arrows represent?



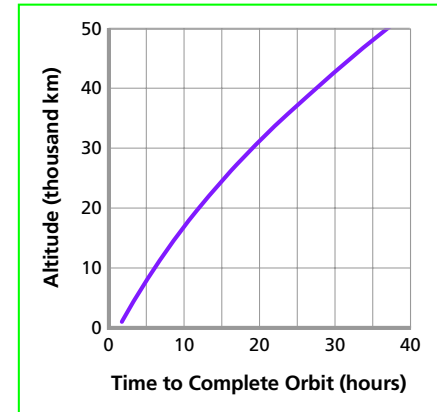
17. **Classifying** A jet airplane usually uses liquid fuel that is burned with oxygen from the atmosphere. A jet engine expels hot gases to the rear, and the airplane moves forward. Is a jet a type of rocket? Explain.
18. **Relating Cause and Effect** When the Soviet Union launched *Sputnik I* into orbit in 1957, educators in the United States decided to improve math and science education in U.S. schools. Why do you think educators made that decision?
19. **Making Judgments** Do you think that the benefits of the Apollo program outweighed the program’s costs? Explain.

20. **Comparing and Contrasting** How is orbital velocity different from escape velocity?
21. **Making Generalizations** How could the International Space Station help with further exploration of the solar system?

Applying Skills

Use the graph below to answer Questions 22–24. The graph shows the amounts of time needed for satellites at different altitudes above Earth’s surface to complete one orbit.

Satellite Orbits



22. **Interpreting Diagrams** How long will a satellite orbiting at an altitude of 50,000 km take to complete one orbit?
23. **Applying Concepts** A geosynchronous satellite orbits Earth once every 24 hours. At what altitude does such a satellite orbit?
24. **Making Generalizations** What is the relationship between satellite altitude and the time needed to complete one orbit?

Lab zone Chapter Project

Performance Assessment Before testing your vehicle, list your design goals and criteria. Describe some of the challenges you faced. What could you change to improve your model?

Lab zone Chapter Project

L3

Project Wrap Up Give students the opportunity to explain their design goals and criteria. Criteria should focus on ease of navigation and include costs and benefits. Ask students to describe any challenges they faced and how they resolved them. For example, students might have changed the size of a model’s wheels or its power source.

Reflect and Record Students will reflect that it is hard to design and build a vehicle that cannot be controlled directly—that is, they will grasp the difficulties inherent in controlling a vehicle from Earth that is moving on a distant planet or moon with a rough terrain.

Standardized Test Prep

Test-Taking Tip

Watching for Qualifiers

Many multiple-choice questions use qualifiers like *most*, *least*, *always*, and *except*. In a question where *except* is used, all of the answers but one accurately complete the statement in the question stem. In the sample question below, three of the four answer choices are tasks that space shuttles have performed. You must select which of the possible answers is not a task that the space shuttle has performed. Read the answer choices carefully to eliminate the incorrect choices.

Sample Question

1. Space shuttles have been used to perform all of the following tasks except
- A placing satellites in orbit.
 - B landing on the moon.
 - C carrying astronauts and equipment to and from space stations.
 - D repairing damaged satellites.

Answer

The correct answer is B. The space shuttle has been used to place satellites in orbit, to repair damaged satellites, and to carry astronauts and equipment to and from space stations. So choices A, C, and D are all tasks performed by space shuttles. The exception is choice B. The space shuttle has not traveled to the moon.

Choose the letter of the answer that best answers the question or completes the statement.

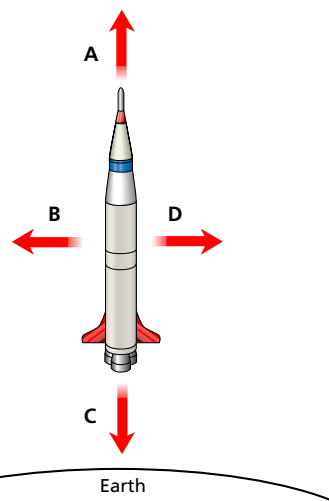
1. Which of the following developments was most directly responsible for the creation of rockets that were capable of going to the moon?
- A gunpowder
 - B explosives
 - C single-stage rockets
 - D multistage rockets
2. What force must a rocket overcome to be launched into space?
- F thrust
 - G gravity
 - H orbital velocity
 - J escape velocity

3. During the space race, the former Soviet Union was the first to accomplish all of the following except
- A launching the first satellite into orbit.
 - B sending the first living creature into space.
 - C sending the first human into space.
 - D landing the first human on the moon.
4. A satellite in geosynchronous orbit revolves around Earth once each
- F hour.
 - G week.
 - H month.
 - J day.

The diagram below shows a rocket and the direction of four forces. Use the diagram and your knowledge of rockets to answer Question 5.

5. Which of the lettered forces shown in the diagram represents an equal and opposite force to the thrust of the rocket?

- A Force A
- B Force B
- C Force C
- D Force D



Constructed Response

6. Space probes have been used to explore all the planets except Pluto. Describe three types of information that a probe orbiting Pluto could gather about the planet.

Applying Skills

22. The satellite will take about 37 hours to complete one orbit.
23. The satellite orbits at an altitude of about 36,000 km.
24. In general, the higher a satellite's altitude is, the longer its orbital period.

Standardized Test Prep

1. D 2. G 3. D 4. J 5. C
6. Possible answer: The probe could take images of Pluto, which could be used to locate features on the planet's surface. The probe could also look for evidence of minerals or ices on Pluto's surface and gases in its thin atmosphere. It could examine how Pluto's surface temperature changes over time and at different locations. The probe could also map the planet's gravitational and magnetic fields.