Chapter Introduction

Lesson 1  Observing the Universe

Lesson 2  Early History of Space Exploration

Lesson 3  Recent and Future Space Missions

Chapter Wrap-Up
Observing the Sky

Telescopes enable astronomers to observe many more stars than they could with their eyes alone.

**WORD ORIGIN**

telescope

from Greek *tele*, means “far”; and Greek *skopos*, means “seeing”
Astronomers use many kinds of telescopes to study the light energy emitted by stars and other objects in space.
Electromagnetic Waves

- Stars radiate energy into space. This energy travels as electromagnetic waves.

- The entire range of radiant energy carried by electromagnetic waves is the **electromagnetic spectrum**.
Most wavelengths of the electromagnetic spectrum are not visible to the human eye.
Electromagnetic Waves (cont.)

- The type of radiant energy a star emits depends on the star’s temperature.
- Some stars are so far away that it takes billions of years for their radiant energy to reach Earth.
Earth-Based Telescopes

• Optical telescopes gather visible light.

• Refracting telescopes and reflecting telescopes are the two types of optical telescopes.
A telescope that uses a convex lens to concentrate light from a distant object is a **refracting telescope**.
A telescope that uses a curved mirror to concentrate light from a distant object is a **reflecting telescope**.
Radio telescopes collect invisible radio waves and some microwaves. They look like TV satellite dishes.
Telescopes in space collect energy of all wavelengths, including those absorbed by Earth’s atmosphere.
The first optical space telescope, the Hubble Space Telescope, is a reflecting telescope that orbits Earth.
Scheduled for launch in 2014, the Webb telescope will help astronomers study the origin of the universe.

To work properly, the telescope must be kept cold. Its large sunshield—the size of a tennis court—will protect the telescope from sunlight.

The 6.5-m segmented mirror will fully open only when the telescope is in orbit.

The Webb telescope will be nearly twice as big as Hubble. It will orbit the Sun 1.5 million km from Earth—too far away to be serviced by astronauts.
Reflecting telescopes use mirrors to concentrate light.
Earth-based telescopes can collect energy in the visible, radio, and microwave parts of the electromagnetic spectrum.

Space-based telescopes can collect wavelengths of energy that cannot penetrate Earth’s atmosphere.
What determines the types of electromagnetic waves that a star emits?

A. age of the star
B. distance of the star from Earth
C. size of the star
D. temperature of the star
Which of these is NOT an optical telescope?

A. radio telescope
B. reflecting telescope
C. refracting telescope
D. the Hubble Space Telescope
Which phrase refers to any telescope that uses a curved mirror to concentrate light from a distant object?

A. radio telescope
B. reflecting telescope
C. refracting telescope
D. space telescope
Rockets

• A **rocket** is a vehicle designed to propel itself by ejecting exhaust gas from one end.

• Rocket engines carry oxygen with them and can operate in space where there is very little oxygen.
Any small object that orbits a larger object is a **satellite**.

**WORD ORIGIN**

**satellite**

from Latin *satellitem*, means “attendant” or “bodyguard”
Artificial Satellites (cont.)

- Rockets place satellites into orbit around Earth or other objects in space.
- Satellites send information back to Earth.
Today, Earth-orbiting satellites are used to transmit television and telephone signals and to monitor weather and climate.

An array of satellites called the Global Positioning System (GPS) is used for navigation in cars, boats, airplanes, and even for hiking.
Early Exploration of the Solar System

• In 1958, the U.S. Congress established the National Aeronautics and Space Administration (NASA), which oversees all U.S. space missions, including space telescopes.

• In the same year NASA was founded, Explorer 1 was launched. It orbited Earth 58,000 times before burning up in Earth’s atmosphere in 1970.
A **space probe** is an uncrewed spacecraft sent from Earth to explore objects in space.
Early Exploration of the Solar System (cont.)

• Space probes are robots that work automatically or by remote control, taking pictures and gathering data.

• Probes are cheaper to build than crewed spacecraft, and they can make trips that would be too long or too dangerous for humans.
The first lunar probes were sent to the Moon by the United States and the former Soviet Union in 1959.

The term **lunar** refers to anything related to the Moon.
In 1961, the first human—an astronaut from the former Soviet Union—was launched into Earth’s orbit, followed shortly thereafter by the first American astronaut to orbit Earth.

In 1961, U.S. President John F. Kennedy challenged the American people to place a person on the Moon by the end of the decade.
Human Spaceflight (cont.)

- **Project Apollo** was a series of space missions designed to send people to the Moon.
- In 1969, Neil Armstrong and Buzz Aldrin, Apollo 11 astronauts, were the first people to walk on the Moon.
Human Spaceflight (cont.)

Space shuttles are reusable spacecraft that transport people and materials to and from space.
The International Space Station is an Earth-orbiting research laboratory where astronauts from many countries work and live.
Space Technology

• The space program requires materials that can withstand the extreme temperatures and pressures of space.

• Many of these materials have been applied to everyday life on Earth, including in firefighting gear, athletic clothing, and medical applications, such as orthodontic braces.
• Exhaust from burned fuel accelerates a rocket.
• Some space probes can land on the surface of a planet or a moon.
• Technologies developed for the space program have been applied to everyday life on Earth.
Which term refers to an uncrewed spacecraft sent from Earth to explore objects in space?

A. satellite
B. space probe
C. space shuttle
D. space station
Which term refers to a vehicle designed to propel itself by ejecting exhaust gas from one end?

A. space probe
B. satellite
C. rocket
D. orbiter
The term lunar refers to anything related to which of these?

A. space  
B. rockets  
C. the Moon  
D. Earth
A major goal for future space travel is to expand human space travel within the solar system.
Scientists study data collected by solar probes, like *Ulysses*, to better understand the Sun’s high-energy radiation and charged particles that can harm astronauts and damage spacecraft.
Missions to the Sun and the Moon

(cont.)

NASA and other space agencies also plan to send several probes to the Moon to collect data that will help scientists select the best location for a future lunar outpost.
Missions to the Inner Planets

Scientists have sent many probes, such as Messenger, to the inner planets to learn how they formed, what geologic forces are active on them, and whether any of them could support life.
Missions to the Outer Planets and Beyond

Missions to the outer planets—Jupiter, Saturn, Uranus, and Neptune—are long and difficult because the planets are so far from Earth.
Human Space Missions

• The first destinations for human space travel are the Moon and Mars.

• The next mission to the Moon is planned for as early as 2020 and is to build a lunar outpost, where people can live and do research in the harsh lunar environment.
To prepare for a visit to Mars, NASA plans to send additional probes.

These probes will explore sites on Mars that might have resources that can support life.
The Search for Life

• No one knows if life exists beyond Earth, but people have thought about the possibility for a long time.

• Life that originates outside Earth is extraterrestrial life.
The Search for Life (cont.)

**Astrobiology** is the study of life in the universe, including life on Earth and the possibility of extraterrestrial life.

**WORD ORIGIN**

**astrobiology**

from Greek *astron*, means “star”; Greek *bios*, means “life”; and Greek *logia*, means “study”
Scientists assume that if life exists elsewhere in space it would have the same requirements as life on Earth: liquid water, organic molecules, and some source of energy.

**KEY CONCEPT CHECK**

What is required for life on Earth?
The dark patches in the inset photo of Jupiter’s moon Europa might represent areas where water from an underground ocean has seeped to the surface.
Information gathered in space helps scientists understand how the Sun and other bodies in the solar system influence Earth, how Earth formed, and how Earth supports life.
To search for Earthlike planets, NASA launched the *Kepler* telescope, which focuses on a single area of sky containing about 100,000 stars.
Satellites that orbit Earth provide large-scale images of Earth’s surface that help scientists understand Earth’s climate and weather.
Summary

• The *New Horizons* spacecraft will reach Pluto in 2015.

• Scientists think there might be liquid water on or below the surfaces of Mars and some moons.
Earth-orbiting satellites help scientists understand weather and climate patterns on Earth.
Which of these planets is referred to by scientists as an “inner planet?”

A. Jupiter
B. Pluto
C. Saturn
D. Venus
What term refers to life that originates outside Earth?

A. astrobiological
B. extraterrestrial
C. lunar
D. solar
Which of these are the next planned destinations for human space travel?

A. Mars and the Sun
B. the Moon and Mars
C. Venus and Jupiter
D. each of the outer planets
Lesson 1: Observing the Universe

- Scientists use different parts of the electromagnetic spectrum to study stars and other objects in space.
- Telescopes in space can collect radiant energy that cannot penetrate Earth’s atmosphere.
- By studying objects in space, astronomers learn what the universe and the solar system were like many millions of years ago.
Lesson 2: Early History of Space Exploration

• Rockets are used to overcome the force of Earth’s gravity when sending satellites, space probes, and other spacecraft into space.

• Uncrewed missions can make trips that are too long or too dangerous for humans.

• Materials and technologies from the space program have been applied to everyday life.
A goal of the space program is to expand human space travel within the solar system and develop lunar and Martian outposts.

All known life-forms need liquid water, energy, and organic molecules.

Information gathered in space helps scientists understand how the Sun influences Earth, how Earth formed, whether life exists outside of Earth, and how weather and climate affect Earth.
Which of these refers to a telescope that uses a convex lens to concentrate light from a distant object?

A. radio telescope
B. reflecting telescope
C. refracting telescope
D. space telescope
Which of the following is any small object that orbits a larger object?

A. planet
B. satellite
C. space probe
D. space shuttle
Which is NOT a reason to use probes to explore space?

A. Some trips are too dangerous for humans.
B. Some trips are too long for humans.
C. Space probes are sometimes cheaper.
D. There are not enough trained astronauts.
Which orbits Earth and provides large-scale images of Earth’s surface that help scientists understand Earth’s climate and weather?

A. the Kepler telescope
B. the Lunar Reconnaissance Orbiter
C. satellites
D. Ulysses
Which of the following is an outer planet?

A. Mars
B. Mercury
C. Neptune
D. Venus
Which type of telescope collects radio waves and some microwaves using an antenna that looks like a TV satellite dish?

A. radio telescope
B. reflecting telescope
C. refracting telescope
D. X-ray telescope
The Hubble Space Telescope is an example of which of these?

A. radio telescope
B. ranging telescope
C. reflecting telescope
D. refracting telescope
Which term refers to a reusable spacecraft that transports people and materials to and from space?

A. rocket  
B. satellite  
C. space probe  
D. space shuttle
Which of the following collects data that will help scientists select the best location for a future lunar outpost?

A. Ulysses
B. the Lunar Reconnaissance Orbiter
C. the Kepler telescope
D. the International Space Station
Which of the following was launched by NASA to search for Earthlike planets?

A. the Apollo program
B. the *Kepler* telescope
C. the *Lunar Reconnaissance Orbiter*
D. *Ulysses*