USING THE UNIT 3 OPENER

TEACHING STRATEGIES

- **Begin the Lesson**—Ask students to begin a Space section in their science logbooks. Suggest they create a title page with images that relate to the topic.
  – Have students write down three "space facts" that they are aware of and share these facts with two other students. Have the group of three students then report to the class on all the facts discussed. Write all of the information on the board and discuss the information and its accuracy.
  – You may wish to use the RAN (Reading and Analyzing Non-Fiction, by Tony Stead) strategy throughout this unit. It is similar to the strategy that is being promoted in Nova Scotia.
- **After Teaching**—Ask students about the Canadian Space Program and the technology that has been developed by Canadians for space exploration.
  – Visit the web site for the Canadian Space Agency and take the students on the virtual tour. The CSA also has videos available. Check your school or local library for titles such as *Canada's Space Program and Your Future*.
  – Ask students to share their prior knowledge of satellites that have been put into orbit around Earth. Students may be aware that the World Meteorological Organization's World Weather Watch system uses satellite information to monitor day-to-day weather conditions and long-term climate change worldwide. Satellites are used to distinguish crops from weeds and healthy plants from sick ones with the help of infrared vision. Satellites are also used in oceanography, where they monitor the environment for the management of living resources, navigation, and coastal erosion.
  – Satellite and Internet technology have led to the development of technologies such as GPS (Global Positioning System) and Google® Street View. Have the class discuss the benefits and problems that have arisen due to the use of these new technologies.
  – Consider contacting the Nova Scotia Geomatic Centre in Amherst, N.S. They offer tours for schools and can tailor the tour to a specific aspect, e.g., satellite imaging, aerial photography, or issues such as shoreline erosion. Their web site can be found by common search engines.


UNIT 3

Space

Several hundred kilometres above Earth's surface, an orbiting satellite records images of the Nova Scotia coastline below. These images help researchers predict changes in weather, changes in temperature, and directions of ocean currents. Also orbiting Earth is the International Space Station, where astronauts from all over the world stay and study our planet and space for weeks at a time.

People have always searched for ways to explore the sky above us. Early scientists and explorers often wondered about the shape of Earth, the twinkling stars, and the bright Sun. What explanations did they come up with? Were they correct? Today we are still exploring space, and forming our own explanations of the world beyond Earth's atmosphere. We have made important discoveries about planets, meteors, comets, and stars. We have also learned how everything from the changing seasons, to the number of hours in a day, to the number of days in a year are all connected to what is happening in space!

In this unit, you will expand your exploration into space and learn how Canadian technologies have helped explore the universe beyond our home planet. As you learn more about space, you will also find out how it affects what happens here on Earth.

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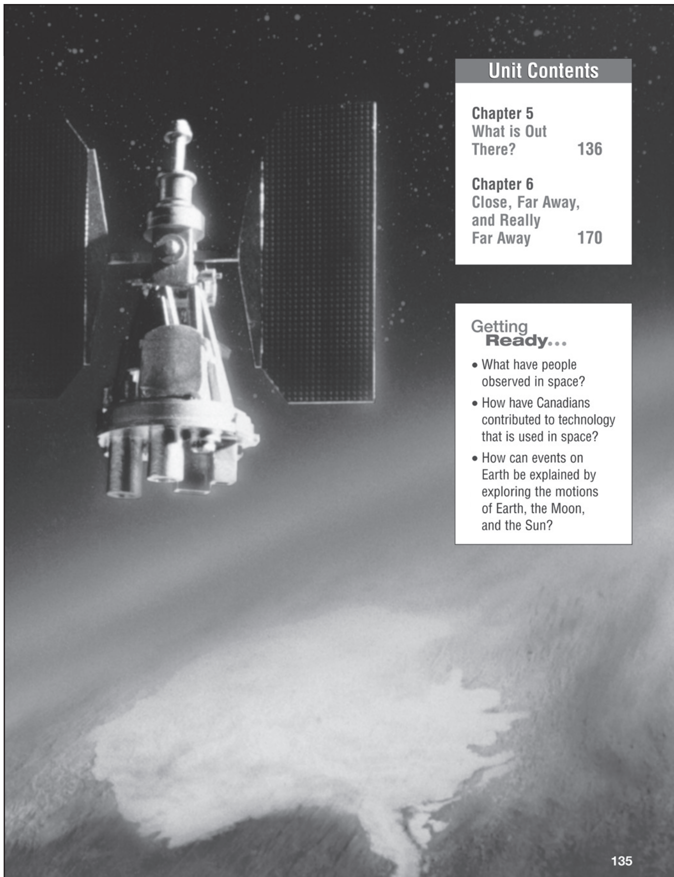
Getting Ready Answers

- **What have people observed in space?** One of the most remarkable images that has ever been observed in space is the image of Earth. A variety of other objects have been observed in space, including the Moon, planets, stars, galaxies, nebulae, super novae, and asteroids.

ATTENTION Grabber to Introduce Unit 3

- Discuss the role of the Hubble Space Telescope in the current exploration of space. Visit www.mcgrawhill.ca/links/ns+science6 as a class and follow the links to view the galleries of photos taken with the Hubble Space Telescope.
- Display pictures and/or models of rockets. Discuss what students know about rockets. Ask them why they think humans didn't travel into space before the 1960s. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to NASA's hands-on activity about launching rockets outdoors.



- **How have Canadians contributed to technology that is used in space?** The most famous contribution of Canadians to space exploration has been the Canadarm. This robotic arm has helped to transfer cargo, repair satellites, and build the International Space Station. It is one of the most-used devices in the space shuttle program. In 2008, a Canadian-built weather station was the first piece of Canadian technology to land on another planet. As part of NASA's Phoenix Mars Mission, the instrument will monitor the atmosphere of Mars.
- **How can events on Earth be explained by exploring the motions of Earth, the Moon, and the Sun?** The relationships between Earth, the Moon, and the Sun are responsible for a number of properties here on Earth. The tides are a result of the interrelationship of gravitational forces among the three. The seasons are caused by Earth's angle to the Sun, and the behaviour of objects in their orbit may be useful in predicting future changes to the surface of Earth. (Students may also wish to explore the notion that the Moon can affect human and animal behaviour and some studies that indicate a correlation between changes in behaviour and full moons.)

Connecting to the World Outside the School

- Ask students to identify one object, other than an optical telescope, that is used to study space or that functions because of space technology. There are a number of answers, including radio telescopes, the Hubble Space Telescope, solar electrical cells, satellite radio and television, and GPS technology, that can be discussed.

Cross-Curricular Connections

- Literacy: The inquiry-oriented lessons and research activities in this unit will support literacy development. The role of evidence and trade-offs in decisions helps the students sort through information and issues-oriented science. Students should be encouraged to read the ancient myths of the Greeks and Romans to see what earlier civilizations thought of what they saw in the sky.
- History: Students may be familiar with stories of navigation of the world in earlier centuries. They should be encouraged to consider the role of the study of the heavens as an aid to navigation.
- Health Education: Movement in Physical Education class might be used to show how the objects move through space.
- Mathematics: Skills in mathematics will be important for understanding the large numbers used in the study of space. The data collection activities in this unit build on the math skills used in Electricity and Flight. In addition, scale is a concept used in math as well as multiple sciences. This unit will give students a chance to practice working with scale as they model parts of the solar system, and their math skills will be tested. The kind of thinking that students will do to handle the meaning of large numbers can take years to develop. Tasks such as designing an accurate scale or model of Earth may be a challenge for many students.
- Career Planning: Students should be encouraged to discuss careers in the space field. These go beyond astronauts to include scientists, technicians, weather forecasters or meteorologists, engineers and a variety of other people who develop, test, or work with space technology.

Promoting Positive Attitudes

- An understanding of the timetables of the stars and planets has historically determined when to plant and harvest crops, when to prepare for long cold nights, and when to celebrate the arrival of new life. Studies taking place on the International Space Station may help develop the cure for a major illness, and the quest for space may lead to the development of new technology here on Earth.

USING THE CHAPTER 5 OPENER

TEACHING STRATEGIES

- **During Teaching**—Divide students into groups of three and have them discuss the *Getting Ready* questions. Each student in the group will present their group's answer to one of the questions.
  – Read the caption of the image on page 136 to the students and discuss possible answers to the question. Answers will include everything from spacesuits and spacecraft to food, water, and fuel. Answers should relate to the fact that many different people developed many different tools in order to put humans in space and have them return safely.
  – Read the section on page 136 aloud. Pause and reflect upon the students' answers to each question.
  – Have students read the *What You Will Learn*, *Why It Is Important*, and *Skills You Will Use* sections. Discuss the readings as a group.
  – Discuss the caption to the image on page 137.
  – Advise students to create their own definitions of key terms using language that makes sense of their observations. Distribute BLM 5.1 Key Terms for students to use as a reference throughout the chapter. Alternatively, students could use another graphic organizer for learning new vocabulary in context.
- **After Teaching**—Identify through discussion and questions the previous knowledge of the class and any misconceptions that may need to be addressed.

CHAPTER 5 What is Out There?

Getting Ready...
- What can we see in space?
- How have observations and knowledge about space changed over time?
- Why do you think it is important to study space?

The first humans stepped onto the Moon in July 1969. What knowledge and tools made their journey possible?

When Neil Armstrong first stepped onto the Moon in 1969, he said, "That's one small step for man, one giant leap for mankind." What do you think he meant by a "giant leap for mankind?" In order for the giant leap to happen, many questions needed to be answered. What materials would be suitable for the construction of a spacecraft? What fuel would provide enough energy to carry a spacecraft into space? What technology would be needed to allow people to survive outside Earth's atmosphere? How would space travellers communicate with people on Earth? How could the spacecraft return safely to Earth? Then scientists made that "giant leap" and began to develop the necessary tools and technologies to answer these questions.

While space shuttles, astronauts, and satellites may not seem new to us, imagine what people thought about space and what existed beyond Earth hundreds of years ago. In this chapter, you will learn what early people thought about the skies. You will find out how people learned about space and what they discovered. You will also learn about the tools needed to go to the Moon and to distant planets.

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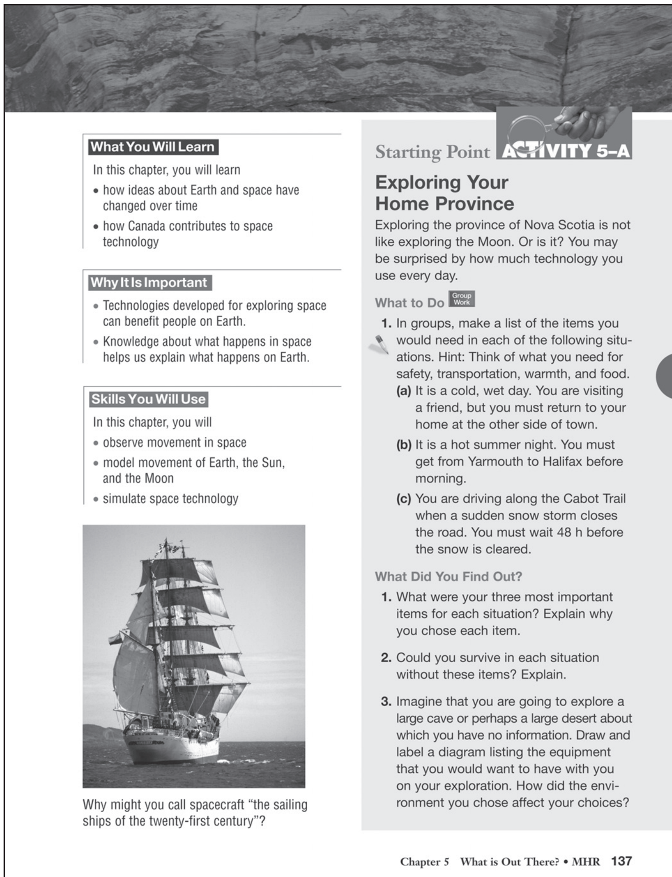
Getting Ready Answers

- **What can we see in space?** At night when we look into space from Earth with our eyes we can see many points of light and a big globe of light on a full moon. If we use a telescope, the points of light are revealed as galaxies, stars, planets, moons, and satellites. When we look at space from space via the Hubble Space Telescope, we can see clouds of gas forming new galaxies, stars, planets, and as-yet-unidentified objects.
- **How have observations and knowledge about space changed over time?** When people first looked at space they told stories to try to explain the existence of the many objects that circle Earth each night. Stories of gods, the future to come, and myths of the past were all explained in the stars. As knowledge developed, people used stars to determine times to plant crops, host events or prepare for seasonal changes. Today we look to space with much more knowledge in order to explain the origins of the universe, the creation of matter, and to determine whether humans or other life can exist off beyond Earth.
- **Why do you think it is important to study space?** The main reason we study space is to answer questions about the universe and our place in it. The study of space may also lead us to new developments in energy, biology, or other fields of science that will help us deal with problems we have on Earth.
- Further question: How many places are there in the universe? There are hundreds of billions of galaxies each with hundreds of billions of stars. Some of these may contain planets and moons similar to those in our own solar system.



What You Will Learn

In this chapter, you will learn
- how ideas about Earth and space have changed over time
- how Canada contributes to space technology

Why It Is Important

- Technologies developed for exploring space can benefit people on Earth.
- Knowledge about what happens in space helps us explain what happens on Earth.

Skills You Will Use

In this chapter, you will
- observe movement in space
- model movement of Earth, the Sun, and the Moon
- simulate space technology

Why might you call spacecraft "the sailing ships of the twenty-first century"?

Starting Point ACTIVITY 5–A

Exploring Your Home Province

Exploring the province of Nova Scotia is not like exploring the Moon. Or is it? You may be surprised by how much technology you use every day.

What to Do Group Work

1. In groups, make a list of the items you would need in each of the following situations. Hint: Think of what you need for safety, transportation, warmth, and food.
   (a) It is a cold, wet day. You are visiting a friend, but you must return to your home at the other side of town.
   (b) It is a hot summer night. You must get from Yarmouth to Halifax before morning.
   (c) You are driving along the Cabot Trail when a sudden snow storm closes the road. You must wait 48 h before the snow is cleared.

What Did You Find Out?

1. What were your three most important items for each situation? Explain why you chose each item.
2. Could you survive in each situation without these items? Explain.
3. Imagine that you are going to explore a large cave or perhaps a large desert about which you have no information. Draw and label a diagram listing the equipment that you would want to have with you on your exploration. How did the environment you chose affect your choices?

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STARTING POINT ACTIVITY 5-A EXPLORING YOUR HOME PROVINCE

Purpose
- Students will describe the basic necessities for any exploratory journey. They will also identify the relationship between knowledge of the environment of the place being explored and the preparations for exploration.

Advance Preparation

None

MATERIALS
– pencils and paper or science logbooks

Suggested Time
- 30 min

HINTS & HELPS
- It may be useful to complete the first scenario as a class to set expectations for the results of the activity.
- Images of the scenarios being explored may help the students complete the activity.

Implementing the Activity
- Together with the students, design a chart to record the suggested supplies required for the exploration. The chart should include food, shelter, warmth, transportation, energy, water, and facilities for waste disposal. Students should suggest other necessities.
- Set a challenge goal of six or more unique items for each group to identify.
- Ask students to compare their lists and determine which items are important regardless of the area of exploration.

Adaptations
- Some students may wish to diagram their list rather than write it.
- Students may be challenged by limiting the number or mass of items that they can bring on their exploration in order to be safe.

Activity Wrap-Up
- Have students share their lists with other groups by presenting them to the class. Identify items common to each group's list.
- Have students create a diagram of the most important items for a safe journey anywhere in the province.
- Ask students how preparing to drive across the province is similar to preparing to go into space. What considerations are the same? What considerations are different?

What Did You Find Out? Answers

1. Answers may include: (a) raincoat, bus pass, boots, umbrella; (b) car, driving partner, water, snacks; (c) blankets, matches, cell phone, food, water.
2. Student answers could include:
   (a) The rain, without lightning, is not a life-threatening instance, so the answer is yes.
   (b) Driving at night can be dangerous. A driving partner and water to keep alert would help to ensure the safety of the driver and passengers.
   (c) If a nearby shelter is not found, warmth and water are extremely important for surviving two days out in the cold.
3. Student answers should include food, water, first-aid equipment, and proper clothing and shelter from the environmental conditions they've chosen.

SECTION 5.1 OBSERVING THE SKY

What Students Do in Section 5.1

- examine the historical development of our knowledge of space
- describe the roles of various scientists in the development of our current knowledge of space
- explain how the continuing advancement of telescopes and other technologies has allowed us to continue to expand our knowledge of space
- identify the components of space
- investigate the difference between refracting and reflecting telescopes.
- describe the role of Canadian scientists, Canadian astronauts, and Canadian technologies in the space program at home and abroad.

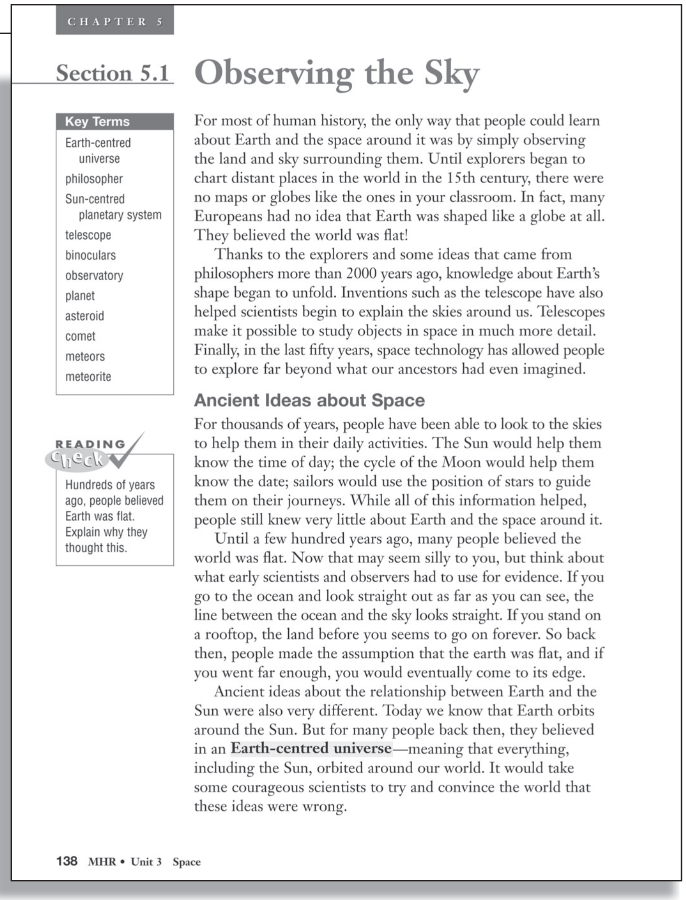
ANCIENT IDEAS ABOUT SPACE

BACKGROUND INFORMATION

- The idea of an Earth-centred universe was founded upon observations of the night sky over many hundreds of years. The motion of the objects in the sky appeared to circle around us through the day and night. Variations in the motion of some objects, including Mercury and Venus, led some to question the Earth-centred view.

TEACHING STRATEGIES

- **Begin the Lesson**—Encourage students to share their interests and views of space. Have them share how their understanding of space has changed over time and relate it to their upcoming study.
  – Have students copy the key terms into their science logbooks and write one sentence describing what they think each term means. Students should be asked to update these definitions as they go through the section.
- **During Teaching**—Use the reading check as a starter and ask students to describe three reasons why people of the past would have believed that Earth was the centre of the universe.
- **After Teaching**—Discuss the reasons why some people would oppose changes to the Earth-centred view.
  – Ask students to write a paragraph describing to a person who believes in a flat Earth the reasons to believe Earth is round. Students should research reasons that supported the spherical view in the past, as well as the reasons why we now know the spherical view is correct.



CHAPTER 5

Section 5.1 Observing the Sky

Key Terms
Earth-centred universe
philosopher
Sun-centred planetary system
telescope
binoculars
observatory
planet
asteroid
comet
meteors
meteorite

For most of human history, the only way that people could learn about Earth and the space around it was by simply observing the land and sky surrounding them. Until explorers began to chart distant places in the world in the 15th century, there were no maps or globes like the ones in your classroom. In fact, many Europeans had no idea that Earth was shaped like a globe at all. They believed the world was flat!

Thanks to the explorers and some ideas that came from philosophers more than 2000 years ago, knowledge about Earth's shape began to unfold. Inventions such as the telescope have also helped scientists begin to explain the skies around us. Telescopes make it possible to study objects in space in much more detail. Finally, in the last fifty years, space technology has allowed people to explore far beyond what our ancestors had even imagined.

Ancient Ideas about Space

For thousands of years, people have been able to look to the skies to help them in their daily activities. The Sun would help them know the time of day; the cycle of the Moon would help them know the date; sailors would use the position of stars to guide them on their journeys. While all of this information helped, people still knew very little about Earth and the space around it.

Until a few hundred years ago, many people believed the world was flat. Now that may seem silly to you, but think about what early scientists and observers had to use for evidence. If you go to the ocean and look straight out as far as you can see, the line between the ocean and the sky looks straight. If you stand on a rooftop, the land before you seems to go on forever. So back then, people made the assumption that the earth was flat, and if you went far enough, you would eventually come to its edge.

Ancient ideas about the relationship between Earth and the Sun were also very different. Today we know that Earth orbits around the Sun. But for many people back then, they believed in an **Earth-centred universe**—meaning that everything, including the Sun, orbited around our world. It would take some courageous scientists to try and convince the world that these ideas were wrong.

READING Check
Hundreds of years ago, people believed Earth was flat. Explain why they thought this.

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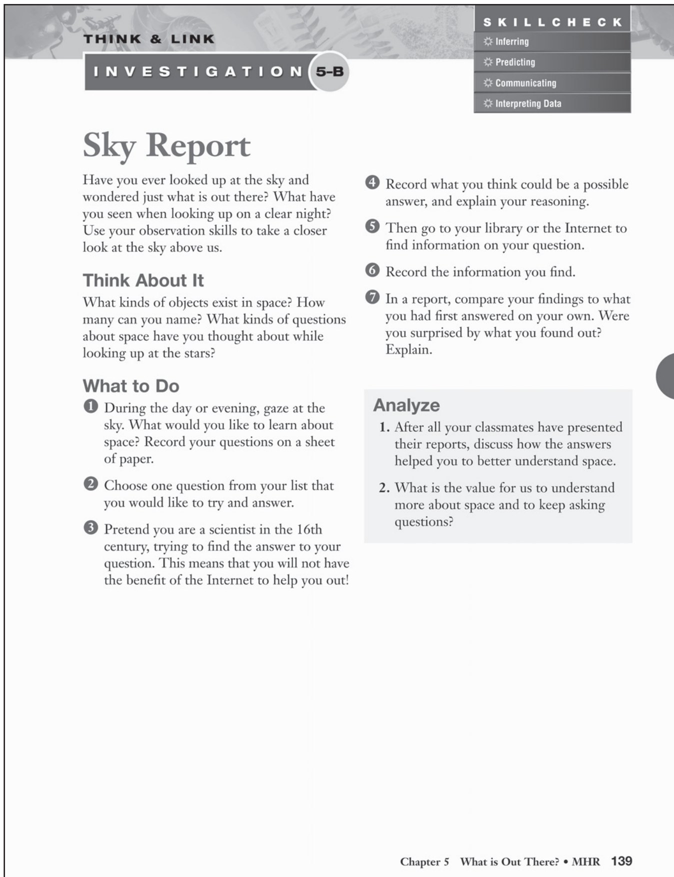
Common Misconceptions

- Many believe that Columbus was the first person to hypothesize that the world was round. This concept actually goes back more than 1000 years before Columbus in Western civilization—to the sixth century B.C.E.—and was based on observations of both Earth and space. Early Chinese civilizations were also developing these theories.
- Students may believe that astronomy and astrology are closely related. Discuss the difference between the two terms and their methods. Students could prepare a compare-and-contrast chart between astronomy and astrology to catalogue the differences.

READING Check People may have believed that the world was flat because they could not see beyond the horizon, because the sky looks straight, because they did not travel very far from home, or because they lacked the technology to see and travel around the globe.



THINK & LINK
INVESTIGATION 5-B

SKILLCHECK
Inferring
Predicting
Communicating
Interpreting Data

Sky Report

Have you ever looked up at the sky and wondered just what is out there? What have you seen when looking up on a clear night? Use your observation skills to take a closer look at the sky above us.

Think About It

What kinds of objects exist in space? How many can you name? What kinds of questions about space have you thought about while looking up at the stars?

What to Do

1. During the day or evening, gaze at the sky. What would you like to learn about space? Record your questions on a sheet of paper.
2. Choose one question from your list that you would like to try and answer.
3. Pretend you are a scientist in the 16th century, trying to find the answer to your question. This means that you will not have the benefit of the Internet to help you out!
4. Record what you think could be a possible answer, and explain your reasoning.
5. Then go to your library or the Internet to find information on your question.
6. Record the information you find.
7. In a report, compare your findings to what you had first answered on your own. Were you surprised by what you found out? Explain.

Analyze

1. After all your classmates have presented their reports, discuss how the answers helped you to better understand space.
2. What is the value for us to understand more about space and to keep asking questions?

Chapter 5 What is Out There? • MHR 139

THINK & LINK INVESTIGATION 5-B SKY REPORT

Purpose
- Students will discover information about space through observation of the evening and night skies and follow-up research.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Discuss the activity with students and have them look at the sky and formulate a list of questions.

MATERIALS
– Internet and/or text resources about space

Suggested Time
- 10 min for introduction
- 30+ min at home for student observations and data analysis
- 20 min for presentation preparation
- 30 min to present and discuss class discoveries

Safety Precautions
- Advise students to find safe viewing areas for their sky watch.
- Review safe Internet practices with the class.

HINTS & HELPS
- Prepare some questions for students who have trouble coming up with them on their own.
- Regular binoculars can be used to enhance the viewing of the night sky if there are not enough telescopes available.
- Collect and identify a number of books and web sites that students may use to answer their questions.
- If possible, organize a sky-watch night with your class to look at the sky and answer your questions together.

Implementing the Investigation
- Prepare for student presentations by arranging for projectors, poster board, or other supplies.
- Have students share their questions before beginning their sky watch in order to limit repetition of questions.

Adaptations
- Students who have trouble working independently may need to complete the investigation at school with the assistance of a partner, teacher, or teaching assistant.
- Allow students with writing difficulties to use diagrams to answer their questions.

Investigation Wrap-Up
- Share a question of your own with the class and share the answer to it based on your own observations of the sky.
- Discuss how space research was conducted before space stations, powerful telescopes, and the Internet, and have students share their experiences from their sky watch.

Assessment Option
- Use Learning Skills Checklist 3, Oral Presentation and/or Learning Skills Rubric 5, Research Project to assess student work in Think & Link Investigation 5-B Sky Report.

Analyze Answers
1. Student answers should highlight information that was new to them.
2. Ongoing questioning and understanding of space helps us answer questions about life here on Earth. It also leads to the development of technology that can be used for research on Earth.

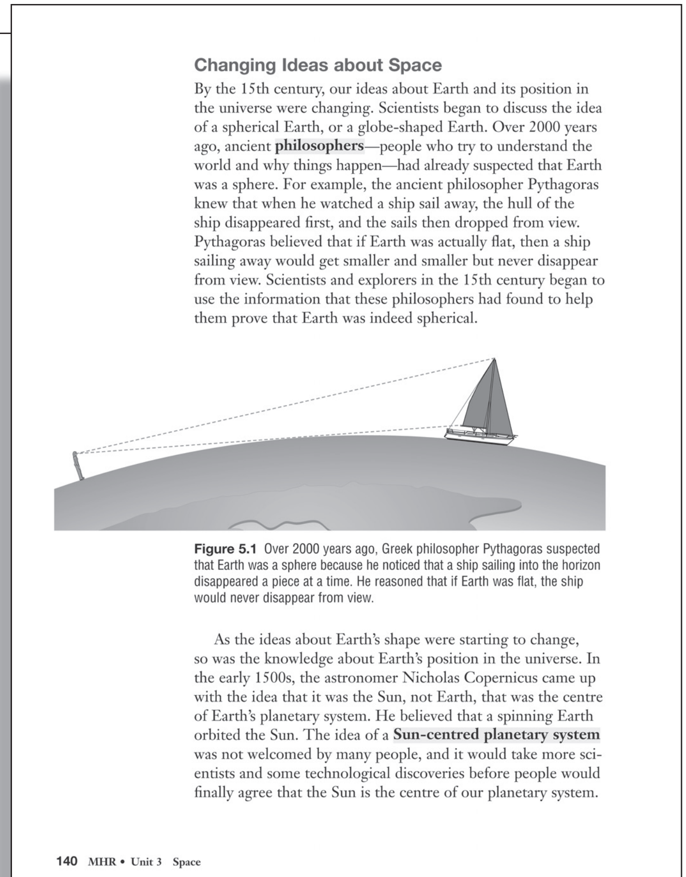
CHANGING IDEAS ABOUT SPACE

BACKGROUND INFORMATION

- The shift from the idea of an Earth-centred to a Sun-centred planetary system was met with much resistance from society and the church. Scientists, Galileo in particular, were persecuted and even jailed for promoting the Sun-centred view of the solar system. This section can lead to some interesting discussion about the relationship between society and scientific developments.
- The concept of the spinning Earth was a key factor in the development of the Sun-centred view. It helped to explain why all of the objects in the sky appear to circle around Earth each day and night.

TEACHING STRATEGIES

- **During Teaching**—Read through the section aloud and discuss with students the reasons some people would have believed in the Sun-centred planetary system and others might have opposed it.
- **After Teaching**—Discuss why the spinning Earth concept assisted in the development of the idea of a Sun-centred system.
  – Have students begin a research report in which they investigate a scientist who has contributed to our knowledge of the universe. They should examine the contributions of the scientist, the changes they have made to our view of the universe and the public's response to their discoveries. Some possible research subjects are Johannes Kepler, Nicholas Copernicus, Galileo Galilei, Edwin Hubble, Stephen Hawking, or Albert Einstein.



Changing Ideas about Space

By the 15th century, our ideas about Earth and its position in the universe were changing. Scientists began to discuss the idea of a spherical Earth, or a globe-shaped Earth. Over 2000 years ago, ancient **philosophers**—people who try to understand the world and why things happen—had already suspected that Earth was a sphere. For example, the ancient philosopher Pythagoras knew that when he watched a ship sail away, the hull of the ship disappeared first, and the sails then dropped from view. Pythagoras believed that if Earth was actually flat, then a ship sailing away would get smaller and smaller but never disappear from view. Scientists and explorers in the 15th century began to use the information that these philosophers had found to help them prove that Earth was indeed spherical.

Figure 5.1 Over 2000 years ago, Greek philosopher Pythagoras suspected that Earth was a sphere because he noticed that a ship sailing into the horizon disappeared a piece at a time. He reasoned that if Earth was flat, the ship would never disappear from view.

As the ideas about Earth's shape were starting to change, so was the knowledge about Earth's position in the universe. In the early 1500s, the astronomer Nicholas Copernicus came up with the idea that it was the Sun, not Earth, that was the centre of Earth's planetary system. He believed that a spinning Earth orbited the Sun. The idea of a **Sun-centred planetary system** was not welcomed by many people, and it would take more scientists and some technological discoveries before people would finally agree that the Sun is the centre of our planetary system.

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Common Misconception

- The timeframe of the circular, Sun-centred view of Earth is often thought to have begun in the 1400s. Predictions of these concepts, however, go back more than 2000 years.

What You Can See from Earth

A **telescope** is an instrument that uses lenses and mirrors to collect light and small lenses in eyepieces to magnify distant objects. This allows the viewer to see objects more clearly. The telescope was developed by the Italian scientist Galileo Galilei in 1609. Using the telescope, Galileo (he was known by his first name) could see the craters on the Moon, Saturn's rings, and the four large moons of Jupiter. Today, bigger and better telescopes help people see much further than Galileo could. Scientists can also see much more detail, and these new telescopes have helped scientists discover many more objects in our universe.

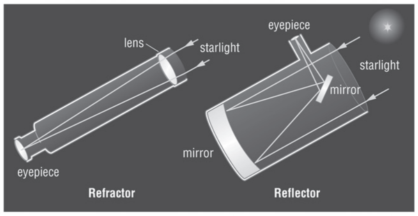


Figure 5.2 The job of a telescope is to gather as much light as possible into a small eyepiece or into a camera lens. There are two basic kinds of telescopes. Refractors use a large lens to collect light, and reflectors use a large curved mirror to collect light.

Another tool that was developed after the telescope was binoculars. **Binoculars** are really two telescopes that are hinged together and have an eyepiece that allows both eyes to view an object. The science behind binoculars is slightly different than telescopes, and the advantage of using binoculars is that it gives the viewer a better perception of distance.

Figure 5.3 Binoculars use prisms to shorten the optical path and lenses to collect the light from distant objects and enlarge the image for the viewer. Binoculars are usually less expensive than telescopes and can be used for viewing the Moon, comets, planets, and the Milky Way.

WHAT YOU CAN SEE FROM EARTH

BACKGROUND INFORMATION

- Telescopes started as simple magnifying glasses and developed into reflector and refractor telescopes, radio telescopes, and then space-based telescopes, such as the Hubble Space Telescope, that have allowed us to see further into space.

TEACHING STRATEGIES

- **Begin the Lesson**—Display a variety of pictures of different telescopes on the board and a variety of pictures or images related to the types of telescopes. Have students try to match the images up with the general descriptions of the different types of telescopes.
  - Discuss how viewing objects through telescopes and observing the Moon and other planets helped support the view that Earth is round and the Sun is the centre of the solar system.
- **During Teaching**—Discuss the caption of Figure 5.2 and the difference in the function of reflecting and refracting telescopes. Compare the size of the telescopes and how it may affect the objects that the telescope would be able to view in space. BLM 5.2 Telescopes provides a larger version of Figure 5.2 and can be used as an overhead master.

Common Misconception

- Microscopes and telescopes are sometimes confused with one another. Discuss the difference between the two and the idea that microscopes are for viewing small, close objects while telescopes are for viewing large, distant objects.

WHAT YOU CAN SEE FROM EARTH (CONTINUED FROM PREVIOUS PAGE)

BACKGROUND INFORMATION

- The atmosphere changes our perspective of the skies above us in many ways. Things we see, including shooting stars and the blue sky of day, are a direct result of the atmosphere. It is important for observers of space to limit the effects of the atmosphere in their studies.

TEACHING STRATEGIES

- **During Teaching**—Review the Reading Check with students before reading the section. Have students predict answers to the question, then revisit their answers following a reading of the section.
- **After Teaching**—Discuss the advantages of a space telescope over a backyard telescope or observatory.
  – Some students may wish to research different types of telescopes to find out how the images are collected and processed by each type.

Common Misconception

- Some students may believe that telescopes only work by collecting images that can be collected by the human eye. Students may be surprised to discover that radio waves, infrared light (heat), ultraviolet light, gamma rays, and other types of energy can also be detected by different types of telescopes.

READING Check Observatories are built away from cities in order to reduce the effects of air pollution and light pollution on the telescope. Being away from buildings and other tall objects also increases the area of space that can be viewed successfully by a telescope.

Figure 5.5b

You can tell the photograph was taken by a spacecraft near the planet because of the detail of the image. Everything from the rings to the shadows shows up very clearly in the image.

So, with better telescopes, how do present-day astronomers study the skies? Earth is surrounded by a dense atmosphere. That atmosphere can be filled with dust, clouds, smog, and haze that make the images dim and fuzzy. Especially near cities, tall buildings and light also make seeing the stars very difficult.

To get the best view of the sky, astronomers go to high mountain tops in remote areas, away from cities. These are the best places to build observatories. An **observatory** is a special type of building with a very large telescope. The roof of the observatory rotates and opens. Canadian astronomers share an observatory 4200 m above sea level on Mauna Kea in Hawaii. It is one of the world's best infrared observatories, which allows scientists to study the infrared light (radiant heat) coming from planets, stars, and galaxies. But even observatories on mountain tops do not always get the best pictures.

READING Check
Explain why observatories are built away from cities.

Figure 5.4 The observatories at Mauna Kea in Hawaii sit on top of high mountains. Eleven countries share the various telescopes. Each telescope has a special function such as infrared or optical abilities.

To get the best quality astronomical images, telescopes that orbit above Earth's atmosphere are ideal. The most famous orbiting telescope is the Hubble Space Telescope, which was placed into low Earth orbit in 1990 with the help of Canadarm1 and the Space Shuttle *Discovery*.

AT HOME ACTIVITY 5-C THE MOVING SKY

Purpose

- Students will examine the night sky over two or three nights in order to discover the motion of objects through the night sky.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Use the Internet, a star chart, or other source to identify some unique objects that the students may see in the sky when they complete the activity.
1 day before	– Distribute BLM 5.3 The Moving Sky or have students prepare their own chart to record their observations.

MATERIALS
– journal – compass – clock

Suggested Time

- 20 min for activity overview
- 3 nights × 2 h of sky viewing
- 20 min for classroom review and discussion

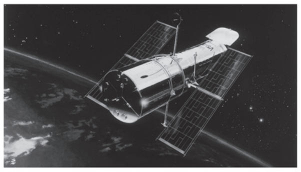
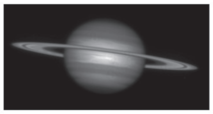
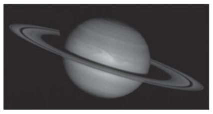


Figure 5.5a The Hubble Space Telescope provides clearer images than Earth-based telescopes because it orbits outside of Earth's atmosphere.

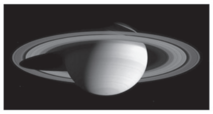
Small backyard telescope



Canada-France-Hawaii Telescope



Hubble Space Telescope



Cassini-Huygens Spacecraft

Figure 5.5b View of the planet Saturn taken with various telescopes. How can you tell that the Cassini-Huygens photograph was taken by a spacecraft?

At Home **ACTIVITY 5–C**

The Moving Sky

Your view of the sky does not always stay the same. What you see will depend on your location and the time of day or year. In this activity, you will monitor changes in the night sky.

For this activity you will need to find a safe spot in your backyard, neighbourhood, park, or your schoolyard where you can observe stars in the nighttime sky. An east-facing window will do fine if it shows enough of the sky.

The task is to monitor the motion of the sky from hour to hour (for a few hours) and to monitor the motion of the Moon from night to night (for at least two nights in a row, but three or more are best).

What You Need

journal
compass
clear view of the eastern sky
clock

continued

Safety Precaution

- Advise students to be careful when viewing the sky outside and to wear warm, visible clothing.

HINTS & HELPS

- Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to sites that will help students predict a time to watch the sky and objects to be on the lookout for.
- A clear view of the eastern sky is required for students to observe the path of the Moon.
- Completing this activity in the winter makes it easier for students because they can see the stars much earlier in the day.

Implementing the Activity

- Allow for a five-day period of sky viewing to allow for bad viewing weather.
- Send a note home to parents so they are aware of what is going on in the classroom and outside with students at night.
- Distribute BLM 5.3 The Moving Sky or have students create their own chart for recording observations.

Adaptation

- Students who are unable to complete the activity at home may use software or Internet activities to track the motion of objects through space.

Activity Wrap-Up

- Display each student's moving sky picture to the class and identify what objects, other than the Moon, the students watched in the night sky.
- Discuss the methods each student used to label their diagrams and how using a clear method to describe their observations is important when sharing their information with other astronomers in their class.

Assessment Option

- Use Science Skills Checklist 15, Making Observations and Inferences to assess student work in At Home Activity 5-C The Moving Sky.

Analyze Answers

1. The position of the Moon should rise or fall depending on the time that it was observed. The overall pathway should be an arc rising in the east, reaching a maximum height in the south, then setting in the west.
2. Some of the stars will have completed more of an arc than the Moon in the same time period if they are *below* the Moon in the sky. Other stars will have completed less of an arc in the same period if they are *above* the Moon in the sky.
3. Student answers should show that the overall arc pattern should be the same regardless of the objects they chose to track.
4. Student answers should include references to changes in the height of the Moon as it rises, depending on the time of the month, and changes to the stars that can be seen in the night sky throughout the year.
5. Come back to this topic after some time has passed and have students who have not been keeping track of the sky repeat the activity and see how things in the sky have changed.

WATCHING THE SKIES

BACKGROUND INFORMATION

- The planets, particularly Mercury and Venus, appear to wander and even loop in the night sky. This movement and changing of position relative to other night sky objects identified the planets as unique and helped to suggest the Sun-centred model of the solar system.
- Many satellites and the International Space Station appear as bright, fast-moving objects in the night sky.
- Both planets and human-made objects can be identified in the sky by the fact that they do not *twinkle*. Because they merely reflect the Sun's light and do not produce their own, the light pattern seen from them is relatively consistent.

What to Do

Part 1: Night One

1. Select a clear night when the Moon is near 1st quarter (that is when you can only see half of the Moon). Find a location and use your compass to find east. Your location should give you a clear view of the eastern sky, without trees or buildings in your way.

Select an observing location that will give you a clear view of the eastern horizon.

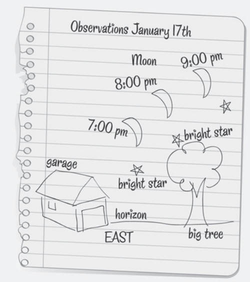
2. At your selected location, make a sketch showing the position of the Moon and one or two bright stars that are near the Moon. Record the exact time that you made your observation.
3. After exactly one hour, record the position of the Moon and the same bright stars on your sketch. If you are able to, repeat this step after exactly one more hour.

Part 2: Night Two

4. Repeat steps 1 to 3 exactly as you did the previous night.
5. If you are able to observe for extra nights, repeat steps 1 to 3 each night.
6. Prepare a report or poster that shows the changes in the Moon's position, and discuss your results with the class.

Analyze

1. What happened to the Moon from the first time you observed it at night until the last time you observed at night?
2. How did the stars change during the same amount of time?
3. Did everyone in the class see the same thing?
4. Describe how you think the Moon and stars would change during several months or a year.
5. Observe the motion of the Moon and the stars over a period of several weeks or months.



A sample journal entry for one evening's observations showing the position of the stars and the Moon.

Watching the Skies

During the daytime, the cloudless sky is usually a brilliant blue colour. Because the day sky is so bright, you can usually only see the Sun and the Moon. (Yes, the Moon can often be seen in the daytime sky!) The Moon is the biggest object in the nighttime sky.

On a cloudless night, the sky in the countryside or seaside, away from smog and city lights, becomes deep black and is studded with thousands of twinkling stars. Early astronomers watching this sky noticed five unusual objects that looked almost like stars from Earth. Unlike stars, however, these five objects did not stay in the same place in relation to all the other stars in the sky. These moving objects are planets. A **planet** is a large body that orbits a star. Most of the planets have several moons in orbit around them, unlike Earth, which has just one moon. The word *planet* is derived from the Greek word *planētai* meaning "wanderer."

If modern astronomers watch the sky carefully for long enough, especially in the early evening or morning twilight, they will see some objects that look like stars moving across the sky. These are artificial satellites that orbit Earth high above the atmosphere.

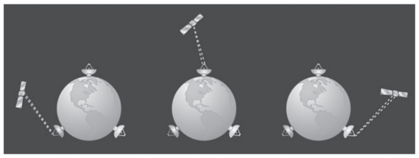


Figure 5.6 Satellites orbit Earth and transmit signals to receiving stations. These satellites can be used to send radio, television, and cellular phone signals.

TEACHING STRATEGIES

- **During Teaching**—Read the section aloud as a group and discuss the content together.
- **After Teaching**—Ask the students what it might mean for an object in the night sky to wander and have them explain the reasons they think this motion may be observed in planets.

Common Misconception

- The classification of Pluto as a planet was changed in the summer of 2006 by the body governing astronomy around the world. Today there are technically eight planets and three dwarf planets in our solar system.

ASTEROIDS, COMETS, AND METEORS

BACKGROUND INFORMATION

- The majority of asteroids in our solar system mark the dividing line between the rocky planets (Mercury, Venus, Earth, and Mars) and the Gas Giants (Jupiter, Saturn, Uranus, and Neptune). These rocks may have been leftovers from the formation of the solar system billions of years ago.
- Comets have been known and studied for centuries. In the past, different cultures around the world thought they were signs of good and/or bad things to come.
- The Oort cloud and the Kuiper belt lie at the far reaches of the solar system and are made up of millions of comet-like objects in extremely large orbits around the Sun.

TEACHING STRATEGIES

- **Begin the Lesson**—Describe the different structure of comets and asteroids to students and discuss how the difference in their structure leads to their unique features, in particular the tail of a comet.
- **During Teaching**—Use the caption to Figure 5.8 to ask students to determine if anyone in their family may have the opportunity to see Halley's Comet twice in their lifetime.
- **After Teaching**—Discuss the asteroid theory of the extinction of the dinosaurs with students. Do they think a relatively small object could have such a devastating impact on the entire planet? Why or why not?

Figure 5.7 This asteroid, named *Ida*, is so large that it has its own moon!

Figure 5.8 Halley's Comet can be seen from Earth every 75–76 years. It appeared last in 1986. In what year will people be able to see it again?

Asteroids, Comets, and Meteors

Along with planets, moons, satellites, and stars, there are many other objects in the solar system. Three of the most common objects are asteroids, comets, and meteoroids. An **asteroid** is an irregularly shaped rock orbiting the Sun. The larger ones are considered to be "minor planets" and can range in size from a few metres to hundreds of kilometres. The largest known asteroid is Ceres, which is almost 1000 km across! There are millions of asteroids in the solar system. A large number of them exist between Mars and Jupiter in what is called the "asteroid belt."

Occasionally comets appear in the sky. A **comet** is a mass of dust and ice that is surrounded by gases, water vapour, and rocky dust particles. Millions of comets orbit the Sun at large distances away from it. The orbits of comets, however, are very different in shape from the orbits of the planets. Comet orbits are long and narrow, and extend far out in space, even beyond our solar system. As the comet gets closer to the Sun, material begins to dissolve from the comet, forming tails that can be thousands of kilometres long. Two famous comets are Halley's Comet and Comet Hale-Bopp. These two comets are famous because their orbits are well-known, and scientists can predict when people will be able to see them.

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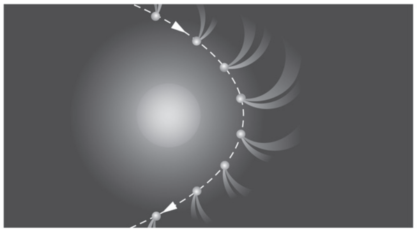

Figure 5.9 The dust tail and the gas tail of a comet always point away from the Sun. The dust tail usually is ahead of the gas tail.

DidYouKnow?

"Comet" comes from the Greek word for "hair." Early scientists thought comets looked like stars with hair flowing behind.

Every day, Earth's atmosphere is struck by thousands of rock fragments from space. We do not notice them because when they enter Earth's atmosphere, most of them burn up and nothing is left. If the fragment is large enough, it can create enough heat and light to make it visible in the sky. These are called **meteors**. Meteors are often called "shooting stars" because they look like a fast-moving star across the sky. If the fragment is very large, it can survive through the atmosphere and strike Earth's surface. These are called **meteorites**.

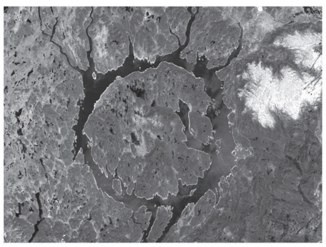

Figure 5.10 The Manicouagan Crater in Quebec was created 210 million years ago when a meteorite struck Earth's surface. The crater is about 70 km in diameter.

Common Misconception

- The outgassing of comets may lead some students to think that a comet melts completely as it approaches the Sun. The majority of comets orbit the Sun in a regular cycle like the planets and are not destroyed by the heat of the Sun.

Figure 5.8

- Halley's Comet will return in the year 2061/2062.

DidYouKnow? This information, along with the word planet, shows students that the sky has been studied for a very long time, including by many societies past and present. Discuss some other aspects of the ancient study of the night sky that students are aware of.

MOVING ON THE MOON/ SURVIVING IN SPACE

BACKGROUND INFORMATION

- The lunar rover and several other machines from the Apollo missions were built to be very compact and easy to operate. Most were left behind on the Moon when the astronauts left the surface of the Moon.

TEACHING STRATEGIES

- **During Teaching**—Read the section aloud with students and answer the question in the caption of Figure 5.11 together with the students.
- **After Teaching**—*ICT Option:* Complete an Internet search to find out what other everyday objects we now use were first created for use during the exploration of space. Everything from ballpoint pens and powdered drink crystals to satellite television, solar panels, and UV shields are required for space exploration.

Common Misconception

- Some students may believe that astronauts find new ways to use the existing tools and materials we use on Earth. Explain that some of the technologies we use on Earth were first developed for astronauts to use in space.

Off the Wall Discuss the impressions left on the Moon and what they may tell visitors to the Moon in the near and distant future. How do you think alien visitors would interpret footprints and equipment that has been left behind.

DidYouKnow? Discuss with students how something developed for spacecraft would end up being used to create braces.

Off the Wall

The Moon has no atmosphere. This means it has no weather such as rain and wind. Because of this, footprints left by the first astronauts on the Moon in 1969 are expected to last for millions of years.

Moving on the Moon

After the first time astronauts walked on the Moon in 1969, a series of trips to the Moon soon followed to allow astronauts the chance to find out more about Earth's close companion. To help them get around on the Moon's surface, a vehicle called the Lunar Roving Vehicle (also called the LRV or the lunar buggy) was invented. The LRV allowed astronauts to leave their spaceship and travel on the surface of the Moon.

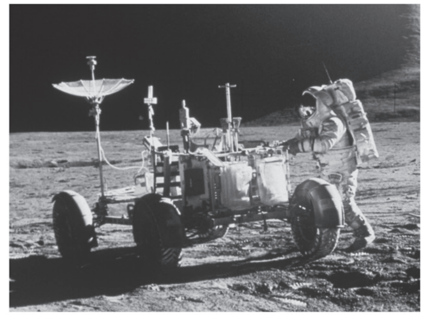

Figure 5.11 What types of information about the Moon do you think astronauts could gather when using the lunar buggy?

DidYouKnow?

The material for clear braces that orthodontists use is related to material created for space- and aircraft.

Surviving in Space

Did you know that many of the products that we use here on Earth were first developed for use in space? For example, smoke detectors were invented to help detect toxic vapours in an orbiting space station in 1973. And what about all those cordless tools such as cordless vacuum cleaners, drills, or screwdrivers? The first cordless tools were developed so astronauts could drill for samples on the Moon's surface. Where do you think the technology for the joystick that was used on early computer games came from? The joystick was first developed to help steer the Lunar Roving Vehicle!

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THINK & LINK INVESTIGATION 5-D SPACE REPORT

Purpose

- Students will discover detailed information about space by finding answers to questions about specific topics.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Collect Internet and text resources for students to use in their research.

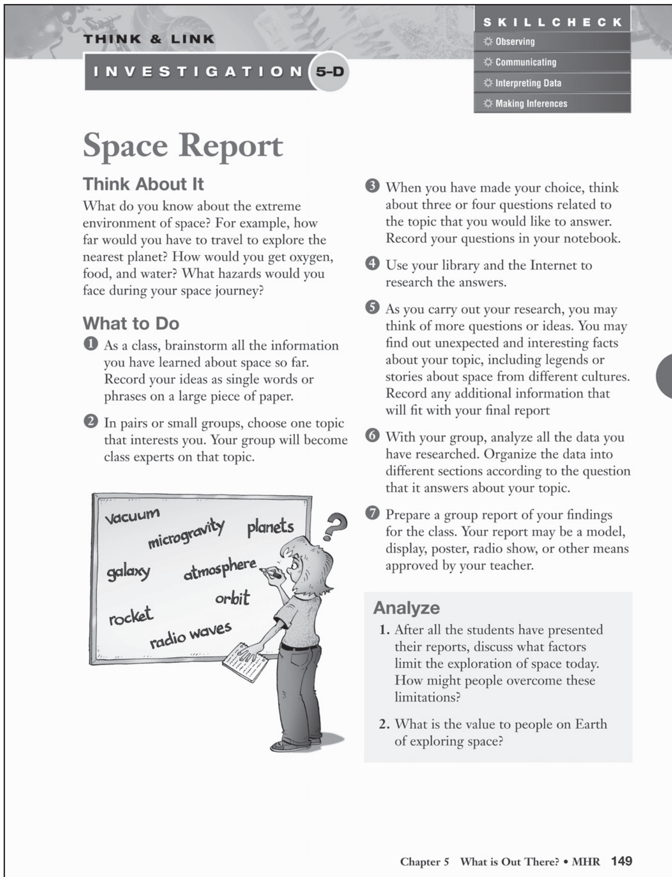
MATERIALS
– resource materials – computers – arts and crafts supplies for presentations

Suggested Time

- 40 min for steps 1–3
- 40–60 min for steps 4–6
- 40 min for step 7
- additional presentation time

Safety Precaution

- Review safe Internet practices with students.


THINK & LINK

INVESTIGATION 5-D

SKILLCHECK
- Observing
- Communicating
- Interpreting Data
- Making Inferences

Space Report

Think About It

What do you know about the extreme environment of space? For example, how far would you have to travel to explore the nearest planet? How would you get oxygen, food, and water? What hazards would you face during your space journey?

What to Do

1. As a class, brainstorm all the information you have learned about space so far. Record your ideas as single words or phrases on a large piece of paper.
2. In pairs or small groups, choose one topic that interests you. Your group will become class experts on that topic.
3. When you have made your choice, think about three or four questions related to the topic that you would like to answer. Record your questions in your notebook.
4. Use your library and the Internet to research the answers.
5. As you carry out your research, you may think of more questions or ideas. You may find out unexpected and interesting facts about your topic, including legends or stories about space from different cultures. Record any additional information that will fit with your final report
6. With your group, analyze all the data you have researched. Organize the data into different sections according to the question that it answers about your topic.
7. Prepare a group report of your findings for the class. Your report may be a model, display, poster, radio show, or other means approved by your teacher.

Analyze

1. After all the students have presented their reports, discuss what factors limit the exploration of space today. How might people overcome these limitations?
2. What is the value to people on Earth of exploring space?

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HINTS & HELPS

- Review the format for a clear scientific question and what constitutes a complete answer to a scientific question.
- Use BLM SSR-8E Group Roles (from the Skills Review section) to help students make the best use of their research time.

Implementing the Investigation

- Explain the time frame and expectations. Have partners/groups write up a job description for each member.
- While students are writing their questions, have volunteers share their best question. This sharing will help all students who are having difficulty focussing or getting started.
- Discuss the various types of presentations students can choose to use for their final report.

Adaptations

- Students can be grouped such that a variety of strengths are present in each group and no student feels overwhelmed.
- Allow students to present their answers in a variety of formats. They should choose one that best represents their learning and presentation style.
- Keep a few questions on hand to provide to students who become frustrated while trying to formulate questions.

Investigation Wrap-Up

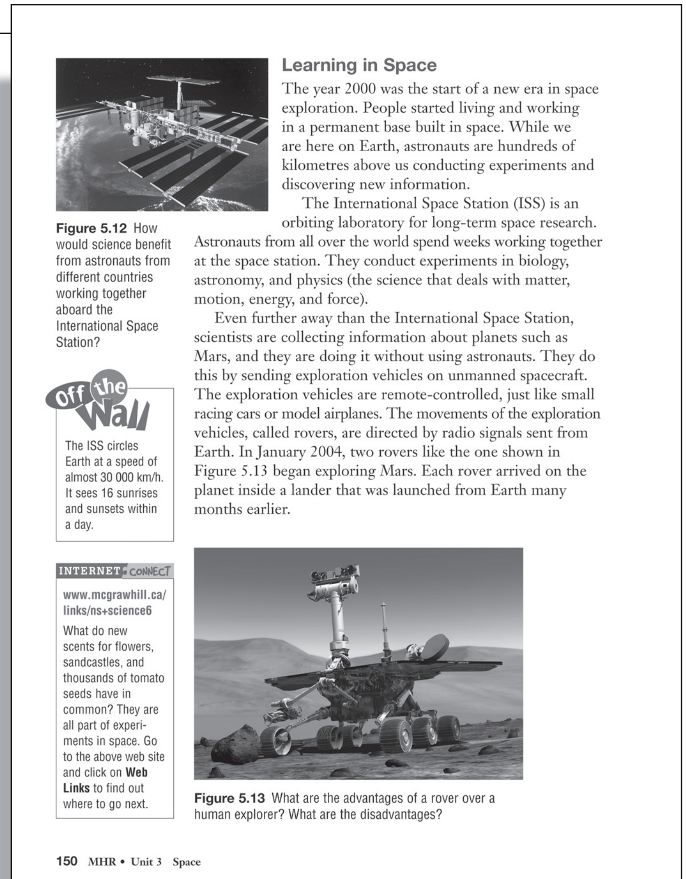
- Have each group present their discoveries to the class and have a group discussion following all of the presentations.
- Ask students to hand in all work completed throughout their study. Alternatively, you may prefer a series of staggered deadlines that will allow you to monitor ongoing progress (or lack thereof).

Assessment Option

- Use Learning Skills Rubric 3, Co-operative Group Work and/or Learning Skills Rubric 5, Research Project to assess student work in Think & Link Investigation 5-D Space Report.

Analyze Answers

1. Answers should include words and phrases from the original brainstorming session plus any new knowledge.
2. Answers should include ideas such as finding new information, scientific/medical discoveries, new places to colonize, and understanding Earth better by understanding its place in the universe, etc.



Learning in Space

The year 2000 was the start of a new era in space exploration. People started living and working in a permanent base built in space. While we are here on Earth, astronauts are hundreds of kilometres above us conducting experiments and discovering new information.

The International Space Station (ISS) is an orbiting laboratory for long-term space research. Astronauts from all over the world spend weeks working together at the space station. They conduct experiments in biology, astronomy, and physics (the science that deals with matter, motion, energy, and force).

Even further away than the International Space Station, scientists are collecting information about planets such as Mars, and they are doing it without using astronauts. They do this by sending exploration vehicles on unmanned spacecraft. The exploration vehicles are remote-controlled, just like small racing cars or model airplanes. The movements of the exploration vehicles, called rovers, are directed by radio signals sent from Earth. In January 2004, two rovers like the one shown in Figure 5.13 began exploring Mars. Each rover arrived on the planet inside a lander that was launched from Earth many months earlier.

Figure 5.12 How would science benefit from astronauts from different countries working together aboard the International Space Station?

Off the Wall: The ISS circles Earth at a speed of almost 30 000 km/h. It sees 16 sunrises and sunsets within a day.

INTERNET CONNECT: www.mcgrawhill.ca/links/ns+science6
What do new scents for flowers, sandcastles, and thousands of tomato seeds have in common? They are all part of experiments in space. Go to the above web site and click on **Web Links** to find out where to go next.

Figure 5.13 What are the advantages of a rover over a human explorer? What are the disadvantages?

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LEARNING IN SPACE

BACKGROUND INFORMATION

- The International Space Station (ISS) is continually growing in size and scope. Missions from the United States and Russia repeatedly bring new labs to the space station and attach them through spacewalks and the use of devices such as the Canadarm.
- The Mars rovers were designed to operate for 90 days but are still operating and collecting information four years after they landed on the planet.

TEACHING STRATEGIES

- **During Teaching**—Read through the section as a class and discuss the captions of Figures 5.12 and 5.13.
- **After Teaching**—Ask students to identify some possible advantages people may gain from studying the surface of Mars.
  – Organize a group discussion related to the cost of space exploration and the pros and cons of spending the money for continued exploration.

Common Misconceptions

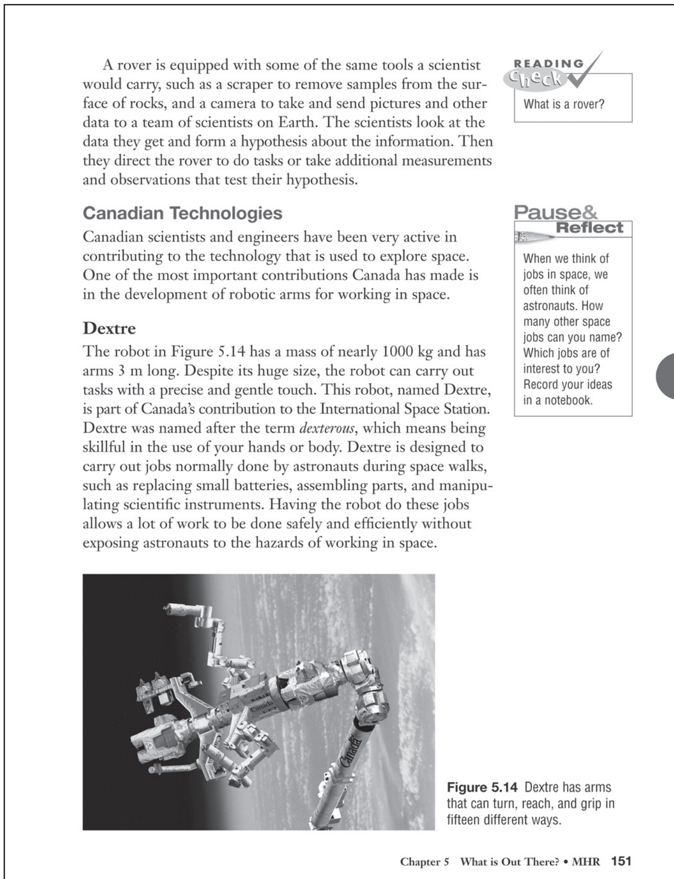
- Shuttle missions are often thought to be missions of the United States. Most shuttle missions use technologies and astronauts from all over the world.
- Cost estimates based on NASA's budgets suggest that it costs about US$1.3 billion per launch; more moderate estimates suggest a launch costs about US$60 million.

Figure 5.12

- Scientists would benefit from the astronauts working on the ISS in a number of ways. The first is the shared experience of the individuals put together provides a large wealth of knowledge based on different past experiences and worldviews. The second benefit would be in the interest of sharing the results of experimentation. An international team is likely to share the results of their research with the world.

Off the Wall: Have students try to imagine how fast this velocity is by comparing it to the velocity of the fastest race cars (300 km/h). Have students try to imagine what travelling at this speed would be like on Earth.

INTERNET CONNECT: Students will find links to a variety of experiments that have been carried out in space. You may wish to challenge them to explain why the experiments had to be carried out in space.



A rover is equipped with some of the same tools a scientist would carry, such as a scraper to remove samples from the surface of rocks, and a camera to take and send pictures and other data to a team of scientists on Earth. The scientists look at the data they get and form a hypothesis about the information. Then they direct the rover to do tasks or take additional measurements and observations that test their hypothesis.

READING Check: What is a rover?

Canadian Technologies

Canadian scientists and engineers have been very active in contributing to the technology that is used to explore space. One of the most important contributions Canada has made is in the development of robotic arms for working in space.

Pause& Reflect: When we think of jobs in space, we often think of astronauts. How many other space jobs can you name? Which jobs are of interest to you? Record your ideas in a notebook.

Dextre

The robot in Figure 5.14 has a mass of nearly 1000 kg and has arms 3 m long. Despite its huge size, the robot can carry out tasks with a precise and gentle touch. This robot, named Dextre, is part of Canada's contribution to the International Space Station. Dextre was named after the term *dexterous*, which means being skillful in the use of your hands or body. Dextre is designed to carry out jobs normally done by astronauts during space walks, such as replacing small batteries, assembling parts, and manipulating scientific instruments. Having the robot do these jobs allows a lot of work to be done safely and efficiently without exposing astronauts to the hazards of working in space.

Figure 5.14 Dextre has arms that can turn, reach, and grip in fifteen different ways.

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Figure 5.13

- The advantages a rover has over a human explorer are that it can be abandoned in space without concern for its loss, can obtain its energy from the Sun through solar panels, and can operate safely in a variety of conditions. The disadvantages of a rover are the requirement for remote operation from Earth, the lack of decision-making ability and the inability to repair it once deployed.

READING Check A rover is a remotely operated robot that can travel over the surface of a distant object and collect and analyze samples. The results of the sampling can then be transmitted back to scientists on Earth.

CANADIAN TECHNOLOGIES/DEXTRE

BACKGROUND INFORMATION

- Canadian engineers have become world specialists in the design of robotic arms for use in space. The arms/robots designed to work in conjunction with the space shuttle and ISS have made repairs in space possible. They have helped with the construction and repair of the ISS and the Hubble Telescope and the launch of satellites.

TEACHING STRATEGIES

- **After Teaching**—*ICT Option:* Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to the Canadian Space Agency's web site. With the students, view images of Canadian technology in space.
  - Discuss Canada's contribution to the current Mars mission, a weather monitoring station on the Phoenix Mars Lander.

Pause& Reflect Some careers related to space exploration are engineering, ground control, safety inspection, and production. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to the careers section of the Canadian Space Agency's web site.

CANADA TO THE RESCUE

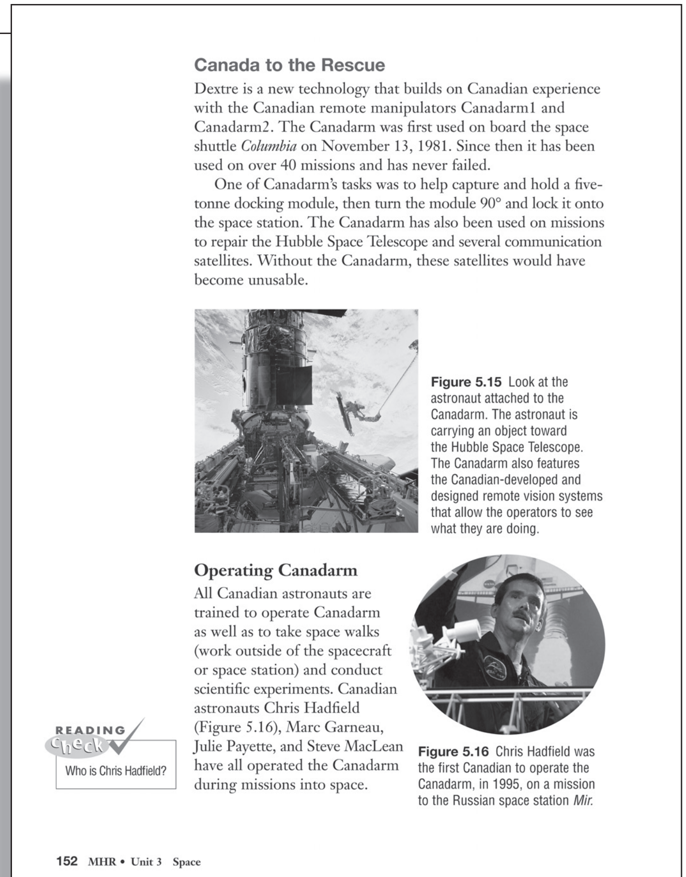
BACKGROUND INFORMATION

- The success rate of the Canadarm has led NASA and other space agencies to look to Canada when they need to repair or manipulate satellites or International Space Station materials.

TEACHING STRATEGIES

- **During Teaching**—Read and discuss the text together as a class.

READING Check Chris Hadfield is a Canadian astronaut who has been on two space missions (1995 and 2001). Hadfield was the first Canadian to operate the Canadarm, has been on space walks, and is scheduled to be the first Canadian to have an extended stay at the ISS in 2009.



Canada to the Rescue

Dextre is a new technology that builds on Canadian experience with the Canadian remote manipulators Canadarm1 and Canadarm2. The Canadarm was first used on board the space shuttle *Columbia* on November 13, 1981. Since then it has been used on over 40 missions and has never failed.

One of Canadarm's tasks was to help capture and hold a five-tonne docking module, then turn the module 90° and lock it onto the space station. The Canadarm has also been used on missions to repair the Hubble Space Telescope and several communication satellites. Without the Canadarm, these satellites would have become unusable.

Figure 5.15 Look at the astronaut attached to the Canadarm. The astronaut is carrying an object toward the Hubble Space Telescope. The Canadarm also features the Canadian-developed and designed remote vision systems that allow the operators to see what they are doing.

Operating Canadarm

All Canadian astronauts are trained to operate Canadarm as well as to take space walks (work outside of the spacecraft or space station) and conduct scientific experiments. Canadian astronauts Chris Hadfield (Figure 5.16), Marc Garneau, Julie Payette, and Steve MacLean have all operated the Canadarm during missions into space.

READING Check: Who is Chris Hadfield?

Figure 5.16 Chris Hadfield was the first Canadian to operate the Canadarm, in 1995, on a mission to the Russian space station *Mir.*

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FIND OUT ACTIVITY 5-E CANADIANS AND SPACE EXPLORATION

Purpose

- Students will investigate one of a number of Canadian contributions to the exploration and study of space and share their discoveries with the class.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Collect resources and web sites that will allow students to complete their research. – Reserve the computer lab, library or other required research rooms in order for students to complete their investigation.

MATERIALS
– craft supplies – poster board and other materials for students to prepare their presentation

Find Out **ACTIVITY 5–E**

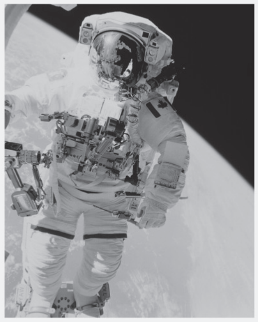
Canadians and Space Exploration

Canadians have been important partners in the international exploration of space. Some Canadians have been astronauts, others have been engineers, astronomers, computer specialists, and vital support personnel. There are thousands of roles that need to be filled to safely and efficiently explore space.

What To Do

For one of the following Canadian contributions to space exploration and technology, perform an information search. Make a poster, write a report, or make a presentation explaining your finding to your class.

1. Research Canadarm1 and Canadarm2. Find out what is meant by the term “degrees of freedom.”
2. Learn about Canada’s development of robotic vision systems. What do they do and how are they important?
3. What are SciSat and RadarSat? For what purpose have they been built?
4. What is the Phoenix Lander? Where will it land? What Canadian instruments are on the Phoenix lander and what will they measure?
5. What is the CFHT? What do scientists do with the CFHT?
6. Take a tour of a university observatory or public observatory.



Canadian astronaut Chris Hadfield on a space walk.

7. Locate an amateur or professional astronomer in your area. Invite them to give a presentation to your class or conduct an interview. Report back to your class what you learned during the interview.
8. Write a biography of one of the Canadian astronauts such as Steve MacLean, Bjarni Tryggvason, Dave Williams, Chris Hadfield, Bob Thirsk, Julie Payette, Mark Garneau, or Roberta Bondar.

Suggested Time
- 10 min for introduction
- 40 min for research
- 40 min for presentation preparation
- 30 min for classroom presentations

Safety Precaution
- Review safe Internet practices with students.

HINTS & HELPS
- Prepare a summary sheet for each of the research topics for students before the project begins. This will speed up research if students are having trouble finding pertinent information.

Implementing the Activity
- Assign students to computer and/or research stations before starting the activity and give them time limits so all of the class gets equal research time.
- Prepare for a variety of presentation methods that may include multimedia presentations, poster displays, or other methods of presenting information.

Adaptations
- Group students with literacy challenges with students who can assist them with research.
- Select methods of presentation for students who will do better with specific types of presentations to encourage success.

Activity Wrap-Up
- Have students share their discoveries with the class.

Assessment Options
- Use Learning Skills Checklist 3, Oral Presentation; Learning Skills Rubric 5, Research Project; and/or Learning Skills Rubric 7, Multimedia Presentation to assess student work in Find Out Activity 5-E Canadians and Space Exploration.

CONDUCT AN INVESTIGATION 5-F WORKING IN A SPACESUIT

Purpose

- Students will create a spacesuit and discover the challenges and benefits of working in it.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 weeks before	– Ask students to bring in clean and dry 2 L empty milk or juice cartons.
1 week before	– Obtain one set of hockey gloves or oven mitts per group.

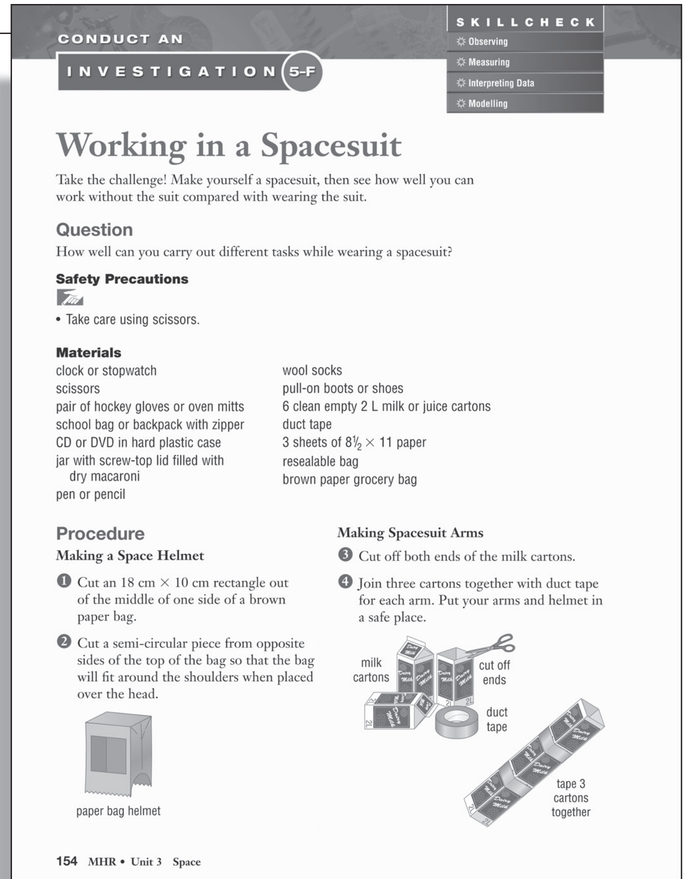
MATERIALS
– clock or stopwatch – scissors – pair of hockey gloves or oven mitts – school bag or backpack with zipper – CD or DVD in hard plastic case – jar with screw-top lid filled with dry macaroni – pen or pencil – wool socks – pull-on boots or shoes – 6 2 L empty milk or juice cartons – duct tape – 3 sheets of 8 ½ x 11 paper – brown paper bag – resealable bag

Suggested Time

- 20 min for Making a Space Helmet and Making Spacesuit Arms
- 40 min for Preparing the Challenge and Taking the Challenge

HINTS & HELPS

- Have students prepare a chart that they can use to record their results before making the spacesuit.
- Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to the web site of the Canadian Space Agency for information about spacesuits and spacewalks.



CONDUCT AN INVESTIGATION 5-F

SKILLCHECK
- Observing
- Measuring
- Interpreting Data
- Modelling

Working in a Spacesuit

Take the challenge! Make yourself a spacesuit, then see how well you can work without the suit compared with wearing the suit.

Question

How well can you carry out different tasks while wearing a spacesuit?

Safety Precautions

- Take care using scissors.

Materials

clock or stopwatch
scissors
pair of hockey gloves or oven mitts
school bag or backpack with zipper
CD or DVD in hard plastic case
jar with screw-top lid filled with dry macaroni
pen or pencil
wool socks
pull-on boots or shoes
6 clean empty 2 L milk or juice cartons
duct tape
3 sheets of 8½ × 11 paper
resealable bag
brown paper grocery bag

Procedure

Making a Space Helmet

1. Cut an 18 cm × 10 cm rectangle out of the middle of one side of a brown paper bag.
2. Cut a semi-circular piece from opposite sides of the top of the bag so that the bag will fit around the shoulders when placed over the head.

Making Spacesuit Arms

3. Cut off both ends of the milk cartons.
4. Join three cartons together with duct tape for each arm. Put your arms and helmet in a safe place.

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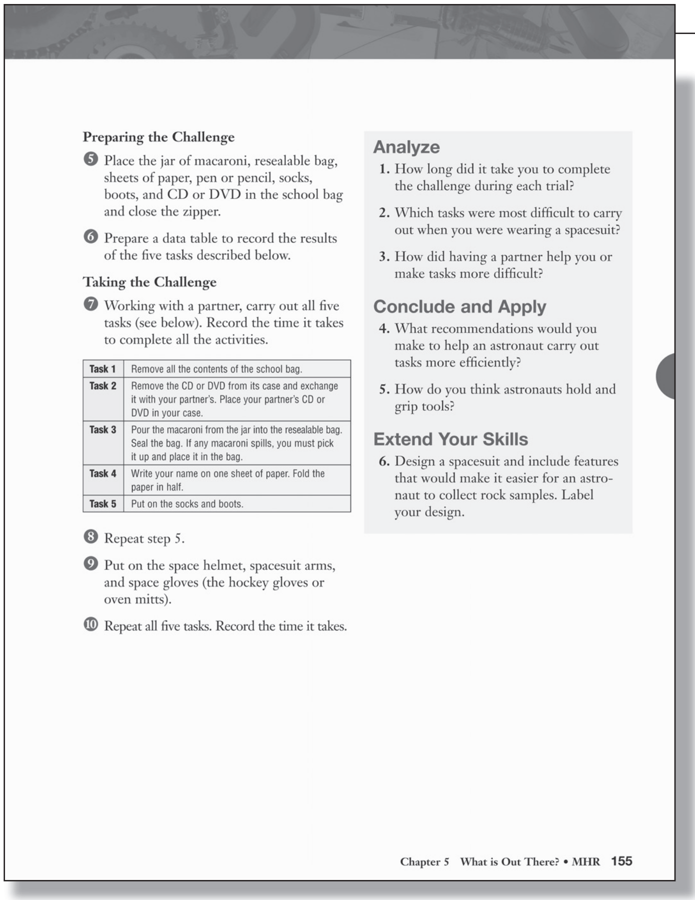
Implementing the Investigation

- Read through the investigation with the class and form groups that match complementary strengths.
- Organize the room so that the trial stations are spaced well enough apart that the students do not interfere with one another when taking the challenge.
- Allow students or groups time to debrief.
- Distribute BLM 5.4 Working in a Spacesuit for students to use to record their data or have students create their own data table.

Adaptations

- Pair students with literacy difficulties with strong readers so the instructions are well understood.
- Devise other challenges for the students to complete in their spacesuits for those who excel at the activity.



Preparing the Challenge

5. Place the jar of macaroni, resealable bag, sheets of paper, pen or pencil, socks, boots, and CD or DVD in the school bag and close the zipper.
6. Prepare a data table to record the results of the five tasks described below.

Taking the Challenge

7. Working with a partner, carry out all five tasks (see below). Record the time it takes to complete all the activities.

Task 1	Remove all the contents of the school bag.
Task 2	Remove the CD or DVD from its case and exchange it with your partner's. Place your partner's CD or DVD in your case.
Task 3	Pour the macaroni from the jar into the resealable bag. Seal the bag. If any macaroni spills, you must pick it up and place it in the bag.
Task 4	Write your name on one sheet of paper. Fold the paper in half.
Task 5	Put on the socks and boots.

8. Repeat step 5.
9. Put on the space helmet, spacesuit arms, and space gloves (the hockey gloves or oven mitts).
10. Repeat all five tasks. Record the time it takes.

Analyze

1. How long did it take you to complete the challenge during each trial?
2. Which tasks were most difficult to carry out when you were wearing a spacesuit?
3. How did having a partner help you or make tasks more difficult?

Conclude and Apply

4. What recommendations would you make to help an astronaut carry out tasks more efficiently?
5. How do you think astronauts hold and grip tools?

Extend Your Skills

6. Design a spacesuit and include features that would make it easier for an astronaut to collect rock samples. Label your design.

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Investigation Wrap-Up

- Have the students share their times and experiences with the rest of the class.

Assessment Option

- Use Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 5-F Working in a Spacesuit.

Analyze Answers

1. Most students will report that their times were longer when wearing the spacesuit.
2. Most students will report that any tasks requiring dexterity were challenging.
3. Most students will find that having a partner made the tasks easier to complete.

Conclude and Apply Answers

4. Recommendations might include using the least bulky and most flexible materials possible to create a spacesuit, and working with a partner to complete tasks.
5. Accept all reasonable answers. Students might infer that astronauts have to look at their hands to make sure they have a good grip.

Extend Your Skills

6. Student answers should include features for collecting and transporting rock samples. Remind students to label their drawings.

OTHER CANADIAN TECHNOLOGIES IN SPACE

BACKGROUND INFORMATION

- Many experiments that are done on Earth and in space require a very stable environment in order to complete. The Microgravity Vibration Isolation Mount (MIM) will allow for the careful manipulation of experimental variables in space.

TEACHING STRATEGIES

- **During Teaching**—Read the section aloud and discuss the content with students.

Off the Wall

The entertainment industry has adopted many scientific discoveries both for use in their story lines and for use in the creation of content. The Internet, robots, and digital technologies have advanced the entertainment industry as much as they have advanced the science community. Ask students if they can recall any recent movies they've seen that used robot technology.

Off the Wall

Robot technology that was originally developed for space is now at work in movie studios. Dinosaurs and monsters move with better motion, thanks to robot technology.

Other Canadian Technologies in Space

Canadian astronaut Bjarni Tryggvason (Figure 5.17) invented the Microgravity Vibration Isolation Mount or "MIM," (Figure 5.18). MIM uses magnets to make a vibration-free floating platform for conducting experiments. Canadian researchers hope to use this platform on the ISS to melt and mix various materials to make new metals, computer parts, and other products for Canadian industry.

Figure 5.17 Canadian astronaut Bjarni Tryggvason is about to perform an experiment in space.

Figure 5.18 This is a Microgravity Vibration Isolation Mount.

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SECTION 5.1 SUMMARY

Read the section summary as a class and have students review and update the key terms list in their science logbooks. Sort the students into four groups and assign each group one of the following four headings: 1. Flat Earth vs. Round Earth; 2. Objects that Orbit the Sun; 3. Space Technology; and 4. Canadians in Space. Have each group prepare a short presentation to report on their topic based on their logbook notes. Alternatively, as a review, students could also make an information poster about an idea that they reviewed in this section.

Section 5.1 Summary

In this section, you learned that:
- Beliefs in a flat Earth changed to an understanding that we live on a spherically shaped Earth.
- Beliefs in an Earth-centred universe changed to an understanding of a Sun-centered planetary system.
- Asteroids, comets, and meteoroids also orbit the Sun.
- Technology has played an important part in helping people gain knowledge about Earth and space.
- Many products developed for space also benefit us on Earth.
- Canadians have made many important contributions to space exploration.

Check Your Understanding

1. What did ancient philosopher Pythagoras see that made him suspect that Earth was a sphere?
2. Why was the telescope such an important invention for helping scientists explore the skies?
3. List two ways technology has helped people explore space.
4. Explain two ways Canadians have contributed to exploring space.
5. You hear a news program that suggests they may decide to stop exploring space. Prepare a short response you would give if they interviewed you on television.
6. Should countries continue to work together on projects like the International Space Station? What are the advantages? What are the disadvantages?

Key Terms
Earth-centred universe
philosopher
Sun-centred planetary system
telescope
binoculars
observatory
planet
asteroid
comet
meteors
meteorite

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✓ ASSESSMENT OPTIONS FOR SECTION 5.1

- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook to evaluate them.
- Use the following rubrics to assess student work:
  - Learning Skills Checklist 3, Oral Presentation and/or Learning Skills Rubric 5, Research Project to assess student work in Think & Link Investigation 5-B Sky Report
  - Science Skills Checklist 15, Making Observations and Inferences to assess student work in At Home Activity 5-C The Moving Sky
  - Learning Skills Rubric 3, Co-operative Group Work and/or Learning Skills Rubric 5, Research Project to assess student work in Think & Link Investigation 5-D Space Report
  - Learning Skills Checklist 3, Oral Presentation, Learning Skills Rubric 5, Research Project and/or Learning Skills Rubric 7, Multimedia Presentation to assess student work in Find Out Activity 5-E Canadians and Space Exploration
  - Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 5-F Working in a Spacesuit

Check Your Understanding Answers

1. Pythagoras observed ships sailing off towards the horizon and noticed that the hull of the ship disappeared from view before the mast and sails. If Earth was flat, all should disappear from view at the same rate.
2. The telescope was an important invention to further the study of space because it allowed people to observe objects in space as more than points of light. The distant features of solar objects, including surfaces, rings, and moons, could be seen through a telescope.
3. One way technology has helped people explore space is that it allowed them to venture into space and observe it outside of the atmosphere. A second technology that has aided space exploration is the use of radio, infrared, and other telescopes. These tools allow us to study objects in space by looking at more than the light they give off.
4. Canadians have contributed to space exploration in a number of ways, as astronauts and researchers and by contributing technology. Canadian astronauts have been part of the development and completion of space missions; Canadian technologies such as Dextre and the Canadarm assist with shuttle missions and the ISS; and Canadian scientists have developed a number of experiments that are currently being completed on the ISS.
5. Students should devise a variety of solutions. If they suggest stopping the support of space studies, they will likely discuss the cost of exploration and question the usefulness of discoveries on planets such as Mars. If they support the continuation of space studies, they may cite the value of potential discoveries, and the development of Earth-based technologies thanks to the space program.
6. Yes, countries should continue to work together on space projects. The advantages of working together include a sharing of costs, a sharing of knowledge, and the opportunity to work together in space regardless of the relationships here on Earth. The disadvantages of working together could include an unequal sharing of costs, political strife interfering with the further development of the program, and the changing abilities of different countries to contribute to the program.

SECTION 5.2 EVENTS ON EARTH AND EVENTS IN THE SKY

What Students Do in Section 5.2

- discover that the rotation of Earth is responsible for the day and night cycle
- investigate the tilt of Earth's axis and its relationship to the seasons
- describe how the orbit of the Moon is responsible for the phases of the Moon
- explain the causes of both lunar and solar eclipses
- describe the development and changing of the tides

BACKGROUND INFORMATION

- The belief that the Sun moved around Earth in the day and the Moon moved around it at night was held for thousands of years. Eventually, it became clear that day and night are a result of the rotation of Earth, not the orbiting of the Sun.

TEACHING STRATEGIES

- **Begin the Lesson**—Ask students to take a moment to consider how day and night happen. Ask them to write their ideas in their logbooks.
- **During Teaching**—Read and discuss the key terms and introductory paragraph together as a class following the students' logbook entries. Probe the students' knowledge of day and night, the seasons, the phases of the Moon, tides, and eclipses.

DAY AND NIGHT

BACKGROUND INFORMATION

- The day-night cycle is regulated by the rotation of Earth around its axis. It takes 24 hours for Earth to complete one rotation. When an area is experiencing day, Earth is facing the Sun; when it is experiencing night, that portion of Earth is facing away from the Sun.

CHAPTER 5

Section 5.2 **Events on Earth and Events in the Sky**

Key Terms
axis
orbit
lunar phases
solar eclipse
lunar eclipse
tides

Many parts of our daily routines are influenced by the universe in which our planet exists. Earth's rotation and path around the Sun gives us night and day. It is also the reason why we have seasons, and why there are 365 days in the year. Learning how Earth, the Moon, and Sun exist together is an important step to explaining daily changes here on Earth.

Day and Night

Each morning, the Sun appears to rise in the east and set in the west in the evening. At night, the Moon and stars seem to rise in the east and set in the west in the morning. What causes this constant movement above us? Stand in one spot and point your left arm to the east. Now, turn your arm and body until your arm is pointing west. How would you get back to pointing east without moving backward? That is right. You would continue to spin in the same direction as you started. Now spin again and watch what you see. Do you see the same things over again? Just as you see the same things because you are spinning, Earth sees the same Sun, Moon, and stars because it is spinning, too. Earth rotates in a counterclockwise direction as seen looking down from the North Pole. When Earth rotates your side of the globe toward the Sun, you experience daytime. As Earth continues to spin, the Sun disappears from view and you experience nighttime as you face away from the Sun. We define the length of one day to be exactly 24 hours. Twenty-four hours is the average amount of time it takes for the Sun to cross an observer's meridian (an imaginary line in the sky) each day.

READING Check

How long does it take Earth to make one complete rotation?

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TEACHING STRATEGIES

- **After Teaching**—*ICT Option:* Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to an animation that demonstrates the concept of changing day and night and the length of day and night throughout the year.

Common Misconception

- The length of day varies with the seasons. This, however, is not true near the equator. When Canadians visit Florida or other hot spots for winter vacation, they are sometimes surprised that a sunny day ends at 6:00 P.M. and not later in the evening like it does in the summer in Nova Scotia.

READING Check It takes 24 hours for Earth to complete one rotation on its axis.

CONDUCT AN INVESTIGATION 5-G

SKILLCHECK
- Observing
- Interpreting Observations
- Interpreting Data
- Modelling

Model Earth's Rotation

Although it looks as if the Sun is moving around us on Earth, in fact, the Earth is rotating on its axis. Can you explain how this causes night and day to occur? You will find out when you build this model of Earth and Sun.

Question

What causes us to have day and night?

Safety Precautions

Be careful never to shine a flashlight in someone's eyes.

Materials

globe(s) toothpick(s) modelling clay
compass(es) high-powered flashlight

Procedure

Part 1

1. As class, take a globe outside into an area where there are no other shadows from other objects.
2. Using a compass, point the North Pole on the globe to the North. This means that the equator will be facing up.
3. Rotate the globe so that the area where you live is now on top.
4. Put the toothpick in a small piece of modelling clay, and use it to mark where you live on the globe.
5. As a class, discuss the shadow produced by the toothpick on the globe compared to those on the ground.
6. Look at the rest of the globe. Which areas are receiving light? Which areas are in darkness?
7. Now rotate the globe to the East and observe what you see about Earth.

Part 2

1. Moving inside, five students hold hands and form a circle.
2. Standing outside the circle, a sixth student shines a flashlight toward the centre of the circle.
3. Dim the lights in the room.
4. The five students forming the circle will follow each other and walk in a circle without holding hands. This will represent Earth rotating.
5. The part of the circle that is in the light represents daytime while the part that is in the darkness represents the night.

Analyze

1. How does the rotation of Earth produce day and night?

Conclude and Apply

2. What would happen if Earth stopped rotating?

Extend Your Skills

3. Design a small and simple model that you could use to explain to a fellow student how day and night occur on Earth.

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CONDUCT AN INVESTIGATION 5-G MODEL EARTH'S ROTATION

Purpose

- Students will discover how the rotation of Earth creates the day-night cycle.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Collect materials.

MATERIALS
– high-powered flashlight – globes – compasses – toothpicks – modelling clay

Suggested Time

- 15 min for Part 1
- 15 min for Part 2
- 10 min for discussion and questions

HINTS & HELPS

- Ensure students move carefully and quietly through the school when going outside for Part 1.
- Try to complete the investigation on a sunny day and close to noon.
- A bright flashlight with a wide beam best models the Sun for Part 2 of the activity.

Implementing the Investigation

- Large classes should be broken up into groups of five or fewer in order to complete the activities.
- Make other teachers in the area aware you will be travelling through the school in order to complete the activity.

Investigation Wrap-Up

- Discuss the Analyze and Conclude and Apply questions as a class.

Assessment Option

- Use Process Skills Rubric 8, Developing Models and/or Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 5-G Model Earth's Rotation.

Analyze Answer

1. The rotation of Earth produces day and night by turning locations on the surface towards and away from the Sun. When a location is facing the Sun the location experiences day; when the location rotates away from the Sun, it is in shadow and experiences night.

Conclude and Apply Answer

2. If Earth stopped rotating, some locations would be in constant daylight and other locations would be in constant night.

Extend Your Skills

3. Have students complete the activity at home and involve parents or siblings in the activity. Ask them to share their results with their classmates the following day.

THE FOUR SEASONS/EARTH'S AXIS

BACKGROUND INFORMATION

- The tilt of Earth on its axis (23.5°) is responsible for the seasons we experience. The intensity of the Sun's light varies as we face towards and away from the Sun.
- Not all planets have seasons the way Earth does. Mercury and Jupiter have very small axial tilt angles and very little seasonal change. Venus is tilted almost 180° and therefore spins backwards with little seasonal change. Mars, Saturn, and Neptune have axial tilts comparable to Earth and experience seasons similar to Earth. Uranus is tilted a little more than 90°; this angle creates very little seasonal or day and night changes on the planet (Some areas experience all day and all summer, while other areas experience all night and all winter.)

TEACHING STRATEGIES

- **After Teaching**—If you have students from other parts of the world, ask them to tell the class about the seasons where they come from. Have students speculate where in the world it would be summer while they are experiencing winter, and explain their reasoning.

Common Misconception

- The seasons in Nova Scotia are not experienced by everyone on Earth. There are no true seasons at locations along the equator because they receive almost the same amount of sunlight year-round and maintain the same temperatures.

The Four Seasons

It usually surprises most people to learn that Nova Scotia and the rest of Canada are closer to the Sun in the wintertime than in the summertime. Why do you think we are further away from the Sun during the hottest time of the year? The answer can be explained by the fact that seasons are not caused by our distance from the Sun. Seasons happen because of the tilt of Earth.

Earth's Axis

Imagine you are holding a globe in front of you. The North Pole is pointing to the ceiling, and the South Pole is pointing to the ground. Now, tilt the globe slightly to the right. Earth rotates in this position. If you could draw a straight line from the North Pole to the South Pole, the line would be tilted as well. Although in real life there is no line drawn from pole to pole, the tilted imaginary line that it forms is called Earth's **axis**. Earth's axis is tilted at an angle of 23.5°.

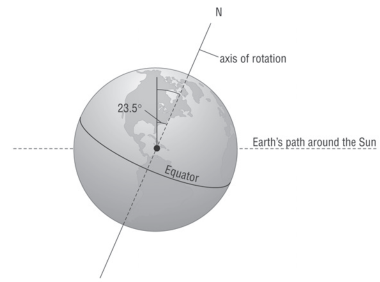

Figure 5.19 What do scientists mean when they say, "Earth spins on its axis"?

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FIND OUT ACTIVITY 5-H SEEING THE REASONS FOR THE SEASONS

Purpose

- Students will discover that the tilt of Earth's axis is responsible for the changing seasons we experience on the surface.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Collect enough materials for each group to complete the activity.

MATERIALS
– flashlights – globes – lamps – coloured tape – paper – coloured pens – toothpicks – modelling clay – large place cards (4 per group)

Find Out ACTIVITY 5–H

Seeing the Reasons for the Seasons

How does the tilt of Earth's axis of rotation and its orbit around the Sun affect the seasons on Earth?

Safety Precautions

Be careful never to shine a flashlight in someone's eyes.

Materials

flashlight(s), globe(s), toothpick(s), modelling clay, coloured tape, sheet of paper, lamp(s), pens, 2 different colours, 4 large place cards, labelled with the seasons

What to Do

Part 1

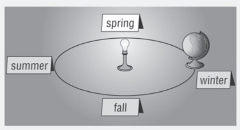
1. Place the sheet of paper on a desk.
2. In a dimly lit classroom, hold the flashlight about 30 cm away from the surface of the desk, and shine the light on the paper at a 90-degree angle. Draw a circle around the pool of light on the paper.
3. Change the angle of the flashlight to 60 degrees, and outline the light on the paper using a different colour pen.
4. Compare the two areas. Is the shape and size of the second circle the same as the first one? Discuss how this different size of circle could affect the concentration of the light (brightness and heat) shining on the object.
5. At what angle do you think the Sun's rays come to your part of Earth in summer? At what angle in winter?

Part 2

1. On the floor of the classroom, draw or tape an oval that represents Earth's orbit. Put the "season" place cards around the oval, as shown.
2. Use a piece of modelling clay to mount the toothpick where you live on the globe.
3. Place a lamp in the centre of the oval to represent the Sun.
4. Now place the globe at the spring season position, with the toothpick facing the Sun. Discuss how much light is on different parts of the globe.
5. Move the globe to the summer season. Keep the same side of the globe facing the Sun. Keep the axis pointing the same way. How is the area of light changing for different parts of the globe?
6. Complete step 5 for the fall and winter seasons.

What Did You Find Out?

1. What is the difference in the concentration or amount of the Sun's light between winter and summer where you live?
2. How do you think these different concentrations of sunlight relate to the different seasons on Earth?



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Suggested Time
- 15 min for Part 1
- 15 min for Part 2
- 10 min for What Did You Find Out?

Safety Precaution
- Advise students to not shine bright flashlights in each other's eyes.

HINTS & HELPS
- Make the room as dark as possible in order to complete this activity.

Implementing the Activity
- Ask students to hypothesize about the cause of seasons in their logbooks before beginning the activity.
- Divide students into groups of three and arrange the classroom so that each group has plenty of space to lay out their ovals on the floor.

Adaptations
- Arrange groups to place students with literacy difficulties with strong readers in order to facilitate the completion of the activity.
- Prepare definition cards for students with more limited vocabulary. Be prepared to review terms such as axis and concentration for some students.
- Ask an extended question: Does the Maritime region ever receive rays from the Sun that are not angled?

Activity Wrap-Up
- Review What Did You Find Out? answers with the class.
- Have students update their science logbooks based on the last few lessons.

Assessment Option
- Use Process Skills Rubric 8, Developing Models to assess student work in Find Out Activity 5-H Seeing the Reasons for the Seasons.

What Did You Find Out? Answers
1. The concentration of the Sun's light that is directly on Nova Scotia is much greater in summer than it is in winter.
2. The period of the year when the sunlight is most concentrated on an area of Earth represents summer in that area, and the period of the year when it is least concentrated on an area of Earth represents winter.

THE SEASON REASON/ PHASES OF THE MOON/ECLIPSES

BACKGROUND INFORMATION

- Earth actually takes 365 ¼ days to orbit the Sun. Because of this time period an entire day is added to every fourth year or leap year.
- The Moon is one of the objects in the solar system that takes basically the same amount of time to rotate on its axis once as it does to orbit Earth. This means that only one side of the Moon ever faces the Sun. The light side of the Moon is what we see in the sky and the dark side of the Moon is what faces us when the Moon is new, waxing (getting bigger), or waning (getting smaller).
- Eclipses occur much the same way as a cloud casts a shadow over Earth. An object passes between the Sun and Earth, and blocks the light, forming a shadow. Shadows cast on Earth by the Moon are called solar eclipses (they appear to block the Sun), and shadows cast on the Moon by Earth are called lunar eclipses (they appear to block the Moon).

TEACHING STRATEGIES

- **During Teaching**—Read through the section aloud with the class and discuss the changes in the Moon as the month passes.
  - Examine Figure 5.21 and Figure 5.22 and discuss the relationship between the position of the Moon and the phase of the Moon as seen from Earth. BLM 5.5 Lunar Phases provides a larger version of these figures and can be used as an overhead master.
  - Examine Figure 5.23 and Figure 5.24 and discuss the difference between a full and partial eclipse.

READING Check

Use the word *orbit* correctly in a sentence.

The Season Reason

As Earth rotates on its axis, it also travels in an oval-shaped path around the Sun. This path is called an **orbit**. Earth takes 365 days, or one year, to complete one full orbit of the Sun. While Earth moves around the orbit, the position, or tilt, of the axis never changes. This means that during the summer months in Canada, the axis is pointed toward the Sun, but during the winter months, the axis is pointed away from the Sun. In the winter, sunlight is spread out over a larger area. In the summer, sunlight is concentrated in a smaller area, meaning it will be hotter.

Figure 5.20 The angle of the axis never changes during Earth's orbit of the Sun. However, the concentration of sunlight reaching the hemispheres does change. These changing levels of sunlight create what we call the seasons of winter, spring, summer, and fall. (These diagrams are not to scale.)

Phases of the Moon

Have you ever noticed that the Moon looks different from night to night? Sometimes it is big and round, and other times it looks like a tiny crescent. Why do you think it changes? The answer has to do with the positions of the Moon and the Sun and how they look from our view on Earth.

Just as Earth travels in an orbit around the Sun, the Moon travels in an orbit around Earth. The Moon orbits in the same counterclockwise direction as Earth. It takes about 29 days (almost one month) for the Moon to make one complete orbit of Earth. As the Moon travels around its orbit, the amount of surface we see that reflects sunlight changes. That is the reason why sometimes the Moon appears large, and other times it appears small. As the Moon completes its orbit once a month, these changes in its appearance are called **lunar** (moon) **phases**.

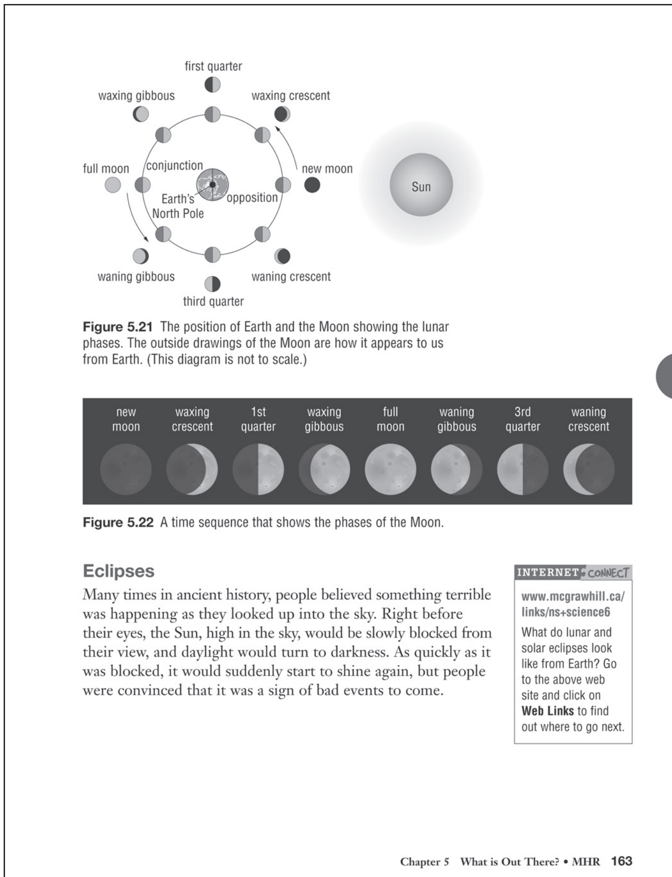


Figure 5.21 The position of Earth and the Moon showing the lunar phases. The outside drawings of the Moon are how it appears to us from Earth. (This diagram is not to scale.)

Figure 5.22 A time sequence that shows the phases of the Moon.

Eclipses

Many times in ancient history, people believed something terrible was happening as they looked up into the sky. Right before their eyes, the Sun, high in the sky, would be slowly blocked from their view, and daylight would turn to darkness. As quickly as it was blocked, it would suddenly start to shine again, but people were convinced that it was a sign of bad events to come.

INTERNET CONNECT

www.mcgrawhill.ca/links/ns+science6

What do lunar and solar eclipses look like from Earth? Go to the above web site and click on **Web Links** to find out where to go next.

Common Misconceptions

- The Moon is often described as rising at night. It actually appears in the sky at various times throughout the day and can be seen at different times each day. It does not generate light. It reflects light from the Sun.
- During a solar eclipse, although the Sun is blocked, it is not safe to look at the Sun. There are safe ways to view eclipses using devices such as goggles and pinhole cameras.

READING Check Students' answers should include statements such as, "Earth completes one orbit each time it goes all the way around the Sun once." or "The Moon orbits Earth each month."

INTERNET CONNECT Students will find links to representations of lunar and solar eclipses.

CONDUCT AN INVESTIGATION 5-I MODELLING MOON MOVEMENT

Purpose

- Students will discover how the movement of the Moon causes the phases of the Moon and solar and lunar eclipses.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Reserve a projector from your school's audiovisual library

MATERIALS	
– overhead projector	– black marker
– volleyball	– white chart paper
– baseball	

Suggested Time

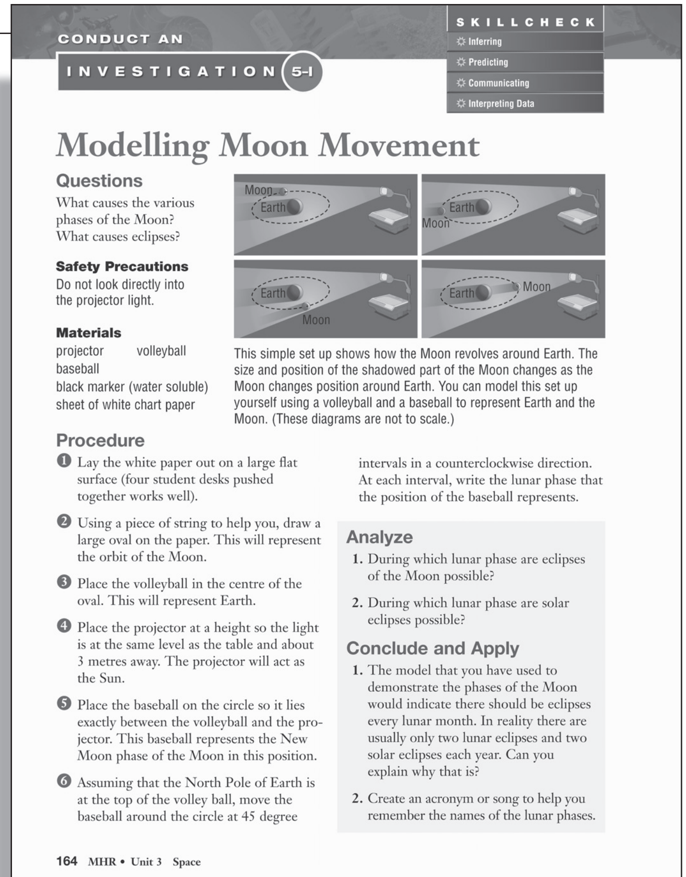
- 30 min for discussion and completion of the activity
- 15 min for completion and discussion of the Analyze and Conclude and Apply questions.

Safety Precaution

- Advise students to not look directly into the light from the projector.

HINTS & HELPS

- Having the paper laid out for each group before the activity begins will save some time and explanation during the activity.
- Use small chairs or desks to set up the projector at the correct height to complete the investigation.



CONDUCT AN INVESTIGATION 5-I

SKILLCHECK
- Inferring
- Predicting
- Communicating
- Interpreting Data

Modelling Moon Movement

Questions

What causes the various phases of the Moon? What causes eclipses?

Safety Precautions

Do not look directly into the projector light.

Materials

projector, volleyball, baseball, black marker (water soluble), sheet of white chart paper

This simple set up shows how the Moon revolves around Earth. The size and position of the shadowed part of the Moon changes as the Moon changes position around Earth. You can model this set up yourself using a volleyball and a baseball to represent Earth and the Moon. (These diagrams are not to scale.)

Procedure

1. Lay the white paper out on a large flat surface (four student desks pushed together works well).
2. Using a piece of string to help you, draw a large oval on the paper. This will represent the orbit of the Moon.
3. Place the volleyball in the centre of the oval. This will represent Earth.
4. Place the projector at a height so the light is at the same level as the table and about 3 metres away. The projector will act as the Sun.
5. Place the baseball on the circle so it lies exactly between the volleyball and the projector. This baseball represents the New Moon phase of the Moon in this position.
6. Assuming that the North Pole of Earth is at the top of the volley ball, move the baseball around the circle at 45 degree intervals in a counterclockwise direction. At each interval, write the lunar phase that the position of the baseball represents.

Analyze

1. During which lunar phase are eclipses of the Moon possible?
2. During which lunar phase are solar eclipses possible?

Conclude and Apply

1. The model that you have used to demonstrate the phases of the Moon would indicate there should be eclipses every lunar month. In reality there are usually only two lunar eclipses and two solar eclipses each year. Can you explain why that is?
2. Create an acronym or song to help you remember the names of the lunar phases.

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Today we know that these people were watching an event that occurs because of the orbital paths of Earth and the Moon. Sometimes in their paths, the Moon and Earth move into a straight line with the Sun. When this happens, either the Moon or the Sun can become blocked from our view for a brief time. This event is called an eclipse. There are two types of eclipses: a **lunar eclipse**, and a **solar eclipse**.

During a lunar eclipse, Earth moves between the Moon and Sun, and blocks the Sun's light from reaching the Moon (the Moon is in Earth's shadow) (Figure 5.23). A solar eclipse happens when the Moon travels between Earth and the Sun, and prevents most of the Sun's light from reaching Earth (the Moon casts a shadow on Earth) (Figure 5.24). If the Moon and Sun are in a perfect line, it is called a total eclipse, but these do not happen very often. Most eclipses are partial eclipses because the Moon and Sun are not in a perfect line.

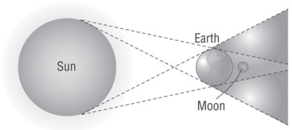


Figure 5.23 During a lunar eclipse, Earth is between the Moon and Sun, and casts a shadow over the Moon.

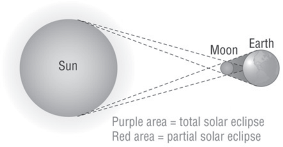


Figure 5.24 During a solar eclipse, the Moon passes in between Earth and the Sun and casts a shadow on Earth.

Implementing the Investigation

- Divide the class up into groups determined by the number of projectors available to the class.

Adaptations

- Ensure students with visual difficulties get a good look at the changing light pattern on the baseball.
- Students who show strength in astronomy may explore the phase-locking of the Moon's orbital and rotational periods.

Investigation Wrap-Up

- Review the Analyze and Conclude and Apply questions as a class.
- Watch online videos of lunar and solar eclipses. (An Internet search will turn up many good videos.)

Assessment Option

- Use Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 5-I Modelling Moon Movement.

Analyze Answers

1. Eclipses of the Moon are possible during the full moon phase.
2. Eclipses of the Sun are possible during the new moon phase.

Conclude and Apply Answers

1. The reason there are only two lunar eclipses and two solar eclipses each year is that the Sun, Earth, and the Moon do not orbit in a straight line. The Moon orbits around the centre of Earth, which is tilted at a 23.5° angle on its axis, thus a perfect alignment does not occur every month.
2. NM WaxC 1Q WaxG FM WanG 3Q WanC NM or DOC are sometimes used to represent D (shape of waxing), O (full moon) and C (shape of waning).

TIDES

BACKGROUND INFORMATION

- Although the Sun exerts the largest gravitational force in our solar system, the proximity of the Moon to Earth means the gravity of the Moon is the force that influences the tides on Earth.
- The strength of the gravitational attraction between two objects depends on two factors: the mass of the two objects and the distance between them. The amount of water in Earth's oceans and seas gives it a large mass. The gravitational pull of the Moon on the mass of water on Earth causes tides.

TEACHING STRATEGIES

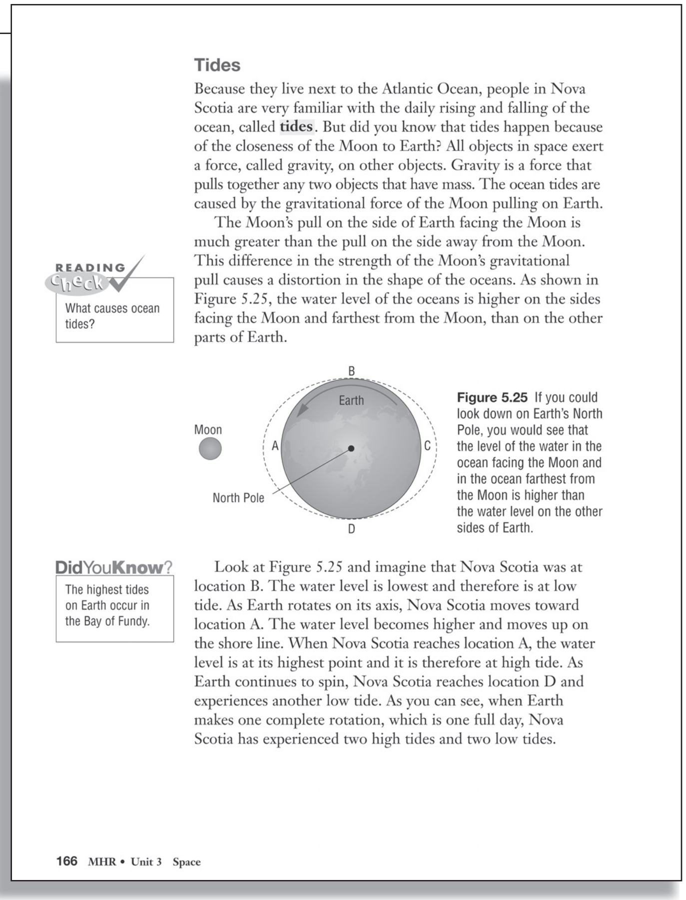
- **Begin the Lesson**—Ask students to speculate in their logbooks about what causes tides and how tides affect their lives.
- **After Teaching**—*ICT Option:* Tides are sometimes difficult for students to visualize. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to animations that help students see the cause of tides.
  - *ICT Option:* Environment Canada keeps up-to-date tide tables for bodies of water across the country. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to the charts. Ask students to track the tide times for various places over a one- or two-week period. Ask them to make some predictions based on their data.

Common Misconception

- The tidal arrival times can vary in one region. The Moon is the main trigger of tides, but the local geography can accelerate or delay the exact time that high and low tides arrive in an area.

Reading Check Ocean tides are caused by gravitational interactions between the Moon and the oceans.

Did You Know? The extreme high tides in the Bay of Fundy have made it a major scientific, tourist, and development area. Studies are currently being done to see if the tides can be used to generate electricity.



Tides

Because they live next to the Atlantic Ocean, people in Nova Scotia are very familiar with the daily rising and falling of the ocean, called **tides**. But did you know that tides happen because of the closeness of the Moon to Earth? All objects in space exert a force, called gravity, on other objects. Gravity is a force that pulls together any two objects that have mass. The ocean tides are caused by the gravitational force of the Moon pulling on Earth.

The Moon's pull on the side of Earth facing the Moon is much greater than the pull on the side away from the Moon. This difference in the strength of the Moon's gravitational pull causes a distortion in the shape of the oceans. As shown in Figure 5.25, the water level of the oceans is higher on the sides facing the Moon and farthest from the Moon, than on the other parts of Earth.

Reading Check: What causes ocean tides?

Figure 5.25 If you could look down on Earth's North Pole, you would see that the level of the water in the ocean facing the Moon and in the ocean farthest from the Moon is higher than the water level on the other sides of Earth.

Did You Know? The highest tides on Earth occur in the Bay of Fundy.

Look at Figure 5.25 and imagine that Nova Scotia was at location B. The water level is lowest and therefore is at low tide. As Earth rotates on its axis, Nova Scotia moves toward location A. The water level becomes higher and moves up on the shore line. When Nova Scotia reaches location A, the water level is at its highest point and it is therefore at high tide. As Earth continues to spin, Nova Scotia reaches location D and experiences another low tide. As you can see, when Earth makes one complete rotation, which is one full day, Nova Scotia has experienced two high tides and two low tides.

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THINK & LINK INVESTIGATION 5-J TIDE'S IN, TIDE'S OUT

Purpose

- Students will learn how to use tide tables to keep track of the rise and fall of the ocean in their local area and compare the local tides with those of a neighbouring area.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Reserve the computer lab or research centre for your class.

MATERIALS
– Internet resources – tide charts

Suggested Time

- 5 min per day for 7 days for local data collection
- 5 min per day for 7 days for comparison data collection
- 20 min for comparison of results and wrap-up activity

THINK & LINK

INVESTIGATION 5-J

SKILLCHECK
- Inferring
- Predicting
- Communicating
- Interpreting Data

Tide's In, Tide's Out

Think About It

Living near the ocean means being aware of the tides. Everyone needs to be careful not to get caught walking far out onto the shore during low tide, only to discover that the high tide is coming in. Most coastal areas now offer timetables to help you calculate high and low tide times. But did you know that the tide times and heights can be different for other places? Even a community that is down the coast might have different tide times and heights. Let's see if we can explain why.

Figure 5.27 The Bay of Fundy is known throughout the world for its high tides. Look how far these boats rise during high tide.

Procedure

1. Check your local newspaper or an Internet site for tide times and heights in your area. (When using the Internet, use search key words "tide table".)
2. For one week, keep track of high and low tide times and the tide heights. Create a chart each day in your notebook that looks like this:

Tide Times: Week 1

Date: Monday	
Time	Height
High:	
Low:	
High:	
Low:	

3. After one week, locate a tide table for the same week in a community in another Atlantic province.

Analyze

1. Compare the tide times from your findings to those of the other community. What differences can you find? Record your findings in your notebook.
2. As a class, discuss the differences that you found between the two sets of tide times and heights.
3. Brainstorm explanations for the reasons why different areas would have different tide times and tide heights.

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Safety Precaution

- Advise students of safe Internet use guidelines.

HINTS & HELPS

- The activity can be done in one class session by printing off tide tables from the government of Canada web site and examining and comparing them. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to the charts.

Implementing the Investigation

- Students should work in groups of no more than two students when completing this activity.
- The activity may be completed as an entire class group through the use of a data projector and computer tide tables.
- Distribute BLM 5.6 Tide's In, Tide's Out for students to use to record their data or have students create their own data tables.

Adaptation

- Prepare tide tables beforehand for students with limited computer access at home or school.

Investigation Wrap-Up

- Place the tide tables together on one poster board and put it up for the class to view.
- Complete and review Analyze questions.

Assessment Option

- Use Process Skills Rubric 15, Interpreting Data and/or Process Skills Rubric 17, Measuring and Reporting to assess student work in Think & Link Investigation 5-J Tide's In, Tide's Out.

Analyze Answers

1. The tidal times in the different communities are likely due to different geography of the tidal basins or slightly different locations on the globe.
2. Students should note the maximum and minimum water levels and variations in the times of the arrival of high and low tides.
3. Answers should focus on slightly different locations on the globe and the different geographies of the tidal locations.

SECTION 5.2 SUMMARY

Read the section summary together as a class and have the students review and update the key terms list in their science logbooks.

- Ask students to write a paragraph that describes the role of the Moon in our lives on Earth.
- Have students describe the relationship between the Sun, Earth, and the Moon, and identify ways that they affect one another.

✓ ASSESSMENT OPTIONS FOR SECTION 5.2

- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook to evaluate them.
- Use the following rubrics to assess student work:
  – Process Skills Rubric 8, Developing Models and/or Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 5-G Model Earth's Rotation
  – Process Skills Rubric 8, Developing Models to assess student work in Find Out Activity 5-H Seeing the Reasons for the Seasons
  – Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 5-I Modelling Moon Movement
  – Process Skills Rubric 15, Interpreting Data and/or Process Skills Rubric 17, Measuring and Reporting to assess student work in Think & Link Investigation 5-J Tide's In, Tide's Out

Section 5.2 Summary

In this section you learned that:
- Day and night occur because of Earth's rotation.
- The tilt of Earth's axis stays the same as it orbits the Sun, and this explains why Earth experiences changing seasons.
- Solar and lunar eclipses happen when the Moon and Earth are in a straight line with the Sun and cast a shadow on each other.
- The Moon goes through a lunar cycle each month as it orbits Earth.
- Tides are caused by the difference in the Moon's gravitational pull between opposite sides of Earth.

Key Terms
axis
orbit
lunar phases
solar eclipse
lunar eclipse
tides

Check Your Understanding
1. Explain how Earth experiences day and night.
2. What is the connection between the tilt of Earth and the seasons?
3. During one month, why does the Moon look different each night?
4. How do solar and lunar eclipses occur?
5. Show how you could model a solar eclipse to a fellow student.
6. Explain why you only observe tides in oceans and not in lakes or ponds.

Pause& Reflect

Would you like to ride a space elevator to the Moon? Engineers are designing a paper-thin, super-strong ribbon of carbon between Earth and a space station in geostationary orbit. An elevator attached to the 100 000 km-long ribbon could haul equipment—and even people—up into space.

Draw a picture of what this elevator might look like. Record your ideas about the view you would have from the elevator. What kinds of problems do you think engineers would encounter trying to build this elevator?

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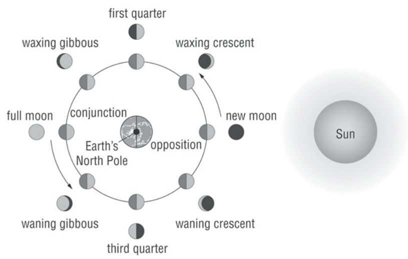
Check Your Understanding Answers

1. Earth experiences day and night because it rotates on its axis as it orbits the Sun. While Earth rotates, only one portion of Earth faces the Sun (day); and parts that do not face the Sun experience night.
2. The tilt of Earth is the key cause of the seasons. In the summer, Nova Scotia is tilted towards the Sun, and it experiences a high concentration of sunlight. In the winter, Nova Scotia is tilted away from the Sun and the Sun's rays are weaker.
3. The Moon goes through phases every 28 days because of the relative positions of Earth, the Moon, and the Sun. When the Moon is between Earth and the Sun, we see a new moon; when the Moon is on the opposite side of Earth from the Sun, we see a full moon; and the Moon waxes and wanes as it moves through its orbit.
4. Solar eclipses occur when the Moon passes directly between Earth and the Sun, blocking the Sun's light and causing a shadow to be cast on Earth. Lunar eclipses occur when Earth passes directly between the Sun and the Moon, blocking the Sun's light on the Moon and causing a shadow to be cast on it.
5. You could model a solar eclipse to a fellow student using a flashlight, another student, and your own body. Have two students stand apart so that one is shining the flashlight towards the other. Walk slowly between the two students and ask the student on the inside to describe the changes in the light.
6. We observe tides in oceans but not in small lakes and ponds because only large masses of water, such as in the oceans, are noticeably affected by the gravitational pull of the Moon. (The greater the mass of one object, the larger the gravitational attraction between two objects.) Because lakes and ponds are relatively small, the gravitational attraction between these bodies of water and the Moon is not enough to affect the water level.

Prepare Your Own Chapter Summary

Summarize this chapter by doing one of the following:
- Create a graphic organizer such as a concept map.
- Produce a poster.
- Write a summary to include the key chapter ideas.

Here are a few ideas to use as a guide:
- Write a pamphlet for visitors to Earth to help guide them on the different things they might see in the night sky.
- Create a news program or documentary to show how Canadians are involved in space exploration.
- Draw a poster showing the different technologies we use to get around in space.



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Pause & Reflect Student diagrams and descriptions should include references to the size of the ribbon and elevator, the view of Earth as a blue and green sphere, and the Moon. Some problems engineers might encounter in construction would be fixing the elevator to a satellite, building such a large device here on Earth and the development of new technologies required to erect the elevator.

Prepare Your Own Chapter Summary

This is a very large chapter. Students may need to build their summaries by section or topic in order to manage the material. Student summaries should incorporate the following main ideas:

- Human understanding of the solar system changed from an Earth-centred view to a Sun-centred view based on observations from several scientists.
- Telescopes come in a number of different varieties with different functions.
- Our current knowledge of the universe would not have been possible without the development of a variety of technologies.
- Objects in the solar system include the Sun, planets, asteroids, comets, and meteors.
- Canadians have played an important role in the exploration of space and the development of space technology.
- The rotation of Earth on its axis as it orbits the Sun means our planet experiences day and night.
- The tilt of Earth's axis as it orbits the Sun is the reason for the seasons on Earth.
- As the Moon travels around its orbit each month, the amount of surface of the Moon we see that reflects the Sun changes, creating the different moon phases.
- Eclipses occur when the Moon, Earth, and the Sun are in a straight line. The body in the middle blocks the Sun's light and casts a shadow on the other.
- Tides are the result of the Moon's gravitational pull.