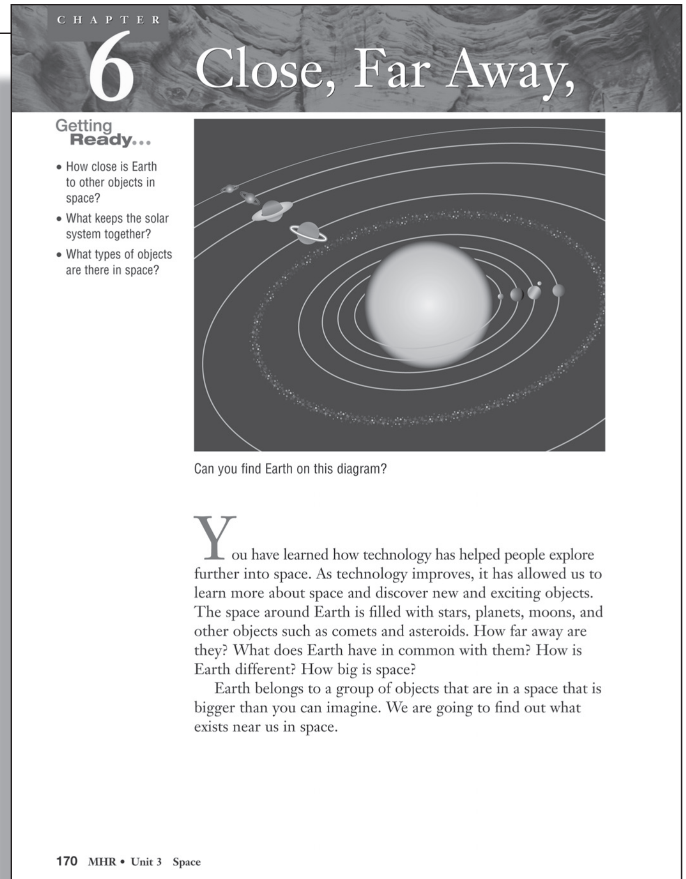
USING THE CHAPTER 6 OPENER

TEACHING STRATEGIES

- **Begin the Lesson**—Discuss the diagram and locate each planet. Have students discuss the situation pictured in which all of the planets are in two close groups. *Is this a common occurrence?* No. *Is Earth the only planet with moons?* It is not, although it's the only one shown with moons in this diagram.
- **During Teaching**—Ask students to create their own definitions of key terms using language that makes sense of their observations. Distribute BLM 6.1 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.
  – Have students complete the Getting Ready questions in pairs.
  – Read the *What You Will Learn*, *Why It Is Important*, and *Skills You Will Use* sections aloud together.
  – Discuss and complete Starting Point Activity 6-A as a class.



CHAPTER 6 Close, Far Away,

Getting Ready...

- How close is Earth to other objects in space?
- What keeps the solar system together?
- What types of objects are there in space?

Can you find Earth on this diagram?

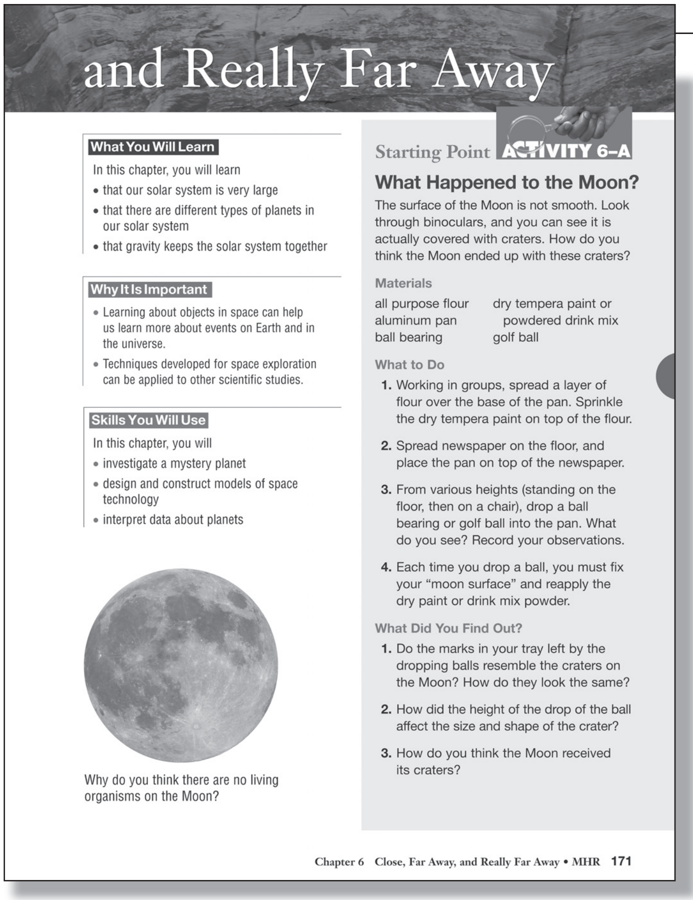
You have learned how technology has helped people explore further into space. As technology improves, it has allowed us to learn more about space and discover new and exciting objects. The space around Earth is filled with stars, planets, moons, and other objects such as comets and asteroids. How far away are they? What does Earth have in common with them? How is Earth different? How big is space?

Earth belongs to a group of objects that are in a space that is bigger than you can imagine. We are going to find out what exists near us in space.

170 MHR • Unit 3 Space

Getting Ready Answers

- **How close is Earth to other objects in space?** Earth's nearest neighbour is the Moon (approximately 385 000 km away); the closest planet is Venus (approximately 40 000 000 km away), and the closest star is the Sun (approximately 149 598 000 km away). The distance to the next nearest star is approximately 43 518 430 700 000 km.
- **What keeps the solar system together?** The force of gravity keeps the solar system together. The Sun is more massive than any other object in our solar system (330 000 times the mass of Earth). This creates a strong gravitational pull towards the Sun, which holds the solar system together.
- **What types of objects are there in space?** In space there are planets, galaxies (clusters of stars), black holes (dead stars), super novae (exploding stars), nebulae (future stars), giant stars, dwarf stars, and objects that orbit stars (planets, comets, asteroids, moons).
- **Further question: How many galaxies and stars are there in the universe?** Current estimates are that there are 100 billion or more galaxies, each containing hundreds of billions of stars.



and Really Far Away

What You Will Learn

In this chapter, you will learn
- that our solar system is very large
- that there are different types of planets in our solar system
- that gravity keeps the solar system together

Why It Is Important

- Learning about objects in space can help us learn more about events on Earth and in the universe.
- Techniques developed for space exploration can be applied to other scientific studies.

Skills You Will Use

In this chapter, you will
- investigate a mystery planet
- design and construct models of space technology
- interpret data about planets

Why do you think there are no living organisms on the Moon?

Starting Point ACTIVITY 6–A

What Happened to the Moon?

The surface of the Moon is not smooth. Look through binoculars, and you can see it is actually covered with craters. How do you think the Moon ended up with these craters?

Materials

all purpose flour, aluminum pan, ball bearing, dry tempera paint or powdered drink mix, golf ball

What to Do

1. Working in groups, spread a layer of flour over the base of the pan. Sprinkle the dry tempera paint on top of the flour.
2. Spread newspaper on the floor, and place the pan on top of the newspaper.
3. From various heights (standing on the floor, then on a chair), drop a ball bearing or golf ball into the pan. What do you see? Record your observations.
4. Each time you drop a ball, you must fix your "moon surface" and reapply the dry paint or drink mix powder.

What Did You Find Out?

1. Do the marks in your tray left by the dropping balls resemble the craters on the Moon? How do they look the same?
2. How did the height of the drop of the ball affect the size and shape of the crater?
3. How do you think the Moon received its craters?

Chapter 6 Close, Far Away, and Really Far Away • MHR 171

STARTING POINT ACTIVITY 6-A WHAT HAPPENED TO THE MOON?

Purpose
- Students will examine impact marks to discover why the surface of the Moon is cratered.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Begin collecting newspapers for the activity.
1 day before	– Sort supplies so that each group has a complete set of materials.

MATERIALS
– aluminum pan – ball bearing – golf ball – all-purpose flour – dry tempera paint or powdered drink mix – newspaper

Suggested Time
- 5 min for discussion of the activity and distribution of activity kits
- 15 min for completion of activity
- 10 min for completion and discussion of What Did You Find Out? questions

Safety Precautions
- Students should take care to keep paint out of their eyes.
- Advise students not to inhale powders.

HINTS & HELPS
- Prepare a large demonstration (using a basketball) for the class to complete following the activity to discuss large impacts.

Implementing the Activity
- Spread the newspaper completely to prevent any of the paint from getting on the floor (it will run when it gets wet).

Adaptation
- The What Did You Find Out? questions may be completed orally for students with literacy difficulties.

Activity Wrap-Up
- Review the What Did You Find Out? questions with the class aloud.

What Did You Find Out? Answers
1. The marks on the tray resembled the shapes and depths of craters in that they are dark and concentrated at the centre and spread away from the centre point. They also have streaks along the outside edges.
2. The higher the ball, the larger and more spread out the crater.
3. The Moon received all of its craters from impacts with asteroids and other large objects that hit its surface.

SECTION 6.1 INSIDE THE SOLAR SYSTEM

What Students Do in Section 6.1

- learn the relative scale of the solar system
- discover all of the main bodies that make up the solar system
- describe the basic properties of the Sun and each of the planets in the solar system
- define the term moon, and describe some of the moons in the solar system

BACKGROUND INFORMATION

- The timeframe for changes to the view of the solar system was fairly rapid. It was believed for more than a thousand years that Earth was the centre of the universe and solar system. This view was changed, not without some backlash, during a 200-year period.
- Pluto was reclassified as a dwarf planet by the International Astronomical Union in August 2006. The reclassification was due to the size of Pluto, and the fact it had not cleared the surrounding space of other objects. There are currently three official dwarf planets: Pluto, Ceres (in the asteroid belt) and Eris (beyond Pluto).

TEACHING STRATEGIES

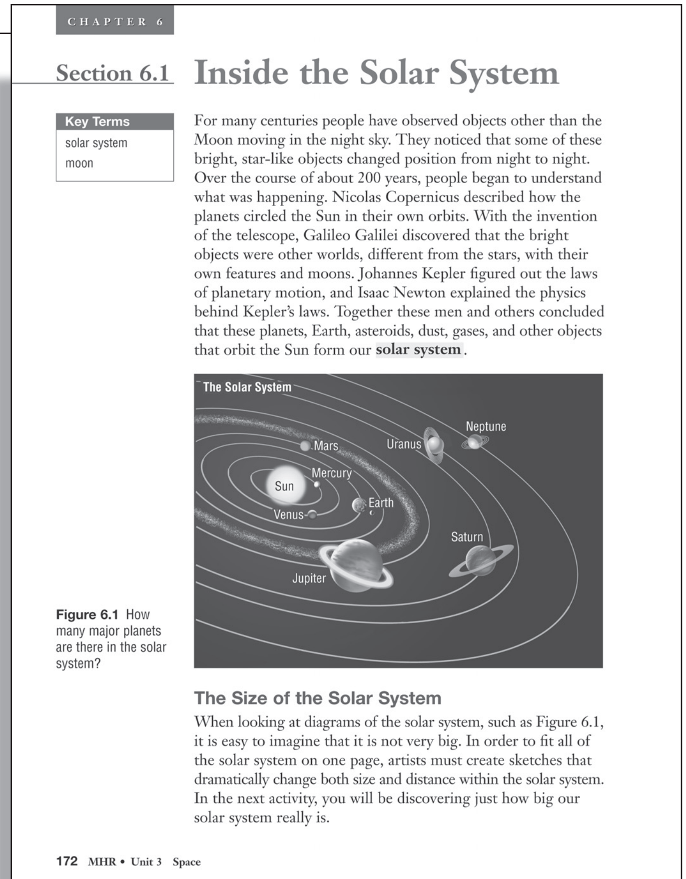
- **Begin the Lesson**—Ask students to define the solar system in their own words in their science logbooks and to speculate on the size of the solar system.
- **During Teaching**—Read the section introduction aloud as a class and discuss some of the names of the scientists involved in changing our view of the solar system. Which names do the students know? How do they know them?
  - Examine Figure 6.1 and discuss the caption as a class.

Common Misconception

- Many still believe, and will argue, that Pluto is a planet.

Figure 6.1

- There are eight major planets in the solar system.



CHAPTER 6

Section 6.1 Inside the Solar System

Key Terms
solar system
moon

For many centuries people have observed objects other than the Moon moving in the night sky. They noticed that some of these bright, star-like objects changed position from night to night. Over the course of about 200 years, people began to understand what was happening. Nicolas Copernicus described how the planets circled the Sun in their own orbits. With the invention of the telescope, Galileo Galilei discovered that the bright objects were other worlds, different from the stars, with their own features and moons. Johannes Kepler figured out the laws of planetary motion, and Isaac Newton explained the physics behind Kepler's laws. Together these men and others concluded that these planets, Earth, asteroids, dust, gases, and other objects that orbit the Sun form our **solar system**.

Figure 6.1 How many major planets are there in the solar system?

The Size of the Solar System

When looking at diagrams of the solar system, such as Figure 6.1, it is easy to imagine that it is not very big. In order to fit all of the solar system on one page, artists must create sketches that dramatically change both size and distance within the solar system. In the next activity, you will be discovering just how big our solar system really is.

172 MHR • Unit 3 Space

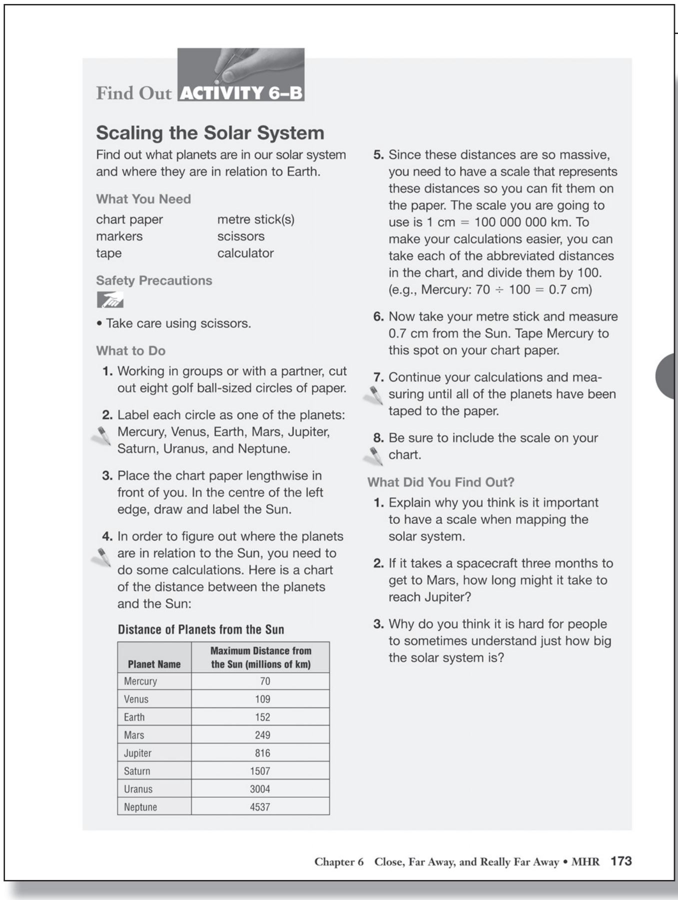
THE SIZE OF THE SOLAR SYSTEM

BACKGROUND INFORMATION

- Most models of the solar system are not created to scale. This is because a scale model would take up more space than is available.
- The astronomical unit (AU) is often used to describe the scale of the solar system. 1 AU is the average distance between Earth and the Sun (149 598 000 km).

TEACHING STRATEGIES

- **Begin the Lesson**—Discuss the term scale with the class and provide some examples of scale using differently sized spheres. Alternatively, use a map to demonstrate the concept.
  - Ask students to recall any math lessons they have had that relate to scale.
  - Have the students define the term scale, as it relates to the position of objects in relation to one another, in their science logbooks. Have them predict the types of scales used to describe the distances between the Sun and planets of the solar system, the distance between stars, and the distance between galaxies. Would they use the same units?



Find Out ACTIVITY 6–B

Scaling the Solar System

Find out what planets are in our solar system and where they are in relation to Earth.

What You Need

chart paper
markers
tape
metre stick(s)
scissors
calculator

Safety Precautions

• Take care using scissors.

What to Do

1. Working in groups or with a partner, cut out eight golf ball-sized circles of paper.
2. Label each circle as one of the planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.
3. Place the chart paper lengthwise in front of you. In the centre of the left edge, draw and label the Sun.
4. In order to figure out where the planets are in relation to the Sun, you need to do some calculations. Here is a chart of the distance between the planets and the Sun:

Distance of Planets from the Sun

Planet Name	Maximum Distance from the Sun (millions of km)
Mercury	70
Venus	109
Earth	152
Mars	249
Jupiter	816
Saturn	1507
Uranus	3004
Neptune	4537

5. Since these distances are so massive, you need to have a scale that represents these distances so you can fit them on the paper. The scale you are going to use is 1 cm = 100 000 000 km. To make your calculations easier, you can take each of the abbreviated distances in the chart, and divide them by 100. (e.g., Mercury: 70 ÷ 100 = 0.7 cm)
6. Now take your metre stick and measure 0.7 cm from the Sun. Tape Mercury to this spot on your chart paper.
7. Continue your calculations and measuring until all of the planets have been taped to the paper.
8. Be sure to include the scale on your chart.

What Did You Find Out?

1. Explain why you think is it important to have a scale when mapping the solar system.
2. If it takes a spacecraft three months to get to Mars, how long might it take to reach Jupiter?
3. Why do you think it is hard for people to sometimes understand just how big the solar system is?

Chapter 6 Close, Far Away, and Really Far Away • MHR 173

Common Misconception

- Many models of the solar system show the planets all aligned on one side of the Sun. This does not occur very often in reality.

FIND OUT ACTIVITY 6-B SCALING THE SOLAR SYSTEM

Purpose

- Students will identify the planets in the solar system and discover the relative distances between them.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 days before	– Collect supplies so that each group can complete the activity.

MATERIALS
– scissors – calculator – metre sticks – chart paper – markers – tape

Suggested Time

- 30 min for discussion and completion of activity
- 10 min for completion of activity wrap-up and What Did You Find Out? questions

Safety Precaution

- Remind students to be careful when using scissors.

HINTS & HELPS

- Time can be saved by cutting out the planets before the activity and distributing them to each group.
- There are a number of web sites that help students visualize the scale of the solar system. Use your web browser to search for The Maine Solar System Model or search the terms "solar system, peppercorn model" for information on how to make a classroom scale model.

Implementing the Activity

- Have each group complete the activity and share their scale with other groups before completing the What Did You Find Out? section.
- Prepare a large-scale model for the class using spheres and the classroom floor as the chart paper.

Adaptations

- Advanced students could also include the mass and radius of the planets and the Sun in their scale models.
- Students with numeracy challenges should be paired with students comfortable working with numbers.

Activity Wrap-Up

- Prepare and examine a class-size model of the scale of the solar system.
- Complete and discuss the What Did You Find Out? section together as a class.

Assessment Option

- Use Process Skills Rubric 8, Developing Models to assess student work in Find Out Activity 6-B Scaling the Solar System.

What Did You Find Out? Answers

1. It is important to have a scale when mapping the solar system in order to determine the relative position of objects to one another and in order to accurately describe any interactions between the different objects of the solar system.
2. Jupiter is almost seven times further from Earth than Mars is, so it will take approximately 21 months for the same spacecraft to reach Jupiter.
3. It is hard for people to comprehend the size of the solar system because of our experience here on Earth. An elephant is big compared to a human, but extremely small on a solar scale. A complete change in perspective is required to comprehend the size of the solar system.

GRAVITY AND ORBITS/THE SUN

BACKGROUND INFORMATION

- Students studied gravity in Science 5. You may wish to do a brief review. Gravity is the force of attraction between two objects based upon their mass. The attraction increases as the mass of the two objects increases. The strength of the attraction decreases as the distance between the two objects increases. The extremely large relative mass of the Sun means that all objects orbit around it, but the relatively close distance to the Moon means that Earth, not the Sun, controls its orbit.
- All objects experience a force of gravity in relation to one another. The chair you sit on exerts a gravitational pull on you. This pull is much smaller than that of much larger Earth, so it goes unnoticed.
- Space exploration has been aided by the gravitational pull of other planets. Deep-space probes use the gravitational pulls of planets they approach to accelerate them and allow them to explore deeper space.
- The constant nuclear reactions from deep within the Sun provide the light and heat that supports life on Earth.
- Galileo discovered markings called sunspots on the surface of the Sun in 1610.
- Gravity on the surface of the Sun is 28 times greater than on Earth. A person who weighs 70 kg here on Earth would weigh almost 2000 kg on the Sun.
- The solar wind is comprised of streams of gas particles that flow outward from the Sun.
- The Milky Way is held together by gravity. Just as the planets orbit around the Sun, the Sun orbits around the centre of the Milky Way.
- The Sun's atmosphere, the corona, reaches extremely high temperatures. This energy causes some of the corona to escape the Sun's gravitational pull and leave the Sun as a solar wind travelling approximately 400 km/s.

Gravity and Orbits

So what keeps all these planets in one solar system, orbiting around the Sun? The answer is gravity. As you know, gravity is a force that pulls together any two objects that have *mass* (the amount of matter in an object). The strength of the gravitational attraction between two objects depends on the masses of the objects. It also depends inversely on the distance between them. This means that the gravitational force between two masses gets larger as the masses get larger. It also means that as the distance between two masses gets larger, their gravitational attraction gets smaller.

Now, think of all the objects in the solar system: the Sun, planets, moons, asteroids, and other objects. All of these objects have *mass*. The Sun has the largest mass and therefore tends to dominate or control the orbital motion of all the planets and other objects in the solar system. The other objects in the solar system have much smaller masses than the Sun and therefore have less influence. If the Sun were to suddenly disappear, its mass would vanish, and its gravitational field would disappear. As a result, each planet and solar system object would "fly" off into space in a straight line.

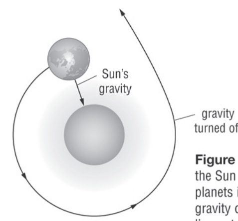


Figure 6.2 The gravitational force of the Sun keeps Earth and all of the other planets in their orbits. If you could turn gravity off, Earth would travel in a straight line out into space.

174 MHR • Unit 3 Space

TEACHING STRATEGIES

- **Begin the Lesson**—Ask students to define gravity in their own words, using their prior knowledge. Have them write their definitions in their logbooks or use one of the vocabulary BLMs provided for this unit.
  – Have students hold a large bed sheet securely and then drop in several differently sized balls. All of the balls will circle around and eventually fall into the ball with the largest mass. This motion models the gravitational interactions of the objects in the solar system.
  – Discuss what the universe would be like without gravity. Have students predict where they would be if the gravity of Earth was suddenly "turned off."
- **During Teaching**—BLM 6.2 The Structure of the Sun provides a larger version of Figure 6.3 and can be used as an overhead master.

The Sun

Without the Sun in space, life on Earth would not exist. The Sun is a huge ball of hot gases, similar to billions of other stars that we see in the night sky. In fact, the Sun is a star. The Sun looks different from other stars because it is part of our solar system and we are much closer to it.

Using observations and measurements from different instruments, scientists have learned a great deal about the structure of the Sun. Some of the Sun's features are shown in Figure 6.3.

Pause& Reflect

In Spanish the Sun is called *el sol*. The French term for the Sun is *le soleil*. Notice that both terms use *sol*. The English word "solar" means "connected with the Sun." Use your dictionary to find other terms that have "solar" in them. List the terms in your notebook.

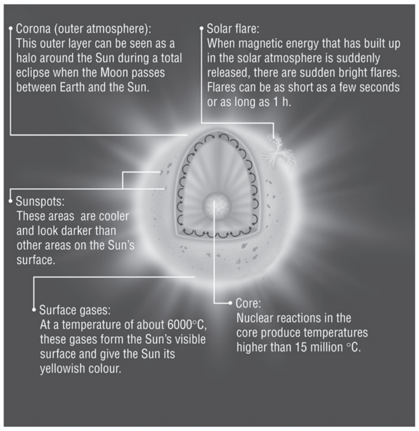


Figure 6.3 The structure of the Sun

- **After Teaching**—Using the facts provided in this section, have the students work in pairs to produce solar interviews. One student (interviewer) asks questions of the other student (the Sun). Once students are comfortable in their roles, have several pairs volunteer to perform their informational skit for the class.
  - Ask students to calculate what they would weigh if they visited the Sun. (Their current weight multiplied by 28.)
  - Some students may wish to do further research about the Sun and its role in Northern Lights (aurora borealis).

Common Misconceptions

- Astronauts in orbit around Earth are not in areas where there is no gravity. The gravitational attraction of Earth keeps the space shuttle and the International Space Station in orbit. The astronauts appear weightless because they are constantly falling towards the centre of Earth. The weightlessness astronauts experience is similar to jumping off a cliff and never landing.
- The Sun has a large variation in temperature throughout its structure. The core is up to 15 000 000°C, the surface has a temperature of only 6000°C, and temperatures in the atmosphere reach more than 1 000 000°C.

Pause& Reflect Student answers could include solar cells, solar electricity, solar furnace, solarium, solar power, and solar system.

Another comparison would be that it would take more than 330 000 Earths to weigh the same amount as the Sun.

The Sun looks brighter to us than other stars because it is much closer to Earth than any other stars.

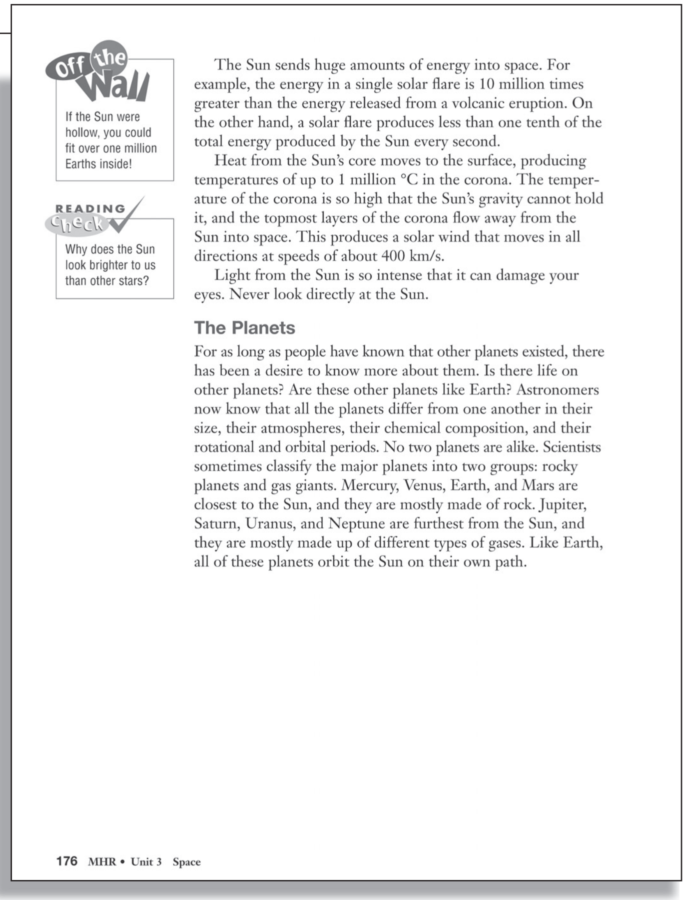
THE PLANETS

BACKGROUND INFORMATION

- All of the planets that orbit the Sun orbit in a counterclockwise motion. All but Venus also rotate in a counterclockwise motion.
- The official definition of a planet stipulates that it must orbit around the Sun, it must have enough mass to be nearly spherical, and it must "clear the neighbourhood around its orbit." This last factor means that the gravitational force of the body in question must dominate the area. The International Astronomical Union delisted Pluto as a planet based on the third factor.

TEACHING STRATEGIES

- **During Teaching**—Read and discuss the section text as a class.
- **After Teaching**—Keep a three-dimensional model of the solar system at the front of the class and vary the location of the planets from day to day.
  - Alternatively, work with students to create a large diorama of the solar system, assigning each planet to a group in the class. They are to research, construct, and do the math to scale the orbits to the size of the diorama (usually a refrigerator box). They will also be asked to create information booklets or cards. The diorama can be put on display for the whole school.



If the Sun were hollow, you could fit over one million Earths inside!

Why does the Sun look brighter to us than other stars?

The Sun sends huge amounts of energy into space. For example, the energy in a single solar flare is 10 million times greater than the energy released from a volcanic eruption. On the other hand, a solar flare produces less than one tenth of the total energy produced by the Sun every second.

Heat from the Sun's core moves to the surface, producing temperatures of up to 1 million °C in the corona. The temperature of the corona is so high that the Sun's gravity cannot hold it, and the topmost layers of the corona flow away from the Sun into space. This produces a solar wind that moves in all directions at speeds of about 400 km/s.

Light from the Sun is so intense that it can damage your eyes. Never look directly at the Sun.

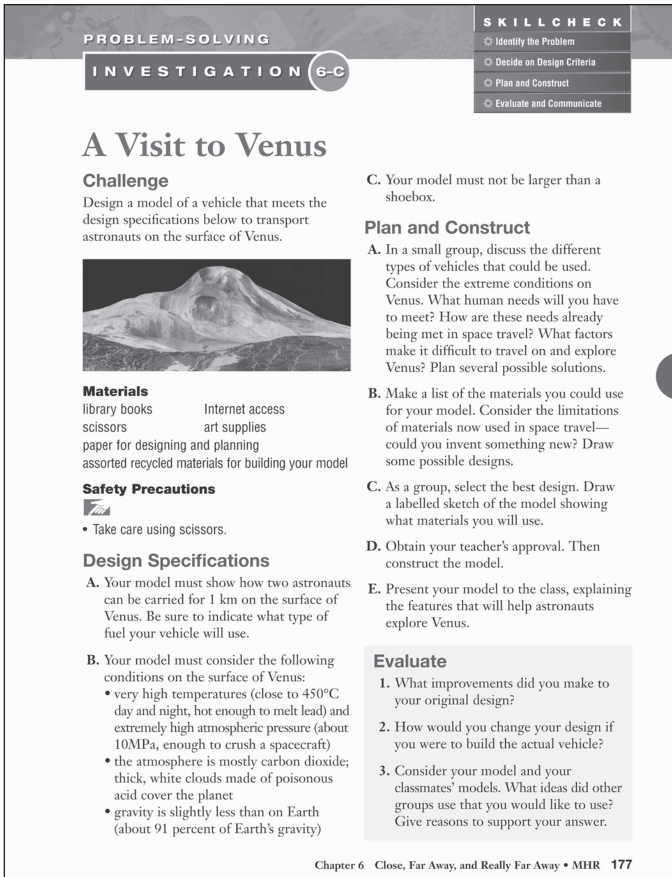
The Planets

For as long as people have known that other planets existed, there has been a desire to know more about them. Is there life on other planets? Are these other planets like Earth? Astronomers now know that all the planets differ from one another in their size, their atmospheres, their chemical composition, and their rotational and orbital periods. No two planets are alike. Scientists sometimes classify the major planets into two groups: rocky planets and gas giants. Mercury, Venus, Earth, and Mars are closest to the Sun, and they are mostly made of rock. Jupiter, Saturn, Uranus, and Neptune are furthest from the Sun, and they are mostly made up of different types of gases. Like Earth, all of these planets orbit the Sun on their own path.

176 MHR • Unit 3 Space

Common Misconceptions

- The gas giants (Jupiter, Saturn, Uranus, and Neptune) are composed mainly of gases. They also have atmospheres with weather patterns that are composed of gaseous mixtures different from the planet itself.
- Saturn is not the only planet with planetary rings. Saturn's rings are the most visible, but each gas giant has its own ring system.



PROBLEM-SOLVING INVESTIGATION 6-C

SKILLCHECK
- Identify the Problem
- Decide on Design Criteria
- Plan and Construct
- Evaluate and Communicate

A Visit to Venus

Challenge

Design a model of a vehicle that meets the design specifications below to transport astronauts on the surface of Venus.

Materials

library books
Internet access
scissors
art supplies
paper for designing and planning
assorted recycled materials for building your model

Safety Precautions

- Take care using scissors.

Design Specifications

A. Your model must show how two astronauts can be carried for 1 km on the surface of Venus. Be sure to indicate what type of fuel your vehicle will use.

B. Your model must consider the following conditions on the surface of Venus:
- very high temperatures (close to 450°C day and night, hot enough to melt lead) and extremely high atmospheric pressure (about 10MPa, enough to crush a spacecraft)
- the atmosphere is mostly carbon dioxide; thick, white clouds made of poisonous acid cover the planet
- gravity is slightly less than on Earth (about 91 percent of Earth's gravity)

C. Your model must not be larger than a shoebox.

Plan and Construct

A. In a small group, discuss the different types of vehicles that could be used. Consider the extreme conditions on Venus. What human needs will you have to meet? How are these needs already being met in space travel? What factors make it difficult to travel on and explore Venus? Plan several possible solutions.

B. Make a list of the materials you could use for your model. Consider the limitations of materials now used in space travel—could you invent something new? Draw some possible designs.

C. As a group, select the best design. Draw a labelled sketch of the model showing what materials you will use.

D. Obtain your teacher's approval. Then construct the model.

E. Present your model to the class, explaining the features that will help astronauts explore Venus.

Evaluate

1. What improvements did you make to your original design?
2. How would you change your design if you were to build the actual vehicle?
3. Consider your model and your classmates' models. What ideas did other groups use that you would like to use? Give reasons to support your answer.

Chapter 6 Close, Far Away, and Really Far Away • MHR 177

PROBLEM-SOLVING INVESTIGATION 6-C A VISIT TO VENUS

Purpose

- Students will investigate the properties of Venus and use the information collected to design a vehicle that will allow for the complete exploration of the planet.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Collect library and Internet resources related to the planet Venus. – Have students bring in materials to build their models.

MATERIALS
– Internet and computer resources – text-based resources – paper and art supplies – recycled materials for constructing models – scissors

Suggested Time

- 30 min for planning and designing model
- 30 min for model construction
- 20 min for class presentations

Safety Precautions

- Advise students of safe Internet practices.
- Remind students to be careful when using scissors.

HINTS & HELPS

- Use Skills Review 8, Technological Problem Solving and the related BLMs to assist students in their planning.
- Review with students some of the necessary components of a planetary explorer.
- Arrange for safe storage of each of the groups' models and materials.

Implementing the Investigation

- Discuss what students know about the environment of Venus. Point out that Venus is a very harsh place for us to explore. The pressure, heat, and sulfuric-acid clouds make it difficult to design and build robots that last for very long on Venus.

Adaptations

- Create an image bank for students to use as models if they have difficulty researching the activity on their own.
- Students with strong artistic skills may be encouraged to draw a full schematic diagram or blueprint of their model explorer.

Investigation Wrap-Up

- Students should have an opportunity to present their model to the class. You can turn this into a peer evaluation activity by having students review and adapt Learning Skills Checklist 2, Developing Models or Process Skills Rubric 8, Developing Models.
- Have the students complete the Evaluate questions and discuss them as a class.

Assessment Option

- Use Learning Skills Checklist 2, Developing Models; Process Skills Rubric 8, Developing Models; and/or Process Skills Rubric 11, Problem Solving to assess student work in Problem-Solving Investigation 6-C A Visit to Venus.

Evaluate Answers

1. Student answers might include refinements to match the temperature, pressure, and gravity on Venus.
2. Based on class discussions and presentations the students should be able to identify the limitations of their spacecraft and the necessary improvements.
3. Students should be able to find at least one possible improvement and present a variety of reasons for choosing it.

CONDUCT AN INVESTIGATION 6-D MISSION TO AN ALIEN PLANET

Purpose

- Students will describe how technology may be used to discover the characteristics of another planet or object in space and to get a closer look at space.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Prepare Planet X with several distinctive features for the class to identify. – Reserve the gymnasium or other area with enough space to complete the activity.
3 days before	– Collect all the materials required to complete the activity.

MATERIALS
– large sphere to create Planet X – telescope (optional) – binoculars (optional) – digital camera (optional) – ruler – paper – markers/paints/pens/crayons – Styrofoam™ balls or other spheres

Suggested Time

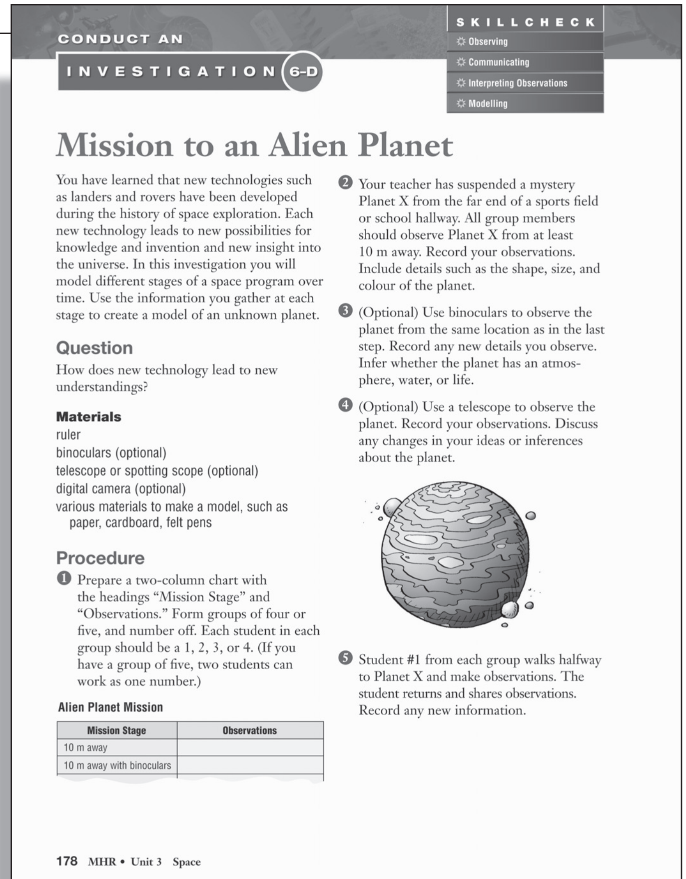
- 10 min for organization and discussion of activity
- 30 min for completion of activity
- 15 min for completion of optional activities
- 20 min for group completion of Analyze and Conclude and Apply
- 10 min for wrap-up discussion

Safety Precautions

- Advise students to spread out when they are approaching or circling the planet.
- Review safe handling and operation of cameras, telescopes, and binoculars.

HINTS & HELPS

- Use contrasting colours on Planet X so students can pick out unique structures from 10 m away.
- Vary the appearance at different points on Planet X, and include water, atmospheric and/or land features.
- Take digital pictures of Planet X before the activity and distribute them to the groups after the viewing.


CONDUCT AN INVESTIGATION 6-D

SKILLCHECK
- Observing
- Communicating
- Interpreting Observations
- Modelling

Mission to an Alien Planet

You have learned that new technologies such as landers and rovers have been developed during the history of space exploration. Each new technology leads to new possibilities for knowledge and invention and new insight into the universe. In this investigation you will model different stages of a space program over time. Use the information you gather at each stage to create a model of an unknown planet.

Question

How does new technology lead to new understandings?

Materials

ruler
binoculars (optional)
telescope or spotting scope (optional)
digital camera (optional)
various materials to make a model, such as paper, cardboard, felt pens

Procedure

1. Prepare a two-column chart with the headings "Mission Stage" and "Observations." Form groups of four or five, and number off. Each student in each group should be a 1, 2, 3, or 4. (If you have a group of five, two students can work as one number.)

Alien Planet Mission

Mission Stage	Observations
10 m away	
10 m away with binoculars	

2. Your teacher has suspended a mystery Planet X from the far end of a sports field or school hallway. All group members should observe Planet X from at least 10 m away. Record your observations. Include details such as the shape, size, and colour of the planet.
3. (Optional) Use binoculars to observe the planet from the same location as in the last step. Record any new details you observe. Infer whether the planet has an atmosphere, water, or life.
4. (Optional) Use a telescope to observe the planet. Record your observations. Discuss any changes in your ideas or inferences about the planet.
5. Student #1 from each group walks halfway to Planet X and make observations. The student returns and shares observations. Record any new information.

178 MHR • Unit 3 Space

Implementing the Investigation

- Place markers around the area to mark the 10 m point away from Planet X. These should be placed at a number of positions around the planet.
- Carefully explain the approaches and fly passes to the students to prevent students from each group from colliding with one another during the activity.
- Distribute BLM 6.3 Mission to an Alien Planet for students to use to record their observations or have students create their own tables.

Adaptations

- Assign the observer and recorder tasks carefully so that students can work to their strengths in the activity.
- A photo bank of images may be created for students who have difficulty seeing things that are far away.

6. Students #2 and #3 walk quickly to 1 m from the planet and walk back without stopping. Share and record observations.
7. Student #4 will take take notes while walking around the planet five times. Share and record observations.
8. (Optional) Have one student walk by the planet taking several photographs with the digital camera. The class views the pictures on a computer and makes observations, notes, and diagrams based on the pictures. As a class, discuss the new information. How did the photographs change your ideas about Planet X?
9. Students #1 and #3 now visit the front side of the planet. Share and record observations.
10. Students #2 and #4 now visit the back of the planet. Share and record observations.
11. Use the data you have collected to design and construct your own small model of Planet X. Compare your model with the original planet.

Analyze

1. (a) What step of the investigation was similar to viewing a planet from Earth?
   (b) What step was similar to flying past the planet?
   (c) What step was similar to putting a spacecraft in orbit around the planet?
   (d) What step was similar to a first landing on the planet?
2. (a) How did your observations, notes, diagrams, and inferences change as the tools and technology changed?
   (b) What caused these changes?
3. (a) How is your model similar to the original object?
   (b) How is it different?

Conclude and Apply

4. How are the mission stages you used similar to exploring Mars or other planets and moons?
5. (a) What are three challenges of exploring other planets?
   (b) What technology would help to meet these challenges?

Chapter 6 Close, Far Away, and Really Far Away • MHR 179

Investigation Wrap-Up

- Safely display each of the groups' models around the classroom for the class to compare and contrast.
- Find correlations between the students' investigation and the historical development of the study of space. Steps could include the invention of the telescope, the development of spacecraft, including unmanned orbiters, etc.

Assessment Option

- Use Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 6-D Mission to an Alien Planet.

Analyze Answers

1. (a) Step 2 was similar to viewing a planet from Earth.
   (b) Step 6 was similar to flying past the planet.
   (c) Step 7 was similar to putting a spacecraft in orbit around the planet.
   (d) Steps 9 and 10 were similar to landing on the planet.
2. (a) As the technology progressed, the ability to view and understand the planet increased. More knowledge was gained as the observer got closer to the planet.
   (b) The changes were caused by the increased ability to observe the finer details of Planet X as technology advanced.
3. (a) Student models should show the key details of the planet.
   (b) The key differences between student models will be artistic in merit or contain some unique structures that other groups did not see.

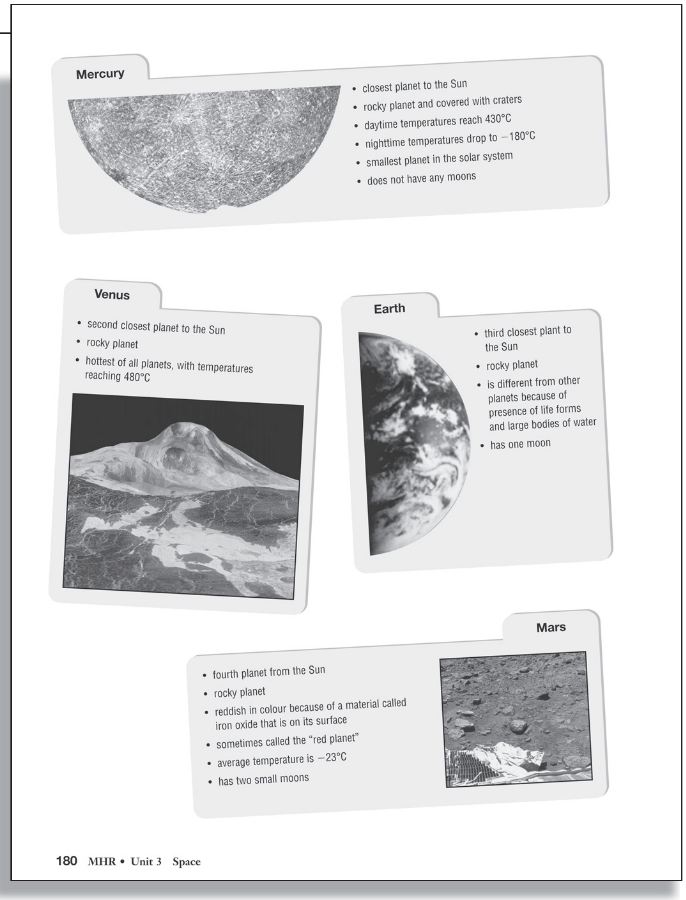
Conclude and Apply Answers

4. Observing Planet X from 10 m is similar to observing the planet from Earth. Walking towards the planet for a closer look is similar to observing the planet through a telescope or from a space-based observatory. Going around the planet is similar to a spacecraft flying around the planet once. Circling the planet is similar to a planetary orbiter. Taking a closer look at the front and back sides of the planet is similar to a planetary lander.
5. (a) Challenges of exploring other planets are: fueling a spacecraft to travel the great distance; setting up communications systems to allow those on Earth to communicate with the spacecraft; navigation of the spacecraft so that it finds its way to the appropriate planet; the function of rovers or other space-exploring robots; and the health and safety of astronauts if the mission is carrying people.
   (b) Satellite communication technology would be key to most of these challenges. Food storage and water recycling would be very important for missions with astronauts.

PLANET FILE CARD INSETS

BACKGROUND INFORMATION

- Mercury is the only planet in the solar system that does not have an atmosphere.
- All of the gas giants have ring systems similar to Saturn.
- The temperature of Venus stays consistently high due to the thick atmosphere of greenhouse gases that surrounds it.
- The great red spot on Jupiter is a storm in the atmosphere that is three times the size of Earth and has been active for more than 400 years.
- Titan, the largest moon of Saturn, has an atmosphere.
- Uranus tilts on its axis at 98°. Most of the planet is in either permanent daytime or permanent nighttime.
- Neptune is smaller in diameter than Uranus, but it is heavier than Uranus.



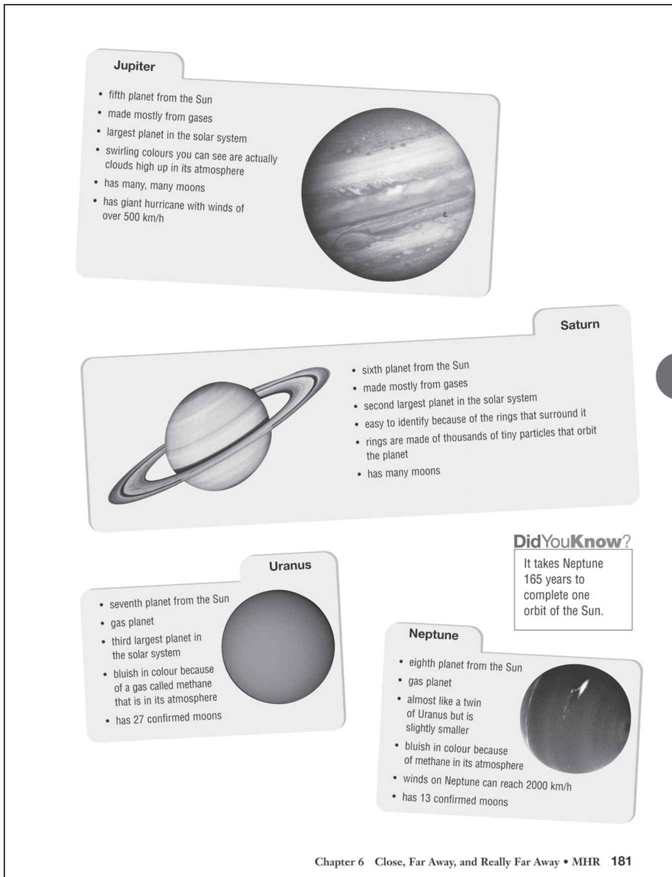
Mercury
- closest planet to the Sun
- rocky planet and covered with craters
- daytime temperatures reach 430°C
- nighttime temperatures drop to −180°C
- smallest planet in the solar system
- does not have any moons

Venus
- second closest planet to the Sun
- rocky planet
- hottest of all planets, with temperatures reaching 480°C

Earth
- third closest plant to the Sun
- rocky planet
- is different from other planets because of presence of life forms and large bodies of water
- has one moon

Mars
- fourth planet from the Sun
- rocky planet
- reddish in colour because of a material called iron oxide that is on its surface
- sometimes called the "red planet"
- average temperature is −23°C
- has two small moons

180 MHR • Unit 3 Space



Jupiter

- fifth planet from the Sun
- made mostly from gases
- largest planet in the solar system
- swirling colours you can see are actually clouds high up in its atmosphere
- has many, many moons
- has giant hurricane with winds of over 500 km/h

Saturn

- sixth planet from the Sun
- made mostly from gases
- second largest planet in the solar system
- easy to identify because of the rings that surround it
- rings are made of thousands of tiny particles that orbit the planet
- has many moons

Uranus

- seventh planet from the Sun
- gas planet
- third largest planet in the solar system
- bluish in colour because of a gas called methane that is in its atmosphere
- has 27 confirmed moons

DidYouKnow?

It takes Neptune 165 years to complete one orbit of the Sun.

Neptune

- eighth planet from the Sun
- gas planet
- almost like a twin of Uranus but is slightly smaller
- bluish in colour because of methane in its atmosphere
- winds on Neptune can reach 2000 km/h
- has 13 confirmed moons

Chapter 6 Close, Far Away, and Really Far Away • MHR 181

TEACHING STRATEGIES

- **During Teaching**—Collect at least one other unique feature about each of the planets and distribute them throughout the class. Read the planetary info cards aloud as a class, then have the students read the additional facts to the class.
- **After Teaching**—Have the students record their understanding of rocky planets and gas giants in their science logbooks.

CONDUCT AN INVESTIGATION 6-E PROFILE THE PLANETS

Purpose

- Students will discover some unique properties of each of the planets in our solar system.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Collect enough supplies for each group to complete the activity. – Discuss with other teachers the use of the gymnasium or corridor to complete the activity.

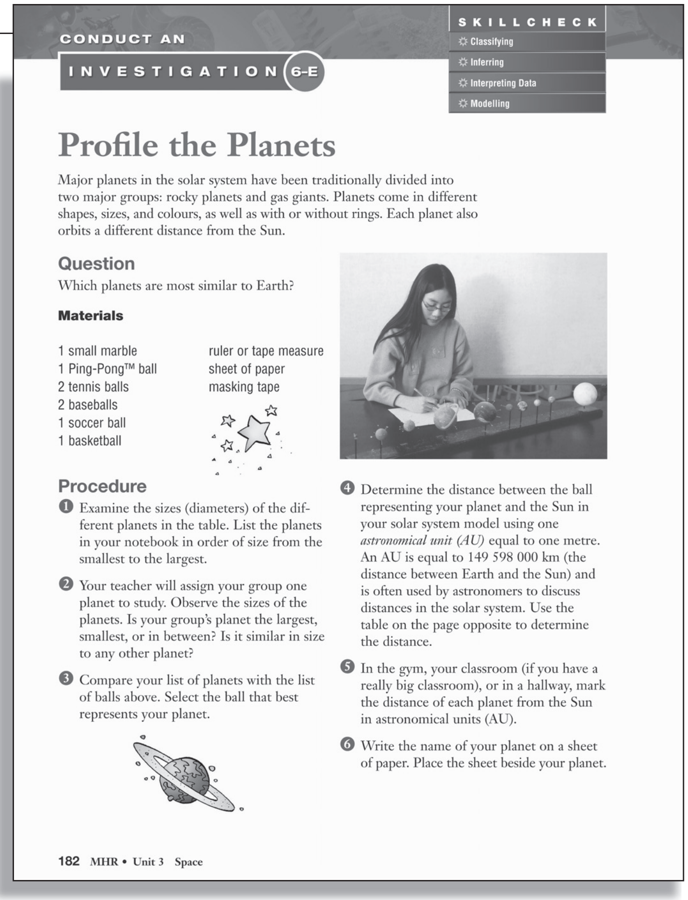
MATERIALS
– 1 small marble – 1 Ping-Pong™ ball – 2 tennis balls – 2 baseballs – 1 soccer ball – 1 basketball – metre stick, tape measure or trundle wheel – paper – masking tape

Suggested Time

- 30 min for discussion and completion of activity
- 10 min for completion of Analyze and Conclude and Apply sections in groups

HINTS & HELPS

- Identify the positions of the planets in the model before the activity in order to provide suggestions for students.



CONDUCT AN INVESTIGATION 6-E

SKILLCHECK
- Classifying
- Inferring
- Interpreting Data
- Modelling

Profile the Planets

Major planets in the solar system have been traditionally divided into two major groups: rocky planets and gas giants. Planets come in different shapes, sizes, and colours, as well as with or without rings. Each planet also orbits a different distance from the Sun.

Question

Which planets are most similar to Earth?

Materials

1 small marble
1 Ping-Pong™ ball
2 tennis balls
2 baseballs
1 soccer ball
1 basketball
ruler or tape measure
sheet of paper
masking tape

Procedure

1. Examine the sizes (diameters) of the different planets in the table. List the planets in your notebook in order of size from the smallest to the largest.
2. Your teacher will assign your group one planet to study. Observe the sizes of the planets. Is your group's planet the largest, smallest, or in between? Is it similar in size to any other planet?
3. Compare your list of planets with the list of balls above. Select the ball that best represents your planet.
4. Determine the distance between the ball representing your planet and the Sun in your solar system model using one *astronomical unit (AU)* equal to one metre. An AU is equal to 149 598 000 km (the distance between Earth and the Sun) and is often used by astronomers to discuss distances in the solar system. Use the table on the page opposite to determine the distance.
5. In the gym, your classroom (if you have a really big classroom), or in a hallway, mark the distance of each planet from the Sun in astronomical units (AU).
6. Write the name of your planet on a sheet of paper. Place the sheet beside your planet.

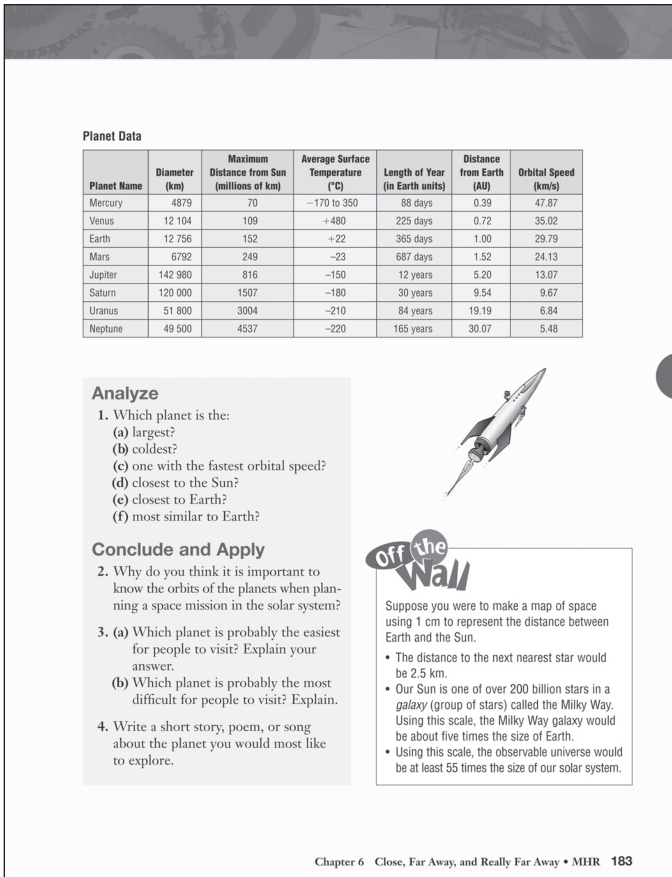
182 MHR • Unit 3 Space

Implementing the Investigation

- Review the planet data table with the class before beginning the activity.
- Discuss the scale of the model being created with the class before beginning the activity.

Adaptation

- Students with weaker math skills should be grouped with students that are strong in mathematics.



Planet Data

Planet Name	Diameter (km)	Maximum Distance from Sun (millions of km)	Average Surface Temperature (°C)	Length of Year (in Earth units)	Distance from Earth (AU)	Orbital Speed (km/s)
Mercury	4879	70	−170 to 350	88 days	0.39	47.87
Venus	12 104	109	+480	225 days	0.72	35.02
Earth	12 756	152	+22	365 days	1.00	29.79
Mars	6792	249	−23	687 days	1.52	24.13
Jupiter	142 980	816	−150	12 years	5.20	13.07
Saturn	120 000	1507	−180	30 years	9.54	9.67
Uranus	51 800	3004	−210	84 years	19.19	6.84
Neptune	49 500	4537	−220	165 years	30.07	5.48

Analyze

1. Which planet is the:
   (a) largest?
   (b) coldest?
   (c) one with the fastest orbital speed?
   (d) closest to the Sun?
   (e) closest to Earth?
   (f) most similar to Earth?

Conclude and Apply

2. Why do you think it is important to know the orbits of the planets when planning a space mission in the solar system?
3. (a) Which planet is probably the easiest for people to visit? Explain your answer.
   (b) Which planet is probably the most difficult for people to visit? Explain.
4. Write a short story, poem, or song about the planet you would most like to explore.

Off the Wall

Suppose you were to make a map of space using 1 cm to represent the distance between Earth and the Sun.

- The distance to the next nearest star would be 2.5 km.
- Our Sun is one of over 200 billion stars in a *galaxy* (group of stars) called the Milky Way. Using this scale, the Milky Way galaxy would be about five times the size of Earth.
- Using this scale, the observable universe would be at least 55 times the size of our solar system.

Chapter 6 Close, Far Away, and Really Far Away • MHR 183

Investigation Wrap-Up

- Take digital photos of the class with the planets in the model.
- Review the Analyze and Conclude and Apply questions as a class.

Assessment Option

- Use Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 6-E Profile the Planets.

Analyze Answers

1. (a) The largest planet is Jupiter.
   (b) The coldest planet is Neptune.
   (c) The fastest-moving planet is Mercury.
   (d) The closest planet to the Sun is Mercury.
   (e) The closest planet to Earth is Venus.
   (f) The planet most similar to Earth is Venus, based on size and year length, or Mars, based upon orbital speed and temperature.

Conclude and Apply Answers

2. Knowledge of the orbit of a planet is necessary when planning a mission to explore it because the trip should be organized at a time when the planet is closest to Earth. It is also useful for navigation of spacecraft.
3. (a) Mars would be the easiest to visit because it has an Earth-like temperature and is relatively close to Earth.
   (b) All planets other than Mars would be a bigger challenge to visit because of distance, temperature, and gaseous makeup.
4. Encourage students to be imaginative in their poems, stories, or songs. Share the results with the class. Alternatively, if students resist fiction, ask them to write a report or other non-fiction piece about travel to another planet.

Off the Wall Use the information presented to reinforce the scale of the total universe. Even 1 cm becomes billions of kilometres when we examine the total universe.

MOONS/OUR MOON/THE MOONS OF OTHER PLANETS

BACKGROUND INFORMATION

- Moons are objects in space made up of rock and ice. They orbit planets just as planets orbit stars.
- The Sun is the largest source of gravity in our solar system, but moons orbit planets due to their relative proximity to the planets that they orbit.
- The lack of an atmosphere on the Moon means that humans wishing to settle the planet would have to create an atmosphere in a closed space and either stay in it or wear spacesuits when they venture outside. They would also have to bring the necessities, such as food and water, which Earth's atmospheric conditions usually provide.
- There are well over 100 moons in our solar system. The only planets that do not have moons are Mercury and Venus.
- Some moons in our solar system are volcanic, others have atmospheres, and others may have liquid-covered surfaces.

READING Check

What is the difference between moons and planets?

Moons

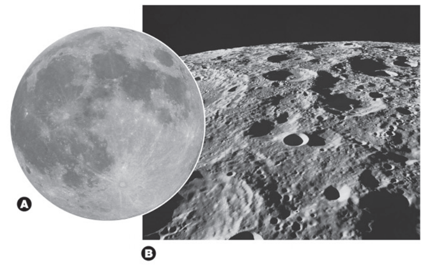
Have you ever wondered why the Moon is not considered to be a planet? It is spherical, and in space, so what makes it different? The answer depends, in part, on what it orbits. If an object orbits a planet, and it is not dust, then it is called a **moon**. Compared to the bright colours of the planets, moons sometimes appear to be plain and uninteresting. If you look at Earth's moon or the moons of other planets more closely, you will discover that they are anything but plain!

Pause& Reflect

Why do you think a lack of atmosphere allows craters on the Moon to last for millions of years? Explain and record your answers in a notebook.

Our Moon

For hundreds of years, the composition of the Moon puzzled scientists. It was not until 1969 that the first astronauts landed on the Moon and brought back samples of the lunar surface. The Moon is a large, rocky body without water. The rocks on the surface of the Moon are much like the volcanic rocks found on Earth. As you discovered in Activity 6-A, the Moon's surface is also covered with many craters.



Figures 6.4 Although the Moon looks smooth from Earth (A), a close-up photograph (B) shows that the Moon's surface is very rugged.

TEACHING STRATEGIES

- **During Teaching**—Read the text aloud as a class and discuss each section as it is completed.
- **After Teaching**—Arrange students so that they model the orbit of planets around the Sun and moons around planets.

The Moon has no atmosphere. An atmosphere covers the surface of a planet or moon and is made of numerous gases. Some of these atmospheres contain a mixture of gases suitable for life. (For example, in Earth's atmosphere, the gas we need is oxygen.) Without an atmosphere, there is no gas to breathe, no ozone layer to protect astronauts from dangerous rays from the Sun, and nothing to prevent asteroids or meteoroids from reaching the surface.

INTERNET CONNECT

www.mcgrawhill.ca/links/ns+science6

Watch videos of the first man to walk on the Moon. Go to the above web site and click on **Web Links** to find out where to go next.

The Moons of Other Planets

Mercury and Venus are the only planets in our solar system that do not have any moons. The gas giants, however, have many. Some moons are small and very hard to see, even with a powerful telescope. Other moons are quite large and can be seen with binoculars. Jupiter has the most moons.

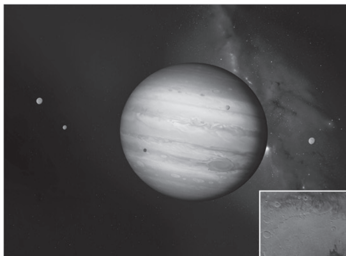


Figure 6.5 Astronomers have found many, many moons orbiting Jupiter.

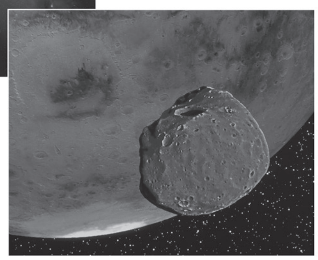


Figure 6.6 This photo shows one of Mars's two moons.

Chapter 6 Close, Far Away, and Really Far Away • MHR 185

Common Misconception

- Not all moons are relatively small. Some of the moons of the gas giants are the size of small planets.

READING Check Moons are objects that orbit planets, and planets are objects that orbit the Sun and clear the surrounding area of other objects.

Pause& Reflect The lack of an atmosphere indicates a lack of weather patterns. Without the rain, the wind, and the snow, erosion does not take place on the surface of the Moon. This, along with the lack of tectonic activity, means that the surface of the Moon rarely changes.

INTERNET CONNECT Students will find links to video of Neil Armstrong's first steps on the Moon on July 20, 1969.

Section 6.1 Summary

In this section, you learned that:
- The solar system is very large.
- There are eight planets in the solar system.
- Gravity keeps the solar system together.
- Other than Mercury and Venus, all of the other planets have moons.

Key Terms
solar system
moon

Check Your Understanding

1. Describe the size of the solar system.
2. Which planets are closest to Earth?
3. Which planets are rocky planets? Which planets are made mostly of gas?
4. Explain why one object in space is a moon and another is a planet.
5. Now that you know more about the other planets in our solar system, how is Earth different? Why is it important to take care of Earth?
6. Describe three challenges for scientists studying the Sun.

186 MHR • Unit 3 Space

SECTION 6.1 SUMMARY

Read the section summary together as a class and have the students review and update the key terms list in their science logbooks. Assign each of the students in the class an object from the solar system. Ask them to stand and sort themselves based on several different criteria, including location relative to one another, strength of gravitational pull, number of moons, and other criteria the students establish.

✓ ASSESSMENT OPTIONS FOR SECTION 6.1

- Collect and review science logbooks, using Learning Skills Rubric 2, Science Logbook to evaluate them.
- Use the following rubrics to assess student work:
  - Science Skills Checklist 15, Making Observations and Inferences to assess student work in Starting Point Activity 6-A What Happened to the Moon?
  - Process Skills Rubric 8, Developing Models to assess student work in Find Out Activity 6-B Scaling the Solar System
  - Learning Skills Checklist 2, Developing Models; Process Skills Rubric 8, Developing Models; and/or Process Skills Rubric 11, Problem Solving to assess student work in Problem-Solving Investigation 6-C A Visit to Venus
  - Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 6-D Mission to an Alien Planet
  - Science Skills Rubric 19, Conduct an Investigation to assess student work in Conduct an Investigation 6-E Profile the Planets

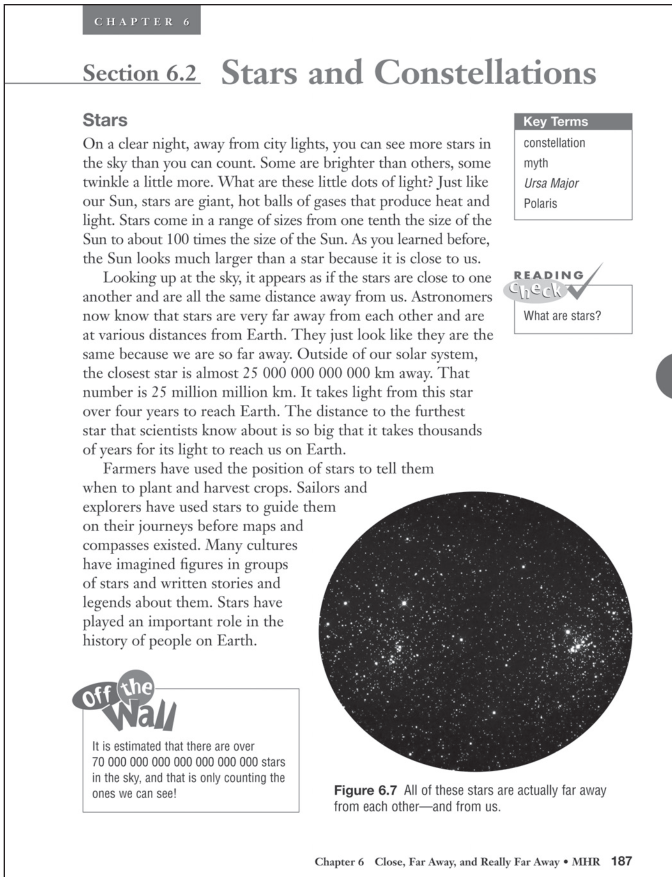
Check Your Understanding Answers

1. The solar system is extremely large. It is billions of kilometres wide.
2. Venus is the closest planet to Earth, and Mars is the next closest planet to Earth.
3. Mercury, Venus, Earth, and Mars are rocky planets. Jupiter, Saturn, Uranus, and Neptune are gas giants.
4. A moon is an object that is under the gravitational pull of, and orbits around a planet. A planet is an object that is under the gravitational pull of the Sun.
5. Earth is different from the other planets in that it has a temperature that is not too extreme for life; it has liquid water on its surface; it has an atmosphere of nitrogen, oxygen, and other gases; and it supports life as we know it. It is important to take care of Earth because it is the only known object in the solar system with the correct conditions to support living things such as us.
6. Three challenges scientists face in studying the Sun are that they cannot look at it directly through a telescope; it is extremely hot and would heavily damage or destroy any spacecraft approaching it; and it is constantly changing due to the reactions and storms that take place at its core and surface. Students may come up with other suggestions.

SECTION 6.2 STARS AND CONSTELLATIONS

What Students Do in Section 6.2

- learn about the vastness of the universe and the number of stars it contains
- discover constellations, their mythology, and how they have been used by societies past and present



CHAPTER 6

Section 6.2 Stars and Constellations

Stars

On a clear night, away from city lights, you can see more stars in the sky than you can count. Some are brighter than others, some twinkle a little more. What are these little dots of light? Just like our Sun, stars are giant, hot balls of gases that produce heat and light. Stars come in a range of sizes from one tenth the size of the Sun to about 100 times the size of the Sun. As you learned before, the Sun looks much larger than a star because it is close to us.

Looking up at the sky, it appears as if the stars are close to one another and are all the same distance away from us. Astronomers now know that stars are very far away from each other and are at various distances from Earth. They just look like they are the same because we are so far away. Outside of our solar system, the closest star is almost 25 000 000 000 000 km away. That number is 25 million million km. It takes light from this star over four years to reach Earth. The distance to the furthest star that scientists know about is so big that it takes thousands of years for its light to reach us on Earth.

Farmers have used the position of stars to tell them when to plant and harvest crops. Sailors and explorers have used stars to guide them on their journeys before maps and compasses existed. Many cultures have imagined figures in groups of stars and written stories and legends about them. Stars have played an important role in the history of people on Earth.

Key Terms
constellation
myth
Ursa Major
Polaris

READING Check
What are stars?

Off the Wall
It is estimated that there are over 70 000 000 000 000 000 000 000 stars in the sky, and that is only counting the ones we can see!

Figure 6.7 All of these stars are actually far away from each other—and from us.

Chapter 6 Close, Far Away, and Really Far Away • MHR 187

BACKGROUND INFORMATION

- Stars come in a variety of sizes from dwarf stars (much smaller than the Sun) to super giant stars (much larger than the Sun). Regardless of the size, all stars are powered by a nuclear fusion reaction at their core that produces the extreme amounts of heat and light that can be detected across the universe. (Nuclear fission takes place when the nucleus of an atom is split in two; nuclear fusion involves two nuclei being joined together. Both reactions release tremendous amounts of energy.)
- Light travels at approximately 300 000 km/s through space. Even at this speed it takes more than 4 years for light from the nearest star to reach us.
- There are 88 named constellations in the night sky. Some of these are only visible north of the equator and others are only visible south of the equator. The constellations of the zodiac are the star patterns that the Sun passes directly through.

TEACHING STRATEGIES

- **Begin the Lesson**—Have students copy the key terms into the space section of their science logbooks and write one sentence describing what they think each term means. Students should be asked to update these logbooks throughout the section. Alternatively, use the vocabulary BLM provided for this chapter.
  – Apply the RAN strategy (Tony Stead) as a literacy connect—using the space section of their science logbooks.
- **During Teaching**—BLM 6.4 Ursa Major and BLM 6.6 Finding Polaris provide versions of Figure 6.8 and Figure 6.10 that can be used as overhead masters or as information handouts that students can use to help them view the night sky.
- **After Teaching**—*ICT Option:* Use many different images to describe the nature of stars and constellations. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to a variety of web sites available with star and constellation information.
  – *ICT Option:* An Internet search for a Hertzsprung-Russell diagram will provide a visual reference of the size and scale of different types of stars.
  – Sketch a series of points on the board representing a star pattern. Have a student or students try to see the constellation in the star pattern and diagram it for the rest of the class.
  – The average distance between the Sun and Earth is 150 000 000 km. Light travels at 300 000 km/second. Challenge students to calculate how many minutes it takes for the Sun's light to reach Earth (8.33 minutes).

Common Misconception

- Stars appear to be very close to one another in space. This is because they are so far away.

STARS

BACKGROUND INFORMATION

- Stars are classified based on two properties: the size of the star and its temperature.

TEACHING STRATEGIES

- **After Teaching**—To help students understand why stars in the sky appear to be so close together, you may wish to use their observations of other objects in the distance.

READING Check Stars are giant balls of hot gases that produce heat, light, and gravitational pull.

Off the Wall With this extremely large number of visible stars, there is an even larger number of planets that should exist in our universe. Since planets do not give off light, they are much harder to detect.

WHAT ARE CONSTELLATIONS?/ CONSTELLATIONS AND SOCIETY

BACKGROUND INFORMATION

- Of the 88 named constellations, only six can be viewed year-round in the northern hemisphere and 14 can be viewed year-round in the southern hemisphere.
- Almost every culture around the world has constellations as part of their mythology. The Mi'kmaq have a legend associated with the Big Bear (Big Dipper) that tells of it chasing birds across the sky. Although the cultures did not know of each other, the Mi'kmaq and Europeans both described a bear in the sky where we usually place the Big Dipper.

TEACHING STRATEGIES

- **Begin the Lesson**—Ask the students what they know about constellations. Can they name some? What do they know about myths? Point out that myths usually have a heroic figure and end with a moral or lesson or explanation of a natural phenomenon.
  – To help students create their own myths, pass out black construction paper. Have the students make five to eight random dots with white or yellow crayon on the paper. Collect the papers, shuffle them, and distribute them randomly. Have the students draw lines connecting the dots in a manner that creates a figure or animal to represent a new constellation. Then ask the students to write a myth that names their constellation and tells the story about it.

INTERNET CONNECT

www.mcgrawhill.ca/links/ns+science6

Find out what constellations are in your sky for each month. Go to the above web site and click on **Web Links** to find out where to go next.

READING Check

What is a constellation?

What are Constellations?

Constellations are patterns made by stars in the sky. People have selected these patterns by imagining that groups of stars form shapes of recognizable objects, people (from myths or legends), or animals. Many cultures have myths or legends that their people associate with the constellation. A **myth** is a story that is created to explain an event or to tell about a hero. These constellation myths tell a story about the object, person, or animal, and explain why their picture is in the sky. There are 88 constellations in the sky. Some are only visible in the northern hemisphere, while others can only be seen in the southern hemisphere. As Earth orbits the Sun, the positions of the constellations appear to change in the sky. Of course, the stars are not really moving, it is Earth that is changing position.

One of the most famous constellations in the northern sky is ***Ursa Major***, or the Great Bear. (The body and tail of the bear are also known as the Big Dipper.) Another well known constellation in the northern sky is Orion. In Greek mythology, Orion was a great hunter. The myth says that Orion's pride was so great that it annoyed the gods. They punished him by sending a scorpion to sting his foot and kill him. Artemis, goddess of hunting, thought that Orion should be remembered for his good hunting skills, so the gods placed him in the sky.

Figure 6.8 These are the stars that form the constellation *Ursa Major*, or Great Bear. Can you locate the Big Dipper within *Ursa Major*?

Figure 6.9 Orion, the Hunter, is another famous constellation in the northern hemisphere.

Constellations and Society

People have spent much time imagining shapes and figures out of stars. There are some very good reasons for this. By creating constellations, people could easily find certain stars as they changed position in the sky. Long ago, these stars helped them figure out important calculations like direction and time of year. For example, in climates where there is not much difference between seasons, farmers could look to see the position of a certain constellation and know that it was time to either plant or harvest their crops.

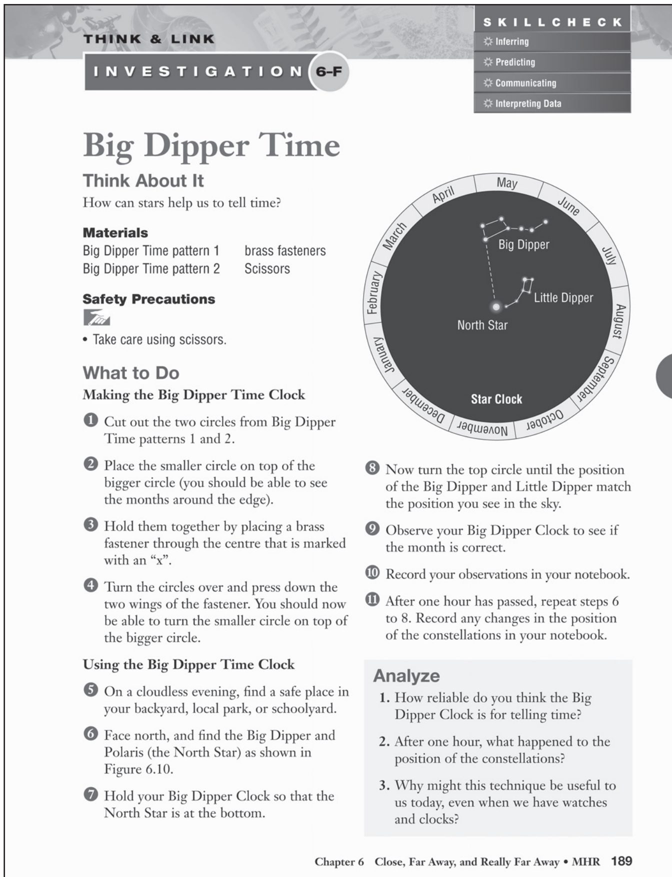
188 MHR • Unit 3 Space

INTERNET CONNECT Students will find links to guide them in sky watching in their part of the sky and information about constellations that are visible during each of the seasons.

READING Check A constellation is a pattern made by stars in the sky that has navigational, seasonal, and/or mythological significance.

Figure 6.8

- The Big Dipper is located in the top-left corner of the image. It makes up the body and tail of the bear.


THINK & LINK
INVESTIGATION 6-F

SKILLCHECK
Inferring
Predicting
Communicating
Interpreting Data

Big Dipper Time

Think About It
How can stars help us to tell time?

Materials
Big Dipper Time pattern 1 brass fasteners
Big Dipper Time pattern 2 Scissors

Safety Precautions
• Take care using scissors.

What to Do
Making the Big Dipper Time Clock
1. Cut out the two circles from Big Dipper Time patterns 1 and 2.
2. Place the smaller circle on top of the bigger circle (you should be able to see the months around the edge).
3. Hold them together by placing a brass fastener through the centre that is marked with an "x".
4. Turn the circles over and press down the two wings of the fastener. You should now be able to turn the smaller circle on top of the bigger circle.

Using the Big Dipper Time Clock
5. On a cloudless evening, find a safe place in your backyard, local park, or schoolyard.
6. Face north, and find the Big Dipper and Polaris (the North Star) as shown in Figure 6.10.
7. Hold your Big Dipper Clock so that the North Star is at the bottom.
8. Now turn the top circle until the position of the Big Dipper and Little Dipper match the position you see in the sky.
9. Observe your Big Dipper Clock to see if the month is correct.
10. Record your observations in your notebook.
11. After one hour has passed, repeat steps 6 to 8. Record any changes in the position of the constellations in your notebook.

Analyze
1. How reliable do you think the Big Dipper Clock is for telling time?
2. After one hour, what happened to the position of the constellations?
3. Why might this technique be useful to us today, even when we have watches and clocks?

Chapter 6 Close, Far Away, and Really Far Away • MHR 189

THINK & LINK INVESTIGATION 6-F BIG DIPPER TIME

Purpose

- Students will discover how the position of a constellation can be used to determine the month of the year and keep track of the hours of the night.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 days before	– Check the weather forecast and determine if the sky will be clear.
1 day before	– print off copies of BLM 6.5 Big Dipper Time Circles for each student in the class.

MATERIALS
– brass fastener (1 per student) – scissors – BLM 6.5 Big Dipper Time Circles

Suggested Time

- 20 min for explanation of activity and construction of the Big Dipper Time Clock
- 2 h at home for recording observations
- 20 min for class discussion and completion of Analyze questions

Safety Precautions

- Advise students to be careful when using scissors.
- Explain to students that their viewing areas should be safe and well away from roadways.

HINTS & HELPS

- Collect observations for two nights prior to the students completing the activity, in order to give a reference and comparison to their observations.

Implementing the Investigation

- Carefully explain the activity to the class to avoid any confusion with what they should be observing.
- Distribute BLM 6.5 Big Dipper Time Circles for students to use to create their Big Dipper Clocks.
- Sketch the expected movement of the Big Dipper on the board.

Adaptations

- Students who have difficulty following instructions may complete the activity using software. Visit www.mcgrawhill.ca/links/ns+science6 and follow the links to web sites showing the night sky in your area.
- Students with a strong interest in sky watching can use other constellations to fill in a star clock with more details.

Investigation Wrap-Up

- Complete the Analyze questions together and discuss the activity as a class.

Assessment Option

- Use Process Skills Rubric 17, Measuring and Reporting and/or Science Skills Rubric 22, Using Tools, Equipment, and Materials to evaluate student work in Think & Link Investigation 6-F Big Dipper Time.

Analyze Answers

1. The clock is reliable for determining the month of the year. If hours were added to the outer ring, it could be used, based on more observations, to tell the time of day.
2. The positions of the constellations moved from the east towards the west.
3. This technique could be useful when we are away from technology, when power outages occur, or when we are looking for particular objects in the night sky.

FIND OUT ACTIVITY 6-G STARS AND ANCIENT CIVILIZATIONS

Purpose

- Students will investigate the beliefs about and uses of constellations by other cultures.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Reserve the library or computer room in order to complete the activity.
3 days before	– Collect books related to the activity.

MATERIALS
– poster boards – arts and crafts supplies

Suggested Time

- 5 min for introduction of activity and arrangement of students into groups
- 40 min for student research
- 20 min for preparation of presentations
- 20 min for class presentations and completion of questions

Safety Precaution

- Advise students of safe Internet use practices.

HINTS & HELPS

- Identify specific web sites related to each of the civilizations before beginning the activity. Use the search terms “constellations, myth” to find a variety of sites.

Adaptation

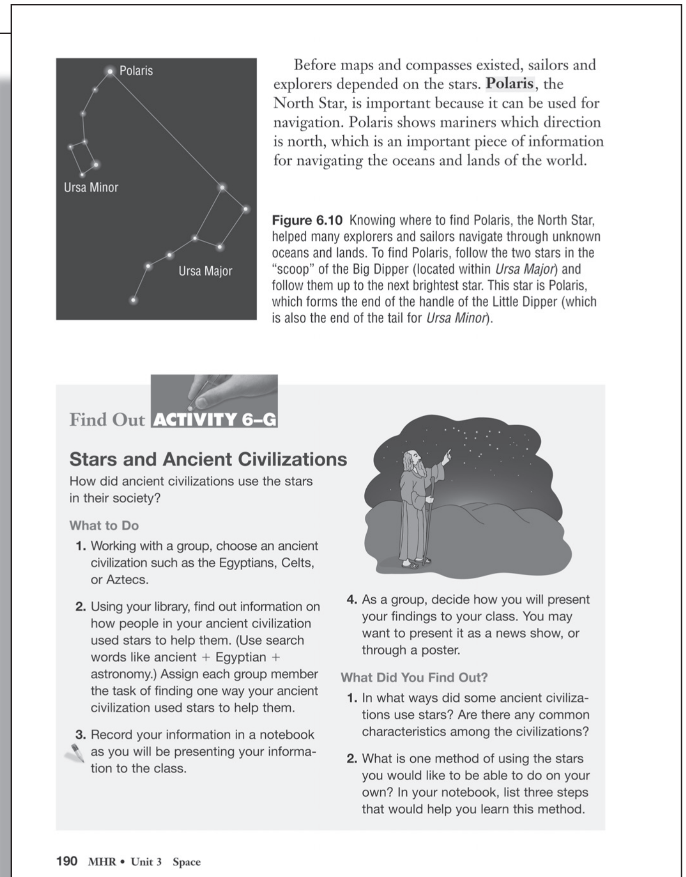
- Students with literacy difficulties should be grouped with strong readers.

Activity Wrap-Up

- Have students present their findings to their classmates.
- Complete the What Did You Find Out? questions together as a class.

Assessment Option

- Use Learning Skills Rubric 3, Co-operative Group Work and/or Learning Skills Rubric 6, Communications to evaluate student work in Find Out Activity 6-G Stars and Ancient Civilizations.



Before maps and compasses existed, sailors and explorers depended on the stars. **Polaris**, the North Star, is important because it can be used for navigation. Polaris shows mariners which direction is north, which is an important piece of information for navigating the oceans and lands of the world.

Figure 6.10 Knowing where to find Polaris, the North Star, helped many explorers and sailors navigate through unknown oceans and lands. To find Polaris, follow the two stars in the “scoop” of the Big Dipper (located within *Ursa Major*) and follow them up to the next brightest star. This star is Polaris, which forms the end of the handle of the Little Dipper (which is also the end of the tail for *Ursa Minor*).

Find Out ACTIVITY 6–G

Stars and Ancient Civilizations

How did ancient civilizations use the stars in their society?

What to Do

1. Working with a group, choose an ancient civilization such as the Egyptians, Celts, or Aztecs.
2. Using your library, find out information on how people in your ancient civilization used stars to help them. (Use search words like ancient + Egyptian + astronomy.) Assign each group member the task of finding one way your ancient civilization used stars to help them.
3. Record your information in a notebook as you will be presenting your information to the class.
4. As a group, decide how you will present your findings to your class. You may want to present it as a news show, or through a poster.

What Did You Find Out?

1. In what ways did some ancient civilizations use stars? Are there any common characteristics among the civilizations?
2. What is one method of using the stars you would like to be able to do on your own? In your notebook, list three steps that would help you learn this method.

190 MHR • Unit 3 Space

What Did You Find Out? Answers

1. Ancient civilizations used the stars to keep track of the seasons of the year, to tell stories and legends of the people’s history, and to mark holidays and other observances. They also used them for navigation, particularly at sea.
2. Students will have a variety of answers to this question. The three steps should be similar to: (1) identify the time of year the stars are present in the sky; (2) determine the precise position of the stars in the sky; and (3) determine the time it takes for the stars to reappear in the same location in the sky.

Find Out ACTIVITY 6–H

Star Light, Star Bright

In this activity, you will be learning how to identify some of the constellations in the sky.

Materials

cylindrical box or can
compass
sheet of black construction paper
an elastic band
scissors
chalk
flashlight
books and Internet sources about constellations and mythology

Safety Precautions

• Take care using scissors.

What to Do

1. Using books or the Internet, select one constellation and research what it looks like and the myth or legend that explains why that figure is in the sky. Record your information in your notebook.
2. Remove both ends of the box or can.
3. Use a compass to draw a circle on the black construction paper about 5 cm wider than the end of the box or can.
4. Using a pencil or white pencil crayon, draw the constellation inside the circle. Make sure to leave a margin between your constellation and the edge of the circle.
5. Cut out the circle, and place it over one end of the can or box. Secure it in place with an elastic band.
6. With the end of the compass, poke holes where each star in the constellation is located.
7. Next, put a flashlight through the open end of the can or box, and darken the room.
8. Point the papered end toward the ceiling until a clear image of the constellation appears.
9. Share your constellation with the class and tell the myth or legend that goes along with the constellation.

What Did You Find Out?

1. How can you identify your constellation in the night sky?
2. What are some common characteristics in the myths?
3. What is your favourite constellation? Explain your answer.

DidYouKnow?

The brightest star in the sky is called Sirius. It is located in the constellation *Canis Major*, or Big Dog. Sirius is twice as big as our Sun and is 23 times as bright!

Chapter 6 Close, Far Away, and Really Far Away • MHR 191

FIND OUT ACTIVITY 6-H STAR LIGHT, STAR BRIGHT

Purpose

- Students will investigate the appearance of a constellation and create a light model of the constellation for their classmates. They will also research any myths concerning the constellation.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Reserve the library or computer room in order to complete the activity.
3 days before	– Ask students to bring in cylindrical cans or boxes.
1 day before	– Collect supplies.

MATERIALS
– flashlights – scissors – compass – cylindrical box or can – elastic bands – chalk – black construction paper

Suggested Time

- 10 min for explanation of activity and organization of groups
- 20 min for completion of Internet and/or text research
- 20 min for completion of constellation models
- 10 min for sharing constellations with the class
- 10 min for completion of What Did You Find Out? questions

Safety Precautions

- Advise students of safe Internet practices.
- Remind students to be careful when using scissors.

HINTS & HELPS

- Prepare some constellation models before the activity for students who may have difficulty with the activity.

Implementing the Activity

- If the classroom has no blinds, the activity should be completed in a different room of the school.

Adaptations

- Students with literacy difficulties should be grouped with strong readers.
- Students with an interest in astronomy may wish to research what stars appear in the local sky at the start and closing of the school year.

Activity Wrap-Up

- Have students present their constellation models to their classmates.
- Complete the What Did You Find Out? questions together as a class.

Assessment Option

- Adapt Learning Skills Checklist 2, Developing Models and/or Learning Skills Rubric 6, Communications to assess student work in Find Out Activity 6-H Star Light, Star Bright.

What Did You Find Out? Answers

1. Student answers should include location in the sky, time of year, unique stars, or groups of stars that are easy to locate.
2. Some common characteristics in the myths include the placing of the hero or spirit into the sky for feats of great importance, or the rise and fall of a being.
3. Accept all reasonable answers.

DidYouKnow? Sirius can be seen by almost everyone on the planet, except to people in the most northerly regions of the globe.

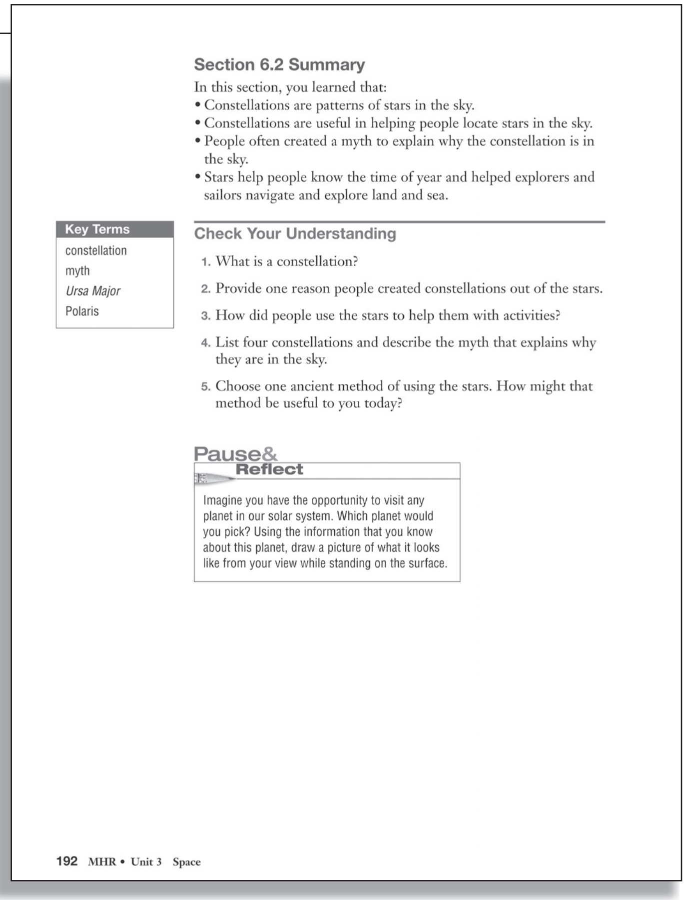
SECTION 6.2 SUMMARY

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

Place the names of the 88 named constellations in a box and have each student select one. Visit the web site at www.mcgrawhill.ca/links/ns+science6 and follow the links to the list. Provide each student with a cue card and create a constellation information card for the star pattern they have selected.

✓ ASSESSMENT OPTIONS FOR SECTION 6.2

- 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 17, Measuring and Reporting and/or Science Skills Rubric 22, Using Tools, Equipment, and Materials to evaluate student work in Think & Link Investigation 6-F Big Dipper Time
  - Learning Skills Rubric 3, Co-operative Group Work and/or Learning Skills Rubric 6, Communications to evaluate student work in Find Out Activity 6-G Stars and Ancient Civilizations
  - Learning Skills Checklist 2, Developing Models or Learning Skills Rubric 6, Communications to evaluate student work in Find Out Activity 6-H Star Light, Star Bright



Section 6.2 Summary

In this section, you learned that:

- Constellations are patterns of stars in the sky.
- Constellations are useful in helping people locate stars in the sky.
- People often created a myth to explain why the constellation is in the sky.
- Stars help people know the time of year and helped explorers and sailors navigate and explore land and sea.

Key Terms

constellation
myth
Ursa Major
Polaris

Check Your Understanding

1. What is a constellation?
2. Provide one reason people created constellations out of the stars.
3. How did people use the stars to help them with activities?
4. List four constellations and describe the myth that explains why they are in the sky.
5. Choose one ancient method of using the stars. How might that method be useful to you today?

Pause& Reflect

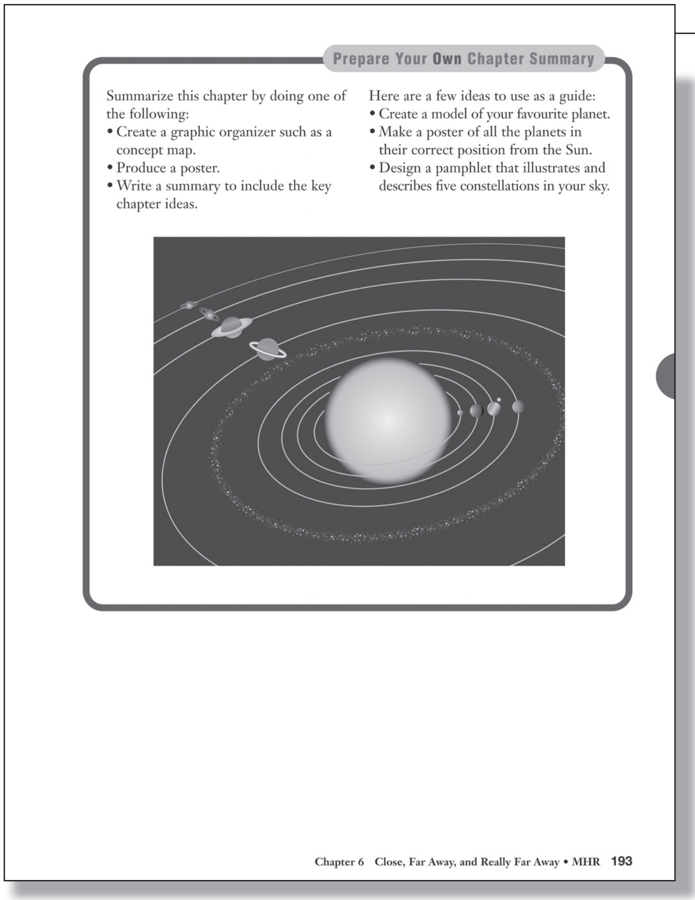
Imagine you have the opportunity to visit any planet in our solar system. Which planet would you pick? Using the information that you know about this planet, draw a picture of what it looks like from your view while standing on the surface.

192 MHR • Unit 3 Space

Check Your Understanding Answers

1. A constellation is a pattern made by a group of stars in the sky.
2. Student answers will include the ideas that myths can explain the history and origin of the people, references to specific times of year, and images that are useful in navigation.
3. People used the stars to help them with navigation, to help them determine when to plant and harvest crops, to help them determine the time of year, and as part of holidays and observances.
4. Students' answers should contain brief references to constellations they or their classmates studied throughout the chapter.

Pause& Reflect Students should include a short description of why they chose the planet and the diagrams should represent the actual planet (e.g., rocky planets should be solid, gas giants should be gaseous).



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:
- Create a model of your favourite planet.
- Make a poster of all the planets in their correct position from the Sun.
- Design a pamphlet that illustrates and describes five constellations in your sky.

Chapter 6 Close, Far Away, and Really Far Away • MHR 193

Prepare Your Own Chapter Summary

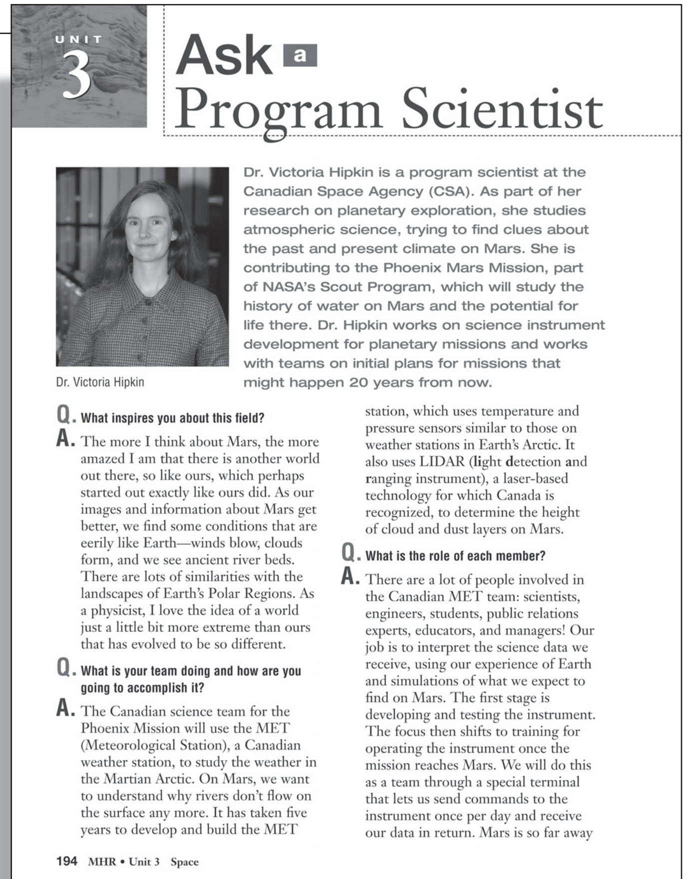
This chapter contains a great deal of information. Suggest students organize their summaries by section or key idea. Student summaries should incorporate the following main ideas:

- Our solar system is very large, and is made up of eight planets, asteroids, dust, gases, and other objects that orbit the Sun.
- The gravitational force of the Sun keeps Earth and all of the other planets in orbits around the Sun.
- The Sun is a star. It looks different from other stars because it is part of our solar system, and we are much closer to it.
- Mercury, Venus, Earth, and Mars are closest to the Sun and are called the rocky planets. The gas giants, Jupiter, Saturn, Uranus, and Neptune, are furthest from the Sun.
- A moon is an object that orbits a planet and is not dust. Earth's moon is a large, rocky body without water. Other than Mercury and Venus, all of the other planets have moons.
- Stars are giant, hot balls of gases that produce heat and light. Some stars are smaller than the Sun and some are much bigger.
- Constellations are patterns in the sky made by stars. Many cultures have myths associated with constellations.
- Constellations help people locate stars in the sky. Stars help people know the time of year and help explorers navigate.

ASK A PROGRAM SCIENTIST

BACKGROUND INFORMATION

- A program scientist is an individual responsible for the co-ordination of a number of different people on a space-exploration team. They begin work on the mission by identifying all of the engineering and computer requirements and then co-ordinate all of the partners in order to complete the mission. They are also responsible for communication between the partners and the agencies and governments funding the missions.
- Program scientists require 4 to 7 years of university study in a specific field. They also must have a lot of practical experience within their field and must be strong communicators and good team members.
- The Phoenix Mars Mission landed successfully in the spring of 2008 and the MET (Canadian weather station) began collecting Martian weather data throughout the summer of 2008. Visit the Canadian Space Agency web site to see the information posted.



UNIT 3

Ask a Program Scientist

Dr. Victoria Hipkin

Dr. Victoria Hipkin is a program scientist at the Canadian Space Agency (CSA). As part of her research on planetary exploration, she studies atmospheric science, trying to find clues about the past and present climate on Mars. She is contributing to the Phoenix Mars Mission, part of NASA's Scout Program, which will study the history of water on Mars and the potential for life there. Dr. Hipkin works on science instrument development for planetary missions and works with teams on initial plans for missions that might happen 20 years from now.

Q. What inspires you about this field?

A. The more I think about Mars, the more amazed I am that there is another world out there, so like ours, which perhaps started out exactly like ours did. As our images and information about Mars get better, we find some conditions that are eerily like Earth—winds blow, clouds form, and we see ancient river beds. There are lots of similarities with the landscapes of Earth's Polar Regions. As a physicist, I love the idea of a world just a little bit more extreme than ours that has evolved to be so different.

Q. What is your team doing and how are you going to accomplish it?

A. The Canadian science team for the Phoenix Mission will use the MET (Meteorological Station), a Canadian weather station, to study the weather in the Martian Arctic. On Mars, we want to understand why rivers don't flow on the surface any more. It has taken five years to develop and build the MET station, which uses temperature and pressure sensors similar to those on weather stations in Earth's Arctic. It also uses LIDAR (**li**ght **d**etection **a**nd **r**anging instrument), a laser-based technology for which Canada is recognized, to determine the height of cloud and dust layers on Mars.

Q. What is the role of each member?

A. There are a lot of people involved in the Canadian MET team: scientists, engineers, students, public relations experts, educators, and managers! Our job is to interpret the science data we receive, using our experience of Earth and simulations of what we expect to find on Mars. The first stage is developing and testing the instrument. The focus then shifts to training for operating the instrument once the mission reaches Mars. We will do this as a team through a special terminal that lets us send commands to the instrument once per day and receive our data in return. Mars is so far away

194 MHR • Unit 3 Space

TEACHING STRATEGIES

- **During Teaching**—Have students pair off, and ask one to read the role of the reporter and one to read the role of the engineer. Encourage them to ad-lib their answers based on their comprehension of the reading. They may wish to record the interview for "broadcast" as a feature.
- **After Teaching**—*ICT Option:* Have students explore the Canadian Space Agency web site and create and answer two more questions related to the Phoenix program.

that the data can take up to 40 minutes to travel through space. The engineers on the team have come from industry and the CSA and have been responsible for building the instrument. They will also be responsible for checking the commands and the health of the instrument. Public relations experts help with web page design and public events. Educators help school students learn and participate in the mission. Managers try to make sure that everything is well planned and that there are enough resources to let the team work properly.

Q. What skills or training do various members have that are important in the work?

A. Imagination, passion, and critical thinking are important in research and science in general and are definitely important for planetary missions, where so much is unknown. Space engineers and technologists need to be systematic, organized people in order to plan for space operations. A broad range of training can prepare you for planetary missions. To be a science team member, you need a science degree. Planetary scientists have training in physics, geology, biology, chemistry, or geography.

Q. Who benefits from the work that you do?

A. This will be the first laser on the surface of another planet. An immediate benefit is to other scientists around the world. Our mission will generate new data that will change how we think of Mars. This mission is also fabulous training for the Canadian students and young researchers and engineers involved and will be a launch pad to international careers in an exciting, cutting-edge field.

Q. What advice would you give to a student who is interested in this field?

A. Believe that you can be part of the space program if you want to be! Find the aspect of it that interests you most. Don't be afraid to contact people and ask questions. If you would like hands-on experience as an undergraduate student, look for a co-op program or for summer placements. Most Mars data is posted directly to the Internet, so you can look at images from Mars and do your own research from home! Look for public and student programs and societies. There are lots of ways to get involved!

EXPLORING Further

The Phoenix Mission will help scientists find out whether water and other molecules have ever existed on Mars. This information will allow comparisons between the climates on Earth and Mars. In addition, it may explain whether life ever existed on Mars, and whether it is possible for humans to explore the planet further. International teams have worked together to carry out missions to Mars. As technology brings us closer to understanding the mysteries of the red planet, how will we answer the questions that arise: Who owns Mars? How should we decide what direction Mars exploration takes? Visit some of the web sites related to the exploration of Mars and prepare a statement for a potential debate on the subject. Visit **www.mcgrawhill.ca/links/ns+science6** and follow the links indicated to begin your research.

Unit 3 Ask a Program Scientist • MHR 195

EXPLORING FURTHER

Purpose
- Students will prepare an official statement about the future of human activity on Mars and be prepared to defend their position.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Identify Internet or text resources that students can use to create their statement.

Suggested Time
- 20 min for research and preparation of Mars statements
- 30 min for presentation and defence of statements

HINTS & HELPS
- Identify specific web sites for each group in the class in order to prevent similar statements from being created.

Implementing the Activity
- Write each of the student statements on the board prior to the presentation and assign at least one person to question each group following their presentation.

Adaptations
- Students with literacy difficulties should be grouped with strong readers.
- Provide a starter phrase for students who have difficulty beginning a formal statement.

Activity Wrap-Up
- Have each group present and defend their statements to the class.
- Discuss the class ideas on the future of humanity on Mars.

Assessment Option
- Use Learning Skills Rubric 5, Research Project and/or Learning Skills Rubric 6, Communication for evaluating student work in the Exploring Further activity.

ASK A PROJECT ENGINEER

BACKGROUND INFORMATION

- A project engineer is involved in all steps from concept development to production to applications of an engineering project. He or she is responsible for the co-ordination of various aspects of a project. Other engineers report to the project engineer in order to ensure that all individuals involved in a project are working towards the same goal and at the same pace.
- Project engineers require a 4-year degree in a specific field of engineering and most complete post-graduate work before becoming project engineers.
- Project engineers are responsible for solving problems once a project is in operation. They are often the first contact between the consumer and the development team.

UNIT 3

Ask a Project Engineer

Daniel Rey

Daniel Rey is the project engineer responsible for the Dextre project at the Canadian Space Agency. Dextre, a "Special Purpose Dexterous Manipulator," is a two-armed robot that will attach to either the Mobile Base System or the Canadarm2 at the International Space Station. Dextre will do tasks that normally would be done by an astronaut. This technology is important because the harsh environment of space makes it difficult and dangerous for astronauts to work outside the station.

Q. What inspires you about this field?

A. I am inspired and motivated by the exploration and discovery aspects of working in the space industry. It is truly exciting to be part of a team that is putting Canada's next-generation robotic system into orbit.

Q. What is your team doing and how are you going to accomplish it?

A. We are working toward the successful launch and commissioning of Dextre, Canada's final contribution to the Mobile Servicing System of the International Space Station. The Mobile Base System and Canadarm2 components are already on orbit and have been a crucial tool for assembly of the space station. Dextre will be used to perform robotic maintenance of the external components of the station. This will be the world's first on-orbit servicing robot with an operational mission. Dextre will lead the way for developments in robotic support to lunar and Martian exploration missions.

Q. What is the role of each member?

A. The team of systems engineers I lead at the Canadian Space Agency (CSA) is focused on the technical aspects of ensuring Dextre's readiness. The team includes members from NASA's Johnson Space Center; MDA Space Systems in Brampton, Ontario; and NASA's Kennedy Space Center. The broader team at CSA includes software specialists, safety and quality assurance specialists, mission planners, training product developers, robotics instructors, managers, and directors.

The team at MDA Space Systems includes mechanical, electrical, thermal, parts, quality, safety, software, and systems engineers, all specialized in space applications. The technicians who manufacture the components and the technicians who assemble the system are vital members of the team.

196 MHR • Unit 3 Space

TEACHING STRATEGIES

- **Begin the Lesson**—Invite a project engineer to visit the classroom and talk about his or her work. Ask students to prepare questions before the visit.
- **During Teaching**—Have students pair off, and ask one to read the role of the reporter and one to read the role of the engineer. Encourage them to ad-lib their answers based on their comprehension of the reading.
- **After Teaching**—*ICT Option:* Have students explore the Canadian Space Agency web site and create and answer two more questions related to the Dextre program.

Q. What skills/training do various members have that are important in the work?

A. It is common for the senior engineers to have significant experience working in the aerospace field or a Master's degree in engineering specializing in the aerospace field. Bachelor's degrees in engineering don't need to be specialized in aerospace.

Q. Who benefits from the work that you do?

A. The Canadian Space Agency's goal is "to promote the peaceful use and development of space, to advance the knowledge of space through science, and to ensure that space science and technology provide social and economic benefits for Canadians."

The Dextre project, in particular, contributes to the strategic outcome of advancing knowledge, innovation, and the Canadian economy. The success of Canadarm was an internationally recognized achievement. It demonstrated Canadian technical savvy and excellence. The success will be renewed and sustained by Dextre.

Q. What advice would you give to a student who is interested in this field?

A. Try to identify your natural skills and interests and let these guide you. Seek advice from a dedicated, professionally trained career counsellor if you are having trouble identifying a direction for your interests. If you know that you are interested in the space industry, seek opportunities for enjoyable extra-curricular activities and challenges related to space science or aerospace engineering. Science fairs, contests, astronomy clubs, university or industrial open houses can help you discover a new passion.

Finally, consider a co-operative academic program for your Bachelor's degree. This will give you the opportunity for regular, structured exposure to a variety of positions of your choosing. Note that you do have to compete for these positions, so good grades can be very helpful. Good luck on whatever path you choose!

EXPLORING Further

Dextre is able to move objects and small tools. Sensors allow it to "feel" its surroundings and objects that it is holding and react to changes in position or pressure. It also has lights and video cameras that allow astronauts inside the International Space Station to observe its work.

Find out more about Canadian technology designed for the International Space Station. How does Dextre differ from the Canadarm2? How could the technology be used on Earth? Prepare your ideas on how Dextre would be useful, and write a short proposal outlining the details of where and how it would be used.

Unit 3 Ask a Project Engineer • MHR 197

EXPLORING FURTHER

Purpose

- Students will prepare a proposal to describe the use of the Dextre space robot created by the Canadian Space Agency.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Identify Internet or text resources that students can use to create their statement.

Suggested Time

- 20 min for research and preparation of Dextre proposals
- 20 min for presentation of proposals to classmates

HINTS & HELPS

- Remind students that Dextre will replace human astronauts on some dangerous missions outside the space shuttle and International Space Station.

Implementing the Activity

- Have student groups pair up and discuss their proposals and combine the proposals to create one new one to be presented to the class.

Adaptations

- Students with literacy difficulties should be grouped with strong readers.
- Provide a starter phrase for students who have difficulty beginning a formal statement.

Activity Wrap-Up

- Have each group present their proposal to the class.

Assessment Option

- Use Learning Skills Checklist 3, Oral Presentation and/or Learning Skills Rubric 6, Communication for Exploring Further activity.

UNIT 3 PROJECT WANTED: A JUNIOR ASTRONAUT

Purpose

- Students create a resume in order to apply for a job as a junior astronaut.

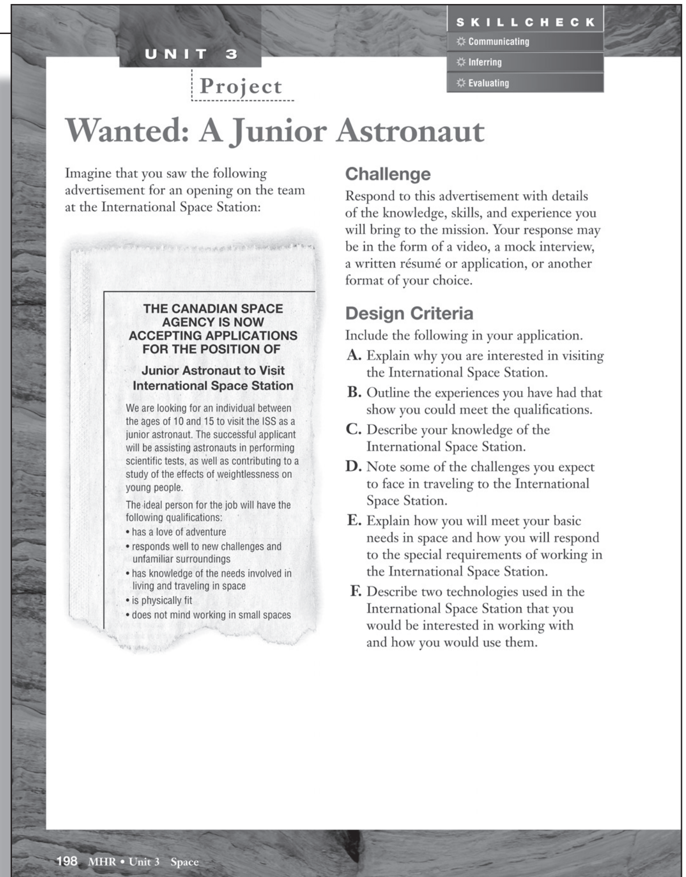
Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 week before	– Obtain or reserve video cameras and computer facilities in order to complete activity.
2 days before	– Review the basic components of a resume and have students select the type of response they will prepare.

MATERIALS
– video camera – paper, pencils, markers, coloured pencils.

Suggested Time

- 5 min for explanation and discussion of project as a class
- 30 min for research and completion of Design Criteria
- 30 min for completion of Plan and Construct section
- 30 min for presentation of applications to the class
- 15 min for completion and discussion of Evaluate questions


UNIT 3

SKILLCHECK
Communicating
Inferring
Evaluating

Project

Wanted: A Junior Astronaut

Imagine that you saw the following advertisement for an opening on the team at the International Space Station:

THE CANADIAN SPACE AGENCY IS NOW ACCEPTING APPLICATIONS FOR THE POSITION OF

Junior Astronaut to Visit International Space Station

We are looking for an individual between the ages of 10 and 15 to visit the ISS as a junior astronaut. The successful applicant will be assisting astronauts in performing scientific tests, as well as contributing to a study of the effects of weightlessness on young people.

The ideal person for the job will have the following qualifications:
- has a love of adventure
- responds well to new challenges and unfamiliar surroundings
- has knowledge of the needs involved in living and traveling in space
- is physically fit
- does not mind working in small spaces

Challenge

Respond to this advertisement with details of the knowledge, skills, and experience you will bring to the mission. Your response may be in the form of a video, a mock interview, a written résumé or application, or another format of your choice.

Design Criteria

Include the following in your application.

A. Explain why you are interested in visiting the International Space Station.
B. Outline the experiences you have had that show you could meet the qualifications.
C. Describe your knowledge of the International Space Station.
D. Note some of the challenges you expect to face in traveling to the International Space Station.
E. Explain how you will meet your basic needs in space and how you will respond to the special requirements of working in the International Space Station.
F. Describe two technologies used in the International Space Station that you would be interested in working with and how you would use them.

198 MHR • Unit 3 Space

Safety Precaution

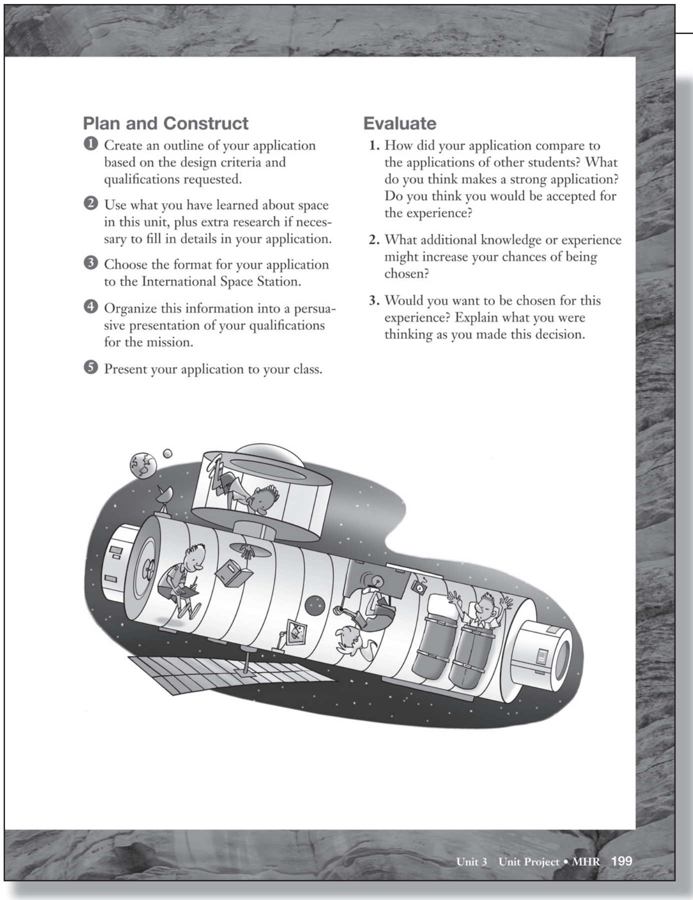
- Advise students of safe Internet practices.

HINTS & HELPS

- Hand out resume templates for students to follow or a prepared script for students to create their video presentations.
- This is an excellent opportunity to authentically explore persuasive writing in science.

Implementing the Project

- Have students share their resume with other classmates throughout the activity in order to gain further insight as to how to sell themselves as an astronaut.
- Remind students that they are acting as salespeople, selling themselves as astronauts. They should think of their audience as the Canadian Space Agency.



Plan and Construct

1. Create an outline of your application based on the design criteria and qualifications requested.
2. Use what you have learned about space in this unit, plus extra research if necessary to fill in details in your application.
3. Choose the format for your application to the International Space Station.
4. Organize this information into a persuasive presentation of your qualifications for the mission.
5. Present your application to your class.

Evaluate

1. How did your application compare to the applications of other students? What do you think makes a strong application? Do you think you would be accepted for the experience?
2. What additional knowledge or experience might increase your chances of being chosen?
3. Would you want to be chosen for this experience? Explain what you were thinking as you made this decision.

Unit 3 Unit Project • MHR 199

Evaluate Answers

1. Strong applications should include a confident presentation, knowledge of the required skills of an astronaut, a good knowledge of the technology involved and a keen interest in exploration.
2. Some knowledge that would increase the chance of being chosen would be in-depth knowledge of a branch of science such as physics or biology, an understanding of the physical standards required of astronauts, and a focus on strong teamwork.
3. Accept all reasonable and well-thought-out answers.

Adaptations

- Students should be encouraged to select a method of presentation that focuses on their strengths.
- Students with literacy difficulties should be provided with the opportunity to prepare a slideshow or other pictorial or visual resume.

Project Wrap-Up

- Students will present their resumes to the class and discuss the challenges of preparing for a job interview.
- Complete and discuss the Evaluate section as a class.
- Ask the class to hire an astronaut based on the specific criteria set out in the project.

Assessment Option for Unit 3 Project

- Use Learning Skills Checklist 11, Project Self-Assessment and/or Learning Skills Rubric 6, Communication to assess student work in Unit 3 Project.