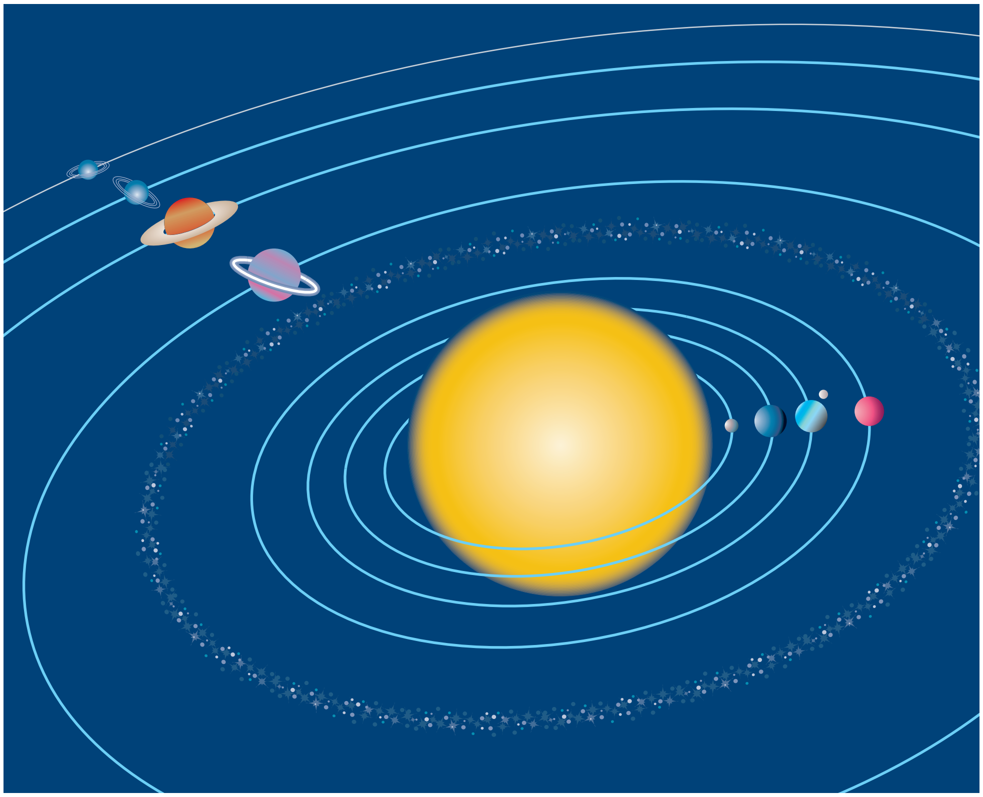
CHAPTER 6

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.

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?

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**.

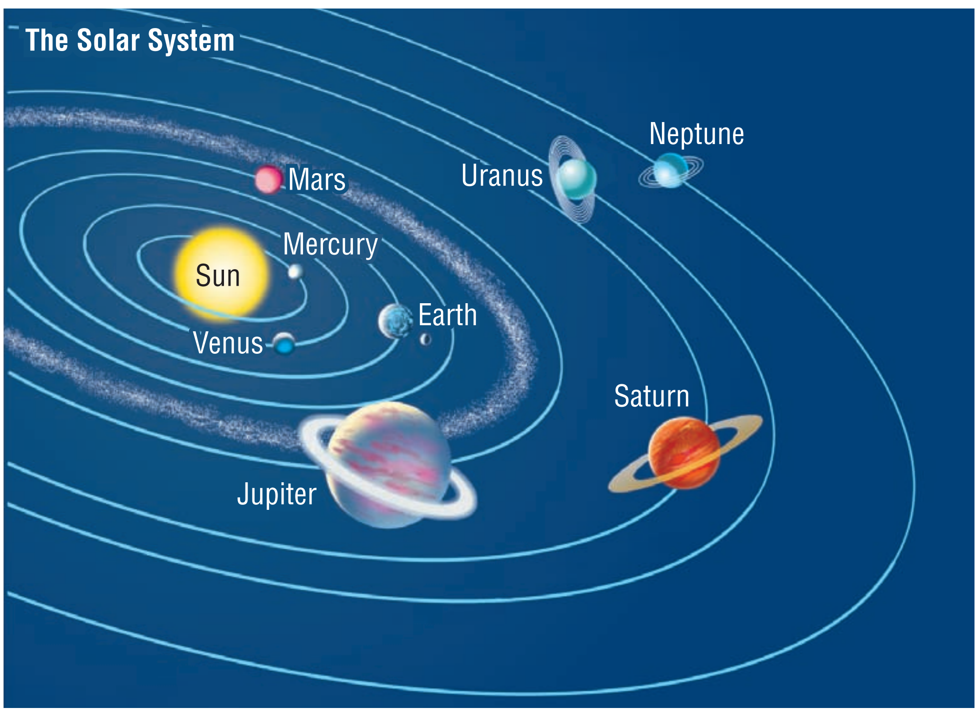


Figure 6.1 How many major planets are there in the solar system?

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.

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	metre stick(s)
markers	scissors
tape	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?

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.

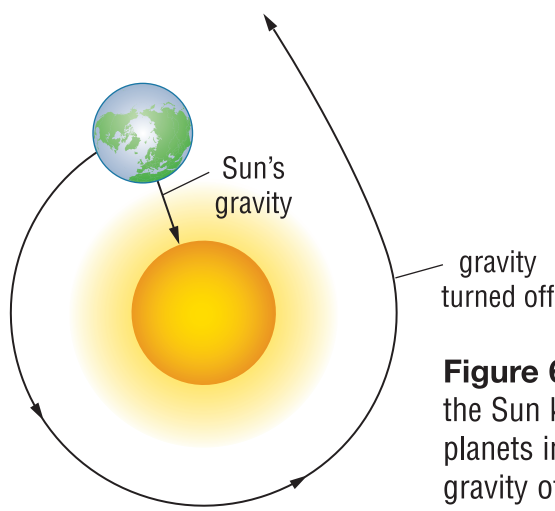


Figure 6.2 The gravitational force of the Sun keeps Earth and all of the other planets in their orbits. If you could turn gravity off, Earth would travel in a straight line out into space.

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.

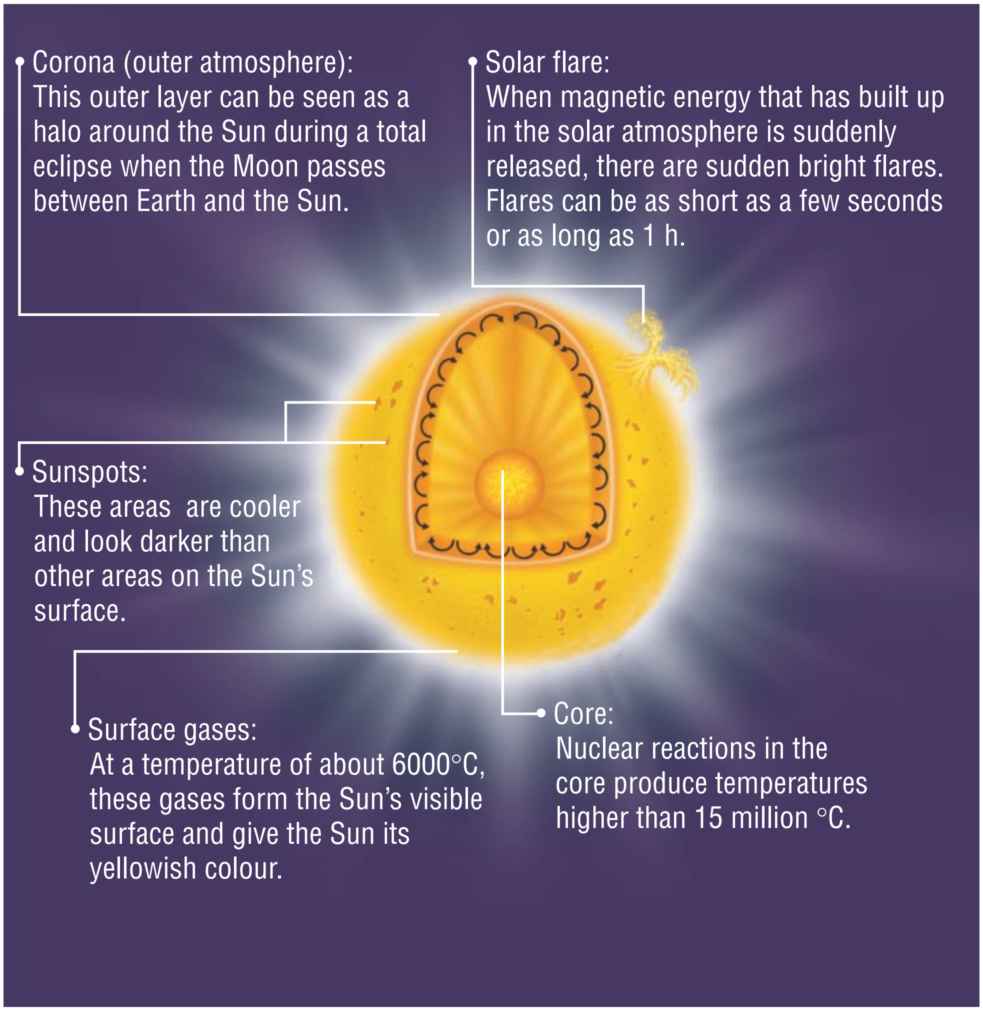


Figure 6.3 The structure of the Sun

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.

Off the Wall

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

READING Check

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.

PROBLEM-SOLVING

INVESTIGATION 6-C

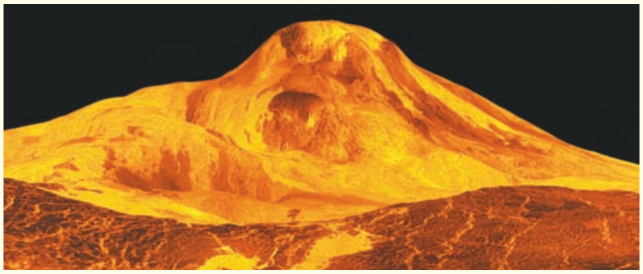
SKILLCHECK

- 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.

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.)

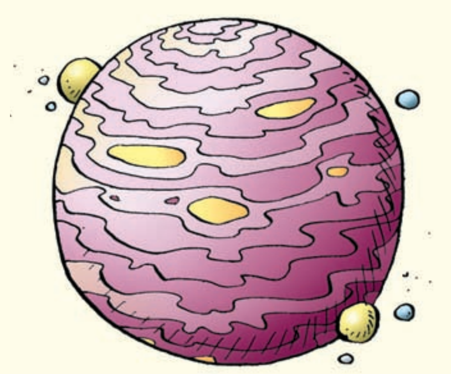
Alien Planet Mission

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.

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?

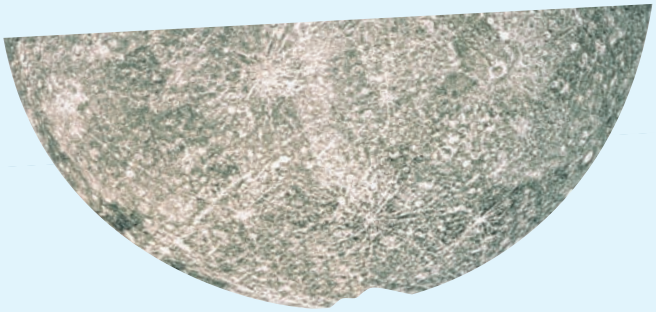
3. **(a)** How is your model similar to the original object?
   (b) How is it different?

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?

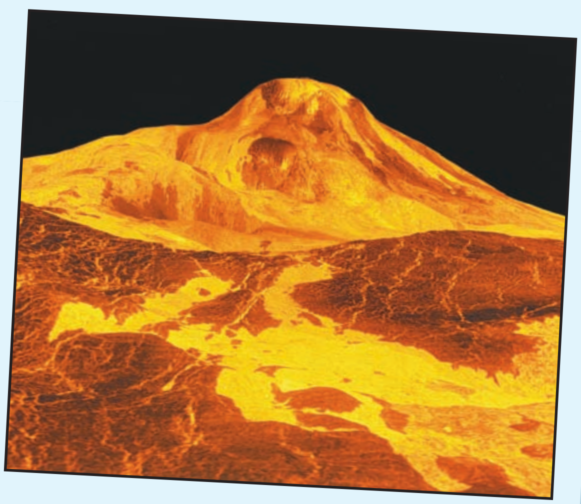
Mercury



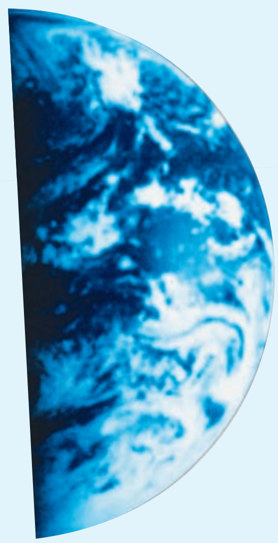
- closest planet to the Sun
- rocky planet and covered with craters
- daytime temperatures reach 430°C
- nighttime temperatures drop to −180°C
- smallest planet in the solar system
- does not have any moons

Venus

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



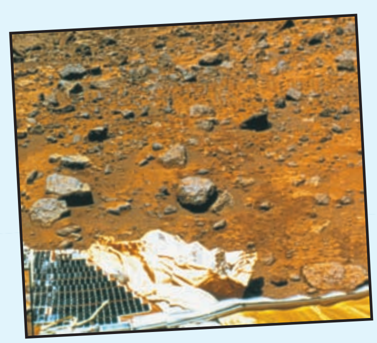
Earth



- 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

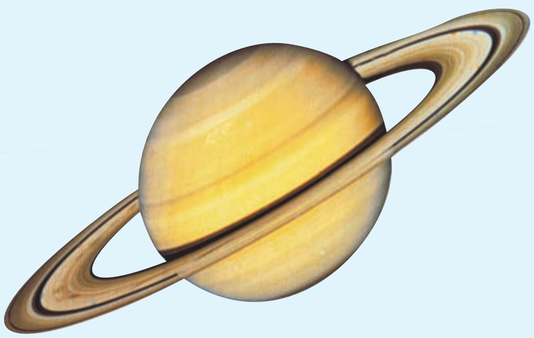
- fourth planet from the Sun
- rocky planet
- reddish in colour because of a material called iron oxide that is on its surface
- sometimes called the "red planet"
- average temperature is −23°C
- has two small moons



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

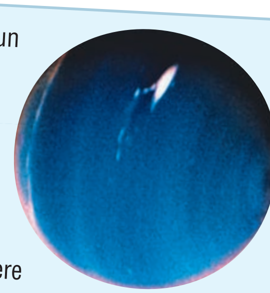
- seventh planet from the Sun
- gas planet
- third largest planet in the solar system
- bluish in colour because of a gas called methane that is in its atmosphere
- has 27 confirmed moons

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



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.

Planet Data

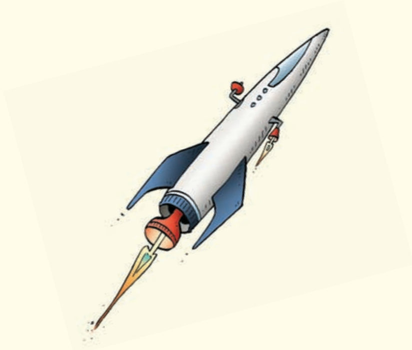
Planet Name	Diameter (km)	Maximum Distance from Sun (millions of km)	Average Surface Temperature (°C)	Length of Year (in Earth units)	Distance from Earth (AU)	Orbital Speed (km/s)
Mercury	4879	70	−170 to 350	88 days	0.39	47.87
Venus	12 104	109	+480	225 days	0.72	35.02
Earth	12 756	152	+22	365 days	1.00	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.

READING Check

What is the difference between moons and planets?

Pause& Reflect

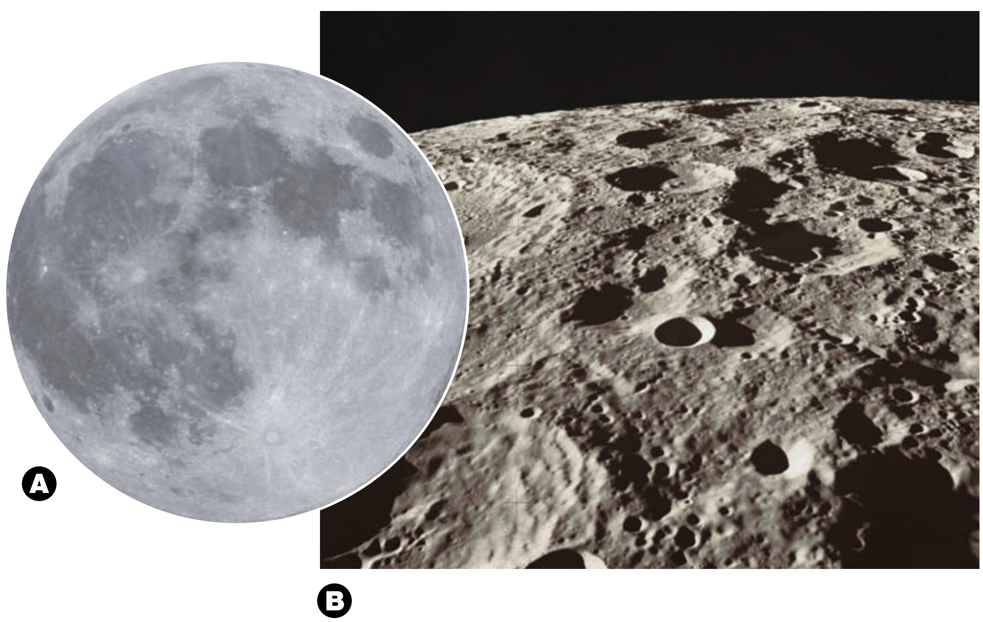
Why do you think a lack of atmosphere allows craters on the Moon to last for millions of years? Explain and record your answers in a notebook.

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!

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.

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.

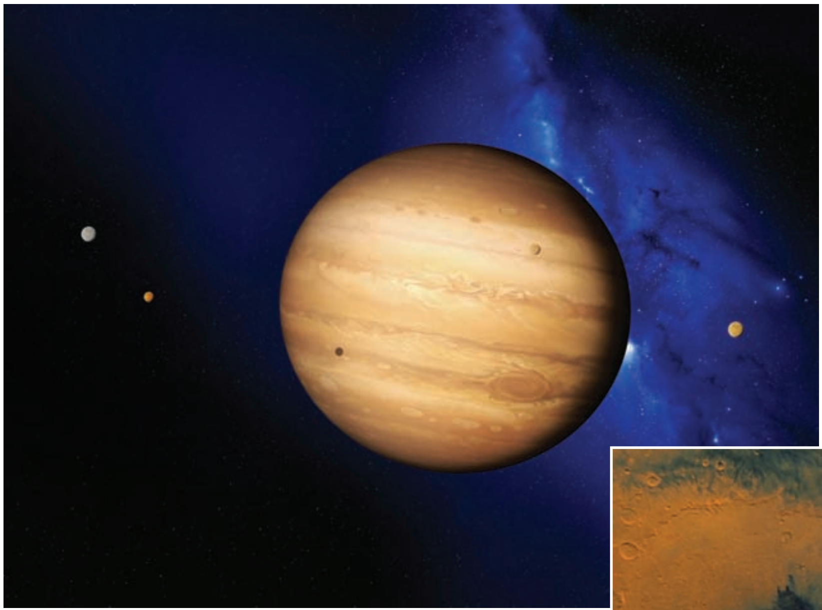


Figure 6.5 Astronomers have found many, many moons orbiting Jupiter.

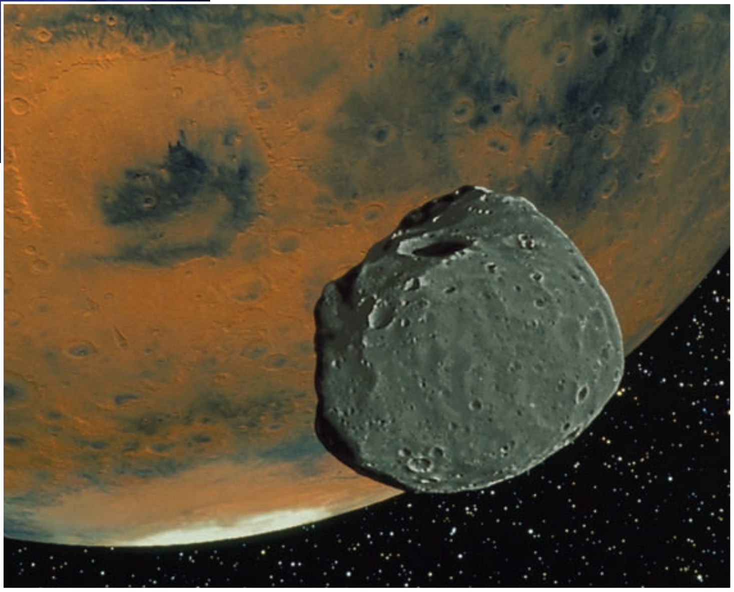


Figure 6.6 This photo shows one of Mars's two moons.

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.

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.

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?

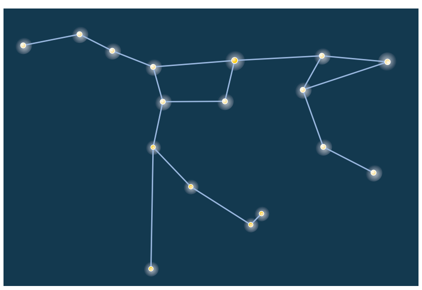


Figure 6.8 These are the stars that form the constellation *Ursa Major*, or Great Bear. Can you locate the Big Dipper within *Ursa Major*?

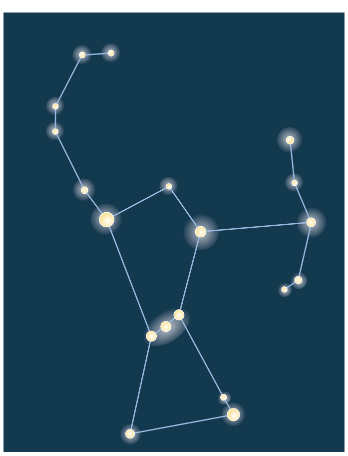


Figure 6.9 Orion, the Hunter, is another famous constellation in the northern hemisphere.

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.

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.

THINK & LINK

INVESTIGATION 6-F

SKILLCHECK
- Inferring
- Predicting
- Communicating
- Interpreting Data

Big Dipper Time

Think About It

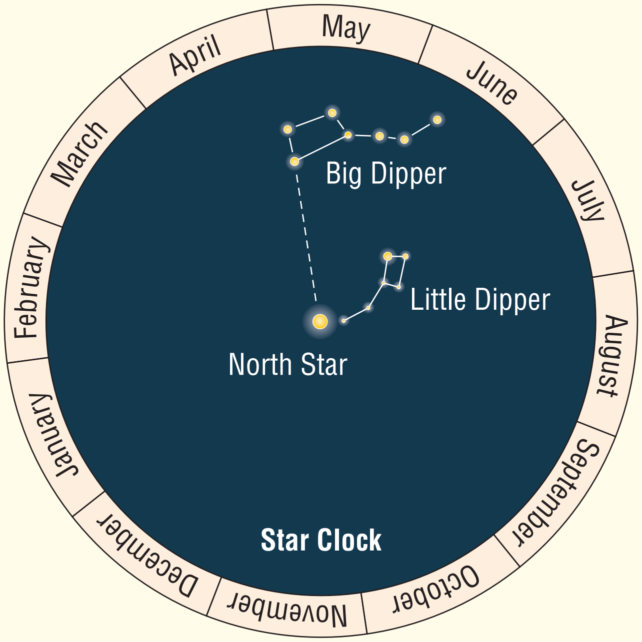
How can stars help us to tell time?

Materials

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

Safety Precautions

- Take care using scissors.



What to Do

Making the Big Dipper Time Clock

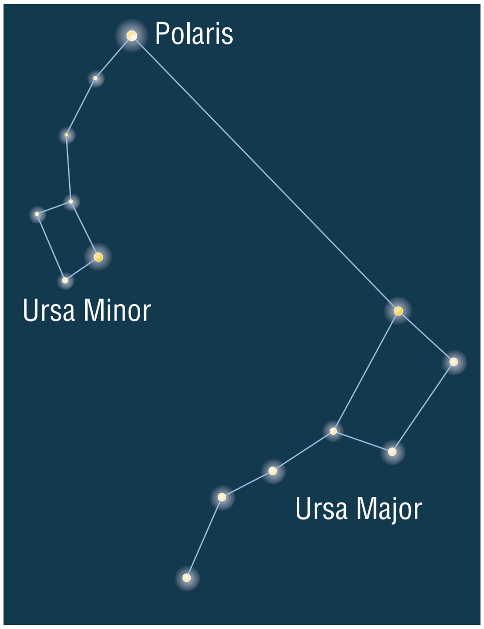
1. Cut out the two circles from Big Dipper Time patterns 1 and 2.
2. Place the smaller circle on top of the bigger circle (you should be able to see the months around the edge).
3. Hold them together by placing a brass fastener through the centre that is marked with an "x".
4. Turn the circles over and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



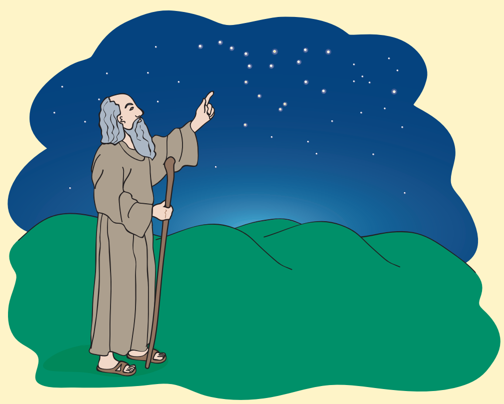
Before maps and compasses existed, sailors and explorers depended on the stars. **Polaris**, the North Star, is important because it can be used for navigation. Polaris shows mariners which direction is north, which is an important piece of information for navigating the oceans and lands of the world.

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.

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!

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.

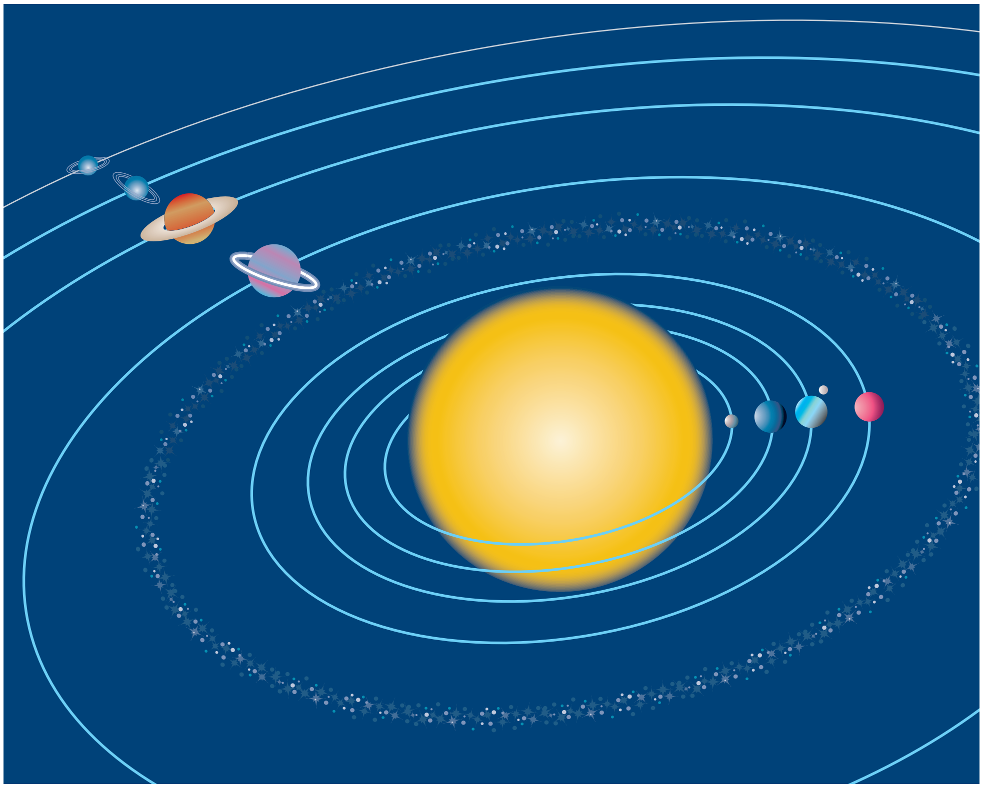
Prepare Your Own Chapter Summary

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.



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 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?**

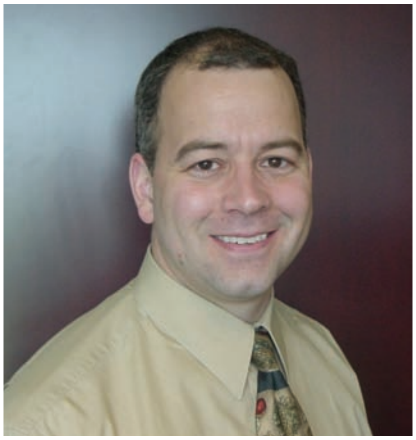
A. Believe that you can be part of the space program if you want to be! Find the aspect of it that interests you most. Don't be afraid to contact people and ask questions. If you would like hands-on experience as an undergraduate student, look for a co-op program or for summer placements. Most Mars data 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 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.

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

Project

SKILLCHECK
- Communicating
- Inferring
- Evaluating

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.

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.