Grade 6

Cluster 4: Exploring the Solar System

Overview

In this cluster, students develop an understanding of the Earth in space, the solar system, and the role of space research programs in increasing scientific knowledge. Positive and negative impacts arising from space research programs are addressed, and the contributions of Canadians to these programs are highlighted. Students develop an appreciation for the nature of science by examining the changing conceptions of the Earth's position in space and by differentiating between astronomy and astrology. Students investigate the causes of phenomena such as the cycle of day and night, the yearly cycle of the seasons, moon phases, eclipses, and the reasons why the apparent movements of celestial bodies in the night sky are regular and predictable. An important distinction is made between weight and mass.

PRESCRIBED LEARNING OUTCOMES
Students will...
6-4-01 Use appropriate vocabulary related to their investigations of Earth and space. Include: astronauts, communication and remote sensing satellites, solar system, inner and outer planets, asteroid belt, mass, weight, points of reference, apparent movement, celestial objects, astrology, astronomy, rotation, revolution, axis, moon phases, eclipses. GLO: C6, D6

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 3, Cluster 3: Forces That Attract and Repel, and in Grade 1, Cluster 4: Daily and Seasonal Changes.

- Introduce, explain, use, and reinforce vocabulary throughout this cluster.

- **"I Wonder . . ." Chart**

  Write the title "Learning about the Solar System" on chart paper and post the chart on a classroom wall. Invite students to record questions, words, or phrases related to this topic at any time throughout the study of this cluster. Review the chart to reinforce vocabulary and use the questions to focus inquiry and instruction.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-02 Identify technological developments that enable astronauts to meet their basic needs in space.

Examples: dehydrated foods, backpacks with an oxygen supply, hermetically sealed cabins with temperature and air controls...

GLO: B1, B2, D1, D6

6-0-1a Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 6, 3.1.2; Math: SP-I.1.6)

6-0-2a ↻ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ↻ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-7g ↻ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

➢ Human Needs

Provide students with the following scenario:

You have been chosen to take part in a television show dealing with how people survive in a wilderness area without modern conveniences. Work with a partner to identify your needs and determine what you would have to do to meet them.

Example:

Wilderness Survival

Need	What We Need to Do
water	Find a source of clean, fresh water within a reasonable distance.
shelter	Select a site, find suitable construction materials, and build a structure.

➢ Meeting Needs in Space

Have students complete the Know (K) and Want to Know (W) sections of a KWL Chart (Ogle, 1986) to deal with the topic of how astronauts meet their needs in space.

(For a BLM of a KWL Chart, see *SYSTH*, Attachment 9.1, or *Success*, p. 6.94.)

Divide the class into small groups. Have each group

- select one of the questions in the W section of the KWL Chart to research, including specific references to technological developments
- report research findings to the class (e.g., in the form of a poster or a multimedia presentation)

Possible questions:

- How/what do astronauts eat in space?
- How do astronauts breathe in space?
- How do astronauts control temperature while on a space mission?
- How do astronauts sleep in space?
- How does technology help solve problems in space?

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Extended Response

Provide students with the following:

Space Travel and Technological Developments

Space travel has resulted in the development of new technological devices.

Do you agree or disagree with this statement? Give reasons to support your answer.

Look for:

- technological developments related to basic human needs:
  - water and food
  - shelter
  - breathing
  - temperature control
  - sleep
- answer is logical and well supported with examples

Addison Wesley Science & Technology 6: *Space* (Chapter 14)

Science Everywhere 6 (p. 117)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-03 Identify Canadians who have contributed to space science or space technology, and describe their achievements.

GLO: A4, A5, B1, B4

6-0-2a ⊂ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-5f ⊂ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

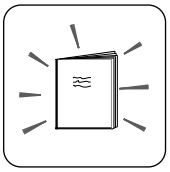
Learning activities related to learning outcomes 6-4-03 and 6-4-04 could be carried out at the same time as part of a major class research project. For example, have groups of students select projects related either to Canadian contributions to space science or space technology/space research programs, ensuring that both topics are well represented.

➢ Canadian Contributions

Have students use The Canadian Space Agency Internet site, available online at <http://www.space.gc.ca>, or another resource to find the names of Canadians who have contributed to space science or space technology. Have pairs of students select one of the people identified and write a newspaper article on this person's contributions, answering the 5 Ws (Who? What? When? Where? Why?)

Students may choose to present their findings in the form of a mock interview or combine the articles into a class newspaper. All students are responsible for the information provided by each group and should use an appropriate format (e.g., summary table, paragraph, labelled illustration) to record key facts about each person studied by the class.

Suggestions for Assessment



Using Resources

Provide students with the following self-assessment tool:

Self-Assessment: Canadian Contributions			
	Yes	No	Comment
• Did I/we find answers to all or most of my/our questions? • Do I/we have information on the most important areas? • Do I/we have enough information in each area?			
What I/we did well:			

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapters 11, 13)

Science Everywhere 6 (p. 94)

World of Invention (Teacher Reference)

Science and Technology Breakthroughs (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-04 Investigate past and present space research programs involving astronauts, and explain the contributions to scientific knowledge.

Examples: Apollo, Mir, International Space Station...

GLO: A1, A2, A5, D6

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

SUGGESTIONS FOR INSTRUCTION

➢ **Space Mission Research**

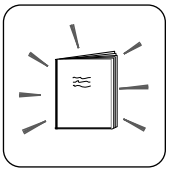
Brainstorm the names of space missions/projects such as the Mir Space Station and/or the National Aeronautics and Space Administration (NASA) Space Shuttle or Apollo missions. Have students work in groups to research one of the space research programs and prepare a report that includes the following:

- name of the mission
- date and length of the mission
- countries involved
- schematic drawing of the spacecraft
- names of people on the mission
- role of each crew member
- purpose of and contributions made by the mission (This is the main focus of the report.)

Have students create their reports in written form or deliver them to the class as an oral presentation. All students are responsible for the information provided by each group and should use an appropriate format (e.g., summary table, paragraph, labelled illustration) to record key facts about each space research program studied by the class.

(For strategies to aid students in using a variety of information sources, making sense of information, and recording and evaluating information, refer to *5-8 ELA*, learning outcomes 3.2.2-3.2.5 and 3.3.2-3.3.3.)

Suggestions for Assessment



Research Report

Look for indications of the following in student work:

Checklist:

The student (or group)

- ❑ introduces the topic
- ❑ presents the main ideas
- ❑ provides elaboration and detail
- ❑ stays on topic
- ❑ maintains sequence
- ❑ provides an effective conclusion

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapters 13, 14)

Science Everywhere 6 (p. 121)

Science and Technology Breakthroughs (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-05 Describe positive and negative impacts arising from space research programs.

Examples: advantages—increased knowledge about space and medicine, the development of technologies such as orange drink crystals and pocket calculators; disadvantages—space pollution and the high cost of research projects...

GLO: A1, B1, B5, D6

6-0-8g ⊂ Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

SUGGESTIONS FOR INSTRUCTION

➢ Positive Impacts of Space Research

Bring to class a variety of items (e.g., orange drink crystals, canned orange juice, a pocket calculator, freeze-dried food, a map of the world, a detailed map of a global region, a crystal). Ask students to identify the items they think are the result of space research.

Example:

Products Resulting from Space Research

Item	Product of Space Research?
orange drink crystals	Yes. This product was initially produced for use in space missions.
canned orange juice	No.
pocket calculator	Yes. This product was initially produced for use in space missions.
freeze-dried food	Yes. This product was initially produced for use in space missions.
maps	Maps of the world have existed since the 1400s. Detailed maps of a global region are, however, produced by remote sensing satellites that use microwave instruments to send and receive signals through darkness, cloud, smoke, or fog. They are a product of space research.
crystals	In her micro-gravity research, Roberta Bondar discovered that crystals grown in zero gravity have a purer and better structure then those grown in the Earth's gravity. These zero-gravity crystals are used in power lasers, high-resolution video cameras, and microwave broadcast devices.

➢ Negative Impacts of Space Research

Ask students what happens to rockets, satellites, and space probes once they have been used. Discuss the implications of all the "junk" that is left in space. In addition, discuss the cost of space research missions. Data can be gathered using the Internet (e.g., websites of organizations such as The Canadian Space Agency at <www.space.gc.ca> and the National Aeronautics and Space Administration at <www.nasa.gov>.)

Suggestions for Assessment

Suggested Learning Resources

Impacts of Space Research Programs

Provide students with the following:

Impacts of Space Research Programs

Answer the following questions in your science notebook:

1. What do you think is the greatest positive impact of space research programs? Explain your thinking.
2. What do you think is the greatest negative impact? Explain your thinking.

Addison Wesley Science & Technology 6: *Space* (Chapter 13)

Science Everywhere 6 (p. 124)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will... **6-4-06** Identify technological devices placed in space that help humans learn more about the Earth and communicate more efficiently. Include: communication and remote sensing satellites. GLO: B1, B2, D6 **6-0-2a** ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1) **6-0-1a** Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 6, 3.1.2; Math: SP-I.1.6) **6-0-7h** Identify potential applications of investigation results. GLO: C4 *(continued)*	➢ **Canadian Tour** Take students on a satellite image tour of Canada through the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada website, available online at <www.ccrs.nrcan.gc.ca>. If it is not possible to use the Internet, obtain satellite pictures to show students. ➢ **Guest Interviews: Satellite Communications** Invite guest speakers to class to discuss satellite communications (e.g., how a cell phone works, how satellite TV works). Have students work in small groups to develop a list of questions prior to the guest visits/interviews. If it is not possible to obtain a speaker to discuss the topic, show students a video, use a CD-ROM, or visit an "ask an expert" site on the Internet. ➢ **Weather Information from Satellites** Have students view a weather broadcast to see how satellite images are used to provide information about the weather. ➢ **Global Positioning System** A Global Positioning System (GPS) uses a satellite to locate the position of people and/or objects on the Earth. Have students share what they know about the uses of this system. As a class, discuss how this system could be helpful (e.g., It may be used for locating cars, boats, airplanes, or people. Mountain climbers on Mount Everest have used the system to enable rescuers to find them more easily, should they experience problems.) ➢ **Remote Sensing** Use explicit instruction to provide students with information on remote sensing. The Canadian Centre for Remote Sensing <http://www.ccrs.nrcan.gc.ca> provides readily accessible information on remote sensing, including a teaching kit appropriate for Grade 6. Provide students with the following discussion questions: 1. How can remote sensing information help with a. identifying and responding to natural and human-made disasters such as forest fires, oil spills on the ocean, and floods? (Remote sensing provides information on the size and movement of a forest fire to aid in fighting it, allows the tracking of oil spills for clean-up purposes, and tracks the spread of a flood to help in damage prevention.) *(continued)*

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

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Science Everywhere 6 (p. 112)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-4-06 *(continued)*	*(continued)*

b. prospecting for mineral deposits? (Geologists can use remote sensing information to identify different types of rock formations, some of which are likely to contain rich minerals. This helps direct prospecting activities and saves time and money.)

c. navigating through ice packs in the Arctic? (Up-to-the-minute remote sensing information on the location of constantly moving ice floes can help captains plot their path.)

d. farming? (Remote sensing information enables farmers to track how their crops are growing and whether they have been affected by disease, flood, and so on.)

2. What else can remote sensing information be used for?

Teacher Notes

Background Information

In its simplest terms, *remote sensing* means observing the Earth with sensors from high above its surface. These sensors, usually contained in satellites, are like cameras except that they use not only visible light but also other bands of the electromagnetic spectrum, such as infrared, radar, and ultraviolet. Because they are so high up, these sensors can make images of a very large area, sometimes an entire province. Many countries, including Canada, have remote sensing satellites in space. Hundreds of images are sent every day from the satellites to receiving stations on Earth. The Earth's entire surface is imaged every week or so, making it possible to obtain current images of what is happening on the Earth's surface.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Extended Response

Provide students with the following:

1. Identify two technological devices placed in space that have enabled us to learn more about the Earth and communicate more effectively.
2. Briefly describe what these devices do.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-07 Describe how the conception of the Earth and its position in space have been continuously questioned and how our understanding has evolved over time.

Include: from a flat Earth, to an Earth-centred system, to a Sun-centred system.

GLO: A1, A2, B2, C5

6-0-2a ⊂ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ⊂ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-7g ⊂ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-8a ⊂ Recognize that science is a way of answering questions about the world, and that there are questions that science cannot answer. GLO: A1, A3

6-0-8b ⊂ Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

SUGGESTIONS FOR INSTRUCTION

➢ How Would You See It?

In an outdoor setting, ask students to look up at the sky and think about how they would explain the position and motion of the Earth and the stars and planets if they had no technology available to assist them. Challenge students to provide "proof" with all their proposed explanations and eliminate any that require technology to prove their validity. Make a class list of their suggestions.

➢ Finding Evidence

Divide the class into small groups and provide each group with one of the four descriptions presented in "Changing Conceptions of the Earth and Its Position in Space" (see BLM 6-B).

Have each group

- read the description provided
- discuss it to ensure they understand it and answer the following question: What evidence did each person use to arrive at his or her explanation?
- select a group member to retell the description or story, using diagrams if necessary
- provide a summary of the evidence that was used to come up with the explanation for the shape of the Earth

As a class, discuss why it is so difficult to change what people believe. Ask students how they would feel if they were told that new discoveries could prove the Earth was really flat.

➢ Timeline of Changing Views

As a class, develop a timeline of the changing views of the Earth and its position in space. (Reference terms identified in the "include" part of learning outcome 6-4-07.) Students can use CD-ROMs, videos, print resources, and the Internet to find the information needed.

➢ Dramatization

Ask students to form small groups and have each student select one of the persons mentioned on the timeline created in the previous learning activity. Have students prepare a speech introducing the selected person and explaining his or her belief about the Earth's position in space and the evidence on which this is based. Students could dress in costumes of the time. Have students present their dramatizations to the class. If possible, invite another class as well.

Suggestions for Assessment

Suggested Learning Resources

Nature of Science

Provide students with the following:

Thinking about Science

Write your own definition of what science is and how it works. (Use examples from recent learning activities to support your answer.)

Addison Wesley Science & Technology 6: *Space* (Chapter 4)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-4-08 Recognize that the Sun is the centre of the solar system and it is the source of energy for all life on Earth. GLO: D6, E2, E4	➢ **The Day the Sun Disappeared** Ask students to write a story about what would happen to the Earth and other planets if the Sun disappeared. Have them include the following concepts: • all life on Earth would be destroyed • planets would not remain in their orbits • planets would cool dramatically
6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)	
6-4-09 Identify the planets in the solar system and describe their size relative to the Earth and their position relative to the Sun. GLO: D6, E1, E2	➢ **Ordering the Planets** Bring to class a variety of spheres (e.g., marbles, peas, golf balls, tennis balls, volleyballs, basketballs, beach balls) in a range of sizes. Have small groups of students • arrange the spheres according to the relative size and order of the Sun and the planets in the solar system • label their models • share their models with the class and justify their placement choices ➢ **Great Distances** Provide students with the "Planet Facts" data presented in the Teacher Notes on the following page. Have students use a large ball of string to plot the location of the planets in relation to the Sun on a school hallway wall. Start with the Sun (attach a label) and then, 58 cm further, add the label for Mercury, and so on. Students will need to calculate how many more centimetres of string to add after each planet. A chart such as the following may be helpful.
6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5 **6-0-5d** ⊂ Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.6)	
(continued)	*(continued)*

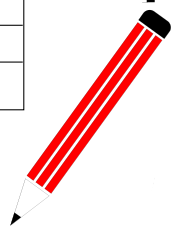
SUGGESTIONS FOR ASSESSMENT	SUGGESTED LEARNING RESOURCES
Refer to the assessment strategy suggested for learning outcome 6-4-10.	Addison Wesley Science & Technology 6: *Space* (Chapter 3) *Science Everywhere 6* (p. 99)

Teacher Notes

The learning experiences suggested for learning outcome 6-4-09 refer to the following data:

Planet Facts

Planet	Distance from the Sun	Average Diameter
Mercury	58 million km	5 000 km
Venus	108 million km	12 000 km
Earth	150 million km	13 000 km
Mars	228 million km	7 000 km
Jupiter	778 million km	143 000 km
Saturn	1 427 million km	120 000 km
Uranus	2 870 million km	52 000 km
Neptune	4 497 million km	50 000 km
Pluto	5 900 million km	3 000 km



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Science Everywhere 6 (p. 82)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-4-09 *(continued)*	*(continued)*

Example:

Relative Distances

Planet	Distance from the Sun	Additional cm Needed
Mercury	58 million km	
Venus	108 million km	50 cm
Earth	150 million km	42 cm
Mars	228 million km	78 cm
Jupiter	778 million km	550 cm
Saturn	1 427 million km	
Uranus	2 870 million km	
Neptune	4 497 million km	
Pluto	5 900 million km	

➢ **How Big Are the Planets?**

Ask students whether they think the spheres they used in their models (see Ordering the Planets learning activity associated with learning outcome 6-4-09) accurately represent the relative sizes of the planets. Have them make a "sizing up the planets" model. This can be done outdoors using sidewalk chalk or indoors (e.g., in the gymnasium) on large pieces of paper.

Using the "Average Diameters" data from the chart presented in the Teacher Notes for learning outcome 6-4-09, have students calculate the radius of each planet. They can use a scale of 1000 km = 1 cm (if done indoors) or 1000 km = 10 cm (if done outdoors). To draw the circles, students can use a compass or create a push-pin string/pencil system. Once the drawings are complete, have students take a cutout model of the Earth and compare its size to that of the other planets.

SUGGESTIONS FOR ASSESSMENT	SUGGESTED LEARNING RESOURCES
Refer to the assessment strategy suggested for learning outcome 6-4-10.	

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-10 Classify planets as inner or outer planets, based on their position relative to the asteroid belt, and describe characteristics of each type.

Include: inner planets are small and rocky; outer planets (except Pluto) are giant balls of gas.

GLO: D6, E1

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ Inner or Outer Planets

Have students complete a chart listing all the planets in our solar system, briefly describing their composition and classifying them as inner or outer planets.

Example:

The Composition and Classification of Planets

Planet	Composition	Inner or Outer Planet
Mercury	rocky, small	inner
Pluto	rocky, small	outer

➢ Word Splash

Give students a Word Splash (Saphier and Haley, 1993) such as the one presented below. Have them work in groups to make connections between the words, based on their prior knowledge, and then use the words to create a descriptive paragraph. Have groups share their paragraphs and compare the similarities and differences. Identify and correct any inaccuracies and misconceptions.

(For a discussion of the Word Splash strategy, see *Success*, p. 6.28.)

Example:

Word Splash

Sun **rocky** **gaseous** **inner**

large **Earth** **centre** **Saturn**

solar system **Mercury** **Jupiter** **small**

Venus **Uranus** **Mars**

outer **energy** **orbit** **Neptune**

Pluto

Suggestions for Assessment

Suggested Learning Resources

Extended Response

Provide students with the following:

The Solar System

Make a labelled diagram of the solar system. In your diagram, include the following: the Sun, the planets (inner and outer), and the asteroid belt.

Look for:

- the Sun
- nine planets in the correct order
- the asteroid belt
- inner and outer planets (labelled)
- a neatly and accurately completed diagram

Addison Wesley Science & Technology 6: *Space* (Chapter 11)

Science Everywhere 6 (pp. 84-85)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-11 Recognize that mass is the amount of matter in an object, that weight is the force of gravity on the mass of an object, and that the force of gravity varies from planet to planet.

GLO: D3

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-5d ↻ Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.6)

6-0-5e Estimate and measure accurately using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-I.1.5)

SUGGESTIONS FOR INSTRUCTION

➢ Measuring Weight and Mass

To demonstrate the difference between weight and mass, have students do the following:

- Measure the weight of a collection of pennies using a *spring scale*. (A spring scale measures the gravitational pull on the pennies or their weight.)
- Measure the mass of the collection of pennies by using a *balance scale.* The scale can be balanced by adding any type of object such as paper clips, cubes, or beans. (A balance scale is an instrument that compares the masses of two objects. The unknown mass is placed on one side of the balance and known masses are added to the opposite side until the instrument balances. When the instrument balances, the unknown mass equals the sum of the known masses.)
- Discuss the difference between the two measurements of the pennies.

➢ How Much Would I Weigh?

Provide students with the following task:

Student A weighs 30 kg on Earth. Use the following chart to calculate student A's weight on each planet/moon. (Multiply student A's Earth weight by the gravity factor.)

Calculating Weight on Planets/Moon

Planet/Moon	Gravity Factor	Student A's Weight
Mercury	0.284	
Venus	0.907	
Earth's moon	0.166	
Mars	0.380	
Jupiter	2.340	
Saturn	0.925	
Uranus	0.795	
Neptune	1.125	
Pluto	0.041	

Have students look at the above chart and answer the following questions:

- On which planet(s) would you weigh about the same as you do on Earth?
- On which planet would you weigh the least?
- On which planet would you weigh the most?
- How would your mass be affected on the other planets? (Mass would not change.)

Suggestions for Assessment

Suggested Learning Resources

Extended Response

Provide students with the following:

Mass Versus Weight

In your science notebook, explain the difference between *mass* and *weight*. Provide examples to support your answer.

Look for:

- an understanding of *mass*
- an understanding of *weight*
- examples to support the answer
- a clear and complete explanation

Science Everywhere 6 (p. 85)

Teacher Notes

Background Information

- On Earth, *weight* is the term used to measure the force of attraction between an object and the Earth. This force is called a *gravitational attraction.* An object's weight would change if it were measured on another celestial body that had a gravitational force different from that of the Earth.
- The amount of weight depends on the *mass* (the amount of matter present). Unlike weight, the mass of an object would not change regardless of where it were measured. The object would have the same mass on the moon as it would on the Earth because mass is the measure of the amount of particles present. An object would weigh less on the moon than on the Earth, but its size would not change because its mass would not change. Regardless of what planet an object is on, the object can gain weight only if more particles (mass) are added to it.

Prescribed Learning Outcomes

Students will...

6-4-12 Explain, using models and simulations, how the Earth's rotation causes the cycle of day and night, and how the Earth's tilt of axis and revolution cause the yearly cycle of seasons.

GLO: A2, D6, E2, E4

6-0-2a ⊂ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-5a ⊂ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7g ⊂ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

(continued)

Suggestions for Instruction

Teacher Notes

Background Information

The Earth rotates around a tilted axis (23.5 degrees). The north end of the axis always points toward the North Star as the Earth circles the Sun. The tilted axis of the Earth and the yearly orbit of the Earth around the Sun cause variations in the amount of heat at different locations on Earth at different times of the year, which cause seasonal changes. Summers in Canada are warmer than winters, not because the Earth is closer to the Sun at that time of year (a common misconception) but because the Sun shines more directly on the Earth in summer than it does in winter. At noon in summer the Sun is directly overhead, whereas in winter it is not. Places nearer the equator do not experience the extremes in climate caused by the tilt of the Earth's axis.

➢ Exploring the Earth's Rotation

1. On a sunny day take students outdoors. Push a long stick into level ground so that it is upright, perpendicular to the ground. Mark the tip of the stick's shadow using a stone or other marker. Have students mark the tip of the shadow every 10 minutes for half an hour. Ask students how the shadow is moving and why. (The Earth has a large diameter, about 13 000 km. It makes one complete rotation in 24 hours.)
2. Provide students with a flashlight and a globe. Ask students to mark their location on the globe. Have one student stand still with the flashlight as another student slowly rotates the globe. Ask students to note the change in the amount of light (day and night) at the location that they marked.
3. Read the following excerpt from *The Missing Sun*, a book exploring the Inuit and Western scientific explanations for day and night in the Arctic:

   "Emily's mother had told her that it would be different living in Inuvik but not that much different than living in Regina.

   Because her mother was a meteorologist, Emily believed her when she said it could be just as cold and just as windy in Inuvik as it was in Regina. But when Emily's mother told her that in Inuvik the sun wouldn't come up for many, many days and that even on Christmas Day, it was going to be night all day long, Emily could not believe her."*

   Have students write a letter to Emily explaining why her mother is correct.

(continued)

* Excerpt reproduced from *The Missing Sun*. Copyright © 1993 by Peter Eyvindson. Reproduced by permission of Pemmican Publications, Inc.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

Given the difficulty of the concepts associated with learning outcome 6-4-12 and the prevalence of strongly held misconceptions through to adulthood, provide students with opportunities to explore these concepts in a variety of ways. In addition to participating in the suggested learning experiences, students should have opportunities to view computer models or videos illustrating the causes of day and night and the seasons. If possible, visit a planetarium.

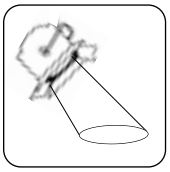
Addison Wesley Science & Technology 6: *Space* (Chapter 5)

Science Everywhere 6 (pp. 96, 102)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-4-12 *(continued)*	*(continued)* ➢ **Exploring Seasons** Assemble the following items: a globe that rotates around a tilted axis, a small lamp, a small nail with a large head, and adhesive tape. Create the following simulations to explore the yearly cycle of seasons: • Place the lamp (without a shade) in the middle of the floor to represent the Sun. • Label north (winter). • Use the small nail to mark the school's location on the globe by taping it head down. • Place the globe on the ground about 1.5 m away from the lamp on the side opposite north. The light bulb should be at the same height as the middle of the globe. The globe should tilt toward north. • Centre the nail in the light and note the length of the shadow. • Repeat the process for each direction: east (fall), west (spring), and south (summer), noting the shadow length. (A short shadow indicates strong, direct sunlight; a long shadow indicates weaker sunlight coming toward a direction at an angle.) Ask students in what season we receive the most sunlight (where the nail's head is in the light the longest) and in what season we receive the same amount of daylight and darkness.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Is It True?

Provide students with the following:

Is the Sun Closest to the Earth in Summer?

At the ball diamond, you overhear a conversation between two young children.

Is the child's answer correct? Explain your thinking. Use both words and diagrams in your answer.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-13 Use the design process to construct a prototype that tells the time of day or measures a time span.

GLO: C3, D6

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?…* GLO: C3

6-0-1d ⊂ Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-3d ⊂ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ⊂ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-4b ⊂ Construct a prototype. GLO: C3

6-0-4c ⊂ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ⊂ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5b ⊂ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-5d ⊂ Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.6)

6-0-5e Estimate and measure accurately using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-I.1.5)

6-0-6d ⊂ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-7d ⊂ Propose and justify a solution to the initial problem. GLO: C3

6-0-7e ⊂ Identify new practical problems to solve. GLO: C3

SUGGESTIONS FOR INSTRUCTION

➢ **Design Scenario**

Present students with one of the following scenarios:

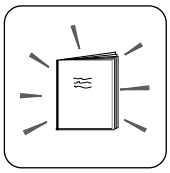
1. You have been selected to design a prototype that tells the time of day for your classmates in a wilderness survival course (e.g., an hour glass, a sun dial, a pendulum).
2. The timer on your stove has broken. You want to bake cookies but you need to time them as accurately as possible for 12 minutes. Design a prototype that will tell you when to remove the cookies from the oven (e.g., an hour glass, a pendulum).

Possible criteria:

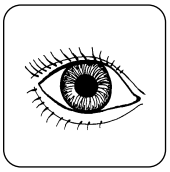
- the cost falls within a given budget
- the prototype works in repeated trials
- it is aesthetically pleasing
- it is portable (small enough to carry around)

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Project Report: Assessment" (BLM 6-F)



"Constructing a Prototype: Observation Checklist" (BLM 6-D)

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 1)

Science Everywhere 6 (p. 97)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

Prescribed Learning Outcomes

Students will...

6-4-14 Explain how the relative positions of the Earth, moon, and Sun are responsible for moon phases and eclipses.

GLO: D6, E2

6-0-5a ⊂ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5f ⊂ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

(continued)

Suggestions for Instruction

Teacher Notes

Background Information

The moon revolves around Earth once every 27.3 days. It appears to rise in the east and set in the west due to the Earth's rotation from west to east. The moon does not generate its own light, but is visible due to reflected light from the Sun.

➢ Moon Phases

Provide students with a flashlight (or a projector with a strong focused beam supported by a stand) and a large basketball. Assign students to specific roles: Have one student hold the flashlight (representing the Sun) in the centre of the room. Have another student represent the Earth and walk around the Sun while slowly spinning. Have another student represent the moon by holding the ball slightly above his or her head. The moon circles the Earth and faces the Earth at all times. The person representing the Earth looks at the moon continuously in order to see its phases. Ensure that students have opportunities to try the different roles and to explain what they saw happening.

➢ Charting the Phases of the Moon

Have students observe the moon each night (for one lunar phase) and chart what they see. Have them compare the phases of the moon observed in the previous learning activity with their actual observations. (Phases of the moon are also reported in newspapers. On nights when the moon is not visible or at times of the year when the moon appears late at night, newspaper reports would provide an alternative source of data.)

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Extended Response

Provide students with the following:

The Moon and the Sun

Answer the following questions in your science notebook:

1. Why does the moon appear to change shape over the course of a month?
2. Why do we have eclipses of the moon and the Sun?

Look for:

- the moon revolves around the Earth once every 28 days
- the Earth rotates on its axis
- the moon is visible due to reflected light from the Sun
- the phases of the moon are caused by the partial blocking of the Sun's light
- an eclipse occurs when one heavenly body obscures another
- a lunar eclipse occurs when the Earth is directly between the Sun and the moon
- a solar eclipse occurs when the moon is between the Earth and the Sun

Addison Wesley Science & Technology 6: *Space* (Chapters 6, 7, 10)

Science Everywhere 6 (p. 92)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-4-14 *(continued)*	*(continued)*

➢ **Total Solar Eclipse**

To demonstrate what happens in a total solar eclipse, have students follow these steps:

- Close one eye and then hold out one index finger (representing the Sun) at arm's length.
- Keep one eye open and look at the index finger.
- Slowly move a finger from your other hand (representing the moon) across in front of your open eye until both fingers line up and the farther finger is completely blocked from view.

➢ **Lunar Eclipse**

Use a flashlight, a large ball, and a small ball to represent the Sun, the Earth, and the moon respectively. Hold the large ball in front of the flashlight and the small ball on the side of the large ball opposite the flashlight. Ask students: What do you observe?

Safety Precaution: Lunar eclipses are safe to view at any time. Solar eclipses must be viewed indirectly or with a proper filter. The Sun's light is strong enough to cause serious eye damage. Instant blindness could result from unsafe viewing of the Sun with binoculars or a telescope.

➢ **Solar Eclipse Safety**

Have students make safety posters demonstrating safe practices for viewing a solar eclipse. Put up the posters and have students take a Gallery Walk (Brownlie and Close, 1992) to observe them.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

Background Information

- An *eclipse* occurs when one heavenly body obscures another.
- A *lunar eclipse* occurs when the Earth is directly between the Sun and the moon. The moon cannot be seen because the Earth blocks the Sun's light from being reflected off the moon.
- A *solar eclips*e occurs when the moon is between the Earth and the Sun. The moon blocks the Sun's light and creates a shadow on the Earth.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-15 Identify points of reference in the night sky and recognize that the apparent movement of celestial objects is regular, predictable, and related to the Earth's rotation and revolution.

Examples: planets, constellations...

GLO: D6, E2, E3

6-0-4c ⊂ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ⊂ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Creating an Umbrella Planetarium**

Demonstration:

- Use chalk or a white pencil to draw stars onto a black umbrella.
- Put the North Star (Polaris) at the centre of the inside of the umbrella. The North Star is at the end of the handle of the Little Dipper.
- Mark the positions of the remaining stars of the Little Dipper, as well as the stars of the Big Dipper and other constellations such as Cepheus, Draco, and Cassiopeia.
- Draw lines to connect the stars in each constellation.
- Turn the umbrella counter-clockwise to show how the stars appear to move through the night sky.

Ask students to demonstrate what really happens. (A student could pretend to be the Earth and rotate under a stationary umbrella.)

As a link to the learning experiences related to changing conceptions of the Earth and its position in space (see learning outcome 6-4-07), ask students to explain why people long ago believed that the stars moved and the Earth was stationary. (From any location on Earth, it seems as though we are standing still while the stars are moving.)

➢ **Shoebox Constellations**

To create a simulated planetarium, have students follow these steps:

1. Bring to class a shoebox and cut a rectangle out of one end of it, leaving a 2 to 3 cm border of cardboard.
2. Cut a hole in the opposite end of the shoebox just large enough to look through.
3. Cut a narrow slit in the lid of the box approximately 2 cm from one end and slightly less than the entire width of the lid, ensuring that the slit is just wide enough to allow a thin cardboard card to be inserted but not so wide as to allow excess light into the box.
4. Paint the inside of the box black, or cover it with black construction paper.

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

Background Information

The stars appear to be moving because of the Earth's movement. The constellations shown in the umbrella are always visible above the horizon. Constellations further from the North Star rise and set each day as the Earth turns. The ribs of the umbrella represent celestial meridians. Astronomers determine the celestial longitude of stars in the same way that longitude is used on Earth.

Addison Wesley Science & Technology 6: *Space* (Chapter 12)

Science Everywhere 6 (p. 79)

Native Studies: Middle Years (Grades 5 to 8) (Teacher Reference)

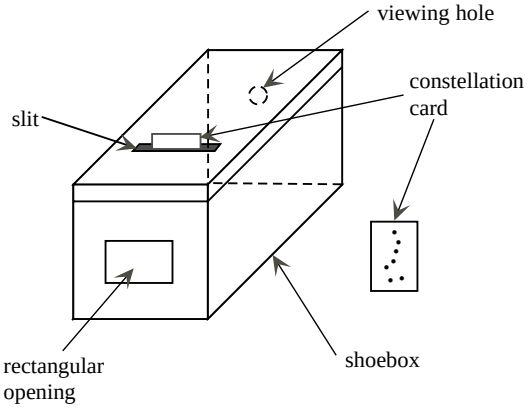
Igniting the Sparkle: An Indigenous Science Education Model (Teacher Reference)

Keepers of the Earth: Native Stories and Environmental Activities for Children (Teacher Reference)

Native Science: Natural Laws of Interdependence (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-4-15 *(continued)*	*(continued)*

5. Create constellation cards by cutting pieces of light cardboard/heavy paper that fit the width of the slot in the lid of the shoebox but are slightly taller than the box. Then, using a sharp pencil, punch holes in each card to represent a different constellation (leave a 2 to 3 cm border without holes).
6. Place a constellation card in the slot, hold the box toward a light source, and look through the eyehole to observe the constellation. (An alternative is to enlarge the eyehole to fit the end of a flashlight and shine the light through the box so that the constellation can be projected onto a screen or light-coloured wall.)



Have students share their constellations with other students and challenge them to identify the constellations depicted.

➢ **Constellations from an Aboriginal Perspective**

Provide students with information regarding Aboriginal perspectives on some of the planets, constellations, and stars according to the Cree and Ojibway people of Manitoba. (See *Native Studies: Middle Years [Grades 5 to 8]*, 1997.) Have students use the blank Star Map (see BLM 6-C) and label the constellations using the Cree and/or Ojibway names.

Students could also research oral and written traditions for legends about each constellation or star.

SUGGESTIONS FOR ASSESSMENT	SUGGESTED LEARNING RESOURCES
Refer to the assessment strategy suggested for learning outcome 6-4-15.	

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-16 Identify and describe how people from various cultures, past and present, apply astronomy in daily life.

Examples: using celestial bodies to navigate; knowing when to plant crops...

GLO: A4, A5, B1, B2

6-0-2a ⊂ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ⊂ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-8b ⊂ Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

6-0-8d ⊂ Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1

6-0-9a ⊂ Appreciate that women and men of diverse cultural backgrounds can contribute equally to science. GLO: A4

SUGGESTIONS FOR INSTRUCTION

➢ **Literature Connection**

Have students look in fiction texts for references to navigation using the stars. This literature may be related to a social studies or an English language arts classroom theme. There are many stories that tell how different groups of people used the constellations as a guide when travelling (e.g., stories of the Underground Railroad often make reference to the constellations).

➢ **Astronomy Timeline**

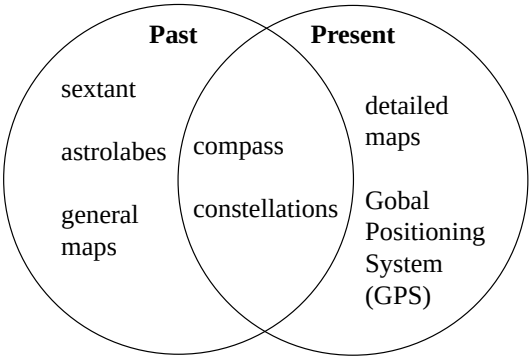
Have students make a timeline to illustrate how astronomy has been used throughout history by different cultures and continues to be used today. Information can be found on the Internet, or CD-ROMs, in print resources from elders, on videos, and so on.

➢ **Past-Present Comparison**

Have students use a Venn diagram to compare navigational devices from the past to those of the present.

Example:

Navigational Devices



Suggestions for Assessment

Astronomy

Have students reflect in their science journals on why astronomy has been so important to people in the past and continues to fascinate people today.

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapters 1, 3)

Science Everywhere 6 (p. 79)

Native Studies: Middle Years (Grades 5 to 8) (Teacher Reference)

Igniting the Sparkle: An Indigenous Science Education Model (Teacher Reference)

Keepers of the Earth: Native Stories and Environmental Activities for Children (Teacher Reference)

Native Science: Natural Laws of Interdependence (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-17 Differentiate between astrology and astronomy, and explain why astrology is considered unscientific.

GLO: A1, A2, C5, C8

6-0-8a ↻ Recognize that science is a way of answering questions about the world, and that there are questions that science cannot answer.
GLO: A1, A3

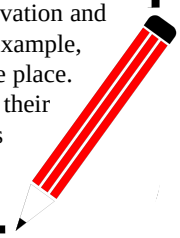
SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

Both astronomy and astrology are concerned with the study of the heavenly bodies and with pinpointing the location of the planets and stars.

- *Astrology* involves personal viewpoints and predictions that are open to interpretation and are not based on tested facts and are difficult to verify. For example, some people believe that the sign of the zodiac in which the Sun, moon, and planets appeared on the day you were born influences your personality. This belief is called astrology.
- *Astronomy* involves explanations based on repeated observation and testing and has a readily proven predictive capacity. For example, scientists can predict when the next lunar eclipse will take place. If it does not take place as expected, scientists will revise their model/understanding until they can accurately predict this event again and again.



➢ How Is Your Horoscope?

Determine the astrological sign for all students based on their birth dates. Refer to a horoscope that is several days old and tell students that you will read out the horoscope prediction for the day before (yesterday). Ask students to think about the day they had yesterday and to list what part of the horoscope prediction actually happened. Once the lists are complete, tell students that the horoscope was not for yesterday but was for an earlier date. Ask students the following questions:

- Why were you able to find things that actually happened (that corresponded with the horoscope prediction) even though the date was incorrect? (Horoscopes are so general that most people would be able to find a word or a phrase that would be true for them.)
- Do you believe that astrology can be called a science? Is it based on fact? Is it testable? Is it observable? Give reasons for your answers.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Cluster Reflection

Provide students with the following sentence stems:

Reflection

1. I found it interesting . . .
2. I was surprised . . .
3. I still have questions about . . .

Science Everywhere 6 (p. 80)

Notes