Topic 3.2
What are the Sun and the Moon, and how are they linked to Earth?

Specific Expectations

- **D3.3** identify the factors that make Earth well suited for the existence of life
- **D3.4** describe the characteristics of the Sun and the effects of its energy on Earth and Earth's atmosphere
- **D3.5** describe the causes of major astronomical phenomena and how various phenomena can best be observed from Earth

Skills

- identify and locate sources
- select, organize, and record information
- draw conclusions
- communicate using a variety of formats
- identify and describe related careers
- identify space scientists (including Canadians)

Materials

Please see the teaching notes for each activity for a list of the materials required. Please see page TR-44 for a summary of the materials required in this topic.

Overview

In this topic, students will explore the relationships between Earth and the Sun, and Earth and the Moon. They will learn about Earth's atmosphere and the qualities of the atmosphere that promote life. In addition, they will create models of solar and lunar eclipses to further their understanding of how celestial objects move.

Common Misconceptions

- **Some students may believe that Earth's orbit around the Sun and Earth's distance from the Sun are responsible for the seasons.** Explain that the reason for Earth's seasons is not the distance from the Sun, but actually Earth's tilt on its axis. Earth is tilted 23.5°. Summer happens in the northern hemisphere when the northern hemisphere of Earth is tilted toward the Sun and the angle of the Sun's rays is more direct. Have a volunteer act as the Sun, and use a globe to model the movement of Earth around the Sun. Information and illustrations about this concept can be found at **www.scienceontario.ca**.
- **Some students may confuse the terms *solar eclipse* and *lunar eclipse*.** A solar eclipse occurs when the Sun's light is blocked by the Moon, which happens during the day. A lunar eclipse occurs when the Moon is shadowed by Earth, which happens at night. Help students remember the right terms by offering a mnemonic: A *solar* eclipse is when the *Sun* is blocked. A *lunar* eclipse is when the *Moon* is blocked.
- **Many students may think that the Moon does not rotate and that is why there is a "dark side."** However, because the Moon's orbit rate and rotation rate match, one side is always facing away from us and is called "the dark side." You might model this concept by having a student act as Earth and stand still. Hold a round object (preferably with different views) in your hands that represents the Moon. Walk around the student in a series of four quarter turns, and hold the object still so it turns as you turn. The student should see only one side of the Moon.

Background Knowledge

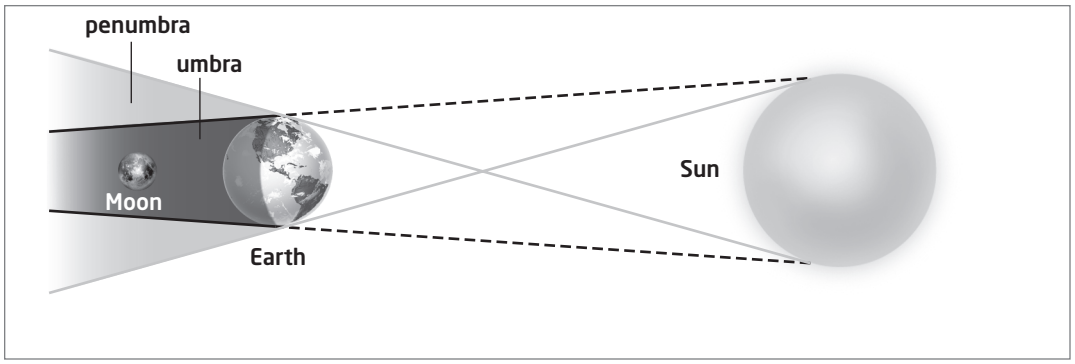
The Sun

The Sun has a lifespan of about 10 billion years. It has different layers that are orbiting at different speeds, and all the layers are held together by gravity. As everything is held together, hydrogen atoms collide and combine to form helium, which produces a huge amount of energy in the core of the Sun.

Sunspots are dark patches on the Sun's surface that indicate an area that is slightly cooler than the rest of the surface. The corona is a very hot layer of gas on the outside of the Sun, with the chromosphere layer beneath it. The photosphere layer is below the chromosphere. For more information and useful websites, visit **www.scienceontario.ca**.

Eclipses

Lunar eclipses can happen only during a full Moon; however, not every full Moon is a lunar eclipse. Lunar eclipses occur when the Moon in its full Moon phase also passes through some or all of Earth's shadow. Passing through all of Earth's shadow results in a full lunar eclipse, whereas passing though only a part of Earth's shadow results in a partial lunar eclipse as shown in the image on the next page.



For more information about lunar cycles and eclipses, visit **www.scienceontario.ca**.

During a solar eclipse, only those people who are standing in the shadow or partial shadow of the Moon can see the eclipse. NASA charts solar eclipses from past decades as well as predictions of upcoming eclipses. For example, NASA predicts eclipses in July 2010. For more information on solar eclipses, visit **www.scienceontario.ca.**

Solar Storms

In 2006, NASA announced the Sun to be at solar minimum. This is the point at which solar flare and solar storm activity is at its lowest and the Sun's activity is minimal. However, NASA scientists warn that solar maximum is approaching in 2012. The solar maximum in 1958 reported sightings of auroras in Mexico. Solar storms and sunspot activity can disrupt telecommunications and electric grids. An article about solar storm activity can be found at **www.scienceontario.ca.**

Magnetospheres

Earth is not the only planet in the solar system with a magnetosphere. The gas giants (Jupiter, Saturn, Neptune, and Uranus) also have magnetospheres, as does Mercury. Mars has some magnetization and Jupiter's moon Ganymede also boasts a weak magnetosphere.

Literacy Strategies

Before Reading

- Remind students of the organization of Topic 3.1 before they work through Topic 3.2. This review should help them navigate through the topic and be able to refer to key concepts quickly.
- ELL Help English language learners understand the Key Terms by teaching them the root words, especially with *solar* and *lunar*. You may wish to have them use **BLM G-31 English Word Study.**
- Have students consider the opening image showing Earth and the Sun. Ask them to consider the location where the photograph was taken (the Moon). Draw their attention to the bottom right section of the photograph. There is a small vehicle and a figure. Ask students if they can identify them. Explain that the image shows a lunar rover and an astronaut (most likely from the *Apollo 15* mission). (A movie of this landing can be seen at **www.scienceontario.ca**.) Explain that 2009 marks the 40th anniversary of the first landing of a human on another celestial body of the universe—the first human on the Moon on July 20, 1969. You could show students a short clip of the first Moon landing, found at **www.scienceontario.ca**.

During Reading

- Have students work in groups. Assign each group one spread in the topic (for example, The Sun is our nearest star.). Have each group read the information on the pages and discuss the heading. Have them come up with another heading and present a brief summary of the information on their spread with their new title to the class. They can refer to the summaries for review.
- ELL Encourage English language learners to draw and label sketches where possible to record information that they have learned.

After Reading

- Enrichment—Many students will know someone who remembers the first Moon landing. Students could interview their parents or grandparents about their memories of this "giant leap" for humankind. Have students record their interviews either in writing or digitally and share the stories with the class.
- Enrichment—Use the discussion of the first Moon landing as a "jumping-off point" to discuss other Canadian astronauts and their contributions to our understanding of the universe. Have students find out more about the accomplishments of Canadian astronauts at **www.scienceontario.ca**. You might also have students research the careers involved in space science and the steps involved in pursuing those careers.
- Students can apply what they have learned by correcting the statements on **BLM 3-10 Correcting Ideas About the Sun and the Moon**.
- ELL Provide sentence strips with the main ideas and supporting details written on them. Have students work in groups to organize the strips on a T-chart under the headings "Main Ideas" and "Supporting Details." Groups can share their charts and explain why they organized the strips in the way that they did. Model this activity to start.

Assessment FOR Learning

Tool	Evidence of Student Understanding	Supporting Learners
Learning Check question 2, page 185	Students show that different areas of the Sun rotate at different rates and that the Sun's temperature ranges, depending on location.	• Students may wish to use a computer graphics program to create their diagram. Alternatively, have students use **BLM 3-11 Diagram of the Sun** and just add the appropriate labels.
Learning Check questions 1 and 2, page 187	Students explain the role of Earth's atmosphere and magnetosphere in maintaining and protecting Earth, and in causing aurora.	• Have students review photocopies of pages 186 and 187 and use a highlighter to mark the key points. • Direct students to Literacy Skills Toolkit 5 on page 390 and have them review the information on graphic organizers. • Draw a simple diagram on the chalkboard of Earth with dotted lines representing the magnetic field lines radiating from the poles in loops around the planet. The solar wind can be represented by specks of particles radiating from the Sun and flowing around the magnetic field lines that shield the planet.
Learning Check question 1, page 189 Topic 3.2 Review question 5, page 195	Students explain the rotation of the Moon in relation to the rotation of Earth and how it creates a "dark side" on the Moon.	• Students may benefit from watching animations of the Moon's rotation. Visit **www.scienceontario.ca** for an example.
Learning Check question 1, Activity 3.8, page 191	Students demonstrate their understanding of the difference between solar and lunar eclipses.	• If students have difficulty with drawing clear diagrams, direct them to Science Skills Toolkit 6 on page 354 and have them review the information on scientific drawing. You may also wish to distribute **BLM A-7 Scientific Drawing Checklist**.

Topic 3.2 (Student textbook pages 182–195)

Using the Topic Opener (Student textbook pages 182–183)

- Open the topic with a class discussion. Ask students to look at pages 182 and 183 and consider what the theme of the topic will be (for example, life on Earth). Explain that the topic looks at both the Sun and the Moon and how our nearest neighbours affect life on Earth. Have students discuss why we know more about the Sun and the Moon than any other celestial objects. (They are the largest objects in Earth's sky; humans have actually visited the Moon; the Moon affects life on Earth with tides; the Sun is the source of all life on Earth.) If students have trouble understanding this concept, have them consider why they know more about their own neighbourhood than a city in a distant country, or why they know more about their family's home than they do about a home in Calgary. Have them discuss the things they know about their own or previous neighbourhood and its importance in their lives versus an unfamiliar city. Then, have them reconsider why we know more about the Sun than Betelgeuse, for example, or why we know more about Earth's Moon than Titan, one of Saturn's moons.
- ELL Read the Key Concepts as a class. Explain that these concepts provide clues to what students will be learning in this topic. Take a moment to ensure that all students understand the term *interaction*. Have students identify the two parts of the word, and explain the meaning of each part. Clarify any misconceptions.
  - ELL If you have not yet started a word wall, you could begin one now. To help English language learners, include brief definitions of, or simple synonyms for, the words.
- To help students focus their thinking, you may have them fill out a K-W-L chart, or use **BLM G-29 K-W-L Chart**. They can refer to their chart at the end of the topic as part of their review.
- Have students work on the Starting Point Activity. Circulate and correct any misconceptions in a class discussion after the completion of the activity.
- Throughout this unit, refer to newspapers and other news sources for stories about astronomical research and discoveries. Post them for students to read. Encourage students to bring in items that they find to share with the class, or to discuss related topics that interest them. For example, ask students whether they think there might be other planets circling other stars and whether life exists on these other planets.
- You may wish to assign Activity 3.9 on page 194 as a culminating activity for this topic. Before they begin reading the topic, have students read through the activity to familiarize themselves with the task. Students can use **BLM G-14 Research Worksheet** to make notes as they work through the topic, or they can review their notes later and fill in the blackline master at that time.

Starting Point Activity (Student textbook page 183)

Pedagogical Purpose

This activity will activate students' prior knowledge of the Sun and Moon and help identify any misconceptions early on.

Planning	
Materials	**BLM G-29 K-W-L Chart** (optional)
Time	15–20 min in class

Skills Focus

- communicate using a variety of formats

Background Knowledge

Earth orbits the Sun, at a distance that is perfect for life to survive on Earth. The Sun creates solar wind and charged particles that can negatively affect Earth. However, Earth's magnetosphere provides protection from solar wind, and Earth's atmosphere traps just enough heat to sustain life on Earth while protecting Earth from harmful bands of energy, such as UV rays and X rays.

The Moon orbits Earth every 27.3 days. During this time, it also completes one rotation, so we always see only the same side of the Moon on Earth.

Eclipses can occur due to the movement of Earth and the Moon. When the Sun, the Moon, and Earth are lined up in space, the Sun's light may be blocked for a short time, causing a solar or lunar eclipse. For more information about lunar eclipses and solar eclipses, visit **www.scienceontario.ca**.

Activity Notes and Troubleshooting

- Lead students in a class discussion on their knowledge of the Sun and Moon and their relationships with Earth. Encourage an open discussion about the questions.
- Alternatively, have students work in small groups to answer the questions and then share their answers with the class. Use chart paper to record their ideas.
- Students may wish to share legends and stories of phenomena, such as seasons or tides. Provide a forum for sharing.
- Students could use a K-W-L Chart, or **BLM G-29 K-W-L Chart**, to organize their thoughts. Have them refer to the K-W-L Chart at the end of the topic as a study guide.

Additional Support

- ELL English language learners may wish to use models or diagrams to express their thoughts and knowledge. Direct questions may be needed to elicit knowledge. Students could also create a bilingual word wall to build familiarity between their native language and the English language, using pictures and words.
- Enrichment—Students who show an interest may wish to research on the Internet or in the library stories that explain phenomena, such as seasons and tides. They may wish to explore other cultures or their own. Ensure that you provide time for them to share their findings orally, visually, or in writing with the class.
  - You may wish to take this opportunity to review Internet safety with students if they intend to conduct research on the Internet. If your school has an Internet safety policy, review it with students before they proceed with their research. For more information on Internet safety, visit **www.scienceontario.ca**.

Answers

1.-2. Students' answers will vary, depending on their previous knowledge and experiences. Ensure that any misconceptions are corrected early.

Instructional Strategies for Topic 3.2

The Sun is our nearest star. (Student textbook pages 184–185)

- ELL Read pages 184 and 185 as a class, and bring in photographs of the Sun for students to look at. You can use the photographs or posters to point out the Sun's features, which will benefit English language learners. Some stunning photographs of the Sun can be found at **www.scienceontario.ca**.

- Ensure that students are clear about the complex numbers presented in this section. Have students who are struggling with scientific notation refer to **BLM G-24 Using Scientific Notation**. You may also refer students to Numeracy Skills Toolkit 1: Scientific Notation on page 366 of the student textbook.
- **BLM 3-11 Diagram of the Sun** can be used to answer Learning Check question 2 on student textbook page 185.
- Enrichment—Have interested students research the answer to the question of why the element hydrogen shares a symbol that is similar to the Sun's. Students can also research the origins of the Sun symbol, which dates back to Egyptian hieroglyphics. Even the ancient Mayans used a similar symbol to represent the Sun. Have students present their findings to the class.
- Assign Activity 3.6 on page 185 as homework or an in-class assignment.

Interactions of Earth and the Sun make life possible.

(Student textbook pages 186–187)

- Explain to students that the shape of the magnetosphere means that some solar wind is still able to reach Earth's atmosphere at the poles. Explain that the magnetosphere surrounds Earth like a bubble that is pinched in at the poles. You may wish to bring in an apple (or a similar object) as a model. Explain that the apple would be the magnetosphere, with Earth inside like the apple core.
- Have students relate their personal experiences with auroras to the class. Explain that auroras are proof of Earth's atmosphere in action. As the aurora becomes more colourful and vibrant, more dangerous charged particles from the Sun are being intercepted. You might compare this concept to a "bug zapper." The more "zapping" you hear, the more bugs have been intercepted by the device.
- DI ELL English language learners and spatial learners may benefit from seeing an image of Earth's magnetosphere. Useful images can be found at **www.scienceontario.ca**.
- Have students look up the definition of *atmosphere* in a dictionary. Tell students that an atmosphere is a layer of gases that surround a planet or moon, and have them add the term to the word wall. Point out the root "sphere." Have students find other words with the same root, such as *magnetosphere*.
- ELL Concrete analogies can be used to aid English language learners in overcoming complex language. For example, the analogy of a car in the hot Sun with its windows rolled up can illustrate the effect of Earth's atmosphere.
- Ask students if Earth is the only planet in the solar system with an atmosphere. Students will likely offer that Earth is unique in its atmosphere. Explain to students that all the planets in our solar system—as well as the Sun and several moons—have a layer of gases that surround them. However, none of them have sufficient quantities or the right combinations of gases to sustain life. Only a few moons are large enough to sustain an atmosphere. Jupiter's moons Io and Europa (Europa's atmosphere contains oxygen!), Saturn's moon Titan, and Neptune's moon Triton have atmospheres. Encourage students to consider this information as a preview to Activity 3.9 on page 194.
- Enrichment—Have interested students select one of the moons with an atmosphere, research its characteristics, and report their findings to the class.

The Moon is our nearest neighbour in space.

(Student textbook pages 188–189)

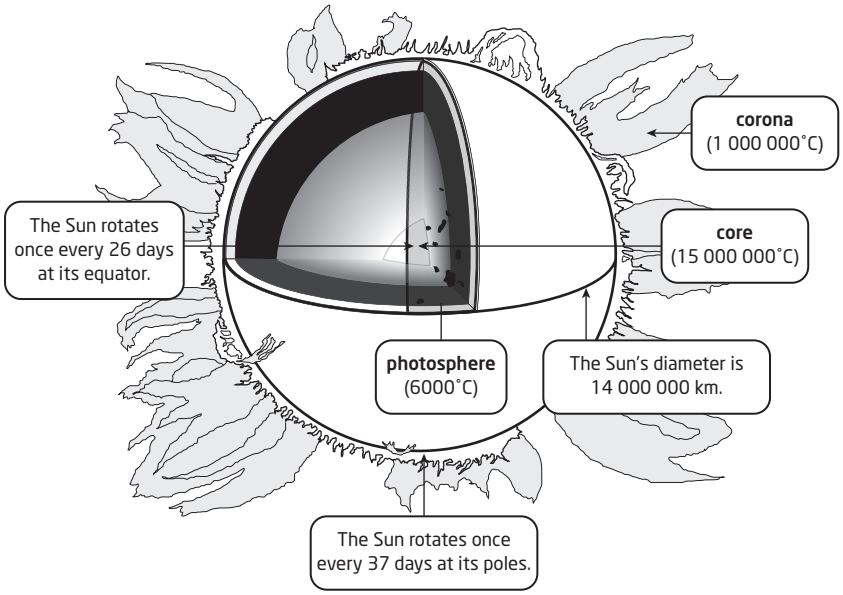
- Have a class discussion about the phases of the moon. Have students share what they know about the phases of the moon to identify any misconceptions. Encourage students to share stories from their cultures with the class.
- ELL Have all students read page 188 individually. Ensure that English language learners understand the terminology. Encourage them to note and look up unfamiliar words. You may wish to demonstrate the difference between *rotation* and *orbit* using a model. Encourage the use of contextual cuing as a reading strategy whenever it is suitable.
- For students who are having difficulty interpreting diagrams, have them refer to the Reading Diagrams section in Literacy Skills Toolkit 3: Reading Graphic Text on page 385 of the student textbook.
- Assign Activity 3.7 on page 189. Have students work in small groups for this activity to allow more flexibility in presentation types.

The Sun, Moon, and Earth interact to create eclipses.

(Student textbook pages 190–191)

- The information on pages 190 and 191 flows out of the discussion on the phases of the Moon. You could move directly into a conversation on solar eclipses once students have grasped the concepts of lunar phases.
- Solar and lunar eclipses are challenging concepts and often have many associated misconceptions. Encourage students to use manipulatives, videos, and animations to help them understand these concepts. Have several balls of different sizes available for students to use as models.
- DI ELL Spatial learners and English language learners may benefit from watching a video of a solar eclipse. Encourage students to jot down terms or sections that need further clarification, and then to discuss these terms or sections with others. Multimedia videos of solar eclipses are available at **www.scienceontario.ca**.
- Students could use **BLM G-38 Venn Diagram** to answer Learning Check question 2 on page 191.
  - If students use a Venn diagram for Learning Check question 2 on page 191, you may wish to use **BLM A-13 Venn Diagram Checklist** to assist you in assessing students' work. If you plan to assess students, ensure that you distribute copies of the assessment criteria beforehand so that students are aware of it.
- Assign Activity 3.8 on page 191. You may have students work in groups for this activity.
  - If students need support in understanding models in science, refer them to Science Skills Toolkit 7: Using Models and Analogies in Science on page 356 of the student textbook.
  - If you wish to assess students' work for this activity, you may want to use **BLM A-6 Developing Models Checklist** or **BLM A-31 Developing Models Rubric** to assist you.
- After completing the Learning Check questions and Activity 3.8, students can demonstrate what they know about solar and lunar eclipses using **BLM 3-12 Solar Eclipses and Lunar Eclipses**.

Learning Check Answers (Student textbook page 185)

1. The Sun produces energy through nuclear fusion, when two hydrogen atoms fuse to form helium.
2. 

3. The Sun's total lifespan is about 10 billion years.
4. Possible answer: The Sun is the brightest object in the sky so many cultures would have stories about it.

Activity 3.6 What's Cool About the Sun? (Student textbook page 185)

Pedagogical Purpose

This research activity helps students consolidate the information they have learned about the Sun and research more information on a variety of topics.

Planning	
Materials	**BLM G-35 Main Idea Web** (optional) **BLM G-14 Research Worksheet** (optional) **BLM A-28 Presentation Rubric** (optional)
Time	20–30 min in class About a week before the activity, reserve time at your school resource centre or computer lab.

Skills Focus

- identify and locate sources
- select, organize, and record information

Background Knowledge

Because the Sun is not a solid object, different parts of the Sun rotate at different rates. The equatorial area of the Sun rotates faster, making a complete revolution approximately every 26 days. The poles rotate more slowly, making a circuit about every 37 days. Scientists use sunspots, which are dark, cooler patches on the Sun's surface, as markers to determine the speed of the Sun's rotation. A video of the Sun's rotation can be found at **www.scienceontario.ca**. Similar to Earth, the Sun is tilted on its axis slightly, by $7\frac{1}{4}°$ and it rotates on its axis in a counterclockwise direction. An interesting activity to measure the speed of the Sun's rotation can be found at **www.scienceontario.ca**.

The ancient symbol for the Sun is similar to the Bohr-Rutherford model of the element hydrogen (see Figure 2.10 on page 124 of the student textbook). This symbol is thought to originate in ancient Egyptian hieroglyphs with the large dot representing a huge sunspot. It is also representative of gold in alchemy. In chemistry, although we use the symbol H, the hydrogen atom could be represented as a central dot for the proton with one electron circling. Since 73 percent of the Sun is hydrogen, it is fitting that the Sun and hydrogen can be represented in a similar way.

Activity Notes and Troubleshooting

- You may wish to have students use **BLM G-35 Main Idea Web** for this activity. You might also have students review Literacy Skills Toolkit 5: Organizing Your Learning: Using Graphic Organizers on page 390 to review how to create a Main Idea Web. Then demonstrate how to complete a Main Idea Web using a similar topic, such as objects in the sky.
- Students could use **BLM G-14 Research Worksheet** to help them organize their thoughts and information for this activity.
- This activity could be assigned as a group assignment. If assigned as group work, the work will be a formative assessment. Ensure that students are assigning tasks equally.
- Ensure that students who select option 5 provide more than just a list of song titles. They should also provide an analysis of their research. For example, ask, "Why do so many songs mention the Sun?" "What themes are represented by the Sun?"
- Have students prepare to present their findings to the class. They may wish to show their idea web enlarged or on an overhead, or use presentation software. If you plan to evaluate students' presentations, you may wish to use **BLM A-28 Presentation Rubric** to assist you.

Additional Support

- DI ELL Encourage students to fill in their idea web using a format that best suits their learning style or background. For example, English language learners may wish to use diagrams or sketches to fill in their idea web. Provide feedback to guide their learning in an effective manner. Students with fine motor skills challenges may prefer to use a computer graphics program for their idea web. Spatial learners might benefit from creating a graphic organizer in the shape of a star, with their main idea in the centre, and points related to their main idea surrounding it.
- ELL Ensure that English language learners understand all of the topics. You might have them make jot notes of their ideas in their first language (working with a partner who has the same first language, if possible) and then translate these ideas into diagrams or English words (working on their own or with an English-speaking partner) on their idea web.

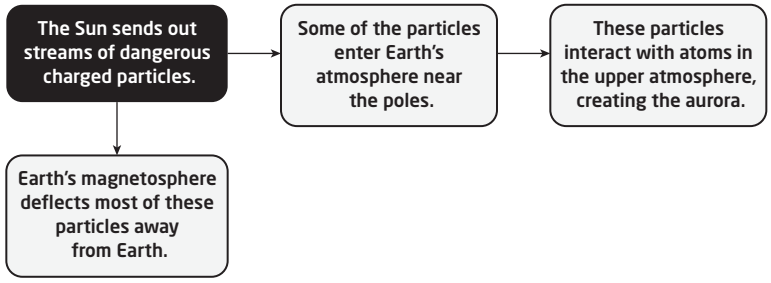
Activity 3.6 Answers

Students' idea webs will vary. Ensure that the topic they chose is included in the centre circle, with surrounding points that are related to the topic. Students can use the keywords and hints included in their topic as starting points for their research.

Learning Check Answers (Student textbook page 187)

1. Some of the energy from the Sun is trapped by Earth's atmosphere and redirected back to Earth's surface. This energy keeps Earth at just the right temperature.

2. Students' graphic organizers will vary. A possible example is included below.



3. If Earth's magnetosphere disappeared, Earth would no longer be protected from solar winds and all life would die.

Activity 3.7 More About the Moon (Student textbook page 189)

Pedagogical Purpose

Students develop their understanding of the Moon, Earth's nearest celestial neighbour, and use their research and presentation skills to share their information.

Planning	
Materials	Access to the Internet or library **BLM G-12 Scientific Research Planner** (optional) **BLM G-14 Research Worksheet** (optional) **BLM A-24 Co-operative Group Work Rubric** (optional) **BLM A-18 Group Investigation Self Assessment Checklist** (optional)
Time	60 min in class

Skills Focus

- identify and locate sources
- select, organize, and record information
- communicate in a variety of formats

Background Knowledge

It is believed that Earth's Moon formed early in Earth's life, as a result of a collision between Earth and another celestial body. This collision would have created debris that began orbiting the remains of Earth. Due to gravity, some of the debris from the collision would have become part of Earth again, but some formed the celestial body that we now call the Moon.

The Moon orbits Earth every 27.3 days, and it rotates on its own axis during the same time. As a result, we see only one "lit-up" side of the Moon, and we do not always see the whole lit-up side because of the relative location of the Moon, Earth, and the Sun. The part of the Moon that we see on Earth is actually light from the Sun reflecting off the Moon.

On July 20, 1969, the first humans landed on the Moon. From 1969 to 1972, six piloted *Apollo* missions landed on the Moon. Since then, there have been a number of unpiloted missions that have orbited or landed on the Moon, but none that have sent people.

Activity Notes and Troubleshooting

- Students can work in groups for this activity so that discussion can facilitate the generation of new ideas and so that students can share the research. Ensure that students are sharing the workload equitably.

- If students worked in groups for Activity 3.6, you may wish to have them work individually for this activity, or vice versa.
- You could provide large circles, folded into four sections, for students to use to record their results.
- If students will be selecting their own presentation format, they could submit their ideas for your approval before proceeding.
- You could use **BLM A-24 Co-operative Group Work Rubric** or have students use **BLM A-18 Group Investigation Self Assessment Checklist** for this activity.
- Topics 1 and 5 might be well known to students, but remind students that they must still provide a well-researched presentation that shows thought and analysis. Encourage English language learners to include examples from their own cultures as well.
- Provide the following blackline masters to help students conduct their research and record their findings in an organized way: **BLM G-12 Scientific Research Planner** and **BLM G-14 Research Worksheet**.

Additional Support

- Ensure that the groups are balanced, and as diverse as possible, in terms of learning styles, in order for the research process and presentation formats to be the most effective.
- ELL Encourage English language learners to share their Moon stories with the class. Interested students could compare and contrast the stories of their country of origin, or of a country that they are interested in, with those of Canadian popular culture.
- ELL Ensure that English language learners understand all of the topics. Preview terms such as *superstition*, *crisis*, *swamp*, *decay*, and the idiom "What's up with that?" You might have them make jot notes of their ideas in their first language and then translate these ideas into diagrams or English words (working on their own or with an English-speaking partner), depending on their chosen presentation format.

Activity 3.7 Answers

Students' answers will vary. Ensure that they present their information in a clear and organized way. Ensure that students adequately research and answer all aspects of their topic.

Learning Check Answers (Student textbook page 189)

1. The Moon's rotation and orbit rates match, so we always see the same side of the Moon—the "light" side.
2. Students' diagrams should be similar to Figure 3.10 on page 188.
3. Answers will vary, but students might mention the extreme temperatures (−170°C to 100°C) and the lack of atmosphere.

Learning Check Answers (Student textbook page 191)

1. Students' drawings should be similar to Figures 3.12 and 3.13, on pages 190 and 191. In a solar eclipse, the Sun should be on the left of the Moon, and Earth should be on the right of the Moon. In a lunar eclipse, the Moon should be on the left of Earth, and the Sun should be on the right of Earth.
2. In a total solar eclipse, the Moon moves directly between Earth and the Sun, and covers the entire face of the Sun, so the Sun's light is totally blocked. The eclipse occurs during the day.

In a partial solar eclipse, the Moon moves directly between Earth and the Sun, but covers only part of the Sun's face, so the Sun's light is partially blocked. The eclipse occurs during the day.

3. Students' warning announcements may vary but should include information on the danger of looking directly at the Sun during an eclipse and how to protect your eyes.

Activity 3.8 Modelling Eclipses (Student textbook page 191)

Pedagogical Purpose

This activity will help students consolidate their understanding of solar and lunar eclipses and practise creating and working with scientific models.

Planning	
Materials	directed light source, such as a flashlight or an overhead projector globe ball for Moon **BLM A-6 Developing Models Checklist** (optional) **BLM A-32 Developing Models Rubric** (optional)
Time	40–60 min in class

Skills Focus

- communicate in a variety of formats

Background Knowledge

An eclipse occurs when Earth or the Moon is lined up in space so that it blocks the Sun's light for a short time. In a solar eclipse, the Moon moves directly between the Sun and Earth, so the Moon casts its shadow on part of Earth, and the Moon covers the face of the Sun. In a partial solar eclipse, only part of the Sun's face is covered by the Moon. In a total solar eclipse, the entire face of the Sun is covered by the Moon.

In a lunar eclipse, Earth moves directly between the Sun and the Moon, so Earth casts its shadow on the Moon. In a total lunar eclipse, Earth's shadow covers the Moon completely. In a partial lunar eclipse, Earth's shadow covers only part of the Moon. Lunar eclipses are more common than solar eclipses because Earth—which is much larger than the Moon—casts a much larger shadow on the Moon compared to the size of the shadow that the Moon casts on Earth.

Activity Notes and Troubleshooting

- To extend this activity into something more creative, have a variety of materials available for students to build their models. For example, provide modelling clay, foam balls, or several different plastic or rubber balls from the dollar store. You could also provide paint so students can paint their materials appropriately.
- To save materials, have students work in small groups for this activity.
- You may wish to use **BLM A-6 Developing Models Checklist** or **BLM A-31 Developing Models Rubric** to assist you in assessing students.

Additional Support

- Allow students to provide explanations orally, visually, or in writing.
- DI Students with strong bodily-kinesthetic intelligence may prefer to model the eclipses using their own bodies and some volunteers. Encourage this option and use it as a demonstration and opener to the activity.
- DI Spatial learners may benefit from watching a video animation of a lunar eclipse. Visit **www.scienceontario.ca** for an example.

- ELL This activity is well suited for English language learners because they can answer the questions using their model instead of words. Read the activity together before students begin, to ensure that these students understand the task and the questions. Ensure students have enough time to summarize their ideas in order to explain their answers. You might provide verbal prompts to assist them with vocabulary and organization.

Activity 3.8 Answers

What Did You Find Out?

1. During a solar eclipse, light is blocked by the Moon, which casts its shadow over Earth. During a lunar eclipse, Earth moves between the Sun and Moon, and Earth's shadow falls on the Moon.
2. Students' models should show that Earth moves in between the Sun and the Moon.
3. Students' models should show that the Sun, Earth, and the Moon are aligned and that the Moon is within Earth's shadow. The model alignment should also show that the Moon is exactly aligned with the plane of Earth's orbit. Ordinarily, the Moon orbits above or below the plane of Earth's orbit and misses Earth's shadow.
4. During a lunar eclipse, all the people on the night side of Earth are able to see it. However, during a solar eclipse, only the people in the shadow of the Moon would see the eclipse.

Using the Case Study Investigation
Solar Storms (Student textbook pages 192–193)

Literacy Support

Before Reading

- Draw students' attention to the Pittsburg Gazette article on the top left. Ask, "How is this article connected to the topic of solar storms?" "Is the date at the top important?"
- Refer students to the image of the aurora and the caption. Ask why seeing auroras over the Caribbean is surprising. (Charged particles from the solar wind enter Earth's atmosphere at the poles.) Have them refer to pages 186 and 187, if necessary.
- Many students may be unfamiliar with the telegraph machine and telegraph technology. If possible, bring in a telegraph machine for students to look at. Some students may be familiar with SOS, Morse code for "help." Take a few minutes to teach students SOS to help them understand telegraph technology. In Morse code, SOS is "· · · — — — · · ·."

During Reading

- ELL English language learners and readers who need support may find the density of text on these pages daunting. Photocopy the pages for them and have them use a highlighter to mark the important passages.
  - ELL To assist English language learners, you could also provide the main points of the case study as headings. Students can then organize the information that they read under these headings, by making jot notes and drawing diagrams.
- ELL As students read the case study, or as you read through it together, have English language learners highlight or indicate words that they do not understand, such as *mysterious*, *hurling*, *classified*, and *haywire*. On the board, write synonyms for each of these words. (For example, *hurling* → *throwing*)

After Reading

- Provide graphic organizers such as **BLM G-32** through **BLM G-39** to help students consolidate their notes. If necessary, fill in part of the organizer before you photocopy it, and have students complete it.

- Enrichment—Have interested students do some further research about telegraph technology and report their findings to the class.

Activity Notes

- The case study can be assigned as homework or a classroom activity. Remember to reserve time at your school's resource centre or computer lab for students to conduct their research.
- DI Students can work with a partner or in small groups to support one another in this investigation, which will help them develop interpersonal skills..
- You may wish to assign this investigation after reviewing pages 184 and 185, The Sun is our nearest star. The case study dovetails into this topic well.
- Students' research may reveal predictions of the next solar storms and solar maximum, predicted by NASA for 2012. Ensure that students see these warnings in context and are not panicked by the media hype. Have them review pages 186 and 187 and how Earth's magnetosphere and atmosphere protect the planet from the intensity of solar storms.

Answers

Pause and Reflect

1. The solar superstorm of 1859 caused Earth to be struck by high-speed solar particles that knocked out communication and caused compasses to act strangely. Auroras covered Earth.
2. During a solar storm, the Sun experiences explosions called solar flares that eject super-hot gases from the Sun's surface and magnetic bubbles of matter.
3. Examples: If we had no power for a long time, we could not cook food, and in the winter, we would not be able to stay at home—it would be too cold. At night, we would not have any power to do anything, nor would we have any light, except for flashlights and candles.

Investigate Further

4. Telecommunications is the method by which people communicate across long distances, using technology. Examples include telegraphs, computers, telephones, satellites, and cellular phones. During a solar storm, telephone lines—especially overseas lines that use satellites—could go down.
5. The 1989 Québec power outage was caused by a powerful solar storm. The power grid acts like a giant antenna, collecting energy from the storm. This excess energy overwhlems the grid and causes it to shut down. About 6 million people were out of power for nine or more hours. Québec Hydro took days to restart the system, replace overloaded equipment, and repair damaged circuits.
6. Without electrical power, there would not be any air traffic control, and planes could not take off or land safely. Solar flares can cause disruptions to electronics on planes at cruising altitude, outside the protection of Earth's atmosphere.
7. Students' news reports will vary. Look for evidence that students understand the effects of solar storms on delicate electronic equipment and telecommunications. Students should show an understanding of how solar storms create radiation and electomagnetic waves that travel to Earth and bypass Earth's protective atmosphere. Students may also mention that a communication disruption would inconvenience many people in many ways due to people's strong dependence on technology in today's world.

Activity 3.9 Colony on Another Planet (Student textbook page 194)

Pedagogical Purpose

Students identify the factors that make Earth well suited for the existence of life and analyze the sample planet for similar factors and qualities.

Planning	
Materials	**BLM G-38 Venn Diagram** (optional) **BLM G-39 Double Bubble Organizer** (optional) **BLM G-32 Cause and Effect Map** (optional)
Time	40–60 min in class

Skills Focus

- draw conclusions

Background Knowledge

Earth is a planet that is located 1 AU (or 150 million km) from the Sun. Earth orbits the Sun once every 365 days and 5 hours, and rotates about its axis once every 23 hours and 56 minutes. Earth has a strong magnetic field called the magnetosphere and an atmosphere to shield living things from the Sun's harmful effects. Its atmosphere is composed of nitrogen, oxygen, argon, water, ozone, and carbon dioxide, which traps heat from the Sun in order to sustain life.

Activity Notes and Troubleshooting

- Students can use **BLM G-38 Venn Diagram** for this activity or they can complete **BLM G-39 Double Bubble Organizer**.
- Have students work with a partner or in small groups for this activity.
- Before beginning this activity, have students reread pages 186 and 187. You may also wish to have them review the process of photosynthesis in Topic 1.2 on pages 18 to 27 of the student textbook, and the definition of photosynthesis in the Glossary on page 400. Students can also research photosynthesis and climatology.
- If students have difficulty recalling the purpose or importance of Earth's atmosphere and magnetosphere, prompt their memory by asking them to recall the effects of solar storms on technology from the case study on pages 192 and 193.

Additional Support

- DI This activity provides an opportunity for students to develop their interpersonal skills by working with a partner or in a small group. Logical-mathematical thinkers will also appreciate this activity because they can use their reasoning skills to make decisions.
- ELL English language learners may find this activity challenging. You may wish to have them break the activity into three steps: identify conditions that make Earth suitable for life; identify conditions that make Loki suitable for life; compare and contrast Earth and Loki. Read each part of the description aloud, and draw and label a diagram on the chalkboard to illustrate the important features of Loki. Students could use a cause-and-effect graphic organizer, or **BLM G-32 Cause and Effect Map**, to isolate the differences and show how they would affect human life on Loki (for example, stronger gravitational pull → stronger bodies needed).
- Interested students could complete the Inquire Further extension activity as homework.
- Some students may wish to dramatize their answers in the form of an interview, a role-play, mime, a story, a narration, or a song.

Activity 3.9 Answers

What Did You Find Out?

1.

Earth	Both Earth and Loki	Loki
• is 1 AU from the star it orbits, the Sun • has a strong magnetic field called the magnetosphere • has an atmosphere to shield living things from the Sun's harmful effects, and to trap heat from the Sun • has an atmosphere that is composed of nitrogen, oxygen, argon, water, ozone, and carbon dioxide	• orbit stars that are about the same temperatures • have water that exists as solid, liquid, and gas • have rocky crusts	• is 1.40 AU from the star it orbits, Alpha Centauri • has a weaker magnetic field than Earth's • has a stronger gravitational pull than Earth's • has a similar atmosphere to Earth's, but has twice as much carbon dioxide • is about 2.3 times the size of Earth • is about 2.9 times the mass of Earth

2. Students' answers may vary. For example: Loki could not support life because it has a weak magnetic field. Without a strong magnetosphere, the Alpha Centauri's solar wind would kill any life on Loki.

3. Students' answers may vary. For example: Yes, plants would be able to carry out photosynthesis on Loki. They would have all the things they need: sunlight, liquid water, and carbon dioxide. In fact, Loki's CO_2-rich atmosphere would make it easier for plants to photosynthesize than on Earth.

Inquire Further

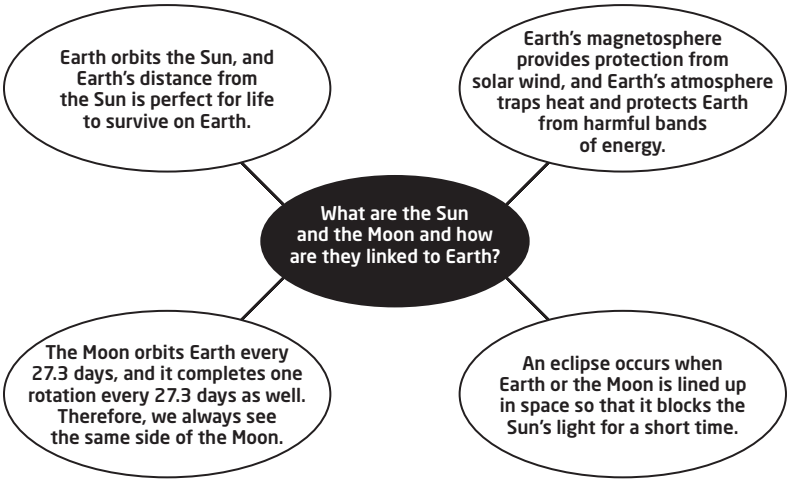
Students' answers will vary. For example: Because gravity is stronger on Loki, mammals would be shorter and stronger. Even plant life would be shorter. Life forms would have to have adaptations that help them reflect solar wind particles, so they may have thick hides or reflective skins.

Topic 3.2 Review (Student textbook page 195)

Please see also **BLM 3-13 Topic 3.2 Review (Alternative Format)**.

Answers

1.



2. In a solar eclipse, the Moon moves directly between the Sun and Earth. The Moon casts its shadow on part of Earth. If you are standing in an area covered by the full shadow of the Moon, you would see a total solar eclipse.

In a lunar eclipse, Earth moves directly between the Sun and the Moon, so Earth casts its shadow on the Moon. In a total lunar eclipse, the whole Moon passes through the full shadow of Earth.

3. Students' answers will vary. Ensure that they clearly explain the main points of the stories, in their own words, and list similarities and differences. Some stories can be found at **www.scienceontario.ca**.

4. Students may mention that Earth's atmosphere protects Earth from the Sun's solar wind and charged particles, and it breaks up other space objects, such as meteors, preventing them from hitting Earth. The Moon does not have an atmosphere, so it is not protected from space objects. When the objects hit the Moon, a crater is formed.

5. Students' diagrams should be similar to Figure 3.10 on page 188. Their captions may include the idea that we see different amounts of lit-up surface of the Moon from Earth because of the way that the Moon, the Sun, and Earth are arranged.

6. If the Moon broke out of its orbit, its appearance in our sky would change, which would affect the lives of animals that use the Moon's appearance for their mating schedule. Ocean tides would also be affected, which could affect water circulation and climate.

7. Some of the Sun's energy passes through, and is trapped by, the atmosphere and is redirected to Earth's surface. The Sun provides the energy we need to sustain life. The harmful energy is reflected by Earth's atmosphere and escapes into space.