Unit 4 Light and Geometric Optics

Chapter 10 Light and Reflection

Chapter 11 Refraction

Chapter 12 Lenses and Lens Technologies

Unit 4 Light and Geometric Optics

BIG IDEAS

- Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses.
- Society has benefited from the development of a range of optical devices and technologies.

Overall Expectations

- **E1** evaluate the effectiveness of technological devices and procedures designed to make use of light, and assess their social benefits;
- **E2** investigate, through inquiry, the properties of light, and predict its behaviour, particularly with respect to reflection in plane and curved mirrors and refraction in converging lenses;
- **E3** demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

Materials

Please see page TR-31 for a summary of the materials required in this unit and other units.

In this unit, students learn some characteristics of light in order to predict its behaviour as it reflects off surfaces or refracts in different media, including lenses. Connects are drawn between natural optical phenomena and optical devices, with an exploration of the ways in which society has benefited from a range of optical technologies.

Using the Unit Opener (Student textbook pages 396 to 397)

- DI For the benefit of linguistic and interpersonal learners, have small groups of students brainstorm ways of reducing light pollution. Appoint one person in each group to ensure that everyone has a chance to participate.
- Check what students know and believe already about light and optics using **BLM 10-1 Unit 4 Anticipation Guide.** Then, when you have completed the unit, check again and have students reflect on how and why their understandings and attitudes may have changed.
- Students may not recognize Toronto's Rogers Centre or may be unfamiliar with a baseball field, and may need additional explanation or connection to personal experience of large-scale outdoor illumination such as parking lots.
- Brainstorm the negative effects artificial light can have such as causing birds to fly into windows, interrupting natural sleep cycles, obstructing the starry sky, and pollution caused by electricity production.
- Start a mind map on a wall of the classroom. Use string to show connections between key terms and ideas written on cards or sticky notes. As a class, build the graphic organizer as the unit progresses. Encourage students to contribute examples from a variety of media, or produce their own illustrations.
- Challenge students to research ways in which light pollution could be minimized while improving lighting efficiency at the same time. Have them write an article either promoting a local dark sky reserve or explaining how people could better illuminate their property at night. Go to **www.scienceontario.ca** for more information and links.
- Students who would benefit from remediation could complete **BLM 10-2 Unit 4 Get Ready (Extra Practice).**

Assessment OF Learning for Unit 4

Tool	Evidence of Student Understanding	Supporting Learners
Inquiry Project, page 522	Reflection and possibly refraction are used to direct light through a tunnel.	Students may find **BLM 12-12 Design a Light Tunnel** provides the scaffolding they need to get started. Encourage students to use their graphic organizers to identify useful properties of light. They may find that manipulating a few "template ray diagrams" helps them get started.
An Issue to Analyze, page 523	Students compare light bulbs in terms of efficiency, cost, and environmental impacts including production, use, and disposal. Students make a decision or concluding statement based on a risk-benefit-cost analysis.	Have students visit **www.scienceontario.ca** to find relevant information. Refer students to the Comparing and Contrasting strategy on page 402 of the student textbook as well as Science Skills Toolkit 1, Analyzing Issues (pages 529 to 531), and Science Skills Toolkit 10, How to Do a Research-Based Project (pages 549 to 550). Students may find that **BLM A-5 Investigating an Issue Checklist** or **BLM G-19 Scientific Research Planner** helps them get started.

Get Ready (Student textbook pages 398 and 399)

Prerequisite Learning

Students would benefit from understanding

- the difference between an object that produces its own light and one that reflects light (questions 1 and 2)
- that light is a form of energy (questions 2 and 3)
- that light travels in a straight line from a source to an object (questions 4, 6, and 7)

Prerequisite Skills

Students need to be able to

- communicate in writing, verbally, and using a variety of different media for different audiences and a variety of purposes (question 5)
- interpret a variety of literary, graphic, and informational texts (questions 1 and 6)
- record and organize data using standard measurements in tables, graphs, or charts (question 8)
- state a conclusion based on information gathered (question 4)

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Concept Check	Students identify several natural and artificial sources of light.	Refer students to the *National Geographic* feature on page 408 of the student textbook.
Inquiry Check	Students identify vertical and horizontal symmetry.	Provide small plane mirrors to test properties of symmetry.
Numeracy and Literacy Check	Students identify features of lines and accurately measure angles.	Provide protractors. As a class, create a word wall for the properties of line, angle, and intersections between lines.

Answers

Concept Check

1. **a.** Sources of natural light—fire, moon, stars, fireflies; sources of artificial light—flashlight, glow stick
   b. Example: Sun
   c. Example: fluorescent light bulb, Light Emitting Diode, phosphorescent paint
   d. Any six of: bicycle reflector, mirror in flashlight, reflective surface on clothing, water, glasses, Moon, planets
2. **a.** colours
   b. prism
   c. straight
   d. reflects
   e. refracts
3. **a.** iv.
   b. ii.
   c. v.
   d. iii.
   e. i.

Inquiry Check

4. a. i. A, H, M, O, T, U, V, W, X, Y

ii. B, D, E, H, I, O, X, Z

iii. H, I, O, X

b. Example: To determine vertical symmetry, I folded the letter in half along a vertical line drawn through the middle of the letter, whereas I determined horizontal symmetry by folding the letter along a horizontal line through the middle.

5. a. MOM will read correctly, DAD will not.

b. Their letters have vertical symmetry and occur in the same sequence from left to right or right to left.

Numeracy and Literacy Check

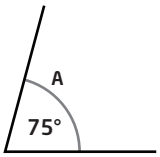
6. a. A and E

b. D and B

c. F intersects A, E, and B; D intersects lines A, E, B, and C

7. a. 20°

b.



8. Example: Applications—*kaleidoscope, microscope, telescope, mirror*
Properties—*speed, straight, beam*
Characteristics—*image, reflection*

Introducing the Unit 4 Projects (Student textbook pages 522 and 523)

Introduce the unit projects and have students read over the instructions to choose which one they would like to do. Encourage students to balance the projects they choose between research and application. Discuss the role that light plays in our homes and in industry. The Inquiry Project examines harnessing natural light, while the Issue to Analyze evaluates artificial alternatives. Preview the Unit 4 chapter headings with students. Have them predict which sections may provide information to complete the project. As students work in Unit 4, draw their attention to concepts that may be helpful in completing one of the projects. For example, the ray diagrams in section 10.2 will be required for the light tunnel, and the explanation of light-emitting electrons in section 10.1 will help them to understand how LEDs work.

Hold mini-conferences throughout the unit to ensure understanding and help students compile resources for their chosen task. You may wish to form small consultant groups that can support each other's work.

Using Making a Difference (Student textbook pages 415, 463, and 500)

Throughout the unit, students encounter examples of technology that uses light to improve the quality of life: simple mirrors improve the effectiveness of solar panels; communication technology spurs social change; and a wine glass tests the theory behind a gravitational lens. Each of the students profiled made a difference by applying what they learned to everyday situations, using readily available materials.

This is an excellent opportunity to feature the benefits of science fairs in general and that of the Canada Wide Science Fair in particular. Students learn how to use the scientific method to conduct meaningful investigations. In addition, they get the opportunity to meet young people like themselves who share an interest in science and technology.

Using Science at Work (Student textbook pages 520 to 521)

Sight is the primary way most people experience the world. Poor eyesight can prevent someone from getting a job, an education, or even from navigating their home town. Even in Canada, eye care and eyeglasses are not accessible to all. The optometrist visits and necessary glasses can be prohibitively expensive. By fitting people with donated eyeglasses, Tuan Trieu significantly improves the lives of everyone involved.

Use this section to remind students of the value and wide application of light and geometric optics. Have students each interview a local person who works in optics. Have them find out what education is required, what a typical day involves, and any highlights or new directions. As a class, prepare a presentation for use by the guidance department or at a job fair. You might choose a website format that can incorporate multimedia and allow students to follow paths of inquiry.

Using the Case Studies

The suggestions below provide opportunities for students of multiple learning styles to engage in and explore issues. The strategies chosen support bodily-kinesthetic, spatial, and interpersonal learning styles. The strategies also serve as pre-reading strategies and scaffolds for English language learners.

Chapter 10 (Student textbook pages 428 to 429)

Before reading the selection, have students share experiences of sunshine "cooking" food. Melting chocolate bars are common experiences. Have students explain what is happening in the diagram. How is the solar oven similar to the radar antenna shown on the same page? How is it different? Other styles of solar oven are based on boxes, rather than a parabola. Ask students to compare the advantages of each.

As a class, brainstorm other reasons these ovens may appeal to people. For example, they are portable, have an infinite lifespan, and can be made from available scrap materials. Finally, challenge students to make their own solar oven to cook a test sample.

Chapter 11 (Student textbook pages 472 to 473)

Before reading the Case Study, have students stand in a value line with "sunglasses are a fashion accessory" at one end and "sunglasses protect eyes" at the other. Then, fold the value line and have facing pairs of students make their case to each other.

Students may not realize the value of sunglasses in protecting vision. People with access to sunglasses suffer less damage to eyes from solar radiation and require less medical care. Encourage students to discover the consequences of eye damage, or have someone speak to the class (e.g., optician, public health educator, or CNIB representative). Finally, connect the need for protection from solar radiation with negative environmental effects linked to greenhouse gases.

To challenge students, have them design an investigation to test the UV blocking claims of a range of sunglasses.

Chapter 12 (Student textbook pages 508 to 509)

Laser eye surgery can free people from wearing corrective lenses. But, not everyone experiences the same results, and the surgery is not recommended for all patients. Additionally, the surgery is expensive.

Students will be too young for this surgery, but can appreciate the technology. Ask students to consider who has access to this technology and why it is not available to everyone. Have students complete a "four corners" activity placemat for this issue. The standpoints might be: this surgery should not be done; everyone possible should get this surgery; this should be available to those who can afford it; this should only be done when the benefits outweigh the risks.

In this case, the power of laser technology is used for progressive purposes. Ask students about other uses of laser technology (e.g., Star Wars-like weapons).