# Unit 4 Summary

## Topic 4.1: What is light and how is it produced?

### Key Concepts

- Many technologies produce light by converting other forms of energy.
- Light is energy and travels like a wave.

### Key Terms

incandescence (page 278)

luminescence (page 278)

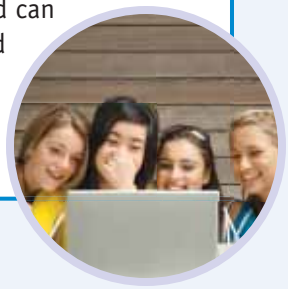
electromagnetic waves (page 280)

wavelength (page 281)

electromagnetic spectrum (page 282)

### Big Ideas

- Light is a form of energy, produced from a variety of sources, and can be transformed into other useful forms of energy.



## Topic 4.2: How does light interact with objects to give them colour?

### Key Concepts

- Light can be reflected, absorbed, or transmitted by objects.
- Objects can absorb some colours and reflect or transmit others.

### Key Terms

ray (page 288)

reflection (page 288)

absorption (page 288)

transmission (page 289)

transparent (page 289)

translucent (page 289)

opaque ( page 289)

### Big Ideas

- The behaviour of light depends on the materials with which it interacts.

## Topic 4.3: How can you mix colours to make different colours?

### Key Concepts

- Colours of light can be added together to form a variety of colours.
- Pigments can subtract colours from light.

### Key Terms

primary colours (page 296)

secondary colours (page 297)

complementary colours (page 297)

tertiary colours (page 299)

### Big Ideas

- A wide range of technologies utilize the properties of light and colour.
- The behaviour of light depends on the materials with which it interacts.

## Topic 4.4: What is the law of reflection and how do mirrors form images?

### Key Concepts

- The angle of reflection is equal to the angle of incidence.
- Plane mirrors form images that are nearly identical to the object.
- Concave mirrors can form images that are larger than the object.
- Concave mirrors can form images that are smaller than the object.
- Convex mirrors always form images that are smaller than the object.

### Key Terms

incident ray (page 306)
reflected ray (page 306)
normal (page 306)
angle of incidence (page 306)
angle of reflection (page 306)
concave mirror (page 312)
principal axis (page 312)
vertex (page 312)
focal point (page 312)
centre of curvature (page 312)
radius of curvature (page 312)
focal length (page 312)
convex mirror (page 318)

### Big Ideas

- A wide range of technologies utilize the properties of light and colour.
- The behaviour of light depends on the materials with which it interacts.

## Topic 4.5: What is refraction and how can it be used?

### Key Concepts

- Refraction is the bending of light when it crosses a boundary between two substances.
- Refraction is used in communications and other technologies.

### Key Terms

medium (page 334)
refraction (page 334)
refracted ray (page 334)
angle of refraction (page 334)
total internal reflection (337)

### Big Ideas

- A wide range of technologies utilize the properties of light and colour.
- The behaviour of light depends on the materials with which it interacts.

## Topic 4.6: What are lenses and what are some of their applications?

### Key Concepts

- Lenses have at least one curved surface and refract light in predictable ways.
- Converging lenses can be used to produce different types of images.

### Key Terms

lens (page 346)
converging lens (page 346)
diverging lens (page 346)

### Big Ideas

- A wide range of technologies utilize the properties of light and colour.
- The behaviour of light depends on the materials with which it interacts.

# Inquiry Investigation: Design a Light Tunnel

Bringing natural light into a room without windows can be a challenge. One way to do this is to construct a light tunnel that redirects light using the properties of lenses and mirrors. For this project, you will take the role of a lighting designer. You have been hired by clients to design a light tunnel that will bring natural light from the roof of their home into a windowless room.

**Investigate Question**

How can mirrors, lenses, and other materials be used to direct natural light through a light tunnel into a windowless room?

## Initiate and Plan

1. Make a table to summarize information to consider for this task, such as reflection, refraction, mirrors, and lenses.
2. Design a light tunnel that will
   - allow sunlight through a flat roof, direct the light from the roof through an attic, and direct the light into the windowless room at the end of the tunnel
   - function morning, afternoon, and evening (sunlight will strike the tunnel at different angles at different times of the day)
   - maximize the amount of light in the windowless room
3. Gather materials to create a model of your light tunnel. Here are some examples:
   - a flashlight to simulate sunlight
   - acetate, plastic wrap, or a small pane of glass to simulate a window on top of the roof
   - cardboard, paper-towel tubes, shoe boxes, or 2 L soft-drink bottles to make the tunnel
4. Make sketches to plan your model, before you begin to assemble it.

## Perform and Record

5. Construct your model to meet the design criteria given in step 2.
6. Draw two well-labelled ray diagrams, showing at least three light rays, to simulate morning and afternoon conditions as the Sun changes position in the sky.

## Analyze and Interpret

1. Identify the challenges you had when designing your light tunnel.

## Communicate Your Findings

2. Assemble your design plans for your clients. Include your ray diagrams, as well as an explanation of how light will be directed through each section of your light tunnel.

**Assessment Criteria**

Once you complete your project, ask yourself these questions. Did you…

- ☑ summarize information about reflection, refraction, mirrors, and lenses, as related to this task? K/U
- ☑ select appropriate materials to create a model of your light tunnel? T/I
- ☑ use the materials in a safe and effective way? T/I
- ☑ design your model to meet the criteria? T/I
- ☑ identify the challenges you faced when designing your light tunnel? A
- ☑ use a ruler and protractor to draw your ray diagrams? C
- ☑ use appropriate scientific terminology, for both your audience and your purpose? C

# An Issue to Analyze: LEDs Brighten Up the Darkness

In countries with rugged terrain or insufficient development, electrical energy is unavailable or very expensive. Artificial light is produced by burning expensive and difficult-to-obtain fossil fuels in generators, or by burning candles. New light-producing technologies, such as light-emitting diodes (LEDs), require much less electricity to generate light. This feature of LEDs makes them suitable for use in remote or developing communities. Research and analyze the costs and benefits of using LED technology in a remote or developing community.

**Issue**

How can LED technology be used to benefit a remote or developing community?

## Initiate and Plan

1. Prepare to analyze LED technology from economic, scientific, and social points of view.

## Perform and Record

2. Using human, print, and electronic resources, research responses to the following questions:
   - How does LED technology differ from conventional incandescent technology?
   - What are the economic costs of using LED technology, compared with the economic costs of using incandescent technology?
   - What scientific challenges prevent the widespread use of LED lighting technology?
   - What are the social benefits of LED lighting technology for a remote or developing community?
3. Based on your research, identify the costs and benefits of using LED technology. Organize your research using an appropriate format.

## Analyze and Interpret

3. Based on your research, prepare a recommendation that you could present to the town council of a remote or developing community to promote the use of LED technology. Consider responses to the following questions as part of your recommendation:
   - Why is LED technology being used now? Why was it not used in the past?
   - Why are some communities unable to use LEDs for artificial light?
   - What could you (or your school community) do to make it possible for remote or developing communities to use LEDs for artificial lighting?

## Communicate Your Findings

2. Select an appropriate format, such as a podcast, poster, or oral presentation, to present your recommendation. Consider both your purpose and your audience.

### Assessment Criteria

Once you complete your project, ask yourself these questions. Did you…

- ☑ compare light generated by conventional technology with light generated by LED technology? K/U
- ☑ research the costs and benefits of LED technology from multiple perspectives? A
- ☑ organize your research in an appropriate format, using proper academic documentation? C
- ☑ select an appropriate format to present your recommendation? C

# Unit 4 Review

## Connect to the Big Ideas

1. A wide range of technologies utilize the properties of light and colour. Identify at least two technologies that make use of the properties of light and at least two that make use of the properties of colour, and explain how they do so.
2. The behaviour of light depends on the material with which it interacts. Use words and diagrams to describe how a ray of light will behave in the following cases.
   - **a)** The light strikes a lemon.
   - **b)** The light strikes a flat mirror.
   - **c)** The light strikes a concave mirror.
   - **d)** The light strikes a clear, glass window.
   - **e)** The light strikes a red brick wall.
   - **f)** The light strikes a straight-sided glass that is filled with water. (Assume the light strikes the glass from the side.)
3. Light is a form of energy, produced from a variety of sources, and can be transformed into other useful forms of energy.
   - **a)** Identify at least five human-made sources that produce light.
   - **b)** For each of the sources that you identified in part a), name at least one useful form of energy into which the light energy is transformed.

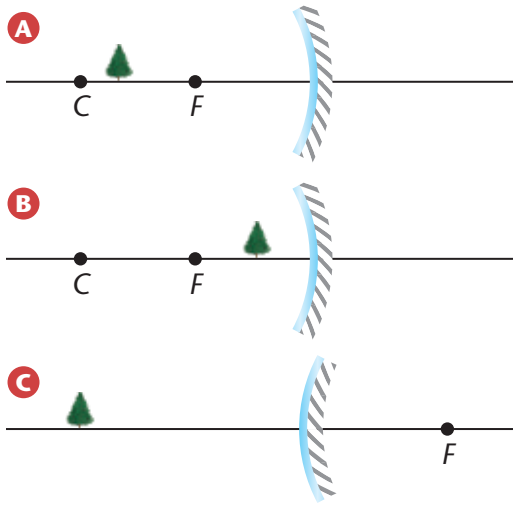
## Knowledge and Understanding K/U

4. State whether the following statements are true or false. If a statement is false, rewrite it to make it true.
   - **a)** An opaque material lets some light through, but no image is visible.
   - **b)** A convex mirror causes light rays to converge toward a focal point.
   - **c)** Waves carry energy.
   - **d)** A luminescent light source produces light because it is hot.
   - **e)** The colour that an object appears to be under white light is the colour of light that it reflects.
   - **f)** Concave mirrors always form images that are upright, virtual, and smaller than the object.
   - **g)** When light passes from a medium in which its speed is faster into a medium in which its speed is slower, it refracts toward the normal.
   - **h)** When parallel light rays pass through a diverging lens, they spread out.
5. For each of the following types of electromagnetic waves, state whether it has wavelengths that are shorter or longer than those of visible light.
   - **a)** microwaves
   - **b)** X-rays
   - **c)** infrared
   - **d)** ultraviolet
6. Draw a labelled diagram to show what happens when light rays strike an object that is
   - **a)** transparent
   - **b)** translucent
   - **c)** opaque
7. **a)** What colour will you see if you shine green light and blue light onto the same spot on a white screen?
   **b)** Green and blue are primary additive colours. What would you call the colour you see on the screen?
8. Name one situation in which subtractive primary colours are used.
9. Leaves are green. What property of leaves causes them to be green?
10. **a)** Make a drawing of a flat, reflecting surface. Add an incident ray, a normal, and a reflected ray. Label your diagram with the underlined terms as well as these terms: angle of incidence and angle of reflection.

**b)** Use your diagram to explain the law of reflection.

**11.** What is the shape of mirrors commonly used for makeup mirrors and shaving mirrors? Why?

**12.** Copy the following drawings in your notebook.




**a)** Complete ray diagrams for all three drawings.

**b)** Refer to your diagrams to explain how concave mirrors can form upright or inverted images.

**c)** Refer to your diagrams to explain the characteristics of images in convex mirrors.

**d)** For each image, state whether it is real or virtual. Explain how you know.

**13.** The speed of light in water is $2.25 \times 10^8$ m/s and the speed of light in glass is $2.00 \times 10^8$ m/s. If light travels from water to glass, will the light refract toward the normal or away from the normal? Explain how you decided on your answer.

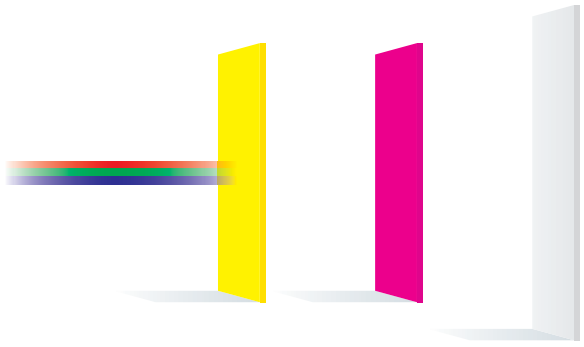
**14.** Explain the difference between converging lenses and diverging lenses.

**15.** You have an eraser and a converging lens. Where must you place the eraser in order to produce an image that is real, inverted, farther from the lens than the eraser, and larger than the eraser?

## Thinking and Investigation T/I

**16.** The diagram below represents a stiff piece of paper mounted on a push pin. If you spin the paper disk very fast, your eyes will see both colours at the same time. What colour will the disk appear to be?

**17.** The following diagrams represent white light passing through a yellow filter and then through a magenta filter. It finally hits a screen on the right. The white light has been represented by the primary additive colours, red, green and blue. Complete the diagram by showing which of the primary colours will continue through the filters. What colour will appear on the screen?



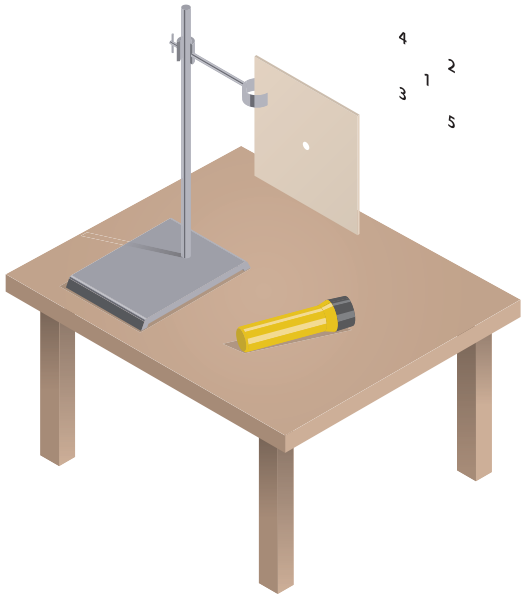
**18.** A person takes a photograph of an image in a plane mirror. If the camera is 2 m in front of the mirror, at what distance should the camera lens be focussed?

**19.** You are using a magnifying mirror that has a focal length of 50 cm. You step backwards until you are 75 cm from the mirror. Describe your image in the mirror.

# Unit 4 Review

**20.** The structures in your eyes that focus light on the light-sensitive cells function like a converging lens that has a focal length of about 1.7 cm. Practically everything that you look at is much more than 1.7 cm away. What is the orientation of all images formed by converging lenses when the object is farther from the lens than the focal point? Why do you think that you see everything as "right side up?"

**21.** The equipment in the diagram below was set up for an experiment to demonstrate that light travels in a straight line. Look carefully at the diagram. Infer how the experiment probably works, and why.



## Communication C

**22.** Use a Venn diagram to compare the reflection of light from a white wall with a rough surface with the reflection of light from a mirror.

**23.** Use a labelled diagram to explain how optical fibres transmit light and carry information.

**24.** Explain how reflected light and absorbed light help you read the print on a page.

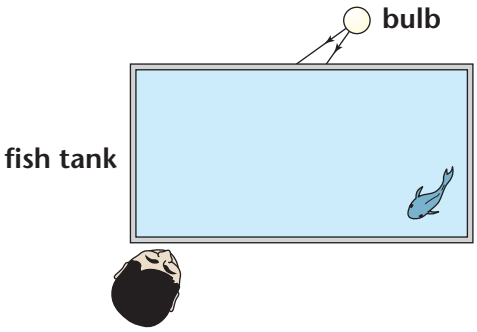
## Application A

**25.** Sunscreen blocks (absorbs) ultraviolet rays. Researchers have used sunscreen on flowers and observed that it affects the ability of bees to find the flowers that they typically use to find food. Infer what this suggests about the vision of bees.

**26.** A man is wearing a cyan tie. He walks into a room in which the light is red. What colour does his tie appear to be? Explain your answer.

**27.** Imagine that you are the only lighting technician for a show. You have red, green, blue, magenta, cyan and yellow filters. In the middle of the performance, your red filter is damaged. What could you do to replace it with the other filters that you have available?

**28.** The diagram below shows the top view of a fish tank full of water. In your notebook, draw a larger diagram similar to this one. A student looks through the tank at a small light bulb on the other side of the tank. Show the refraction of the two incident rays as they travel into the water and then back into the air. Will the student see the bulb to the left or the right of its actual position?




**29.** You are out camping and you run out of matches to start a fire. You see some dry leaves. You are beside a lake that has some ice on it from a late spring. How could you use the ice to start a fire?

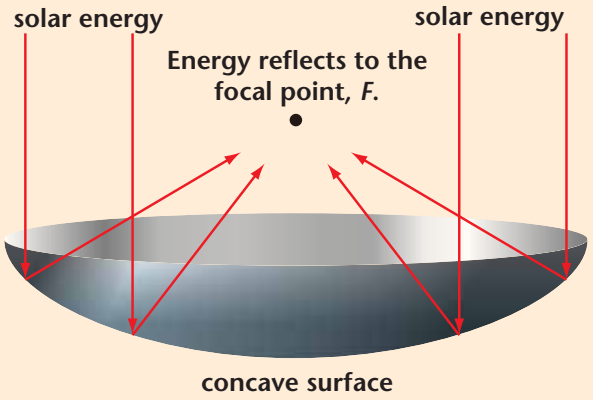
## Literacy Test Prep

*Read the selection below, and answer the questions that follow it.*

People in many parts of the world burn wood or kerosene to cook their food, but people who live in areas that are hot and sunny are starting to use the Sun instead. These areas are home to most of the world's populations, and many of these people are very poor. For example, in Tanzania, an average family lives on less than $600 a year. Stoves and cooking fuels, such as kerosene and propane, are expensive. Therefore, most people collect wood to make cooking fires. The smoke from these fires is a leading cause of respiratory diseases, and the collection of wood is a leading cause of deforestation in equatorial areas. In addition, burning kerosene and propane fuel emit dangerous gases.

In contrast, solar cooking requires no fuel. In a solar oven, the Sun's light rays reflect from a shiny metal (usually aluminum) dish. The reflected rays concentrate at the focal point as shown below. The light that is concentrated at the focal point is converted to heat. When food is placed at the focal point, it is cooked.

While solar ovens cost nothing to operate, they can be expensive to build and ship to the people who use them. To overcome this drawback, solar ovens must be manufactured closer to where they are used. Solar Circle, a volunteer group based in the United States, is helping set up a solar oven industry in Tanzania that will use local materials. This local industry will reduce the cost of solar ovens and make it easier for more people to switch to solar cooking. Solar cooking, in turn, will protect not only the environment but also people's health.




### Multiple Choice

**30.** Which of the following items are contrasted in this selection?

**a)** wood and kerosene
**b)** cooking fires and solar ovens
**c)** United States and Tanzania
**d)** light and heat

**31.** The drawbacks of solar ovens include

**a)** they use fuels such as kerosene, ethanol and propane
**b)** they cause respiratory disease
**c)** they are expensive to build and ship
**d)** they are powered by the Sun

**32.** Which word is closest in meaning to "leading" as used in paragraph 2 of this selection?

**a)** primary
**b)** first
**c)** front
**d)** guide

**33.** Solar ovens work by

**a)** burning wood
**b)** burning kerosene
**c)** burning propane
**d)** converting light to heat

### Written Answer

**34.** Explain why solar cooking is beneficial for the environment and people's health. Use relevant and specific information from the selection to support your answer.