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UNIT 2

Unit 2 Summary

BLM 2-1

Goal • Use this summary to review the concepts in Unit 2, Optics.

Chapter 4 Many properties of light can be understood using a wave model of light.

- Humans built telescopes and microscopes before they understood the nature of light. (4.1)
- Waves are disturbances that transmit energy from one place to another. (4.2)
- Waves have amplitude, wavelength, and frequency. (4.2)
- As wavelength decreases, frequency increases. (4.2)
- Different colours of light have different wavelengths. (4.3)
- White light is a mixture of many wavelengths of light. (4.3)
- A prism can separate and recombine different colours of light. (4.3)
- The electromagnetic spectrum is made up of waves that are similar to light waves that have much longer or shorter wavelengths. (4.4)
- Radio waves, microwaves, and infrared waves have longer wavelengths than visible light. (4.4)
- Ultraviolet waves, X rays, and gamma rays have shorter wavelengths than visible light. (4.4)

Chapter 5 The law of reflection allows mirrors to form images.

- The angle of reflection is equal to the angle of incidence. (5.1)
- Reflection can be either specular or diffuse, depending on the reflecting surface. (5.1)
- An image in a plane mirror is virtual and is the same size, orientation, and distance from the mirror as the object. (5.2)
- A concave mirror curves in at the centre and a convex mirror curves out. (5.3)
- Images in concave mirrors can be real or virtual, upright or inverted, larger or smaller than the object, depending on the distance between the object and the mirror. (5.3)
- Images in a convex mirror are virtual, upright, and smaller than the object. (5.3)
- Ray diagrams allow you to predict the characteristics of images in mirrors. (5.3)

Chapter 6 Lenses refract light to form images.

- The characteristics of images produced by convex lenses depend on the distance of the object from the lens. (6.1)
- Images produced by concave lenses are always upright, virtual, closer to the lens, and smaller than the object. (6.1)
- Light is detected by the eye using the cornea-lens-retina system. (6.2)
- Rod cells detect dim light but are not sensitive to colour. (6.2)
- Cone cells dominate in bright light and distinguish between colours. (6.2)
- Vision deficiencies include near-sightedness, far-sightedness, astigmatism, and deficiencies in distinguishing between different colours. (6.2)
- Eyes, cameras, microscopes, and telescopes have some similarities in the way they operate. (6.3)
- Microscopes and refracting telescopes use only lenses to magnify objects, while reflecting telescopes use both mirrors and lenses. (6.3)

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UNIT 2

Unit 2 Key Terms

BLM 2-2

Goal • Use this page to review the Unit 2 Key Terms.

Chapter 4 Key Terms	Chapter 5 Key Terms	Chapter 6 Key Terms
amplitude	angle of incidence	aperture
compression wave	angle of reflection	astigmatism
crest	angle of refraction	blind spot
electromagnetic radiation	concave mirror	blindness
energy	convex mirror	charge-coupled device (CCD)
force	diffuse reflection	colour blindness
frequency	extended rays	concave lens
gamma rays	focal point	cone cells
hertz	image	convex lens
infrared waves	image distance	cornea
light	incident ray	diaphragm
medium	inverted	far-sighted
microscope	law of reflection	focal length
microwaves	normal	iris
Pythagoras	object distance	lens
radiant energy	opaque	near-sighted
radio waves	particle model of light	night blindness
reflection	plane mirror	optical centre
refraction	principal axis	optical nerve
spectrum	ray diagram	pupil
telescope	ray model of light	reflecting telescope
transverse wave	real image	refracting telescope
trough	rectilinear propagation	retina
ultraviolet waves	reflected ray	rod cells
visible light	refracted ray	sclera
wave	specular reflection	snow blindness
wave model of light	translucent	
wavelength	transparent	
X rays	upright	
	vertex	
	virtual image	

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UNIT 2

Chapter 4 Key Terms

BLM 2-3

Goal • Use this page to review the Key Terms in Chapter 4.

1. List one common use for each type of radiation listed. Then use the types of radiation to label the diagram below.

gamma rays _____

infrared waves _____

microwaves _____

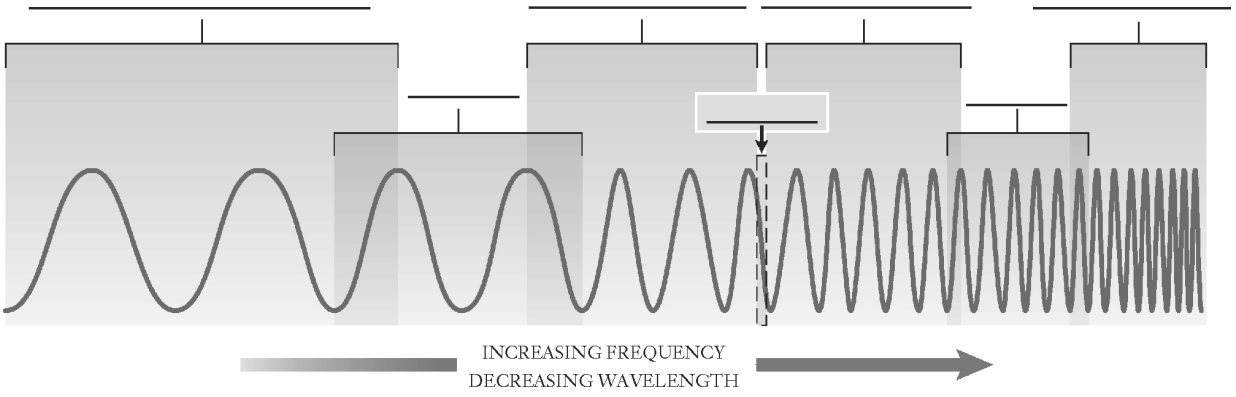
radio waves _____

ultraviolet waves _____

visible light _____

X rays _____

Electromagnetic Spectrum



2. Choose one of these Key Terms to fill in each blank in the following sentences.

amplitude	compression wave	crest	electromagnetic radiation
energy	force	frequency	hertz
medium	microscope	Pythagoras	radiant energy
reflection	refraction	telescope	transverse wave
trough	wave	wave model of light	wavelength

The _____ of a wave describes the number of waves that occur in a certain time, and is often measured in cycles per second, or _____.

The highest point of a wave is the _____ and the lowest is the _____.

The _____ of a wave describes the distance from the highest point to the rest position. The _____ of a wave describes the distance from one crest to the next.

Matter in a _____ moves up and down perpendicular to the direction the wave travels. Matter in a _____ moves back and forth along the same direction that the wave travels.

_____ describes light hitting an object and bouncing off.
_____ describes light changing direction as it passes through a _____.

A _____ helps us see things too small for our eyes alone to see.
A _____ helps us see things too far away for our eyes alone to see.

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UNIT 2

Chapter 4 Key Terms

BLM 2-4

Goal • Use this page to help you review the Key Terms in Chapter 4.

Create a list of 10 words or phrases from the descriptions below. Then find the words and phrases in the puzzle.

1. The height of a wave crest or depth of a wave trough, as measured from its rest position (9 letters)	
2. The number of repetitive motions, or oscillations, that occur in a given time (9 letters)	
3. A disturbance or movement that transfers energy through matter or space, without causing any permanent displacement (4 letters)	
4. The capacity to apply a force over a distance (6 letters)	
5. The lowest point in a wave (6 letters)	
6. The distance from crest to crest or from trough to trough (10 letters)	
7. The bending or changing direction of a wave as is passes through one material to another (10 letters)	
8. A Greek philosopher who believed beams of light were made up of tiny particles (10 letters)	
9. Occurs when a light wave strikes an object and bounces off (10 letters)	
10. Radio waves with the shortest wavelength and highest frequency (10 letters)	

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BLM 2-4 continued

B T R O U G H I M E V R C N O C T R O
H D E N S I T Y C U R A E N T T R E C
C I R C U L A R O R Y M Y S S E R F E
P Y T H A G O R A S N P S E R P E L A
R M E E Y I O I G N I L R U D S A E N
D I S E R M N E C L A I I N P O L C H
I C P E O U O A W R E T L O C T I T T
A R Y S S P L D L A I U E I W E M I G
C O R I O L A S E F V D C T O N A O N
C W N T I N E Q T L L E H C L E G N E
L A C O N V E X U I O L O A E R E L L
C V R N E A E N T E L I R R F G I L E
X E M T Z E K N M F L G L F T Y N E V
W S C E A N C U R R E H T E C M E W A
Q T R F R E Q U E N C Y O R G S R S W

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UNIT 2

Chapter 5 Key Terms

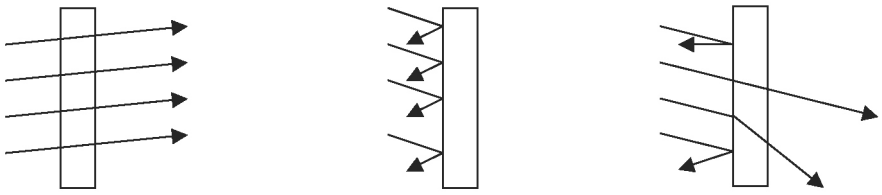
BLM 2-5

Goal • Use the graphic organizer below to help you learn and review the Key Terms in Chapter 5.

Use the following Key Terms to label these diagrams. Use each Key Term only once.

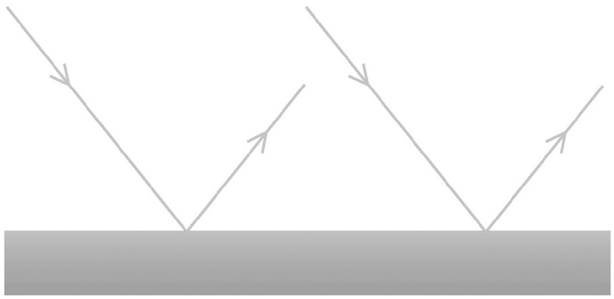
angle of incidence	angle of reflection	angle of refraction	concave mirror
convex mirror	diffuse reflection	extended rays	focal point
image	image distance	incident ray	inverted
law of reflection	normal	object distance	opaque
plane mirror	principal axis	real image	reflected ray
refracted ray	specular reflection	translucent	transparent
upright	vertex	virtual image	

Light passes through some media.



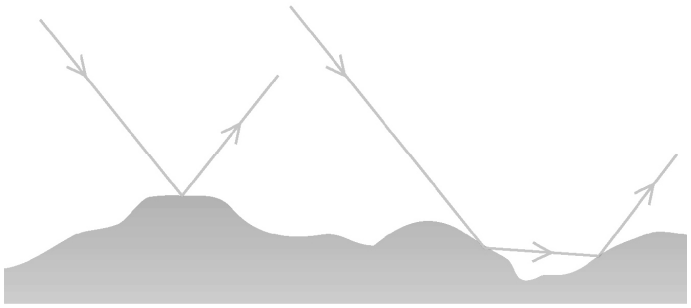
_____ _____ _____

Light reflects off smooth surfaces and rough surfaces.



_____

Light reflects off smooth surfaces and rough surfaces.



_____

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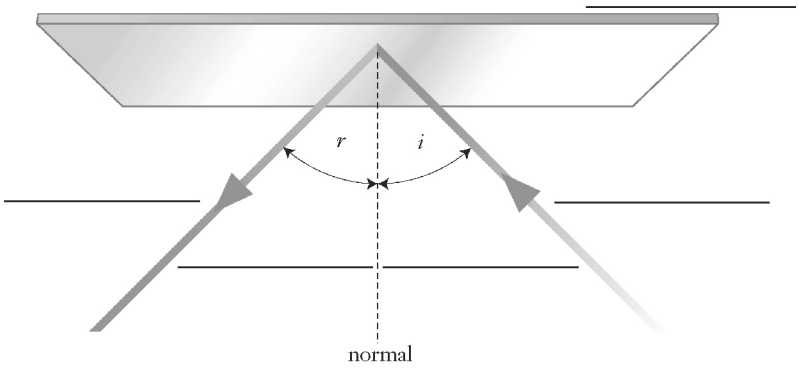
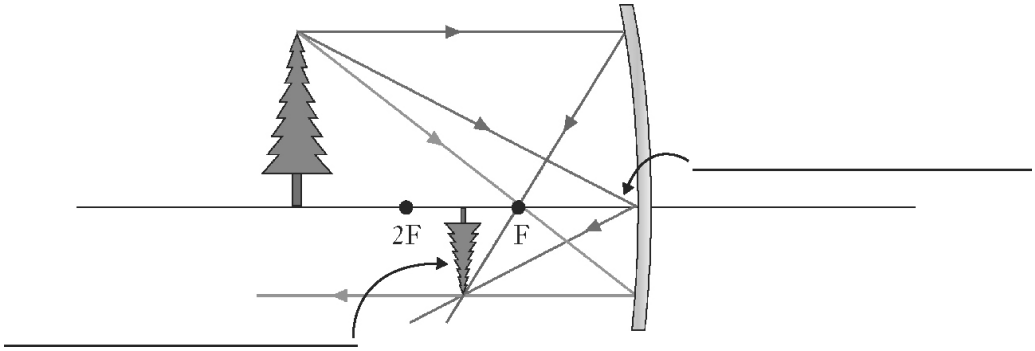
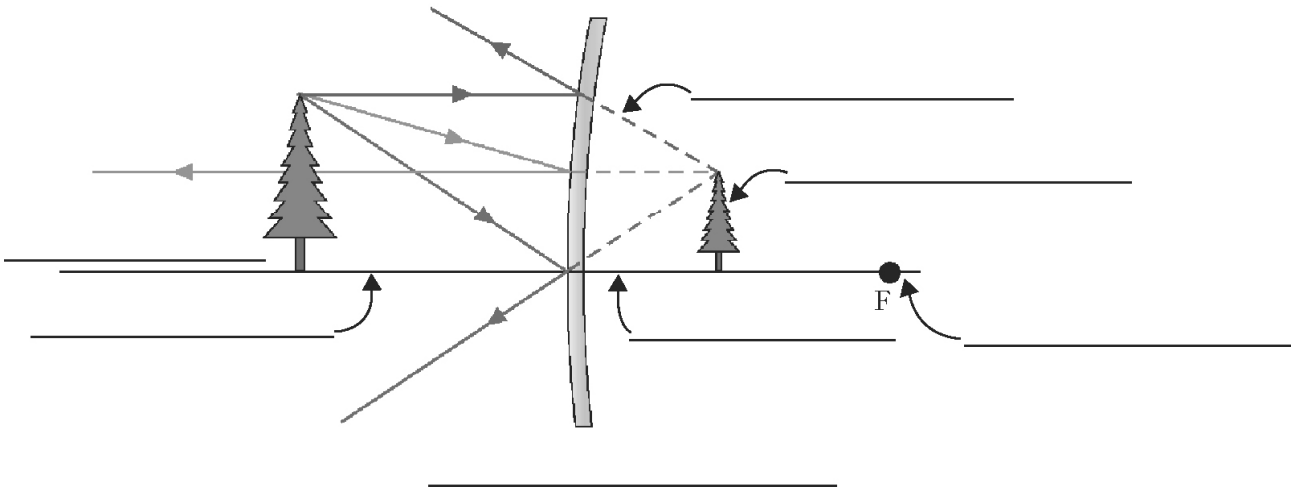
BLM 2-5 continued

Light reflects off different types of mirrors.







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UNIT 2

Chapter 5 Key Terms

BLM 2-6

Goal • Use this page to help you review the Key Terms in Chapter 5.

Create a list of 10 words or phrases from the descriptions below. Then find the words and phrases in the puzzle.

1. Describes a material that allows light to pass through it (11 letters)	
2. Describes a material that prevents any light from passing through it (6 letters)	
3. The point at which the principal axis meets the mirror (6 letters)	
4. Reflection from a rough surface (7 letters, 10 letters)	
5. A flat, smooth mirror (5 letters, 6 letters)	
6. Upside down (8 letters)	
7. A line normal to the centre of a mirror (9 letters, 4 letters)	
8. Formed when reflected rays meet (4 letters, 5 letters)	
9. A mirror that is curved outward (6 letters, 6 letters)	
10. The incoming ray in a ray diagram (8 letters, 3 letters)	

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BLM 2-6 continued

R T R T O R R R M R V A R N R C P Y R
H E R R P I R Y C R R R E N T R R R C
C R R A A L I R U R Y P Y S R Y I D E
A T O N Q A E E X U E L S E E P N T U
R N U S U U O U E G Y A R U A S C U N
D E U P E T N U T U A N I T L O I U R
I C U A C U L A R R E E L E I T P O N
Y L Y R Y A L P E Y I M E M M R A D D
C A R E O L I S V F F I C T A T L E E
C C N N Y N E Y T E Y R H Y G F A S T
L I C T Y V E X Y I R R O R E H X L R
C T R N E A E N T A L O R I F T I L E
X P M I N C I D E N T R A Y Y O S E V
W O C O N V E X M I R R O R C M Y W N
D I F F U S E R E F L E C T I O N S I

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UNIT 2

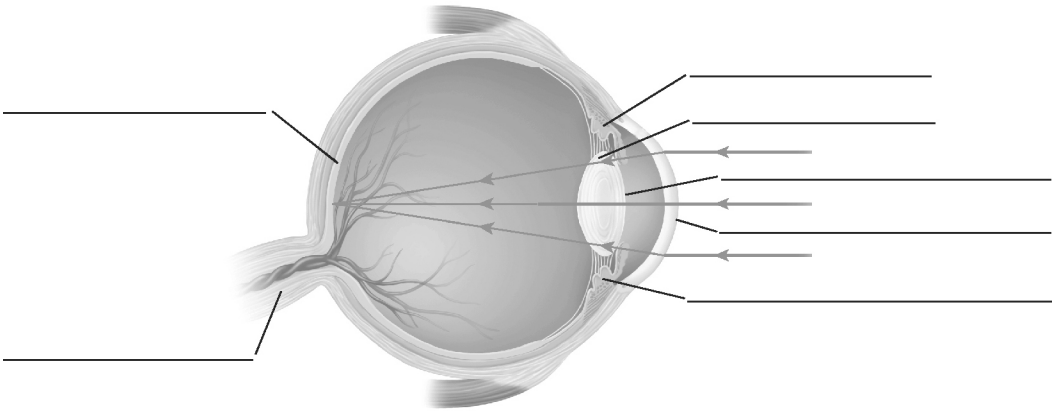
Chapter 6 Key Terms

BLM 2-7

Goal • Use the graphic organizer below to help you learn and review the Key Terms in Chapter 6.

1. Use these Key Terms to label parts of the human eye.

blind spot	cornea	iris	lens
optical nerve	pupil	retina	sclera



2.

Match each Key Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.

Term	Descriptor
_____ 1. astigmatism	A. a condition in which it is difficult or impossible to see in dim light
_____ 2. charge-coupled device (CCD)	B. a condition in which the cornea has an irregular shape, causing an image to focus on more than one point on the retina, resulting in blurred vision
_____ 3. concave lens	C. a device that controls the amount of light that enters a camera
_____ 4. cone cells	D. a lens that causes light rays to bend away from each other
_____ 5. convex lens	E. a lens that causes light rays to bend toward each other
_____ 6. diaphragm	
_____ 7. far-sighted	
_____ 8. focal length	
_____ 9. near-sighted	
_____ 10. night blindness	

_____ 11. optical centre _____ 12. reflecting telescope _____ 13. refracting telescope _____ 14. rod cells _____ 15. snow blindness	F. a telescope that contains lenses, but no mirrors G. a telescope that contains one or more mirrors, as well as lenses H. ability to focus on objects close up, but not far away I. ability to focus on objects far away, but not close up J. cells in our retina that help us see colour K. cells in our retina that help us see shades of light and dark L. part of a camera that absorbs light and provides electrical signals to produce an image M. temporary partial or complete blindness caused by overexposure to the glare of sunlight, for example, as it reflects off snow N. the distance from the centre of a lens to its focal point O. the point where the principal axis of a lens intersects the centre of the lens

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UNIT 2

Chapter 6 Key Terms

BLM 2-8

Goal • Use this page to help you review the Key Terms in Chapter 6.

Create a list of 9 words or phrases from the descriptions below. Then find the words and phrases in the puzzle.

1. A curved piece of transparent material that refracts light in a predictable way (4 letters)	
2. A painful condition of temporary partial or complete blindness caused by overexposure to the glare of sunlight (4 letters, 9 letters)	
3. An opening in a camera through which the light reflected off a subject passes (8 letters)	
4. The distance from the centre of the lens to the focal point (5 letters, 6 letters)	
5. A mirror that is curved outward (6 letters, 6 letters)	
6. The point where the principal axis intersects the centre of the lens (7 letters, 6 letters)	
7. An opening in the eye that appears dark because light passes through it without reflecting back (5 letters)	
8. A transparent tissue covering the iris and the pupil (6 letters)	
9. A condition in which the cornea has a distorted shape (11 letters)	

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BLM 2-8 continued

R T S C O R N E A E V A C F O C T E O

H R E N S I T Y C U R R E O T T R N P

C O R C U L A R O R Y S Y C S E R D T

A R O N C A E E L E N L S A R P E T I

R R E E S I O N G N I R R L D S A H C

D I S E R T N E S P A C I L P O P E A

I M P E C U L A U R E F L E C T E O L

A X Y S S A L P L E I N E N W R R D C

C E R I O L I S V F L E C G O T T E E

C V N T I N E N T E L E H T L F U S N

S N O W B L I N D N E S S H E H R L T

C O R N E A E N T A L T R K F T E L R

X C M T Z E K N M F L L E T A O N E E

W O C E A N C U R R E N T X C P E W R

R A S T I G M A T I S M O F V S E S A

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UNIT 2

Riding the Waves

BLM 2-9

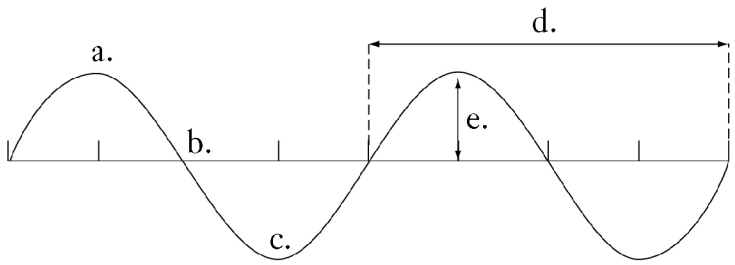
Goal • Use this page to help you review wave concepts.

What to Do

Complete the exercises on this page. You may refer to pages 139 and 140 of your textbook if you need to review.

1. In the diagram below, fill in the labels on the right side of the picture. Choose words from this list:

   trough amplitude crest wavelength rest position



a. _____
b. _____
c. _____
d. _____
e. _____

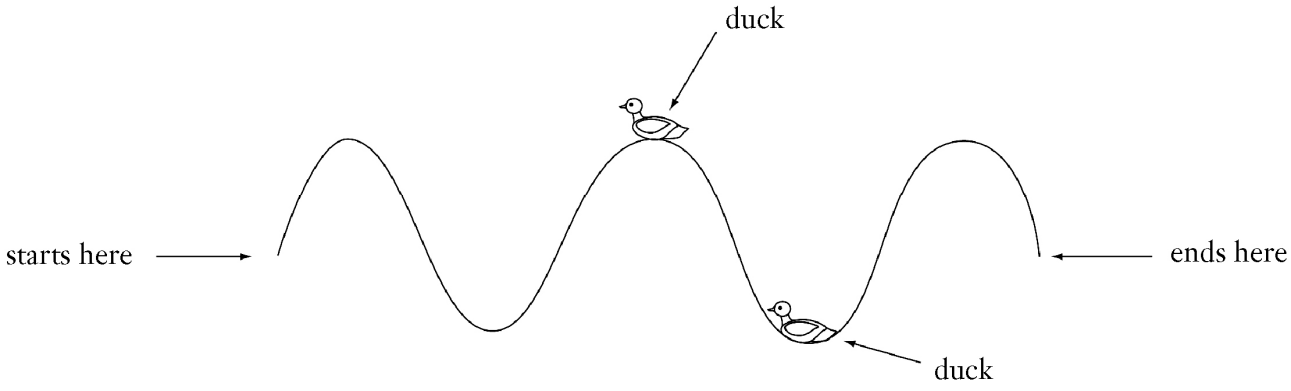
2. How many wavelengths are shown in the above diagram? _____

3. The number of cycles per second is the _____, which is measured in _____ (Hz).

4. Calculate the frequency of a wave that goes up and down 8 times in 4 seconds.

   _____

Use this diagram for questions 5 and 6.



5. How many wavelengths apart are the two ducks? _____

6. How many wavelengths are shown? _____

DATE: NAME: CLASS:

UNIT 2

Frequency Formula

BLM 2-10

Goal • Use this page to complete Think About It 4-2B, Frequency Formula.

What to Do

1. Use the following equation to calculate frequency (in hertz) for each of the examples below. Remember that frequency is equal to the number of cycles (*i.e.*, swings, revolutions, flashes, or beats) per second. The first example is done for you.

(a) pendulum: 24 swings in 6 s

$$\text{frequency} = \frac{24 \text{ swings}}{6 \text{ s}}$$
$$= \frac{4 \text{ swings}}{1 \text{ s}}$$
$$= 4 \text{ Hz}$$

(b) merry-go-round: 12 revolutions per 2 min

$$\text{frequency} = \frac{\_\_ \text{ revolutions}}{\_\_ \text{ s}}$$
$$= \frac{\_\_ \text{ revolutions}}{1 \text{ s}}$$
$$= \_\_ \text{ Hz}$$

(c) flashing red light at an intersection: 30 flashes in 0.5 min

$$\text{frequency} = \frac{\_\_ \text{ flashes}}{\_\_ \text{ s}}$$
$$= \frac{\_\_ \text{ flashes}}{1 \text{ s}}$$
$$= \_\_ \text{ Hz}$$

(d) heart rate: 18 beats per 20 s

$$\text{frequency} = \frac{\_\_ \text{ beats}}{\_\_ \text{ s}}$$
$$= \frac{\_\_}{\_\_}$$
$$= \_\_ \text{ Hz}$$

(e) car drive shaft: 2000 rpm (revolutions per min)

$$\text{frequency} = \frac{\_\_}{\_\_}$$
$$= \frac{\_\_}{\_\_}$$
$$= \_\_ \text{ Hz}$$

What Did You Find Out?

1. In order to calculate frequency measured in hertz, what must you do with the time unit before dividing?

_____

DATE: NAME: CLASS:

UNIT 2

Wire Waves

BLM 2-11

Goal • Use this page to complete Conduct an Investigation 4-2D, Wire Waves.

Question

How can a coiled metal spring be used to investigate amplitude, wavelength, and frequency?

Procedure

3. Draw a diagram of the wave produced in step 3 in the space below. Indicate the wavelength. Use arrows to show the directions in which the marked coil moves.

Low frequency wave

4. Draw a diagram of the wave produced in step 4 in the space below. Indicate the wavelength. What happened to the frequency?

Label: _____ frequency wave

5. Draw and label a diagram for each of your results in step 5.

(a) Wave with increased amplitude

(b) Low frequency, high amplitude wave

(c) High frequency, high amplitude wave

(d) Low frequency, low amplitude wave

Analyze

1. How did the wavelength in the spring change as it moved from side to side more quickly?

_____

2. How did the marked coil move in each of your waves?

_____

3. (a) How are the frequency and amplitude of a wave related?

_____

(b) Can a low frequency wave sometimes have a large amplitude, and sometimes have a small amplitude? Explain.

_____

_____

Conclude and Apply

1. Use the spaces below to draw your diagrams. Use labels to show crests, troughs, wavelength, and amplitude on both diagrams.

(i) a wave with a high frequency, a short wavelength, and a large amplitude

(ii) a wave with a low frequency, a long wavelength, and a small amplitude

2. The amount of energy transferred by the spring changes with frequency, and also with wavelength.

(a) What happens to the amount of energy as the frequency increases?

_____

(b) What happens to the amount of energy as the wavelength increases?

_____

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UNIT 2

At the End of the Rainbow

BLM 2-12

Goal • Discover the causes of rainbows.

Think About It

Sometimes a rainbow appears during a rain shower while the Sun is shining. What must be the relative positions of you, a rain shower, and the Sun for a rainbow to be visible?

What to Do

Draw each diagram in the space provided.

1. If you can, go outside and experiment with a garden hose. Make a wide spray of water and look for a rainbow. You might have to look at various angles, and check several times a day to find out how low in the sky, relative to the spray, the Sun must be. Are you looking toward the Sun or with the Sun behind your head? Are you looking up at the water, level with it, or down? Draw a diagram in this space to show the positions of your eye, the spray, and the Sun.

2. Try to find something that can cast a rainbow (or a spectrum, when rain is not involved) inside your home. Do you have a chandelier or glass beads hanging from a light? Can you find a way to use a glass of water and a flashlight to get a spectrum on a wall or counter? Do you have a clear plastic wand hanging from window drapes or a Venetian blind? Perhaps you could try aiming a flashlight near a corner of a fish tank. Can you make a spectrum from the stem of a glass? Draw a diagram in this space to show the positions of your eye, the object, and the light. Carefully show the angles of each edge relative to the light.

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UNIT 2

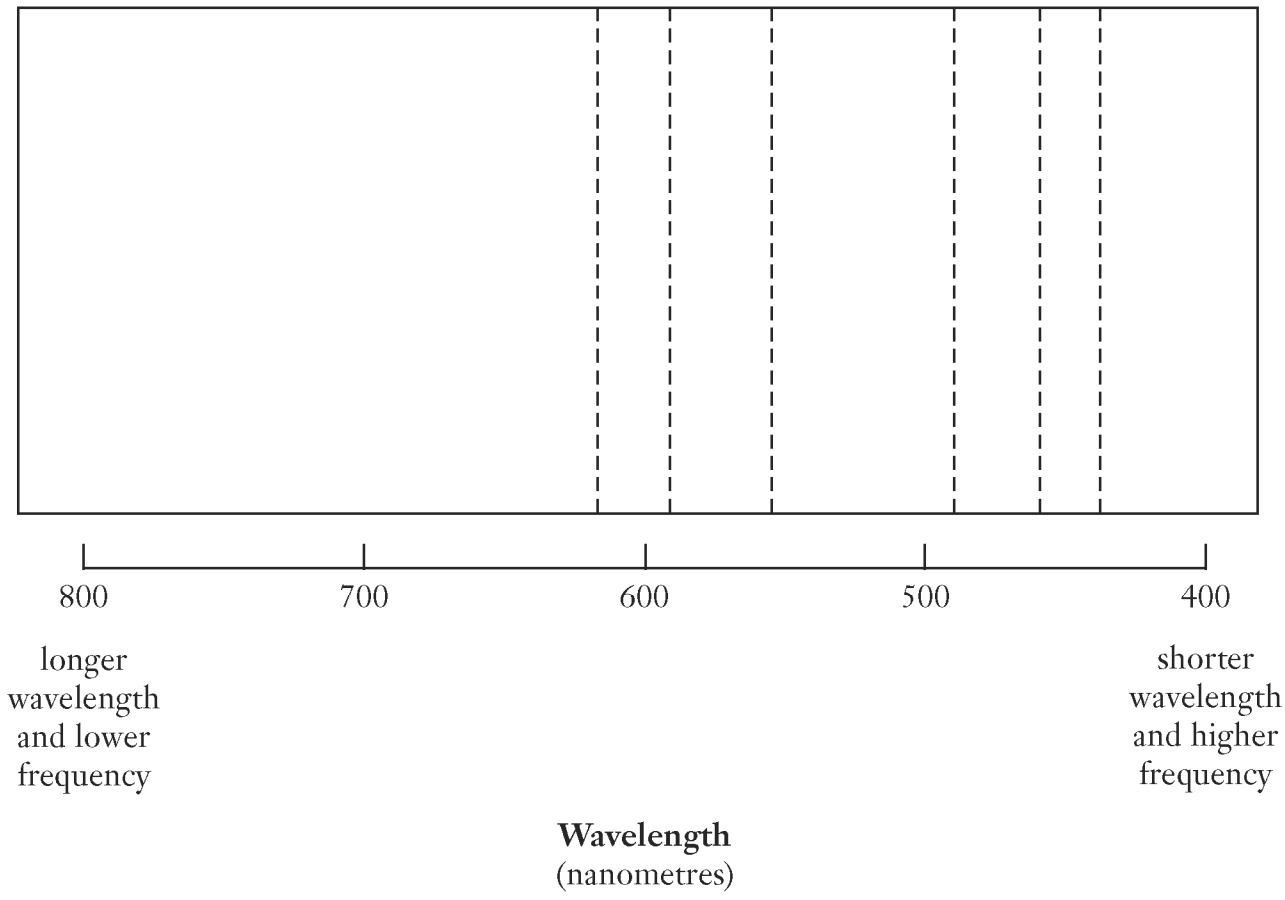
ROY G BIV

BLM 2-13

Goal • Determine the wavelengths of the colours of the spectrum.

What to Do

Fill in the colours of the spectrum in the diagram below. For help, refer to the chart on page 150 of your textbook.



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UNIT 2

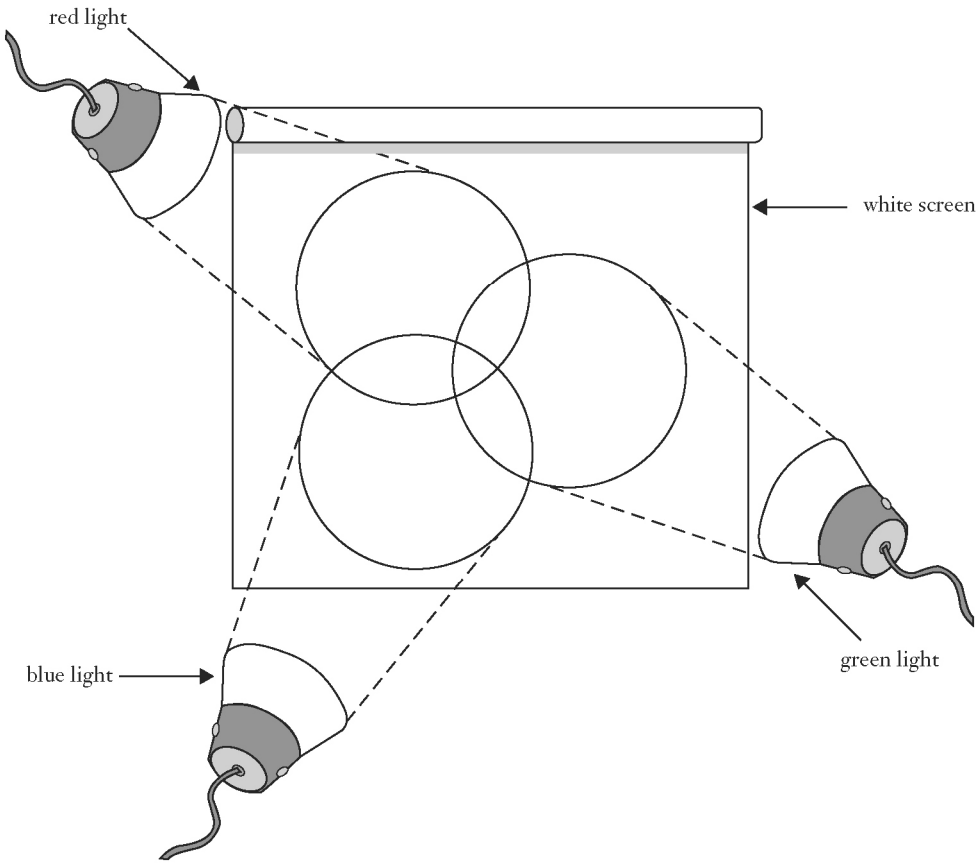
Additive Primary Colours

BLM 2-14

Goal • Review what happens when additive primary colours are mixed.

What to Do

The diagram below shows three coloured spotlights aimed at a screen. Choose appropriate coloured pencils to fill in the colours you would see on the screen. Refer to Figure 4.25(A) on page 152 of your textbook if you need help.



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UNIT 2

What is Colour?

BLM 2-15

Goal • Use this activity to help you determine if light contains colour or if colour is something light picks up when it strikes an object.

Materials

- overhead projector
- red, green, and blue cellophane
- red, green, and blue construction paper
- other colours of construction paper

What to Do

Follow these steps. Record your observations in the table.

1. Darken the room and hold a piece of red construction paper in front of the screen in the light of the overhead projector.

2. Place two layers of red cellophane on the glass plate (stage) of the overhead projector. What colour does the construction paper appear to be under red light?

3. Repeat step 2 using green cellophane, then blue cellophane.

4. Repeat the activity with the other colours of construction paper.

Colour of Paper	Colour of Light	Colour Observed
Red	Red	
Red	Green	
Red	Blue	
Green	Red	
Green	Green	
Green	Blue	
Blue	Red	
Blue	Green	
Blue	Blue	

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UNIT 2

Setting the Stage

BLM 2-16

Goal • Use this page to find out about the use of lighting in theatres.

Think About It

- Imagine that you are the lighting director for your school play and responsible for stage lighting. Your theatre lights must illuminate the set—the audience must be able to see what is going on. Also, the lights must create the mood the director wants.
- To illuminate the set, you might think that all you have to do is shine a spotlight on an actor. Try it. Turn off the lights and point a flashlight at one of your friends. If the light is from the front there are no shadows and your friend's face is "washed out." If the light comes from an angle, shadows help the audience distinguish the actor's features, but there will be a huge shadow on the set beside the actor. What happens if a single light is aimed up at an actor's face?
- Now think about this: when you are outside on a sunny day, shadows all point in the same direction. To make a stage look like the outdoors on a sunny day, lighting directors usually aim a light toward the actor from a high angle. Then they shine softer lights from different angles to lighten the shadows. Why might they do this?

What to Do

Answer the questions that follow.

1. Which technique matches which situation?

Situation	Technique
1. Actor is alone on stage in a jail	a. Soft white light at front of stage, deep blue background
2. In a field on a hot, sunny day	b. Background dark with reddish glow. Use mostly yellow and red lights on actor, all from same direction to cast shadows on the side wall of set.
3. Angels glide across the stage	c. Darkened stage, single spotlight from top makes white circle around actor, shadows softened a bit with other gentle lighting
4. Sitting on a porch in the evening	d. Bright lights, lots of yellow on entire stage, no long shadows

2. Many stages have several banks of alternating red, blue, and green lights connected to a dimmer panel that can control the brightness of each set of coloured lights separately. For example, all the red lights in one bank can be full but the blues brought down halfway. On the back of this page, write about how you might light a 5-min scene that took place while the Sun was setting.

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UNIT 2

Sunrise, Sunset

BLM 2-17

Goal • This activity will help you understand the colours of sunrises and sunsets.

Think About It

- Sunsets are a popular choice of subjects for both artists and photographers. As you work through this activity, consider the reasons why sunsets (and sunrises) produce such interesting displays of colour.

What to Do

- Collect and prepare a photo essay of spectacular sunrises and sunsets. If you take some of the pictures yourself, record the time, date, and weather. You can also look for interesting pictures on the Internet, or find them in magazines. See if you can find pictures of sunrises and sunsets that occurred under unusual circumstances. For example, you might find pictures of sunsets immediately before a hurricane or immediately after a nearby volcanic eruption. Sometimes interesting atmospheric phenomena accompany a sunset. You could look for pictures that contain rainbows in the clouds, halos, or "Sun dogs."
- There are many different ways that you can arrange your photo essay. You might decide on a single theme. For example, you could include only sunsets that resulted from the presence of dust and grit thrown up by a volcanic eruption, or only those of sunsets before a hurricane. On the other hand, you could include only sunrises. Whatever you decide, try to be creative in your use and choice of photographs.
- Another idea you might want to consider is finding some sunrise and sunset pictures taken by spacecraft on Mars. You could write a paragraph comparing and contrasting the Mars and Earth sunsets.
- For each professional photograph, make certain you record the photographer or publisher. You must give credit in your writing to the people who took the photographs or the magazines or websites that published them.

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UNIT 2

Thermograms

BLM 2-18

Objectif • This activity will help you learn about how thermograms are used.

Think About It

- Imagine that a kettle has been turned on. If the room were totally dark, you would not be able to see the kettle, but if you were to hold your hand near it, your hand would feel the warmth. This warmth is infrared radiation. Warm objects give off infrared radiation. Our skin can sense infrared radiation but our eyes cannot see it. If you use infrared film in a camera, however, you can take a photograph of a warm object in a totally dark room. This picture is called a thermogram (or thermograph).

What to Do

- On the Internet or in your library, find several uses of thermograms. Explain three of these uses in the space below, stating how thermographs solve problems or enable a specific task to be completed successfully.
- Tips for Internet searches: try searching for "thermogram" or "thermograph." You could also search for "infrared radiation" or "infrared light."
- Some possible topics you could investigate include the following:

  – cancer detection
  – land use satellites
  – heat loss from buildings
  – military observation equipment
  – weather satellites

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

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UNIT 2

Chapter 4 Review

BLM 2-19

Goal • Check your understanding of Chapter 4.

What to Do

Circle the letter of the best answer.

1. Why do you see lightning before you hear thunder?
   A. Lightning always occurs first, followed by thunder.
   B. The speed of light is much faster than the speed of sound.
   C. The speed of light is much slower than the speed of sound.
   D. none of the above

2. What does "amplitude" mean?
   A. the distance from one point on a wave to the same point on the next wave
   B. the height of a wave crest above the rest position of the wave
   C. the height of a wave crest above the wave trough
   D. the number of times per second that the crest of a wave passes a fixed point

3. What happens as the wavelength of a wave decreases?
   A. Amplitude decreases.
   B. Amplitude increases.
   C. Frequency decreases.
   D. Frequency increases.

4. The range of colours of light that we can see is called which of the following?
   A. the electromagnetic spectrum
   B. the invisible spectrum
   C. the Newtonian spectrum
   D. the visible spectrum

5. Why does a yellow shirt look yellow in the bright sunlight?
   A. The shirt absorbs yellow wavelengths of sunlight while reflecting other wavelengths.
   B. The shirt adds yellow wavelengths of light to the sunlight that falls on it.
   C. The shirt changes all wavelengths of sunlight that strike it into yellow wavelengths.
   D. The shirt reflects yellow wavelengths of sunlight while absorbing other wavelengths.

6. A prism can separate sunlight into a band of different colours in which of the following processes?
   A. absorption
   B. diffusion
   C. reflection
   D. refraction

7. The visible spectrum is part of the electromagnetic spectrum. It occurs between which of the following?
   A. infrared rays and ultraviolet rays
   B. microwaves and infrared rays
   C. radio waves and microwaves
   D. ultraviolet rays and X rays

8. Infrared rays are electromagnetic rays connected with which of the following?
   A. heat
   B. light
   C. radar
   D. radio

9. Microwaves have the shortest wavelength of all radio waves. This result means that compared to other kinds of radio waves, they have which of the following?
   A. the highest frequency
   B. the largest amplitude
   C. the lowest energy
   D. the lowest frequency

10. Which of the following is **not** a typical use for X rays?
    A. detecting breaks in bones
    B. detecting cavities in teeth
    C. detecting the speed of vehicles in traffic
    D. screening luggage at airport security

Match the Term on the left with the best Descriptor on the right.
Each Descriptor may be used only once.

Term	Descriptor
_____ 11. electromagnetic spectrum	A. change in direction of light as it passes into a prism
_____ 12. energy	B. distance from a point on one wave to the same point on the next wave
_____ 13. infrared rays	C. lowest part of a wave
_____ 14. refraction	D. the ability to apply a force over a distance
_____ 15. trough	E. the complete range of wavelengths of radiation
_____ 16. wavelength	F. the highest part of a wave
	G. used by observation satellites

Short Answer Questions

17. A light beam that is composed of blue light and red light is passed through a blue coloured filter.

    (a) What is the colour of light that passes through the filter?

    _____

    (b) What colour is absorbed by the filter?

    _____

    (c) If the blue coloured filter is placed over a red apple, what effect will it have on the appearance of the apple?

    _____

18. Ultraviolet waves carry a lot of energy, relative to visible light rays.

    (a) List one reason why it is essential for our health to have some ultraviolet waves shine on our skin.

    _____

    (b) List two reasons why over-exposure to ultraviolet waves on our skin is harmful.

    _____

    _____

19. Calculate the frequency, in hertz, of each of the following:

    (a) the pendulum of a grandfather clock that swings back to the same spot 6 times in 12 s

    _____

    (b) a runner's heart rate in which the heart beats 180 times in 60 s

    _____

    (c) the frequency of a skipping rope in which the rope touches the ground 15 times in 10 s

    _____

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UNIT 2

Absorb, Reflect, Transmit

BLM 2-20

Goal • Use this to page to complete Find Out Activity 5-1A, Absorb, Reflect, Transmit.

Materials That Mostly Absorb Light (Opaque)	Materials That Mostly Transmit Light But Obscure the Image (Translucent)	Materials That Mostly Transmit Light and Allow the Image to Pass Through (Transparent)

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When Light Strikes

Goal • Review your understanding of how light is affected by different materials.

What to Do

Answer the following questions in the space provided or on a separate page.

1. What does a sharp shadow tell us about the way light travels?

_____

_____

2. Describe how light is affected by

   (a) a transparent object _____

   (b) an opaque object _____

   (c) a translucent object _____

3. Why is frosted glass often used for bathroom windows instead of clear glass or a solid wall?

_____

_____

4. Complete the table below. In the second column, classify each material as transparent, opaque, or translucent. In the third column, state whether light is absorbed, reflected, transmitted, or scattered when it strikes the material. In the last two boxes of the first column, write your own examples.

Material	Classification	Behaviour of Light
Glass		
White clouds		
Stained glass window		
Aluminum foil		
Fog		
Cellophane		
Cardboard		
Wax paper		
Black chalkboard		
Mirror		
	Transparent	
		Scattered

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UNIT 2

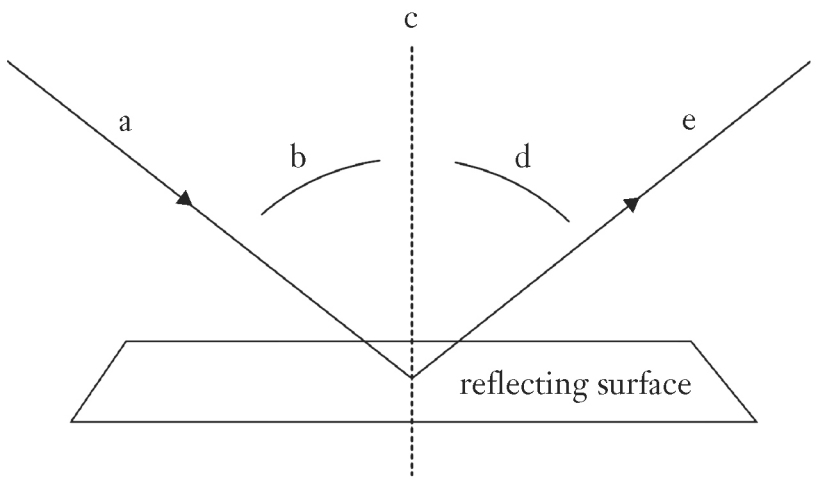
Reflection: Ray Diagrams

BLM 2-22

Goal • Use this page to review your understanding of light rays.

What to Do

Use this diagram to answer questions 1 to 3.



1. Label the diagram above using the terms "reflected ray," "normal," "angle of reflection," "angle of incidence," and "incident ray."

   (a) _____

   (b) _____

   (c) _____

   (d) _____

   (e) _____

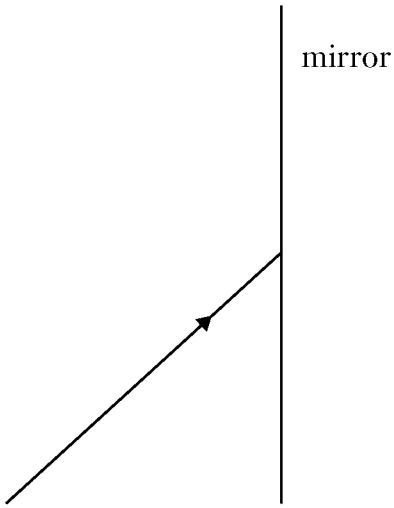
2. Measure the two angles with your protractor.

   Angle of incidence = _____ Angle of reflection = _____

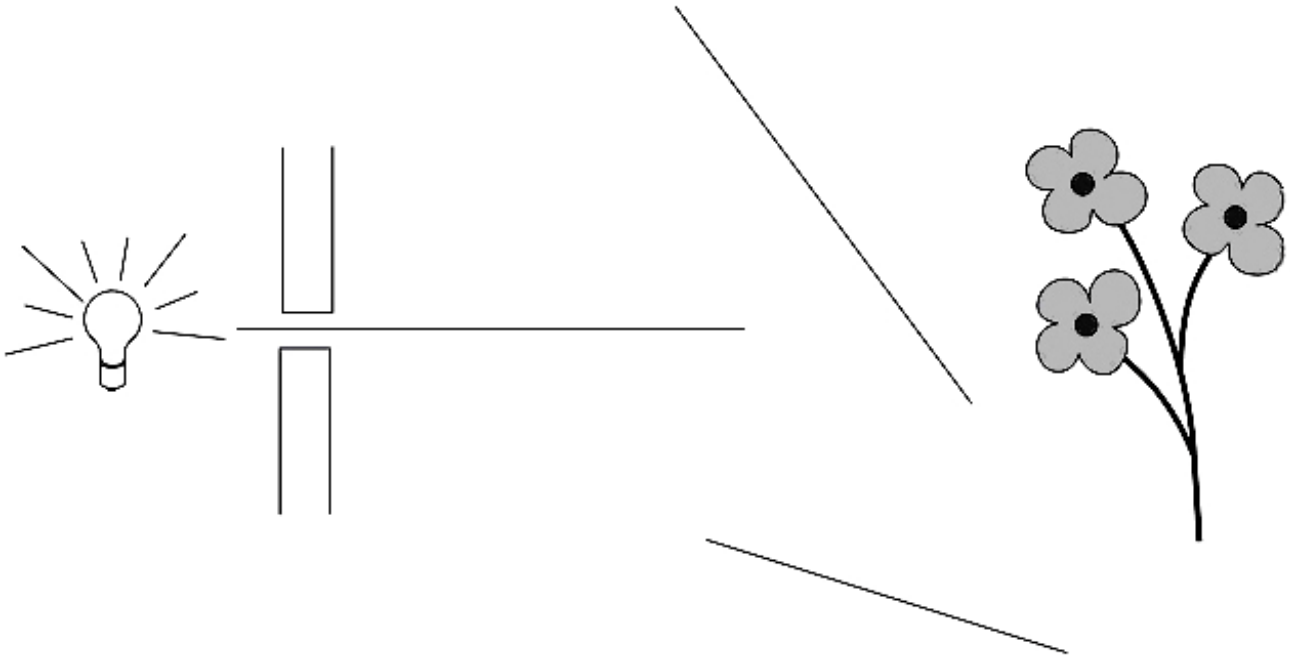
3. Compare the sizes of the angles of incidence and reflection.

   _____

4. Use the law of reflection to draw the path of the reflected ray from the mirror in the diagram below.



5. The diagram below shows a light ray coming through an opening and directed at two mirrors and three flowers. Use the law of reflection, your ruler, and your protractor to draw the light ray as it bounces from one mirror to the next and then to the flowers.



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UNIT 2

Refraction: Light Changes Direction

BLM 2-23

Goal • Use this page to review how light bends when it travels from one material to another.

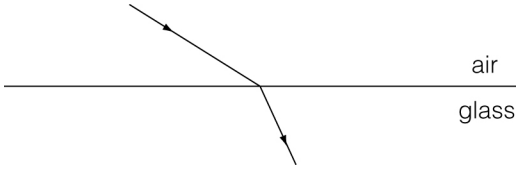
Introduction

When light moves from one medium (such as air) to another (such as water), the light bends. This process is called refraction. The light bends because it changes speed when it moves between materials that have different densities.

What to Do

For each diagram, draw the normal at the point of contact. Measure the incident angle and the angle of refraction. Then complete the sentences using the terms "greater," "less," "toward," or "away from."

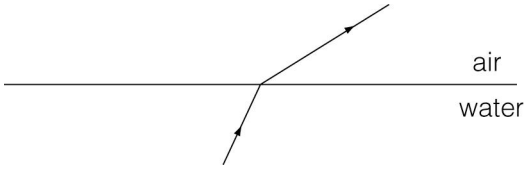
1. Air to glass



(a) The incident angle is _____ than the angle of refraction.

(b) The light entering the glass bends _____ the normal.

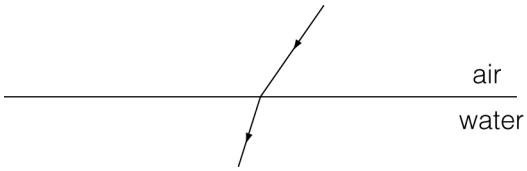
2. Water to air



(a) The incident angle is _____ than the angle of refraction.

(b) The light entering the air bends _____ the normal.

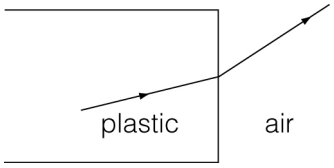
3. Air to water



(a) The incident angle is _____ than the angle of refraction.

(b) The light entering the water bends _____ the normal.

4. Transparent plastic to air



(a) The incident angle is _____ than the angle of refraction.

(b) The light entering the air bends _____ the normal.

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UNIT 2

How Do Two-way Mirrors Work?

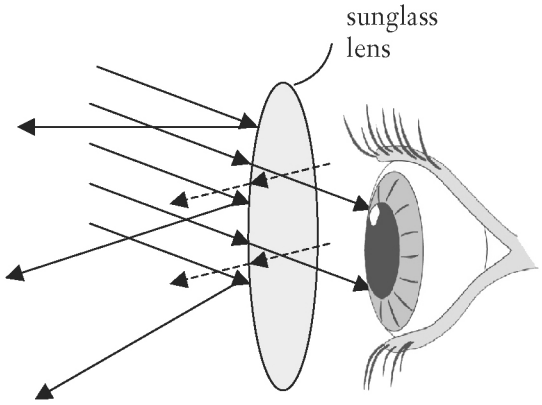
BLM 2-24

Goal • Learn how people make use of partial reflection.

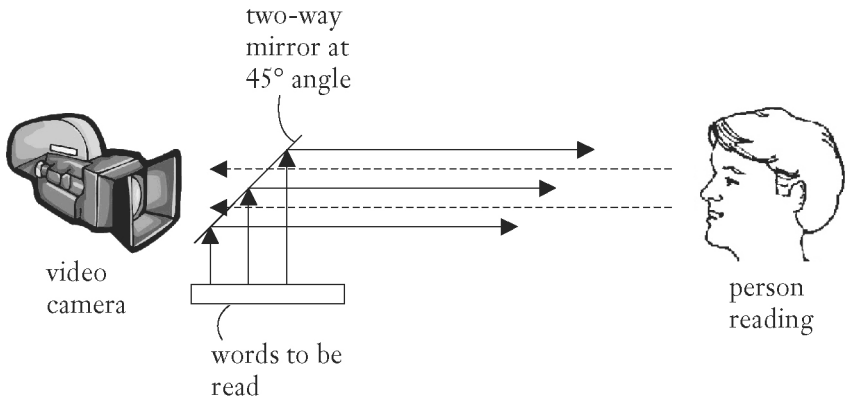
When you look at a shallow lake or pond in bright sunshine, you see a bright clear reflection of the sky. When lighting conditions are different, you might see a partial reflection of the sky, and also some details on the lake bottom. The surface of the lake reflects some light and allows some to pass through.

Two-way mirrors do the same thing. A normal mirror has a reflective coating that reflects all light. No light passes through the mirror. A two-way mirror is "half-silvered." This means that the reflective coating is applied so thinly that some light is reflected and some passes through.

Have you ever seen someone wearing mirrored sunglasses? How can they see through the lenses if you can't see their eyes? The answer is that the lenses are two-way mirrors. Much of the light coming from the sun is reflected off the lenses, making them look like mirrors. Some light does pass through, though, allowing the person wearing the glasses to see. Because it is darker between the lenses and the wearer's eyes, there is little light to pass through the lenses in the other direction. When you look at the person wearing sunglasses, you don't notice the light that does pass through from the back of the lens because the reflected light is so bright.



Teleprompters that people on television use to read notes while they look into the camera work in a similar way. A two-way mirror is used to reflect the words toward the person reading, while the camera records the image of the reader that passes through the mirror.



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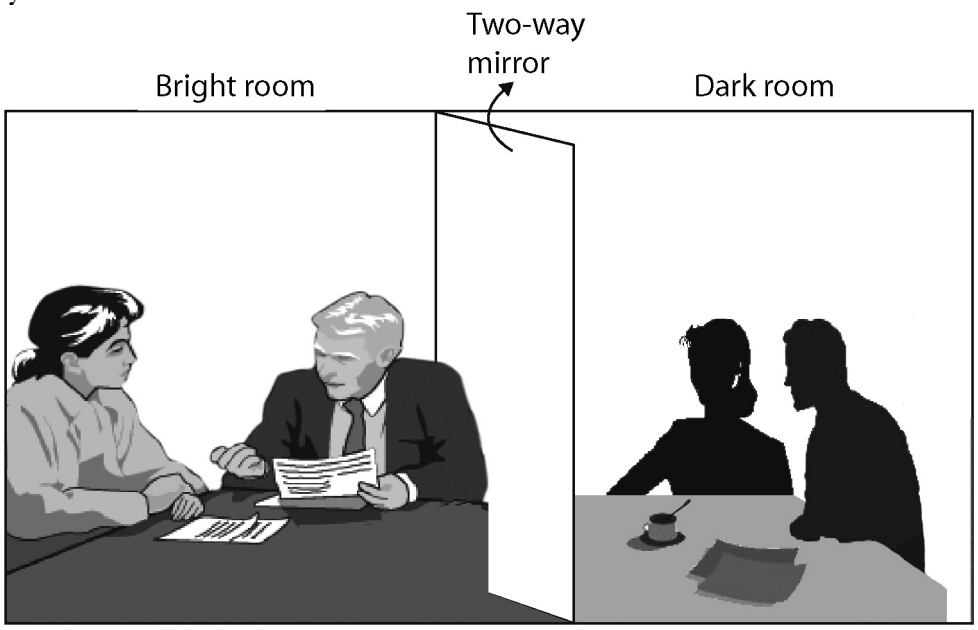
BLM 2-24 continued

Sometimes two-way mirrors are used to observe people without those people getting distracted by the observers. People sometimes do this to watch groups react to a new product. Police officers sometimes do this to interview people accused of crimes. The people being watched are in a brightly lit room. The people watching are in a dark room. There is a two-way mirror between the two rooms.

Draw light rays on this diagram to show what the people in each room see. Explain why they see what they do.



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UNIT 2

Mirror Images

BLM 2-25

Goal • Decipher reflected images to review the laws of reflection.

What to Do

Use a mirror to read the three messages below. Then answer the following questions.

Image A

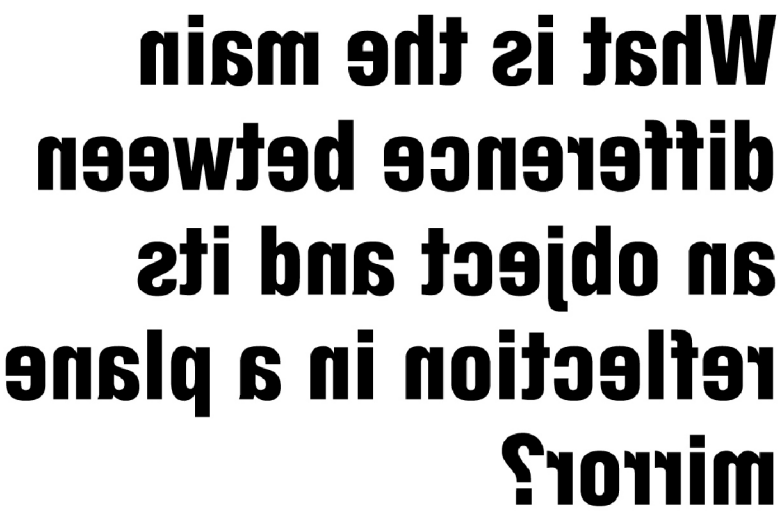

Image B

Image C

1. Which of these images is a true reflection in a plane mirror?

_____

2. How were the other images made?

_____

_____

3. Consider all of the letters of the alphabet. Which capital letters look the same when they are reflected in a mirror?

_____

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UNIT 2

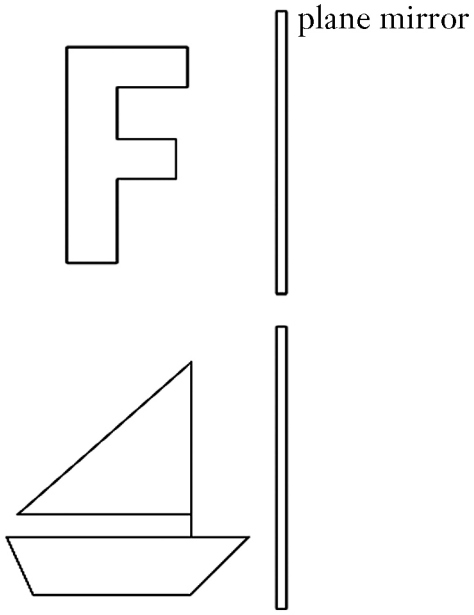
What You See Is What You Get

BLM 2-26

Goal • Use this page to reinforce your knowledge of the principles of reflection.

What to Do

1. Use a ruler to draw the reflected images of the objects below.



2. Were there any differences between the object and its image in the plane mirror with respect to

   (a) size?

   F _____ Sailboat _____

   (b) distance from the mirror?

   F _____ Sailboat _____

   (c) orientation?

   F _____ Sailboat _____

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UNIT 2

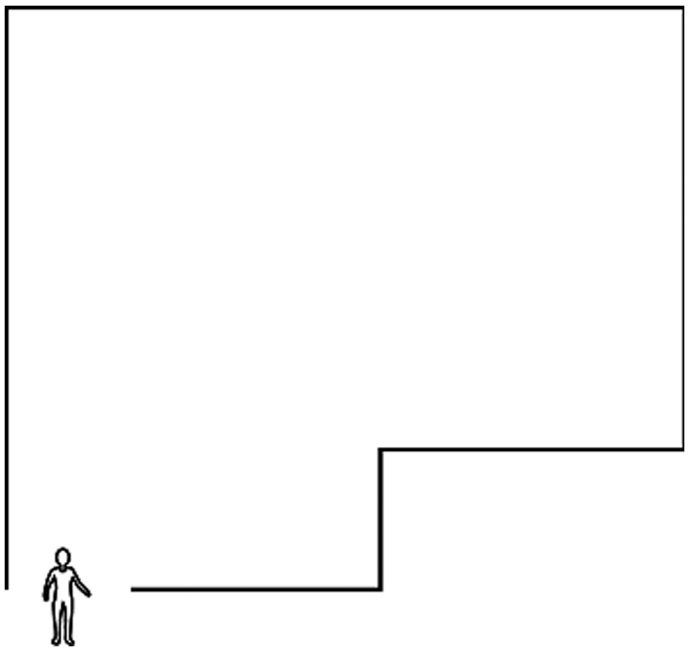
Sight Lines

BLM 2-27

Goal • Use this worksheet to demonstrate how you could position a plane (flat) mirror to observe most places in a room.

What to Do

The diagram shows the floor plan of a store. You are a security guard, with a radio and a flashlight, who stands at the position shown, just inside the door. Are there any places you cannot see? Suppose you could install a large mirror (2 cm on this scale) by hanging it from the ceiling or placing it on a wall. Where could you put it to make sure you could see everywhere? Add your mirror to the diagram. Then trace out light rays showing that light from your flashlight could illuminate every portion of every wall. If you are bouncing light off the mirror, make sure you draw the normal and measure your angles carefully.



Going Further

If you have a small mirror, you could build cardboard walls, place the mirror in position, and demonstrate that when looking from the position of the person, there is no "blind spot" in the room.

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UNIT 2

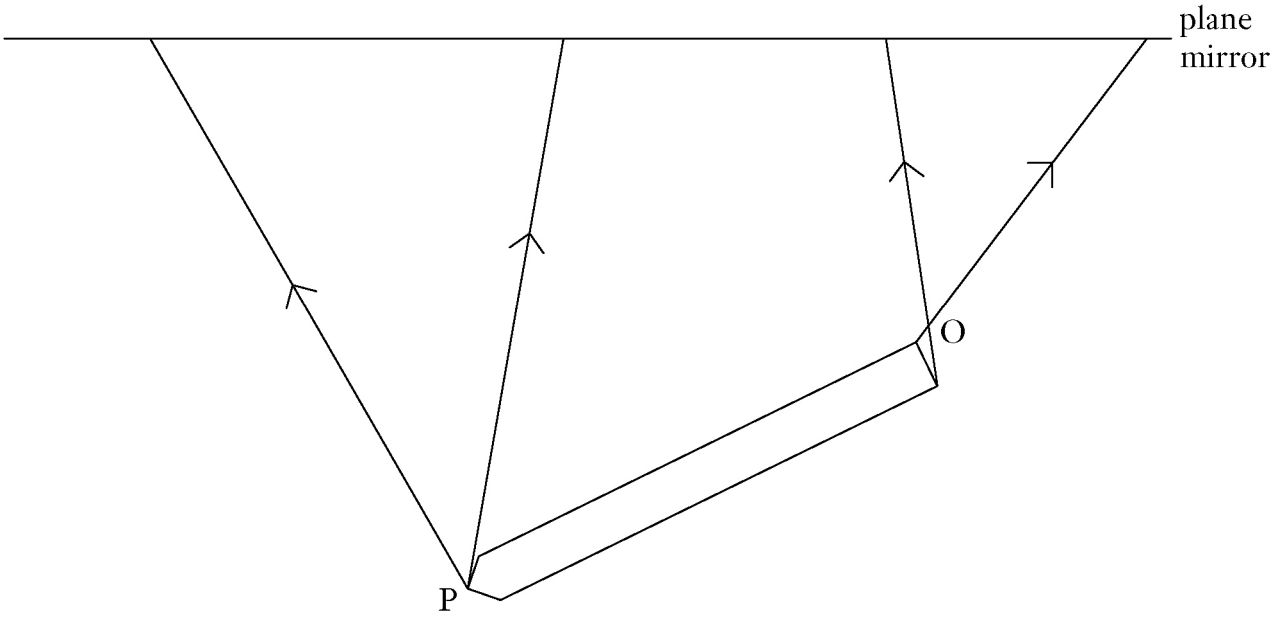
Plane Mirror Template

BLM 2-28

Goal • Use this template to illustrate reflections in Conduct an Investigation 5-2B, Demonstrating the Law of Reflection.

What to Do

Use this template to draw ray diagrams to show reflection in a plane mirror.



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UNIT 2

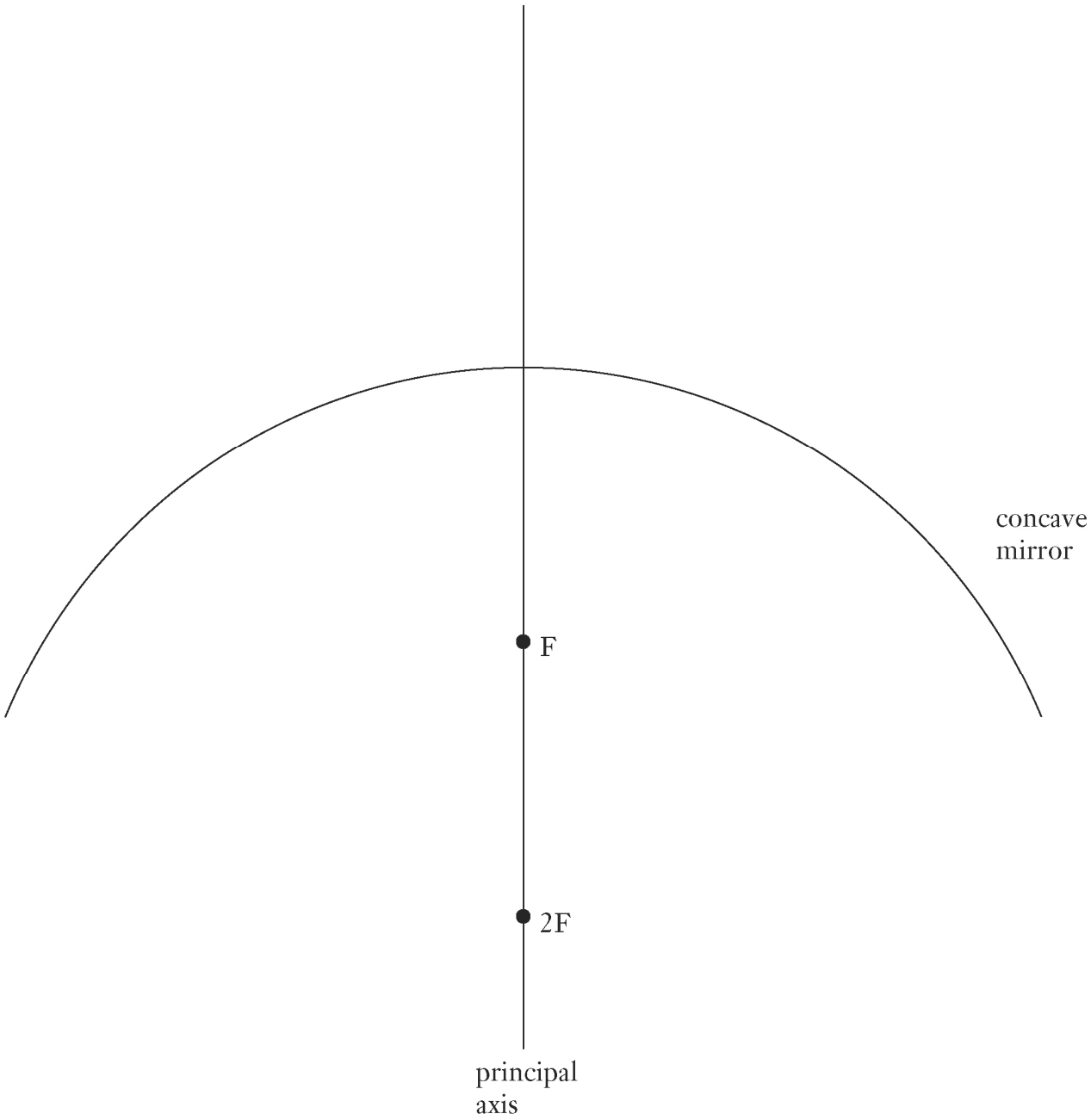
Concave Mirror Template

BLM 2-29

Goal • Draw ray diagrams to show reflection in a concave mirror.

What to Do

Use this template to draw ray diagrams that show reflection in a concave mirror.



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UNIT 2

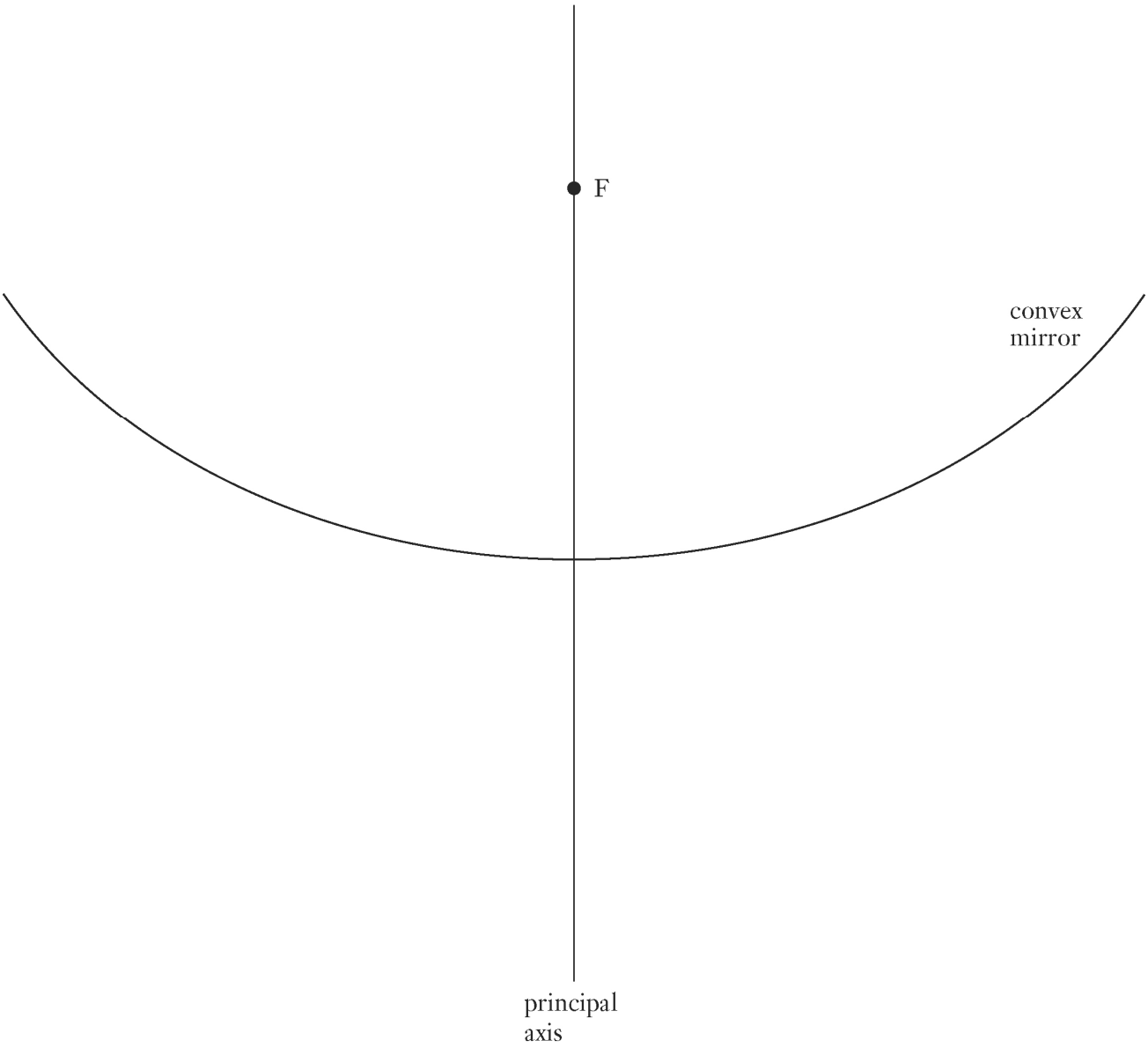
Convex Mirror Template

BLM 2-30

Goal • Draw ray diagrams to show reflection in a convex mirror.

What to Do

Use this template to draw ray diagrams that show reflection in a convex mirror.



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UNIT 2

Different Mirror Surfaces

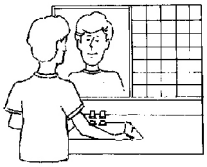
BLM 2-31

Goal • Show your understanding of the kinds of mirrors used for different purposes.

What to Do

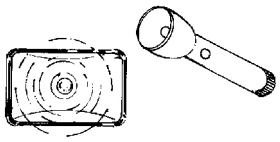
Identify the type of mirror (plane, convex, or concave) used in each situation below. Write your answer on the line provided.

1. bathroom wall mirror



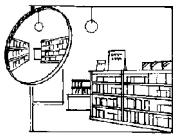
Purpose: to show your exact appearance
Type of mirror: _____

2. car headlights and flashlights



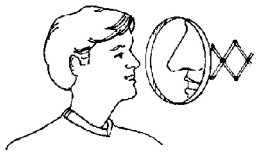
Purpose: to project a strong beam forward
Type of mirror: _____

3. store surveillance mirror



Purpose: to show a wide view
Type of mirror: _____

4. cosmetic mirror

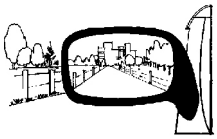


Purpose: to show a magnified view of parts of your face
Type of mirror: _____

5. two-way mirror

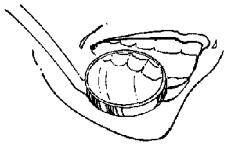
Purpose: to see into a brightly lit room; looks like a mirror to the people being observed
Type of mirror: _____

6. car mirror



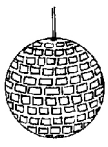
Purpose: to show a wide-angle view behind and beside the car
Type of mirror: _____

7. dental mirror



Purpose: to make teeth visible and to magnify them
Type of mirror: _____

8. reflecting ball at a dance



Purpose: to project portions of lights hitting it in many different directions
Type of mirror: _____

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UNIT 2

Egyptian Mirror

BLM 2-32

Goal • Extend your knowledge of how light rays reflect from the surfaces of mirrors.

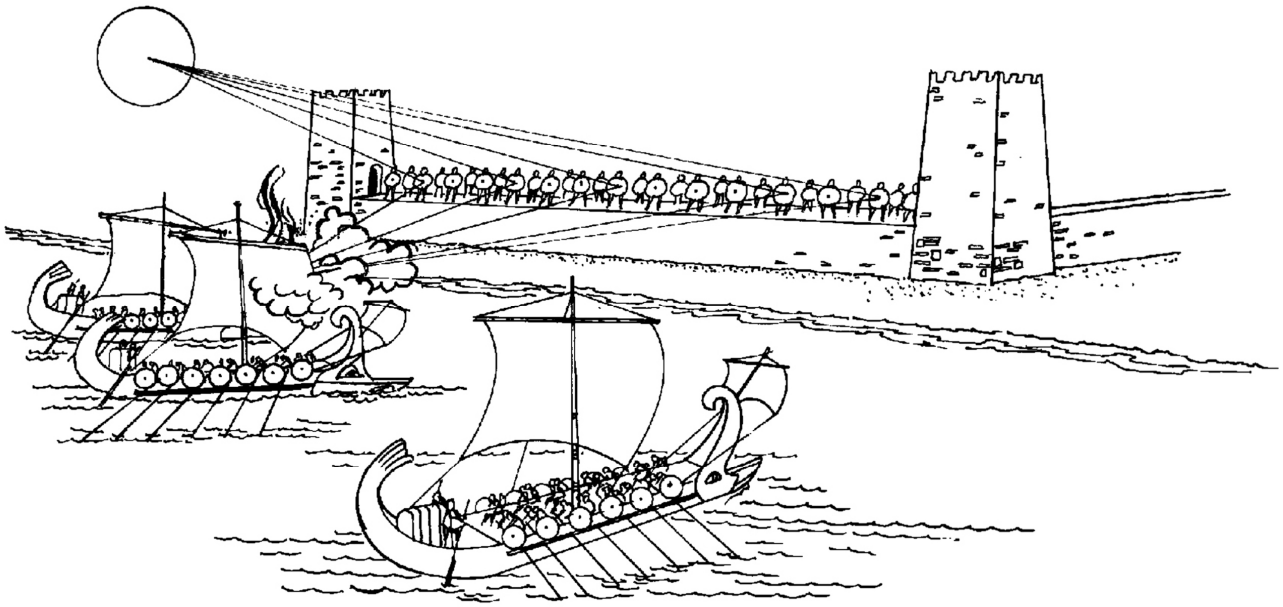
Introduction

Archimedes (287–212 B.C.E.) was a Greek mathematician and inventor. He studied and taught in Alexandria, a city in Egypt with a world-famous university. While there, he discovered formulas for areas and volumes of many shapes. He also figured out how levers and pulleys work, and the rules that govern weights and volumes of objects submerged in water.

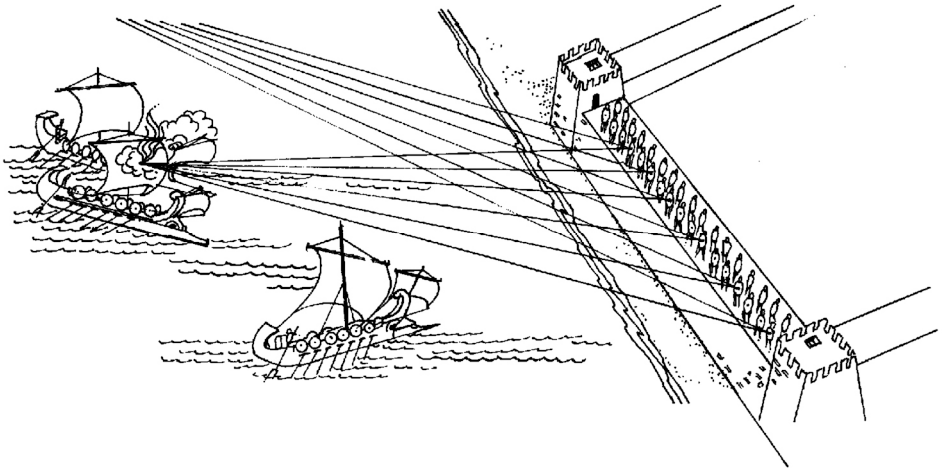
The Defence of Syracuse

A famous legend of Archimedes' life involves his help in the defence of his home town, Syracuse, in Sicily, when Romans came to conquer it. Historical records tell of his giant catapult that could launch rocks against the invaders' ships. It was also said that he had constructed a burning machine that could set the Roman ships on fire. Let us see how that might have worked.

The diagram shows one possible way of igniting the wooden ships. Soldiers with polished shields might have stood in line around the harbour. By tilting their shields at just the right angle, each might have reflected the Sun's light onto the same ship. The total amount of sunlight hitting the ship might have the set sails on fire.



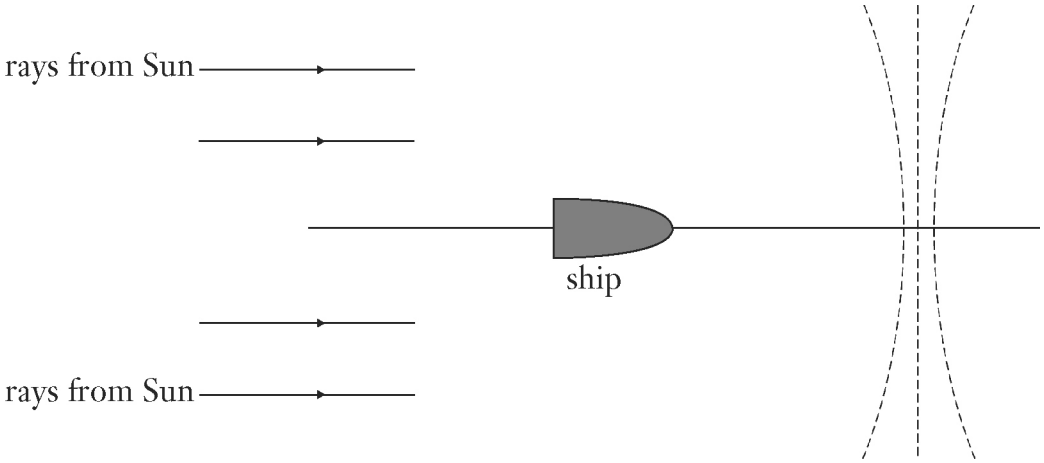
The next diagram shows a top view of the pattern of shields. The shields are like plane mirrors. Rays of light from the Sun have been drawn to show how they would reflect off several of the shields.



What to Do

Imagine we made one large mirror with a reflecting surface that would replace all the individual shields in the diagrams above. Of the three types of mirrors (plane, concave, or convex), which might best focus sunlight onto a point?

In the diagram below, the lines show rays of incoming sunlight. Complete the vertical dotted line that represents the single large mirror you think would reflect them back onto the ship. Place the correct label under your mirror. Then think about what you know about the angle of reflection, and use your ruler and pencil to complete the four light rays by drawing them to the mirror and reflecting back to the ship.



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UNIT 2

Curved Mirrors: Images from a Distant Object

BLM 2-33

Goal • Show your understanding of where images form with concave mirrors.

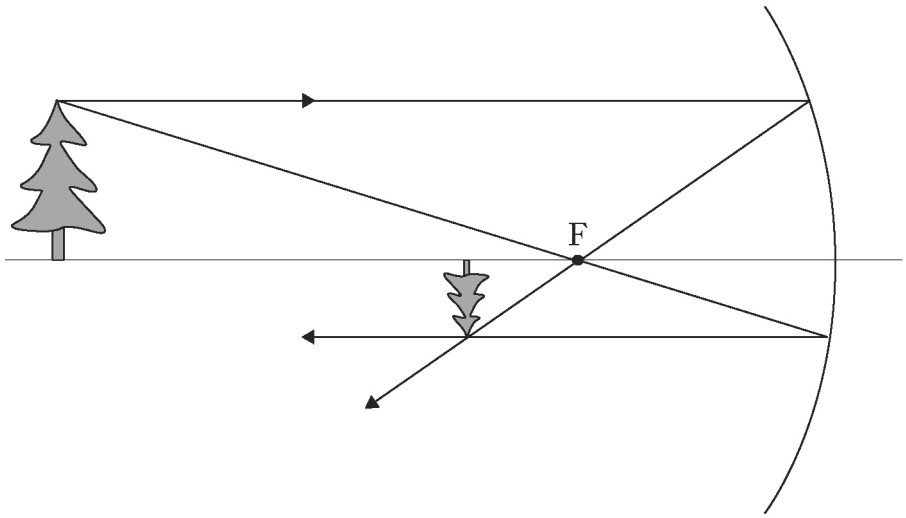
What to Do

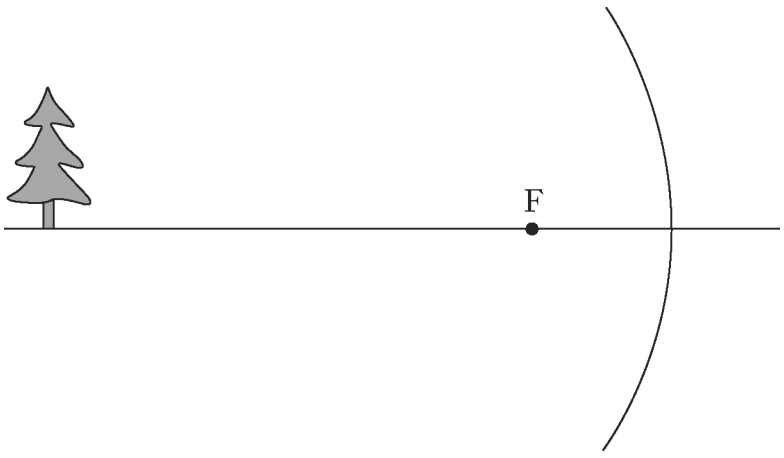
In this activity, find the location of the image of the top of the tree. Then draw the rest of the image.

The first diagram has been completed for you. Here are the steps to follow:

1. Draw a light ray from the top of the tree to the mirror, parallel to the principal axis.
2. Draw a reflected ray from there through *F*, the focal point.
3. Draw a second light ray from the top of the object through *F* and to the mirror.
4. Draw the reflected ray from the mirror parallel to the principal axis. The image of the top of the tree is where the reflected rays cross.
5. To complete the image, draw the rest of the tree to connect it to the axis.

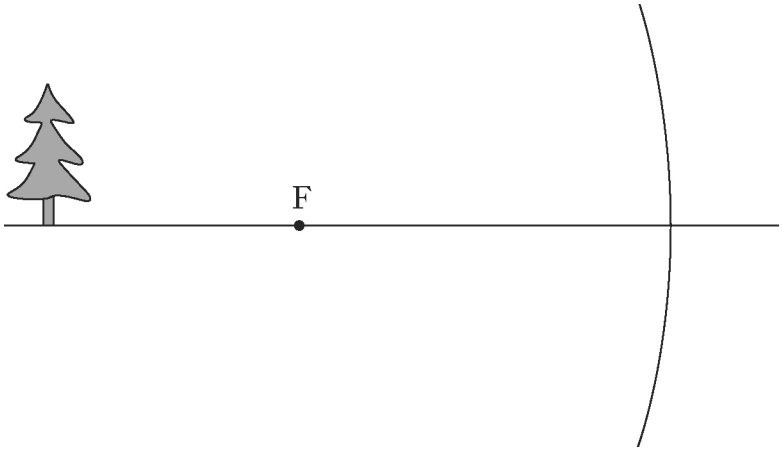
Now find the images of the tree in the other two mirrors.





DATE: NAME: CLASS:

BLM 2-33 continued



Answer the following questions.

1. In what way are the mirrors different?

_____

_____

2. How does the curvature of the mirror affect the location of the image?

_____

_____

DATE: NAME: CLASS:

UNIT 2

Blind Spots in an Automobile

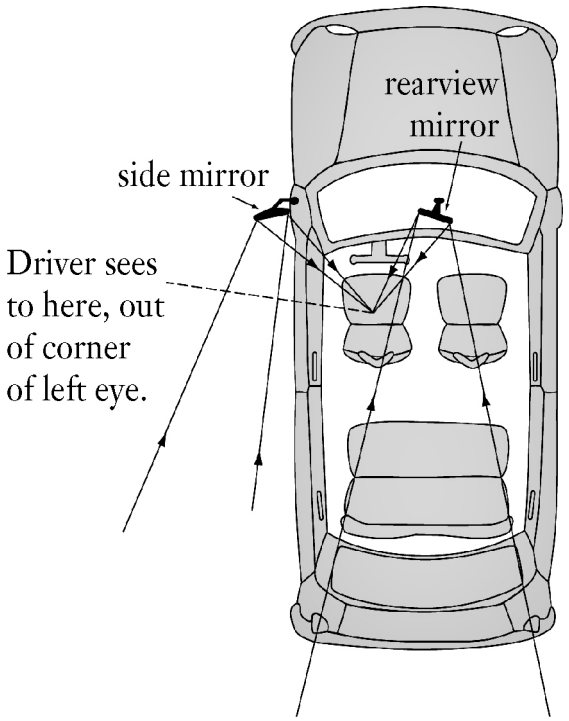
BLM 2-34

Goal • Demonstrate your understanding of angles of incidence and reflection as they relate to the position of mirrors in an automobile.

What to Do

The diagram at the right represents a car, with a rearview mirror and a driver-side plane mirror.

1. Four light rays have been drawn from the position of the driver's eye, off each end of the rearview and driver-side mirrors.
   (a) Identify, on the diagram, the normal and the equal angles of incidence and reflection for each line. (Which way is the light travelling?)
   (b) Indicate the areas that the driver can see by looking in each mirror.



2. The dotted line shows the left edge of the driver's field of view while looking forward.
   (a) Does the driver have a blind spot, where a car or motorcyclist could sit and not be visible to the driver? If so, shade it in on the diagram.
   (b) What rule should drivers always obey when turning or changing lanes to the left?

_____

Going Further

3. At home, have a parent or another driver sit in the driver's seat of a car. When you stand behind the car, you should be able to see the driver's eyes in the mirror. Walk around to the driver's side and look for the driver's eyes in the side mirror. Stand on the left side, behind the driver, and look for any place where you cannot see the driver's eyes in any mirror. Ask the driver if she/he can see you.
   (a) On a separate sheet, write a report of your observations about the car's blind spot.
   (b) Draw a sketch to show the size of the car's blind spot.

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UNIT 2

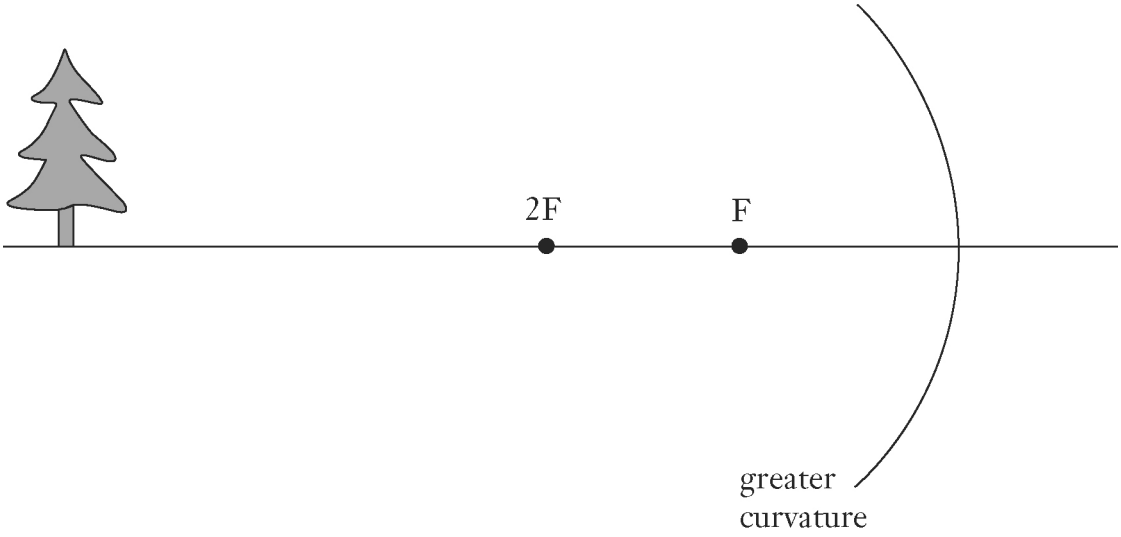
Real and Virtual Images

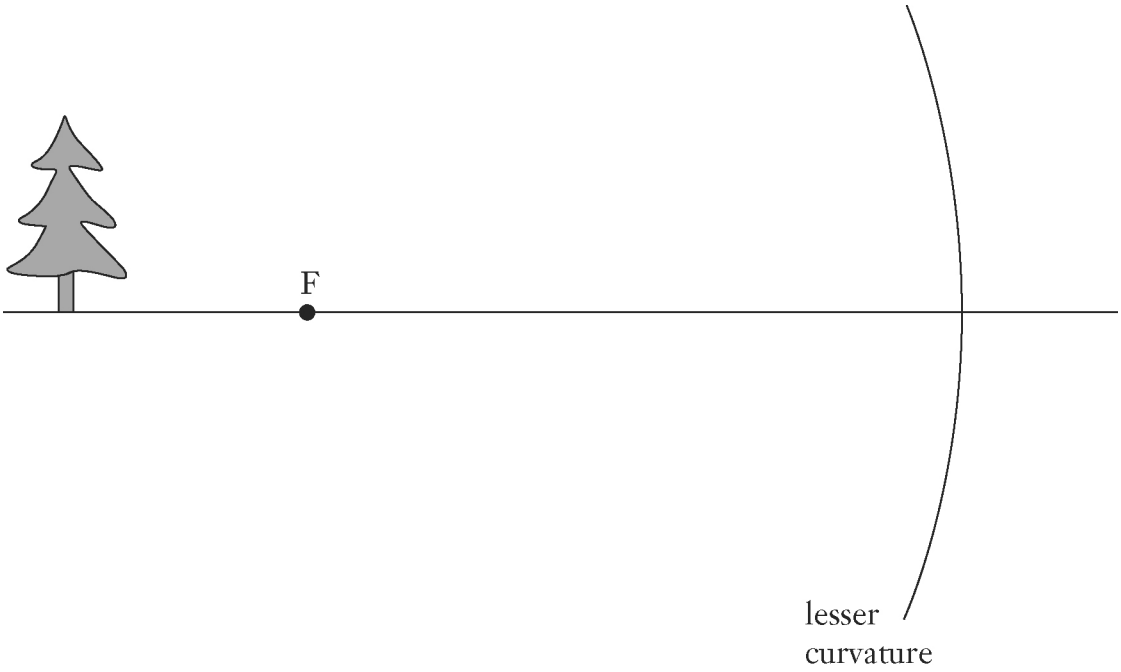
BLM 2-35

Goal • Draw ray diagrams to explain your observations in Conduct an Investigation 5-3B, Real and Virtual Images.

What to Do

Complete these ray diagrams in Conclude and Apply question 5 to show the characteristics of an image when a distant object is reflected in different concave mirrors.





DATE: NAME: CLASS:

UNIT 2

Chapter 5 Review

BLM 2-36

Goal • Check your understanding of Chapter 5.

What to Do

Circle the letter of the best answer.

1. The ray model of light explains that a distant light source is dimmer than a nearby light source. Why is this result observed?
   A. Light travels in straight lines.
   B. The angle of incidence equals the angle of reflection.
   C. The light rays are blocked by objects between the light source and the observer.
   D. The light rays spread out as they travel.

2. In a translucent material, which of the following is true?
   A. The light rays are absorbed and no clear image is seen through the material.
   B. The light rays are scattered and no clear image is seen through the material.
   C. The light rays are transmitted without scattering and a clear image is seen through the material.
   D. The light rays are transmitted without scattering but no image is seen through the material.

3. When light reflects off white paper, why does a mirror image not form?
   A. The law of reflection does not apply to light reflected from paper.
   B. The light rays are absorbed by the paper.
   C. The paper is not made out of metal.
   D. The paper is not smooth enough to reflect light rays in a regular way.

4. When light rays pass from air into glass, which of the following is true?
   A. They bend away from the normal as they move into a material with greater density.
   B. They bend away from the normal as they move into a material with lower density.
   C. They bend toward the normal as they move into a material with greater density.
   D. They bend toward the normal as they move into a material with lower density.

5. A mirror that curves outward is used as a rearview mirror in a car. Why is this type of mirror used?
   A. It allows more objects to be seen than in a flat mirror of the same size.
   B. It magnifies the objects seen in the mirror.
   C. It makes the objects look smaller than they would using a flat mirror.
   D. The image is clearer than in a flat mirror.

6. Which of the following is **not** a typical use for a mirror with an inward curve?
   A. as a make-up or shaving mirror in order to see a magnified image
   B. at the back of a telescope in order to collect light
   C. behind the light in a flashlight to make a focussed beam
   D. on the wall of a store for security purposes

7. In a ray diagram, the incoming ray is called which of the following?
   A. incident ray
   B. normal
   C. reflected ray
   D. refracted ray

8. A large ball is coated with a reflective material so that it becomes a spherical mirror. As you approach this mirror you can see your own reflection in it. What does your reflected image look like?
   A. larger and right side up
   B. larger and upside down
   C. smaller and right side up
   D. smaller and upside down

9. Which of the following is correct?
   A. A real image is behind the mirror.
   B. A real image is formed when extended rays meet.
   C. A real image is formed when reflected rays meet.
   D. A virtual image is in front of the mirror.

Match the Term on the left with the best Descriptor on the right.
Each Descriptor may be used only once.

Term	Descriptor
_____ 10. angle of reflection _____ 11. focal point _____ 12. normal _____ 13. opaque _____ 14. transparent	A. equal to angle of incidence B. light cannot pass through C. light passes though it freely D. perpendicular to a surface E. place where rays converge

Short Answer Questions

15. Contrast these terms:

(a) transmit, absorb

_____

_____

(b) translucent, transparent

_____

_____

16. Draw a light ray reflecting off of a plane mirror. Label the incident ray, reflected ray, normal, angle of incidence, and angle of reflection.

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UNIT 2

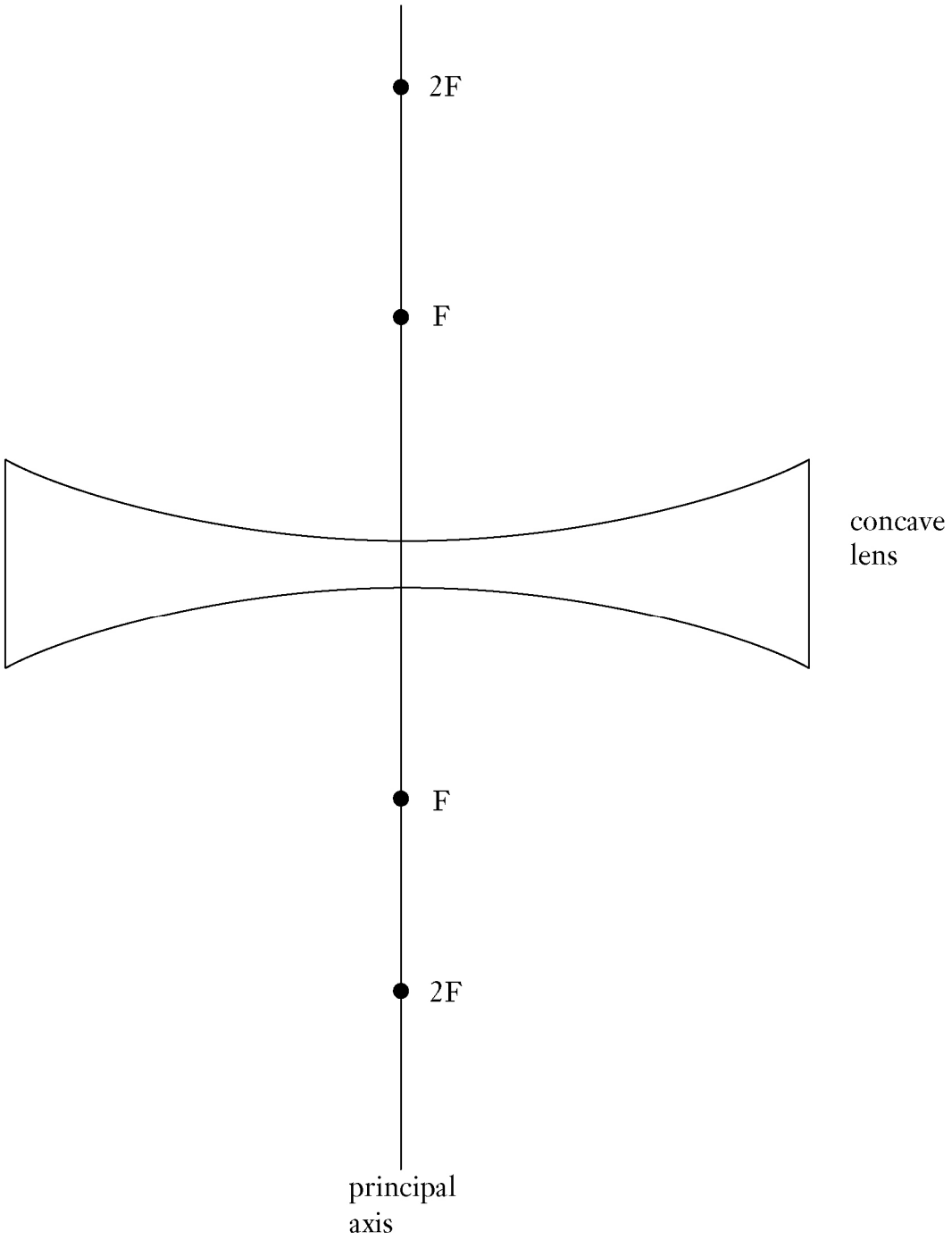
Concave Lens Template

BLM 2-37

Goal • Draw ray diagrams to show refraction through a concave lens.

What to Do

Use this template to draw diagrams that show refraction through a concave lens.



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UNIT 2

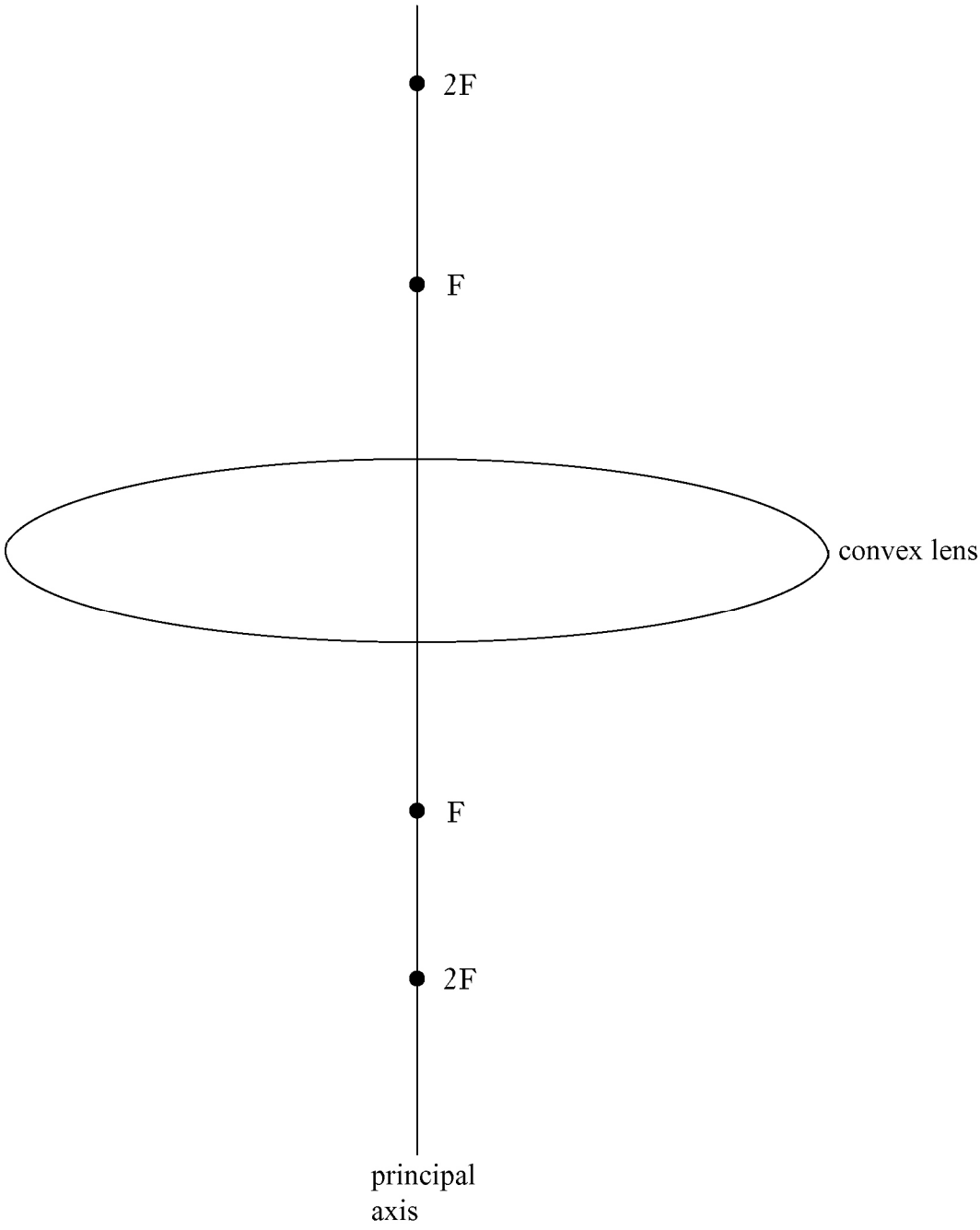
Convex Lens Template

BLM 2-38

Goal • Draw diagrams to show refraction through a convex lens.

What to Do

Use this template to draw diagrams that show refraction through a convex lens.



DATE: NAME: CLASS:

UNIT 2

Lenses and Light

BLM 2-39

Goal • Complete this page to show your understanding of how lenses bend light.

What to Do

Answer these questions and complete the diagrams.

1. Describe a concave lens. _____

   _____

2. Light rays _____ when passing through a concave lens.

3. Describe a convex lens. _____

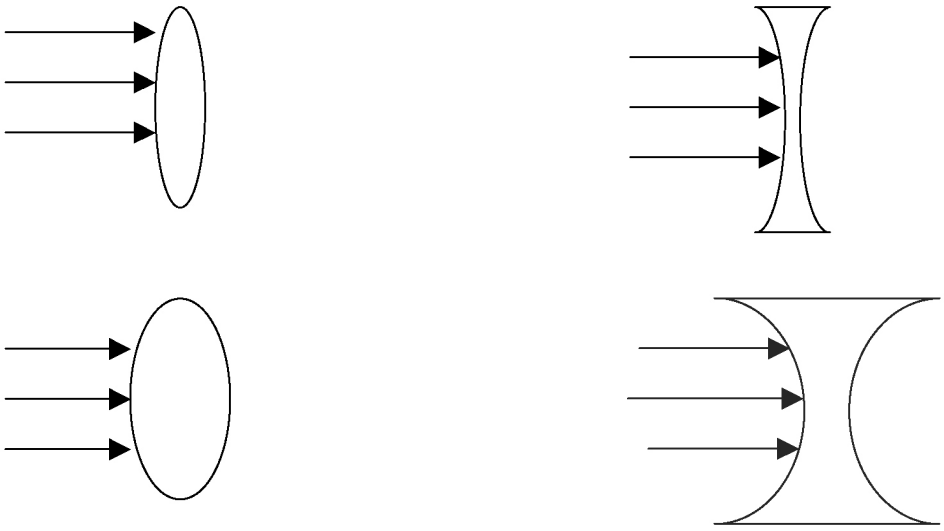
   _____

4. Light rays _____ when passing through a convex lens.

5. To identify concave and convex lenses, it is the thickness of the glass in the middle compared to the thickness at the edges that counts. Classify the following lenses as convex or concave.

_____ _____ _____ _____

6. Draw the paths of the light through each of the following lenses.



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UNIT 2

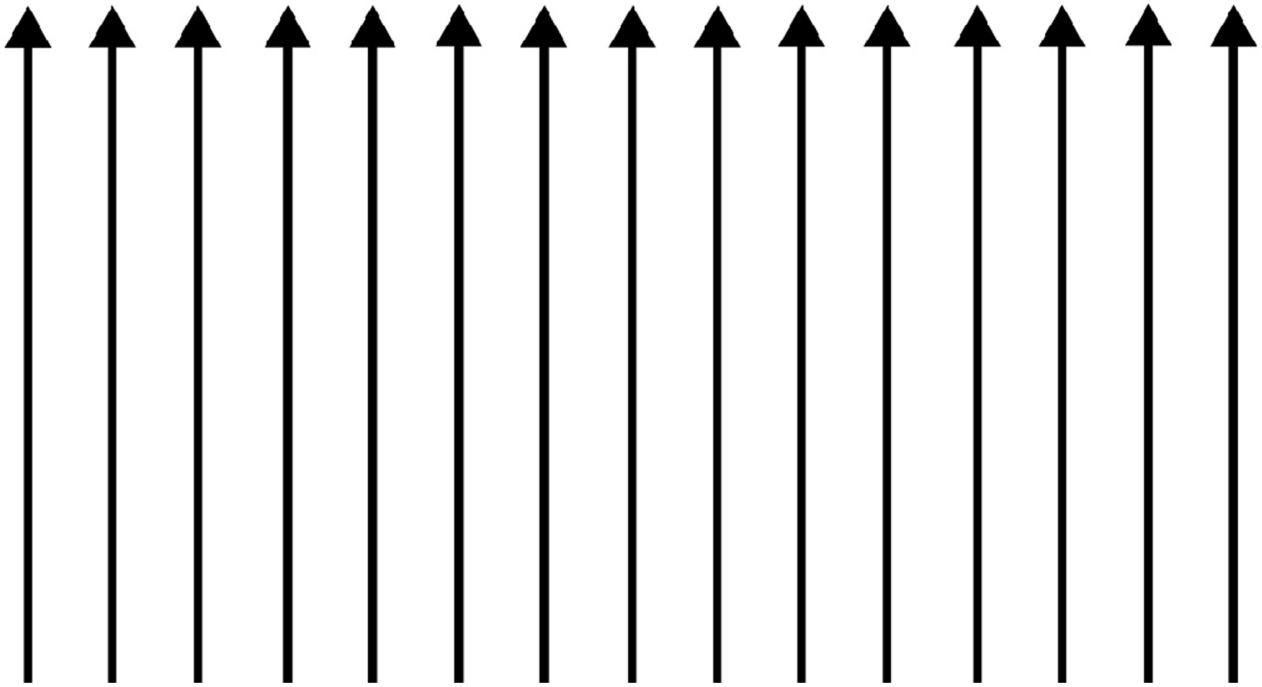
Projector Arrows

BLM 2-40

Goal • Use these arrows for Find Out Activity 6-1C, Make a Model of a Projector.

What to Do

View the arrows through a beaker of water. Move the paper left and right and then compare this to the movement of arrows seen through the beaker.



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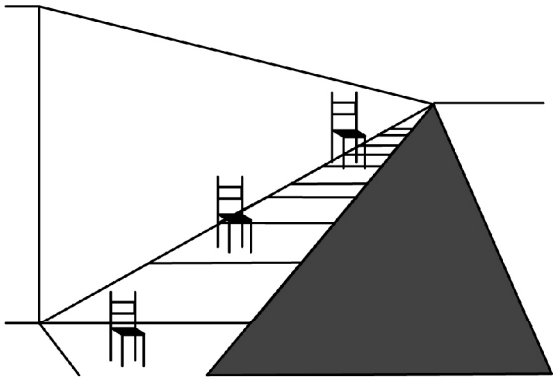
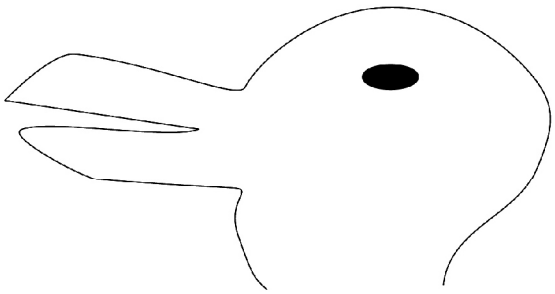
UNIT 2

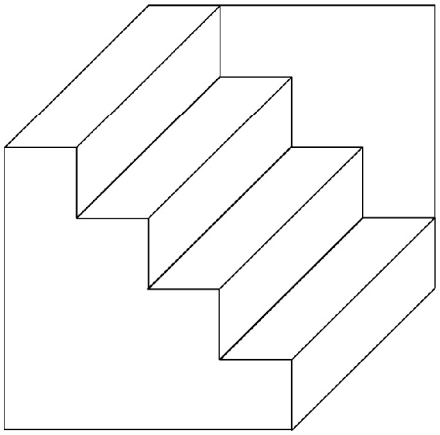
Optical Illusions

BLM 2-41

Goal • Explore the role our brain plays in vision by viewing optical illusions.







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UNIT 2

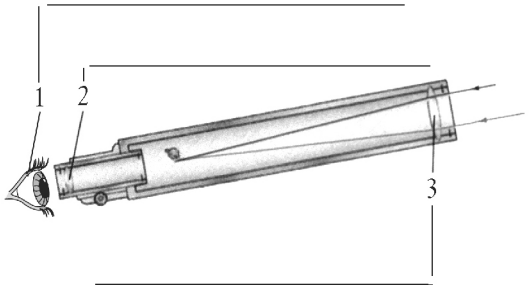
Making Things Bigger

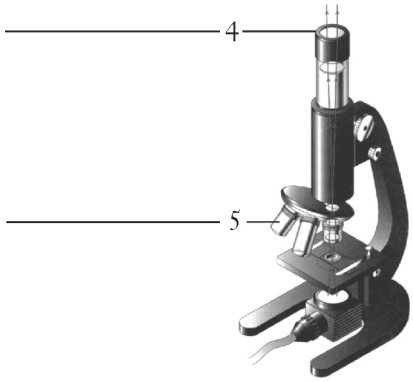
BLM 2-42

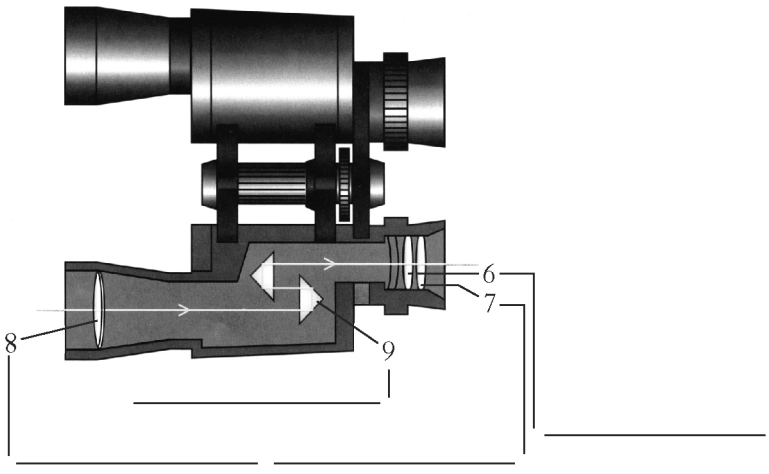
Goal • Reinforce your knowledge of mirrors, lenses, and prisms used in light technologies.

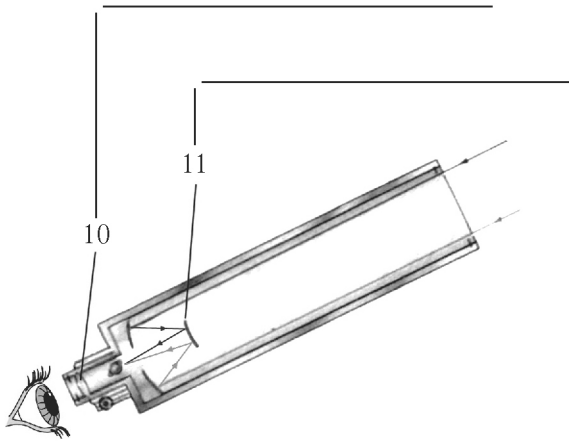
What to Do

Label the lenses and mirrors in these diagrams as concave, plane, or convex. Record your answers at the bottom of the page.









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UNIT 2

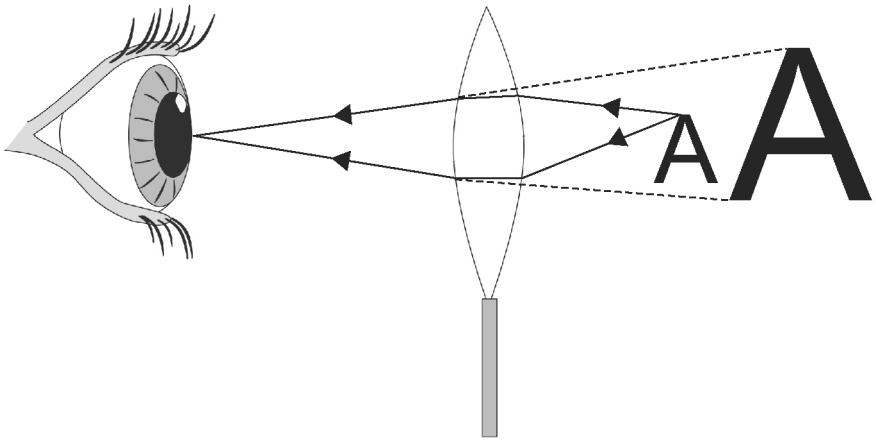
How Does It Work?

BLM 2-43

Goal • Use this page to review how refracting telescopes work.

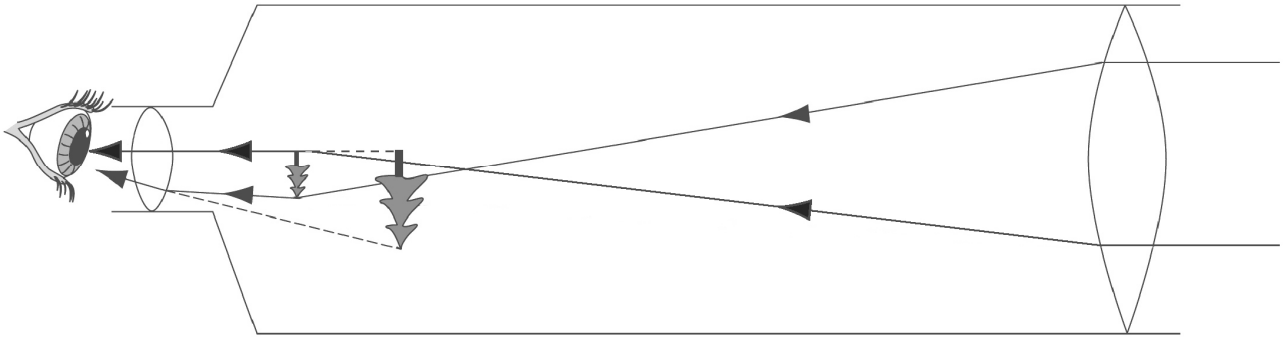
As you trace your finger along the rays of light and their extensions, describe the path on which the light travels, and where the image forms.

Magnifying Glass



When viewing an upright object, the observer sees a magnified, upright image.

Refracting Telescope



The eyepiece acts like a magnifying glass, so the observer sees a magnified, inverted image of the real image cast by the objective lens.

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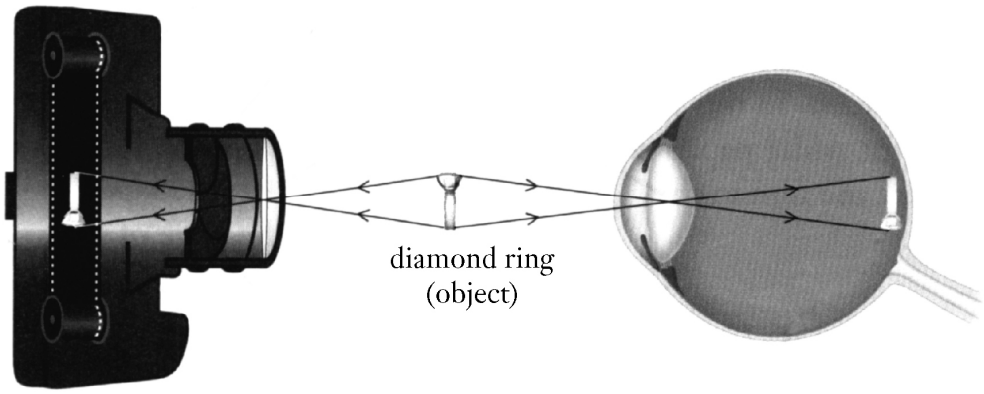
UNIT 2

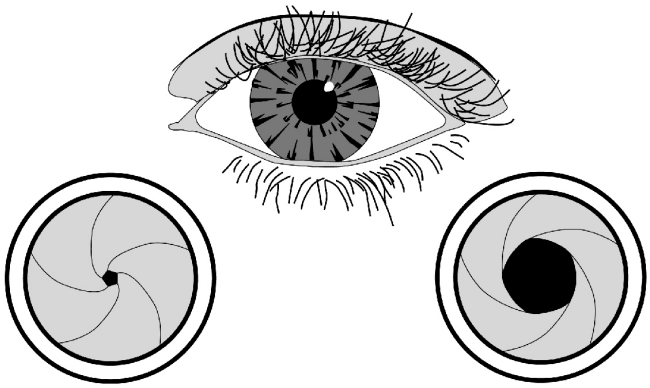
Comparing an Eye with a Camera

BLM 2-44

Goal • Use these images to compare an eye with a camera.

Describe the similarities between a human eye and a camera that are shown in each set of illustrations.





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UNIT 2

Chapter 6 Review

BLM 2-45

Goal • Check your understanding of Chapter 6.

What to Do

Circle the letter of the best answer.

1. In which order does a light ray enter the eye?
   A. cornea, lens, retina
   B. cornea, lens, sclera, retina
   C. lens, sclera, retina
   D. sclera, lens, retina

2. What is a pupil?
   A. a black tissue in the centre of the eye that detects light
   B. an opening that allows light to enter the interior of the eye
   C. the part of the iris that is black
   D. the place where the optic nerve joins to the retina

3. Which of the following do cone cells help detect?
   A. colour
   B. movement
   C. shades of grey
   D. shapes

4. Which of the following statements describes rod cells?
   A. They help detect bright light and are sensitive to colour.
   B. They help detect bright light but are not sensitive to colour.
   C. They help detect dim light and are sensitive to colour.
   D. They help detect dim light but are not sensitive to colour.

5. What is astigmatism?
   A. a vision problem that causes the eye to focus on more than one point on the retina, resulting in blurred vision
   B. a vision problem that makes it difficult to focus on distant objects
   C. a vision problem that makes it difficult to focus on nearby objects
   D. a vision problem that results from the loss of one type of colour-detecting cells, resulting in colour blindness

6. What is the most common cause of blindness in the world?
   A. accidents that cause damage to the eye
   B. being born blind as a result of a genetic defect
   C. disease or malnutrition caused by poverty
   D. looking at the Sun

7. Astronomical telescopes are used to study the night sky. These telescopes almost always collect light using which of the following?
   A. a large concave lens
   B. a large concave mirror
   C. a large convex lens
   D. a large convex mirror

8. The part of a camera that detects light is called the charge coupled-device or CCD. To which part of the human eye does the CCD correspond?
   A. cornea
   B. lens
   C. retina
   D. sclera

9. In a human eye, the iris limits the amount of light that is allowed to enter. Which part of a camera does this same function?
   A. diaphragm
   B. lens
   C. lens cap
   D. shutter

10. A lens with a short focal length that produces a relatively small image of an object but has a wide field of view is a called which of the following?
    A. concave lens
    B. digital lens
    C. telephoto lens
    D. wide-angle lens

Match the Term on the left with the best Descriptor on the right.
Each Descriptor may be used only once.

Term	Descriptor
_____ 11. blind spot	A. a condition in which it is difficult or impossible to see dim light
_____ 12. cone cells	B. allow us to detect colour
_____ 13. microscope	C. makes tiny objects appear large
_____ 14. night blindness	D. records an image of an object
_____ 15. refracting telescope	E. the optic nerve attaches to the retina here
_____ 16. retina	F. uses two lenses to help see distant objects

Short Answer Questions

17. Draw a simple sketch of a human eye, showing the location of the retina, cornea, lens, and optic nerve.

18. (a) How are reflecting telescopes similar to refracting telescopes?

_____

_____

(b) How are they different?

_____

_____

19. (a) Describe one type of vision problem.

_____

_____

(b) Describe how this vision problem can be corrected.

_____

_____

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UNIT 2

Make Your Own Glossary

BLM 2-46

Goal • To reinforce your understanding of the key concepts in this unit, make your own glossary.

What to Do

Fill in the blanks below with the definition of each key term. Also include the page number where the term appears. Use the blank spaces provided at the end of the chart to insert other terms from the unit that you might find helpful. Place this glossary in your notebook, at the beginning of the Optics unit for your reference.

Term	Page	Definition
Amplitude		
Angle of incidence		
Angle of reflection		
Angle of refraction		
Astigmatism		
Blind spot		
Concave		
Convex		
Cornea		
Crest		
Diverging		
Electromagnetic radiation		
Energy		
Focal point		
Frequency		
Gamma rays		
Infrared waves		
Iris		
Lens		
Microwaves		
Normal		
Opaque		
Optic nerve		

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BLM 2-46 continued

Pupil		
Radio waves		
Reflection		
Refraction		
Retina		
Sclera		
Spectrum		
Translucent		
Transparent		
Trough		
Ultraviolet waves		
Visible light		
Wave		
Wavelength		
X rays		

DATE: NAME: CLASS:

UNIT 2

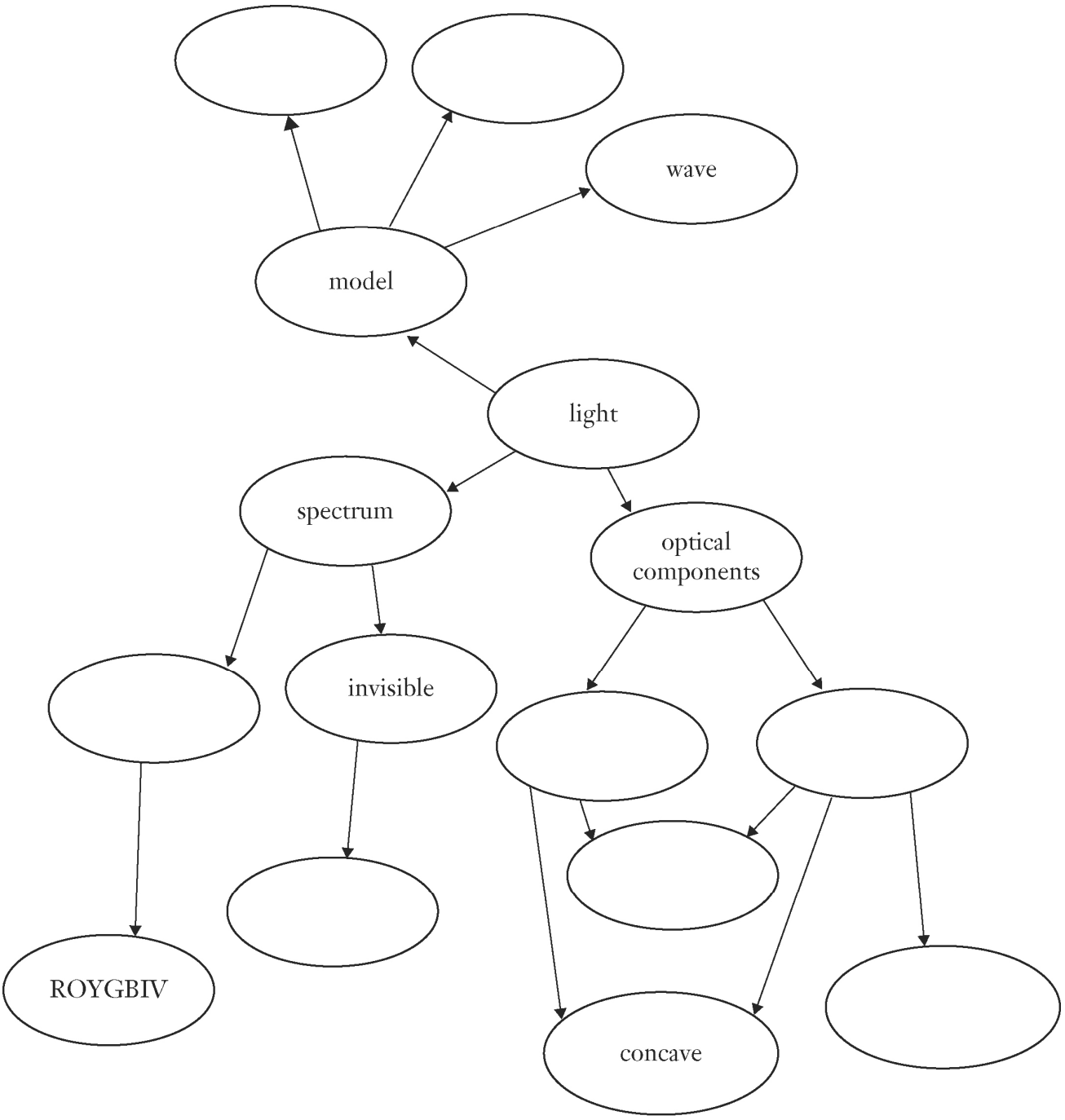
Light Concept Map

BLM 2-47

Goal • Review what you learned in this unit.

What to Do

Complete this concept map about light.



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UNIT 2

Unit 2 Review

BLM 2-48

Goal • Test your understanding of the concepts in Unit 2.

What to Do

Circle the letter of the best answer.

1. Which describes the wavelength of a water wave?
   A. the distance from one point on a wave to the same point on the next wave
   B. the height of a wave crest above the rest position of the wave
   C. the height of a wave crest above the wave trough
   D. the number of times per second that the crest of a wave passes a fixed point

2. What is the complete range of all wavelengths of radiant energy called?
   A. the colour spectrum
   B. the electromagnetic spectrum
   C. the invisible spectrum
   D. the visible spectrum

3. A mirror changes the direction of a ray of light in which process?
   A. absorption
   B. diffusion
   C. reflection
   D. refraction

4. Ultraviolet rays are electromagnetic rays associated with which of the following?
   A. heat
   B. light
   C. radar
   D. sunburns

5. The ray model of light explains why shadows formed in sunlight have sharp edges. Why does this result occur?
   A. Light rays travel in straight lines.
   B. The angle of incidence equals the angle of reflection.
   C. The light rays are blocked by objects between the light source and the observer.
   D. The light rays spread out as they travel.

6. In a transparent material, which of the following is true?
   A. The light rays are absorbed and no clear image is seen through the material.
   B. The light rays are scattered and no clear image is seen through the material.
   C. The light rays are transmitted without scattering and a clear image is seen through the material.
   D. The light rays are transmitted without scattering but no image is seen through the material.

7. When light rays pass from water into air, which of the following occurs?
   A. They bend away from the normal as they move into a material with greater density.
   B. They bend away from the normal as they move into a material with lower density.
   C. They bend toward the normal as they move into a material with greater density.
   D. They bend toward the normal as they move into a material with lower density.

8. Light rays that are made to come together to a point after passing through a lens are described as doing which of the following?
   A. conjoining
   B. converging
   C. diverging
   D. merging

9. Which of the following describes the lens in a healthy living human eye?
   A. opaque and flexible
   B. opaque and hard
   C. transparent and flexible
   D. transparent and hard

10. Which of the following describes near-sightedness?
   A. a vision problem that allows a scene to be clear directly ahead but the edges of the scene are fuzzy
   B. a vision problem that causes multiple blurry images of an object to be seen
   C. a vision problem that makes it difficult to focus on distant objects
   D. a vision problem that makes it difficult to focus on nearby objects

Match the Term on the left with the best Descriptor on the right.
Each Descriptor may be used only once.

Term	Descriptor
_____ 11. amplitude _____ 12. astigmatism _____ 13. concave _____ 14. cornea _____ 15. energy _____ 16. lens _____ 17. optic nerve _____ 18. pupil _____ 19. refraction _____ 20. translucent	A. a transparent material that can focus light B. all waves transfer this C. causes several fuzzy images to form on the retina D. connects the retina to the brain E. part of the eye that does most of the focussing F. permits light to pass but the image is not clear G. the bending of light as it passes from air into glass H. the height of a wave I. the length of a wave J. the shape of a lens or mirror in which the surface bends inward K. transparent part of eye surrounded by the iris and which appears to be black

21. Draw a sketch of a light wave. Label the amplitude, wavelength, trough, and crest.

22. Calculate the frequency, in hertz, of each of the following:
    (a) the tick-tock sound of a wind-up clock, which starts a new sound 60 times in 1 min

    _____

    (b) the heart rate of a cyclist, which beats 300 times in 100 s

    _____

    (c) the frequency of a water wave, which laps up on the shore 6 times in 1 min

    _____

23. For each of the following parts of the invisible spectrum, list one way in which the radiation is used to create some sort of image.
    (a) X rays _____

    (b) infrared rays _____

    (c) microwaves _____

24. Compare and contrast the reflection of light from a white sheet of paper with the reflection of light from a mirror. Ray diagrams may be useful in your answer.

25. A magnifying glass uses sunlight to light a piece of paper on fire. Draw a ray diagram to show how light rays from the Sun are refracted by the lens of the magnifying glass. Be sure to show the general shape of the lens used in the magnifying glass.

26. The rearview mirror of a car on the passenger side usually has this warning: "Objects in the mirror are closer than they appear."

    (a) Sketch and label the kind of mirror used in this application.

    (b) Identify one other common use for this type of mirror.

    _____

27. Draw a sketch of a human eye as viewed from the front. Label the iris, sclera, and pupil.

BLM 2-3, Chapter 4 Key Terms

1. The following uses for each type of radiation are acceptable answers:

gamma rays: radiation therapy to kill cancer cells

infrared rays: television remote control, using a computer to read CD-ROMS, heat lamps, detecting disease at airports, observation satellites

microwaves: telecommunications satellites, heating food, radio telescopes, remote sensing, radar

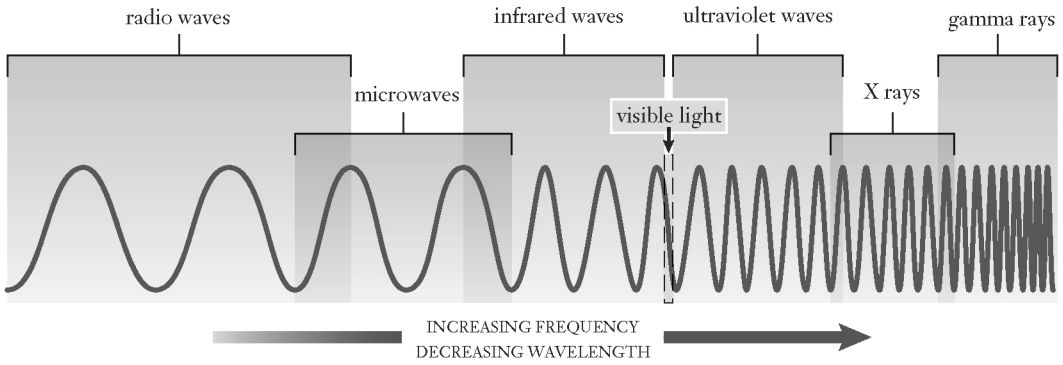
radio waves: radio and television broadcasting, magnetic resonance imaging

ultraviolet waves: the body's production of vitamin D, fluorescent powder to study fingerprints

visible light: vision

X rays: diagnostic imaging (teeth, bones, organs), X-ray screening at airports

Electromagnetic Spectrum



2. The frequency of a wave describes the number of waves that occur in a certain time, and is often measured in cycles per second, or hertz (Hz).

The highest point of a wave is the crest and the lowest is the trough.

The amplitude of a wave describes the distance from the highest point to the rest position. The wavelength of a wave describes the distance from one crest to the next.

Matter in a transverse wave moves up and down perpendicular to the direction the wave travels. Matter in a compression wave moves back and forth along the same direction that the wave travels.

Reflection describes light hitting an object and bouncing off. Refraction describes light changing direction as it passes through a medium.

A microscope helps us see things too small for our eyes alone to see. A telescope helps us see things too far away for our eyes alone to see.

BLM 2-4, Chapter 4 Key Terms

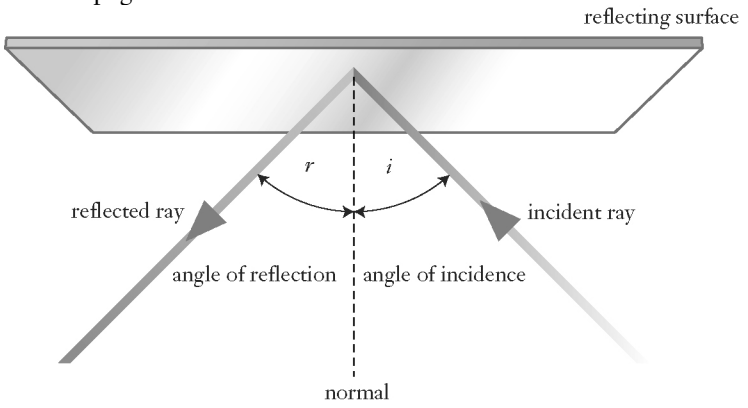
1. amplitude
2. frequency
3. wave
4. energy
5. trough
6. wavelength
7. refraction

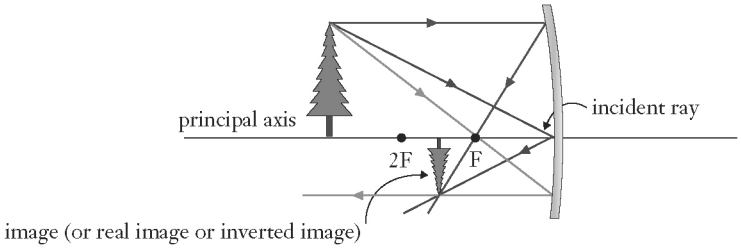
8. Pythagoras
9. reflection
10. microwaves

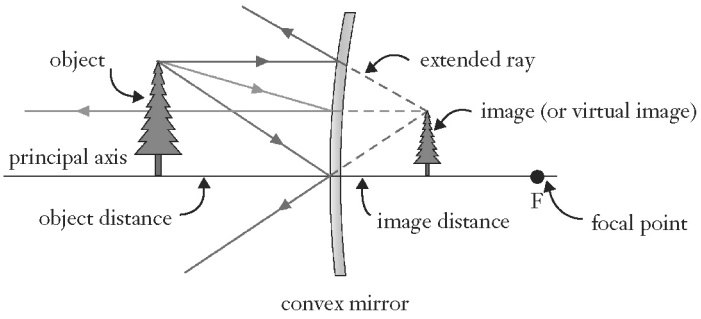
BLM 2-5, Chapter 5 Key Terms

First page:
Top diagrams, from left to right: transparent, opaque, translucent
Bottom diagrams, from left to right: specular reflection, diffuse reflection

Second page:





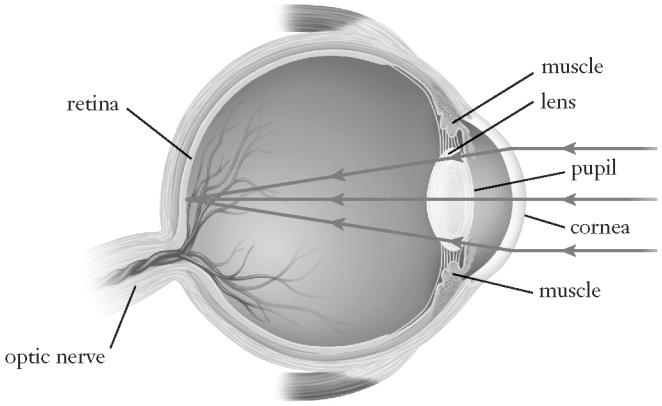


BLM 2-6, Chapter 5 Key Terms

1. transparent
2. opaque
3. vertex
4. diffuse reflection
5. plane mirror
6. inverted
7. principal axis

8. real image
9. convex mirror
10. incident ray

BLM 2-7, Chapter 6 Key Terms



2. 1. B
2. L
3. D
4. J
5. E
6. C
7. I
8. N
9. H
10. A
11. O
12. G
13. F
14. K
15. M

BLM 2-8, Chapter 6 Key Terms

1. lens
2. snow blindness
3. aperture
4. focal length
5. convex
6. optical centre
7. pupil
8. cornea
9. astigmatism

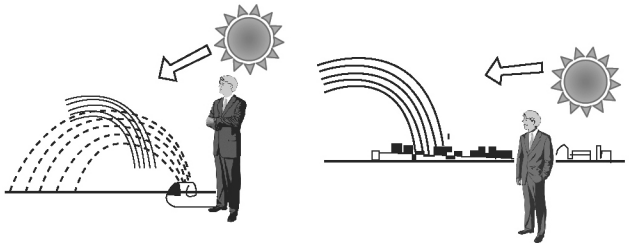
BLM 2-9, Riding the Waves

1. (a) crest (b) rest position (c) trough
   (d) wavelength (e) amplitude
2. Two wavelengths are shown.
3. frequency; hertz
4. 8 cycles in 4 seconds makes a frequency of 2 Hz.
5. The ducks are half a wavelength apart.
6. Two and a half wavelengths are shown.

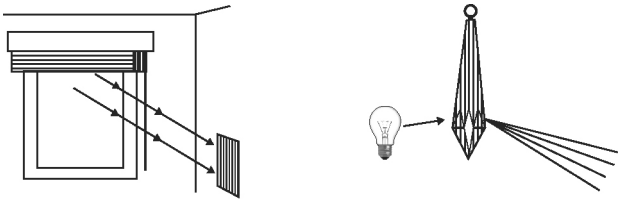
BLM 2-12, At the End of the Rainbow

The following diagrams show the approximate positions of the elements needed to produce a rainbow.

1.



2.



BLM 2-13, ROY G BIV

Answers should reflect Figure 4.21 on page 150 of the student textbook.

BLM 2-14, Additive Primary Colours

Students should colour their diagram using colours as close as possible to those in Figure 4.25(A) on page 152 of the student textbook.

BLM 2-15, What is Colour?

Colour of Paper	Colour of Light	Colour Observed
Red	Red	Red
Red	Green	Black
Red	Blue	Black
Green	Red	Black
Green	Green	Green
Green	Blue	Black
Blue	Red	Black
Blue	Green	Black
Blue	Blue	Blue

BLM 2-16, Setting the Stage

1. 1. c
   2. d
   3. a
   4. b
2. Students should mention lighting from the side, to make long shadows, and using warm colours of light.

BLM 2-19, Chapter 4 Review

1. B
2. B
3. D
4. D
5. D
6. D
7. A
8. A
9. A
10. C
11. E
12. D
13. G
14. A
15. C
16. B
17. (a) Blue
    (b) Red
    (c) The apple will appear darker and bluish, and there will be no red. It will be difficult to see the apple.
18. (a) Ultraviolet waves enable our body to make vitamin D, needed for healthy bones and teeth.
    (b) Over-exposure to ultraviolet waves can result in sunburn and skin cancer.
19. (a) 0.5 Hz
    (b) 3 Hz
    (c) 1.5 Hz

BLM 2-21, When Light Strikes

1. A sharp shadow indicates that light travels in straight lines past the edge of the object to the surface on which the shadow falls. It also indicates that the light source is very small, very far away, or focussed to emit parallel light beams. A fuzzy shadow results from a nearby large light source, as some light rays travel past the edge of the object at different angles.
2. (a) Light passes through a transparent object without scattering (so images can be seen).
   (b) An opaque object casts a black shadow. It prevents light from passing through it by reflecting or absorbing the light.
   (c) A translucent object allows light to pass through, but it scatters the light rays so that clear images cannot be seen through the object.
3. Frosted glass in a bathroom window allows light to pass through but provides privacy by preventing outside observers from seeing clear images of people inside.

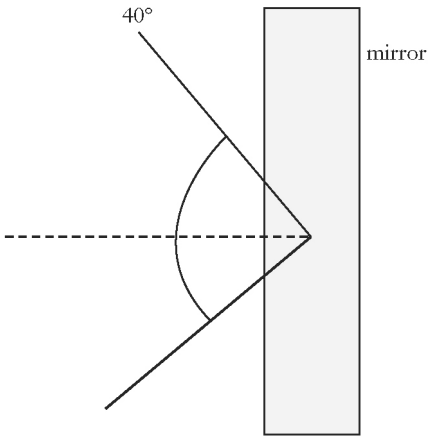
4.

Material	Classification	Behaviour of Light
Glass	Transparent	Transmitted
White clouds	Opaque	Reflected
Stained glass window	Translucent	Scattered
Aluminum foil	Opaque	Reflected
Fog	Translucent	Scattered
Cellophane	Transparent	Transmitted
Cardboard	Opaque	Absorbed
Wax paper	Translucent	Scattered
Black chalkboard	Opaque	Absorbed
Mirror	Opaque	Reflected
(Water)	Transparent	Transmitted
(Tissue paper)	Translucent	Scattered

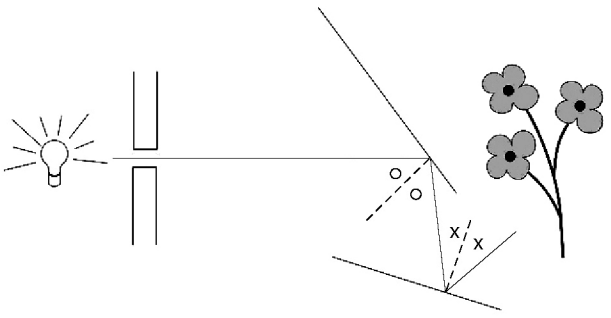
BLM 2-22, Reflection: Ray Diagrams

1. (a) incident ray (b) angle of incidence
   (c) normal (d) angle of reflection
   (e) reflected ray
2. Angle of incidence = 50°, Angle of reflection = 50°
3. They are the same, i.e., the angle of incidence is equal to the angle of reflection.

4.



5.



BLM 2-23, Refraction: Light Changes Direction

1. (a) greater (b) toward
2. (a) less (b) away from
3. (a) greater (b) toward
4. (a) less (b) away from

BLM 2-24, How Do Two-Way Mirrors Work?

Students should draw several light rays toward the glass in the room on the left, most of which travel through the glass, and just a few light rays toward the glass in the room on the right, all or most of which reflect off the glass.

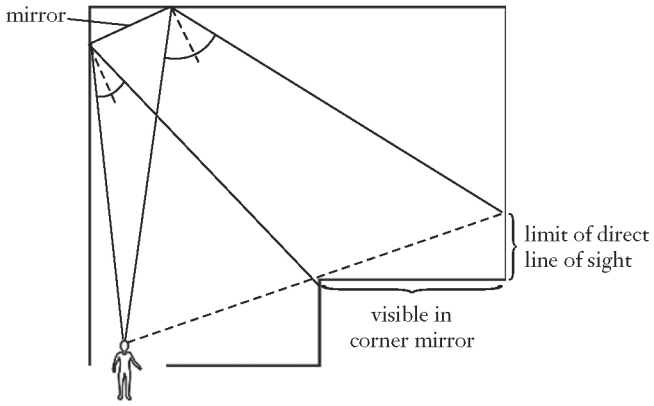
BLM 2-25, Mirror Images

1. Image A is a true reflection.
2. Image B has the words written backward, but all the letters are in their correct orientation. Image C has the words in the right order, but the letters are backward.
3. Capital letters that have left-right symmetry: A, H, I, M, O, T, U, V, W, X, and Y. (The following letters have up-down symmetry: B, E, I, H, O, and X. Some letters have rotational symmetry [they can be rotated 180°]: H, I, O, N, X, and Z.)

BLM 2-26, What You See Is What You Get

Objects and images in plane mirrors are the same size and shape. The image and the reflection are the same distance from the mirror. Both image and object are oriented similarly (e.g., if one is upright, so is the other). The image will be reversed, however.

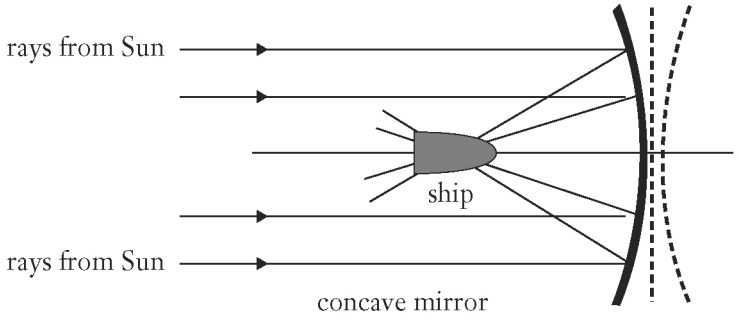
BLM 2-27, Sight Lines



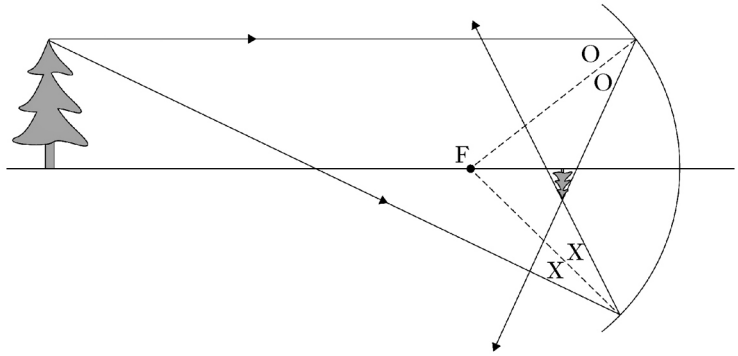
BLM 2-31, Different Mirror Surfaces

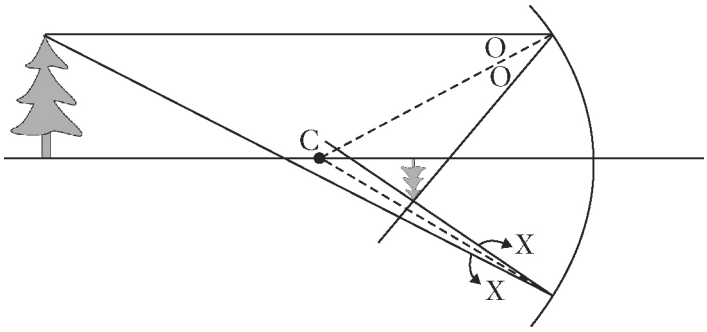
1. plane mirror 2. concave mirror
3. convex mirror 4. concave mirror
5. plane mirror 6. convex mirror
7. concave mirror 8. plane mirror

BLM 2-32, Egyptian Mirror



BLM 2-33, Curved Mirrors: Images from a Distant Object

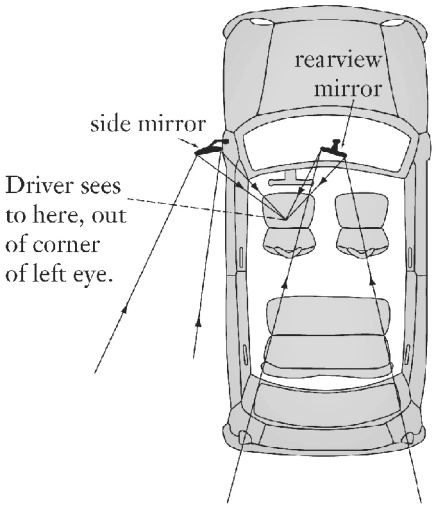




The mirror on the second page is less curved than the one on the first page.
The less curved the mirror, the farther away the image is from the mirror.

BLM 2-34, Blind Spots in an Automobile

1. (a) and (b)

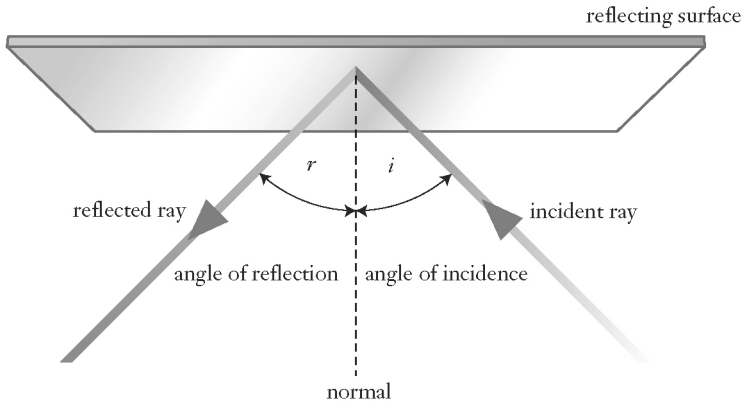


2. (a) The driver has a blind spot, between the right edge of the area seen in the side mirror and the left edge of the area seen in the rearview mirror, and behind the line showing the driver's field of view from the corner of her/his eye.
   (b) When turning or changing lanes to the left, the driver should always glance over her/his left shoulder, to look for traffic in the blind spot.
3. Answers will vary.

BLM 2-36, Chapter 5 Review

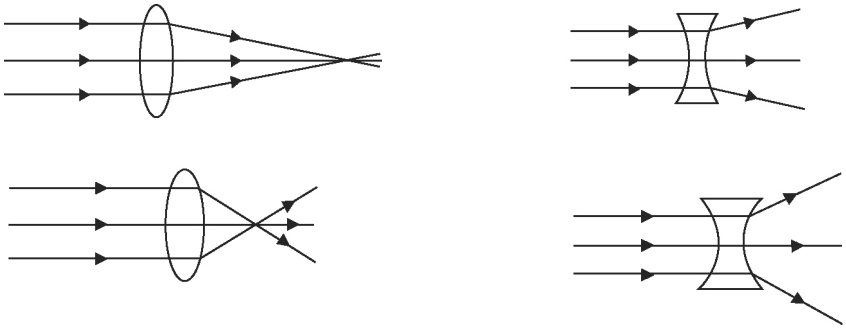
1. D
2. B
3. D
4. C
5. A
6. D
7. A
8. C
9. C
10. A
11. E
12. D
13. B
14. C
15. (a) Transmit means to let light pass through, while absorb means to block light without reflecting or transmitting it.
    (b) Translucent describes an object that lets light pass through, but the image is not clear, while transparent describes an object that permits light through while preserving a clear image.

16.



BLM 2-39, Lenses and Light

1. A concave lens is a lens that is thinner in the middle than at the edges.
2. diverge
3. A convex lens is a lens that is thicker in the middle than at the edges.
4. converge
5. convex, concave, concave, convex
6.



BLM 2-42, Making Things Bigger

1. convex lens (eye)
2. convex lens
3. convex lens
4. convex lens
5. convex lens
6. convex lens
7. convex lens
8. convex lens
9. triangular prism
10. convex lens
11. convex mirror

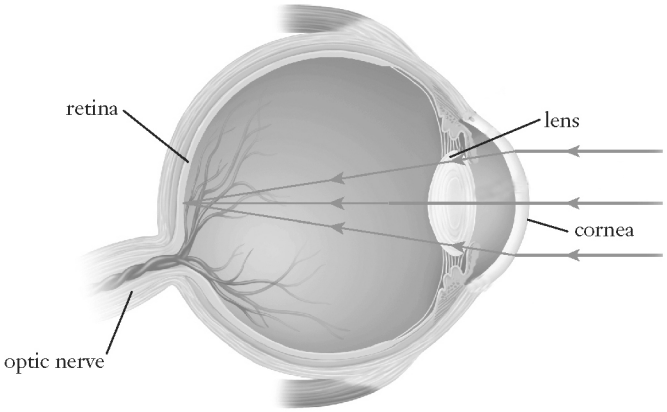
BLM 2-44, Comparing an Eye with a Camera

Eye		Camera	
Part	**Function**	**Part**	**Function**
Eyelid	Opens and closes to let light in or keep light out; also moistens cornea	Shutter	Opens to take a picture
Retina	Receives the light; image is formed here	CCD	Catches the image
Cornea	Clear covering over the eye; focusses light	Protective glass	Lens cover protects the lens
Iris	Expands and contracts the pupil according to brightness of the light	Diaphragm	Opens and closes to allow the correct amount of light into the camera
Iris	Automatically adjusts pupil size	Automatic brightness adjustment	Opens and closes the diaphragm according to brightness of the subject
Lens	Focusses the image on the retina	Lens	Focusses the image on the film
Muscle	Adjusts the thickness of the lens to focus on near or far objects	Focussing ring	Adjusts the distance between the lens and the film to focus on near or far objects
Pupil	The black in the centre of the iris; the hole through which light enters the eye	Aperture	Hole through which light enters the camera
Optic nerve	Transmits signals from light receptors in the retina to the brain		

BLM 2-45, Chapter 6 Review

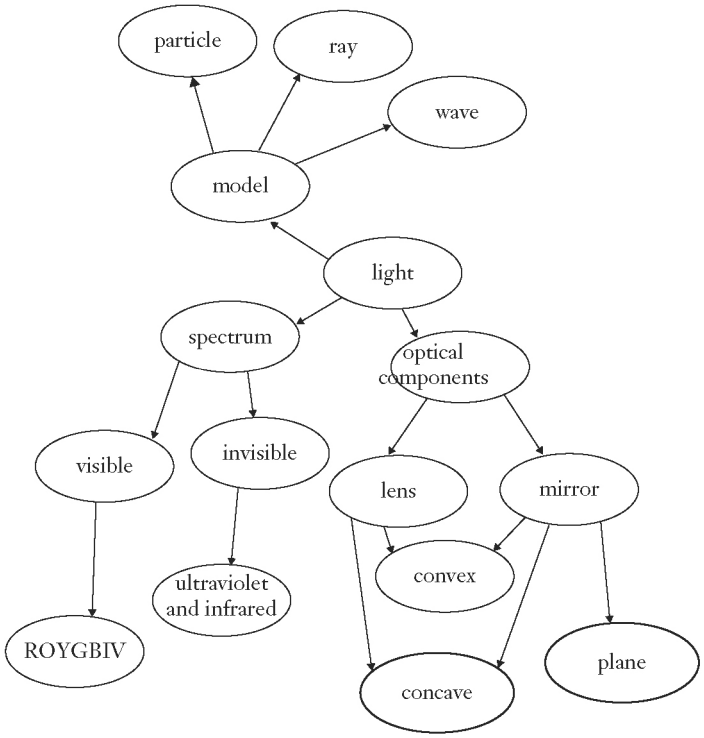
1. A
2. B
3. A
4. D
5. A
6. C
7. B
8. C
9. A
10. D

11. E
12. B
13. C
14. A
15. F
16. D
17.



18. (a) Both allow distant objects to be seen more clearly and both often use an eyepiece lens.
    (b) A refracting telescope collects light with a lens while a reflecting telescope collects light with a mirror.
19. (a) For example, near-sighted vision means a person can see nearby objects clearly but cannot bring distant objects into focus. It occurs because the lens converges the light rays to form an image in front of the retina. The rays are spread out when they hit the retina and the image is fuzzy.
    (b) This problem can be corrected with a concave lens to diverge the parallel rays so that the image forms farther back on the retina.

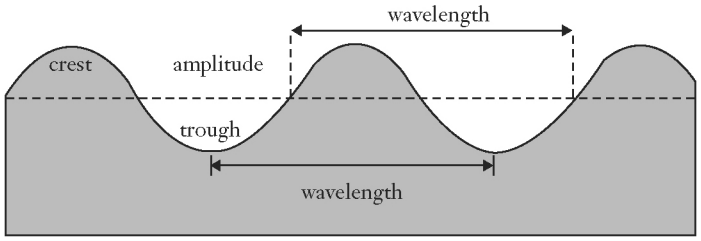
BLM 2-47, Light Concept Map



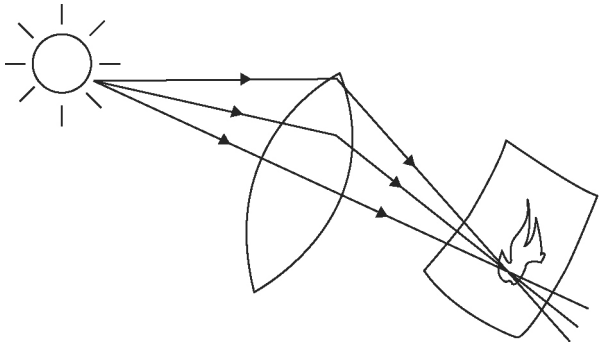
BLM 2-48, Unit 2 Review

1. A
2. B
3. C
4. D
5. A
6. C
7. B
8. B
9. C
10. C
11. H
12. C
13. J
14. E
15. B
16. A
17. D
18. K
19. G
20. F

21.



22. (a) 1 Hz
    (b) 3 Hz
    (c) 0.1 Hz
23. Students' answers may vary but could include the following:
    (a) dental images of cavities
    (b) night vision goggles
    (c) radar used to show the flight paths of aircraft
24. Light reflected from a white sheet of paper is called diffuse reflection because paper is a rough surface. Light rays bounce off the paper randomly at all angles. Reflection from a mirror is specular reflection because mirrors are smooth. Light is reflected uniformly and an image of the surroundings is produced.
25.



26. (a) Students should draw and label a convex mirror.
    (b) Students' answers may vary but could include security mirrors in convenience stores and also in some elevators.
27.