Name Date

Unit 4

Using Your Appendices

Science Skills Toolkit 5: Scientific Drawing

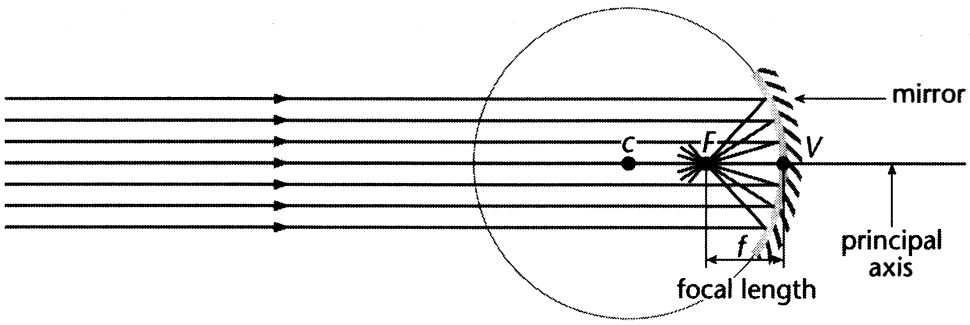
Use with textbook pages 382–383.

If you want to explain a detailed idea, a clear diagram can be the best way to do it.

Steps to Making a Clear Scientific Drawing

1. Get a sharp pencil, a ruler, a sheet of unlined paper—and a good eraser! Scientific drawings need to be clear, neat, and accurate. If your drawing gets too messy, then start over again with a new sheet of paper.
2. Use plenty of space and allow room for labels. Place all your labels on the right of the diagram if you can. If there is no room for them on the right, put them elsewhere.
3. Study what you are going to draw. Think about what you should include. Draw only what you can see from a particular angle. If you need to, draw the object from another angle as well.
4. Use dots to show darker areas and double lines to show thicker areas. Try to avoid using colour. If you do have to use colour, choose colours that are close to those in the object.
5. Label your diagram. Use a ruler to draw a straight line from the part being labelled to the label. Don't allow any label lines to cross.
6. Give your diagram a title. People will want to know what they looking at.

This drawing has all the elements a good drawing needs.



Parallel light rays reflecting in a concave mirror

Name _____ Date _____

Unit **4**

Questions:

1. Why do scientific drawings need to be clear, neat, and accurate? Give an example.

_____

_____

_____

_____

2. What is the wrong with this diagram of penny-farthing bicycle?

_____

_____

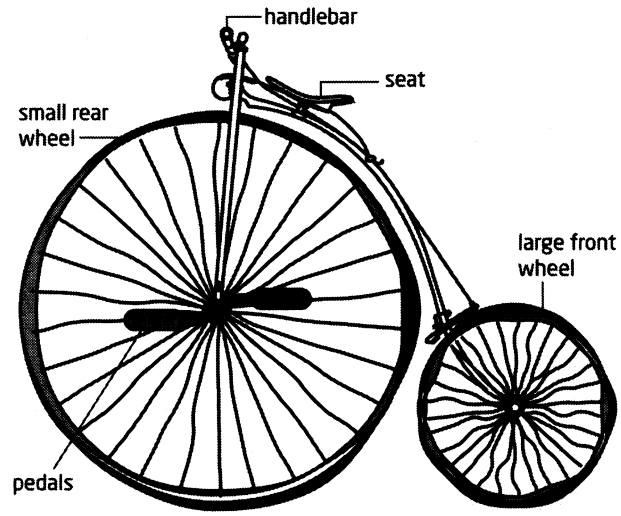
_____

_____

_____

_____

_____



3. Make a scientific drawing of some object in your school or home, such as a light bulb or a cell phone.

Name _____ Date _____

Topic **4.1** Summary

What is light and how is it produced?

Textbook pages 276 to 285

Before You Read

How do you think light is produced? Record your thoughts below.

_____

_____

Mark the Text

Check for Understanding

As you read, stop and reread any parts you do not understand. Highlight the sentences that help you to understand better.

Many technologies produce light by converting other forms of energy.

The light that hot objects emit is called **incandescence**. The light that unheated objects emit is called **luminescence**.

Light-producing technology	What energy is transformed	Examples
Incandescence		
Burning fuel, such as wood, produces light.	Chemical energy	Wood fires, the Sun, candles
Passing **electrical energy** through a light bulb filament causes the filament to glow hot.	Electrical energy	Incandescent light bulbs
Luminescence		
Chemiluminescence occurs when light is released during a chemical reaction.	Chemical energy	Glow sticks, fireflies
Electric discharge occurs when electrons move from one end of a sealed glass tube to the other. They collide with gas particles and transfer energy to them. The gas particles release the energy as visible light.	Electrical energy	Street lights, sodium vapour lights
Fluorescence is like electric discharge, but the inside of the glass tube is coated with phosphor and the gas particles emit (invisible) ultraviolet light, which the phosphor converts to visible light.	Electrical energy	Fluorescent light bulbs

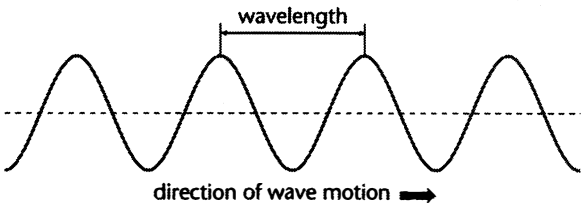
Name _____ Date _____

Topic **4.1** Summary

Light is energy and travels like a wave.

Light is a form of energy. It is related to other forms of energy, including microwaves, X-rays, and ultraviolet. Together, these forms of related energy are part of the **electromagnetic spectrum**. The energy of the electromagnetic spectrum travels in the form of waves. The electromagnetic spectrum is arranged in order of wavelength.

The diagram below is a model of a wave. An important characteristic of a wave is its **wavelength**. This is the distance from the peak of one part of the wave to the next peak. ✔



Electromagnetic waves have different wavelengths. For example, radio waves have very long wavelengths, and gamma rays have extremely short wavelengths. The only waves of the electromagnetic spectrum that human eyes can see are waves of visible light. These are the "colours of the rainbow." From longest waves to shortest, they are red, orange, yellow, green, blue, and violet.

✔ *Reading Check*

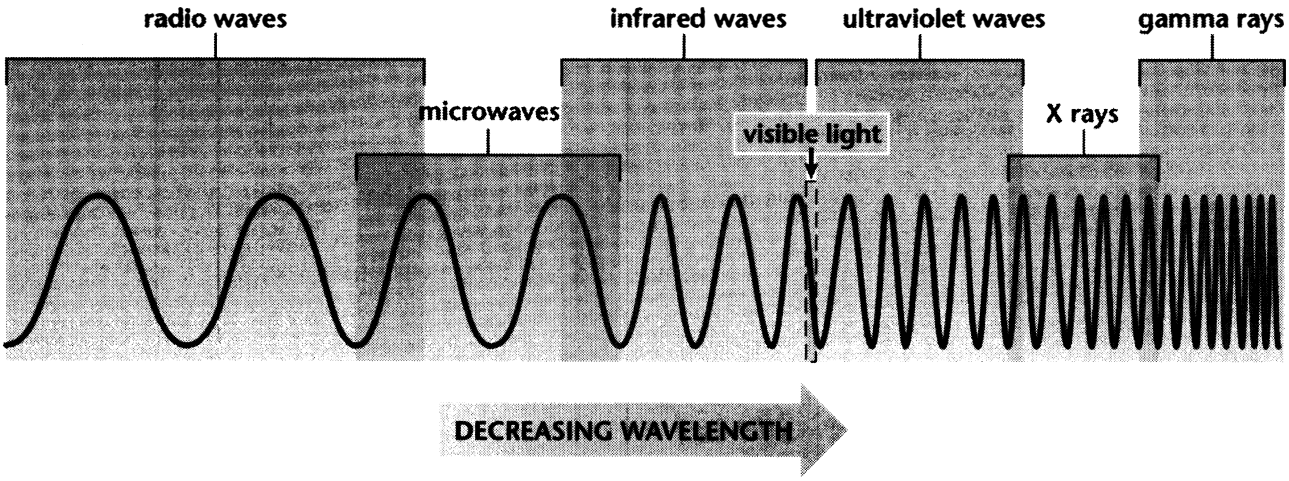
1. How is incandescence different from luminescence?

   _____

   _____

2. What is the distance between two peaks of a wave called?

   _____



Name _____ Date _____

Cloze Activity
Topic 4.1

Use with textbook pages 276 to 285.

Light

Vocabulary	
chemiluminescence	frequency
incandescent	electric discharge
luminescence	electromagnetic spectrum
electromagnetic waves	visible light
energy	wave
fluorescence	wavelength

Use the terms in the vocabulary box to fill in the blanks. You can use each term more than once. You will not need to use every term.

1. Light is a form of _____.
2. The light emitted by a hot object is called _____.
3. The light emitted by an unheated object is called _____.
4. Other forms of _____ can be converted into light.
5. Light released during chemical reactions is called _____.
6. The Sun is an example of _____ light. It converts chemical energy into light energy.
7. Light travels like a _____.
8. The distance between two peaks of a wave is called the _____.
9. _____ includes visible light, ultraviolet, and radio waves.
10. An _____ shows the electromagnetic waves in order of wavelength.
11. Radio waves have a longer _____ than visible light does.
12. The waves of _____ are the only waves of the electromagnetic spectrum that you can see.

Name _____ Date _____

Comprehension
Topic 4.1

Use with textbook pages 278 to 279.

Incandescence and luminescence

1. How are the technologies that produce incandescence and luminescence different?

_____

_____

2. How are the technologies that produce incandescence and luminescence alike?

_____

_____

3. Circle what kind of light each object emits.

(a)	fire	incandescence / luminescence
(b)	a fluorescent light bulb	incandescence / luminescence
(c)	a red burner on an electric stove	incandescence / luminescence
(d)	a flashlight	incandescence / luminescence
(e)	a sodium vapour light	incandescence / luminescence
(f)	a glow stick	incandescence / luminescence
(g)	a candle	incandescence / luminescence
(h)	a firefly	incandescence / luminescence
(i)	a neon sign	incandescence / luminescence
(j)	a torch	incandescence / luminescence
(k)	a kerosene lamp	incandescence / luminescence
(l)	the Sun	incandescence / luminescence
(m)	a glow-in-the-dark watch dial	incandescence / luminescence
(n)	molten lava	incandescence / luminescence
(o)	star light	incandescence / luminescence
(p)	a television screen	incandescence / luminescence
(q)	a computer monitor	incandescence / luminescence

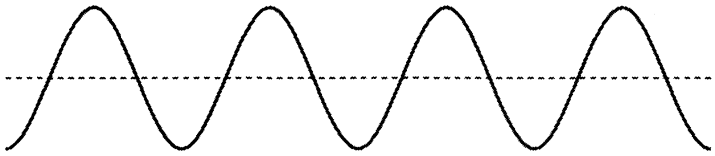
Name _____ Date _____

Interpreting Illustrations
Topic 4.1

Use with textbook pages 280 to 283.

Electromagnetic Waves

1. Label the wavelength of this wave.



2. Order the waves from shortest (1) to longest (4) wavelength.

a)

_____

b)

_____

c)

_____

d)

_____

Use the electromagnetic spectrum below to answer questions 3 and 4.

3. Order the waves from shortest (1) to longest (5) wavelength:

___ radio waves

___ X rays

___ visible

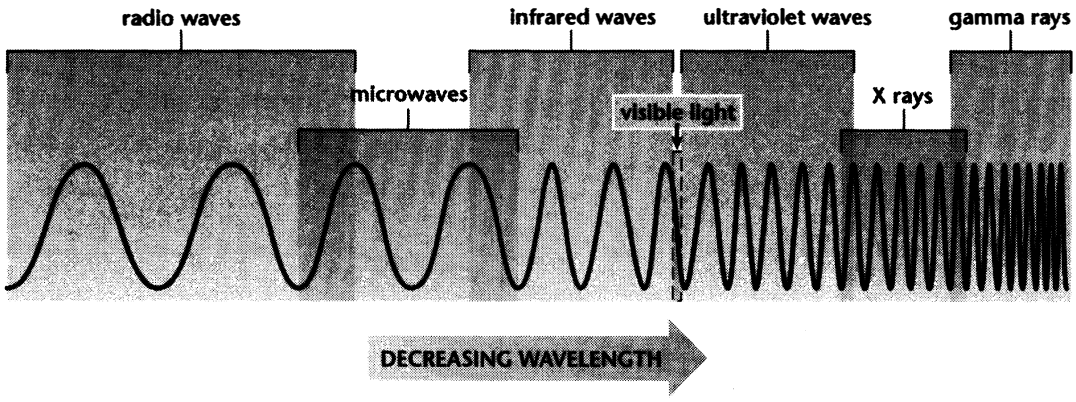
___ infrared

___ ultraviolet

4. Describe two ways that visible light is different from other waves of the electromagnetic spectrum.

_____

_____



Name _____ Date _____

Assessment
Topic 4.1

Use with textbook pages 276 to 285.

What is light and how is it produced?

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

Term	Descriptor
1. _____ light	**A.** light emitted by unheated objects.
2. _____ electromagnetic spectrum	**B.** light emitted by hot objects.
3. _____ incandescence	**C.** the distance between two wave peaks.
4. _____ luminescence	**D.** electromagnetic waves, arranged by wavelength.
5. _____ wavelength	**E.** a form of energy related to radio waves and infrared.

6. Give two examples of each type of light.

a) incandescence:

_____

_____

b) luminescence:

_____

_____

7. Draw a wave and label its parts.

8. What does a wavelength represent?

_____

_____

9. Circle which colour of light has the longer wavelength.

red light / blue light

Name _____ Date _____

Topic **4.2** Summary

How does light interact with objects to give them colour?

Textbook pages 286 to 293

Before You Read

In this topic, you will explore light and colour. How does light give objects their colour? Record your ideas below.

_____

_____

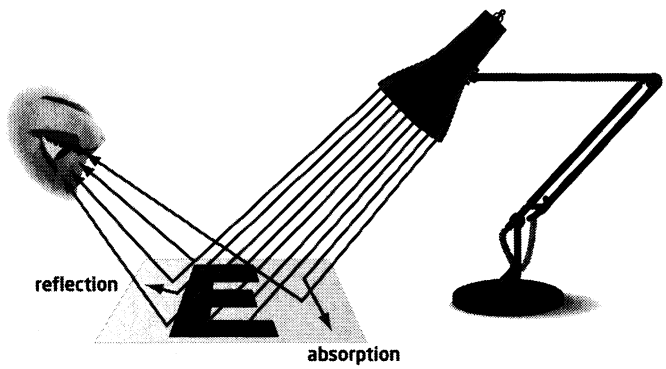
Mark the Text

Identify Definitions

Highlight the definition of each word in bold type.

Objects absorb, reflect, or transmit light.

Light travels in a straight line. You use an arrow called a **ray** to show the direction it travels. Ray diagrams show how light behaves when it hits an object. When light hits an object, it may be reflected, absorbed, or transmitted.

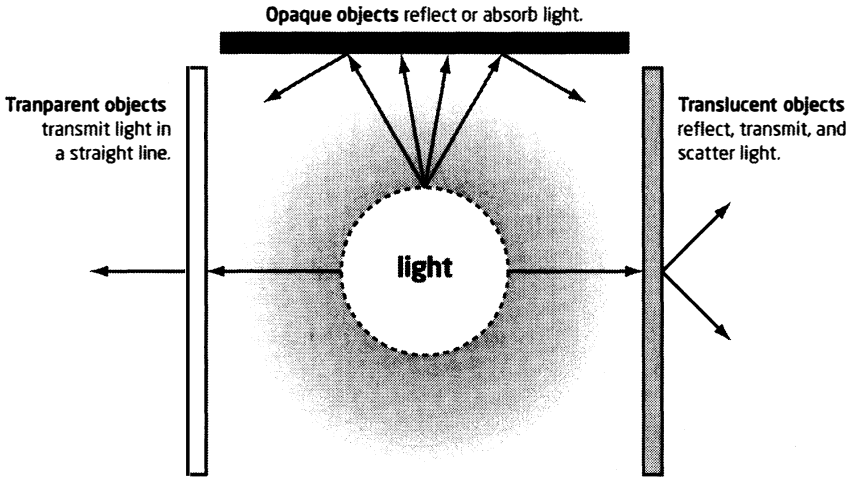


- **Reflection** occurs when light bounces off an object. You can see an object, such as this white paper, because some of the light that reflects off the object travels to your eyes.
- **Absorption** occurs when something, such as black print, absorbs light. You can see the print because your brain interprets this lack of light as the colour black.
- **Transmission** occurs when light goes through an object.
  - A **transparent** object, like a window, transmits all or most light with no change in direction.
  - A **translucent** object, like frosted glass, transmits some light and scatters it in different directions.
  - An **opaque** object, like a book, does not transmit light; it reflects or absorbs light.

Name _____ Date _____

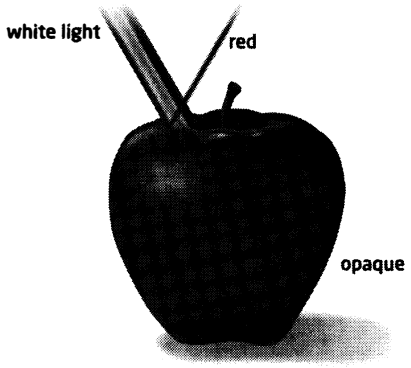
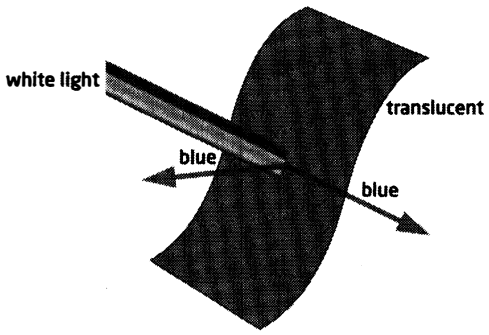
Topic **4.2** Summary

Objects reflect, absorb, and transmit light.



Objects can absorb some colours and reflect or transmit others.

An object's colour is determined by the colours that it absorbs, reflects, or transmits. White light combines all of the colours (wavelengths) of visible light.

When white light hits an opaque object, such as a red apple, the apple reflects its own particular colour and absorbs all other colours.	
When white light hits a coloured transparent or translucent object, such as blue cellophane, the object absorbs every colour except for its own particular colour. That colour will be transmitted and reflected.	

Reading Check

1. Name the three ways light can behave when it hits an object.

_____

_____

_____

2. What are the differences among a transparent, a translucent, and an opaque object?

_____

_____

_____

3. What determines the colour of an object that we see?

_____

_____

_____

Name _____ Date _____

Cloze Activity
Topic 4.2

Use with textbook pages 286 to 293.

Reflect, absorb, and transmit

Vocabulary	
absorb absorption opaque ray reflection	reflect translucent transmission transmit transparent

Use the terms in the vocabulary box to fill in the blanks. You can use each term more than once. You will not need to use every term.

1. The process in which light bounces off an object is called _____.
2. The process in which light travels through an object is called _____.
3. The process in which light energy remains in the object that it hits is called _____.
4. A _____ is an arrow that shows the direction light is travelling.
5. Light will travel through a(n) _____ object as if there was no object in its path.
6. _____ objects do not allow light to go through them.
7. Light scatters in different directions after travelling through _____ objects.
8. Opaque objects will only _____ or _____ light.
9. _____ and _____ objects will transmit light.
10. Clear glass is an example of a(n) _____ object.
11. Wax is an example of a(n) _____ object.
12. A book is an example of a(n) _____ object.

Name _____ Date _____

Comprehension
Topic 4.2

Use with textbook pages 288 to 289.

Light rays

Answer the questions below.

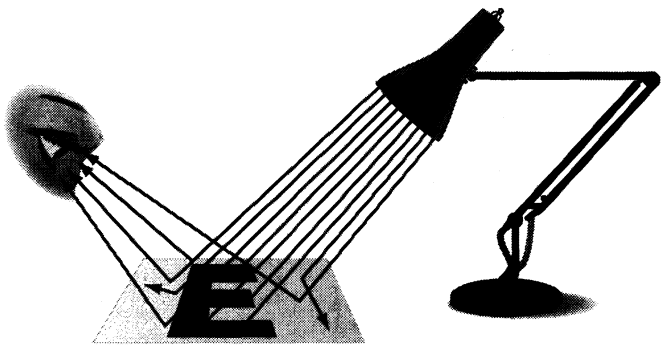
1. Refer to the light rays in the diagram to explain why you can see each item.

(a) the white paper

_____

(b) the black print

_____



2. What will happen when white light strikes each object? Circle all the choices that apply.

a) metal spokes on a bicycle wheel absorption reflection transmission	**b)** black asphalt on a basketball court absorption reflection transmission
c) swimming pool water absorption reflection transmission	**d)** fog absorption reflection transmission

3. Is each material opaque, transparent, or translucent?

a) wood : _____

b) cardboard : _____

c) aluminum foil : _____

d) wax paper : _____

e) plastic wrap : _____

f) clean air : _____

g) clear glass : _____

h) frosted window : _____

Name _____ Date _____

Illustrating Concepts
Topic 4.2

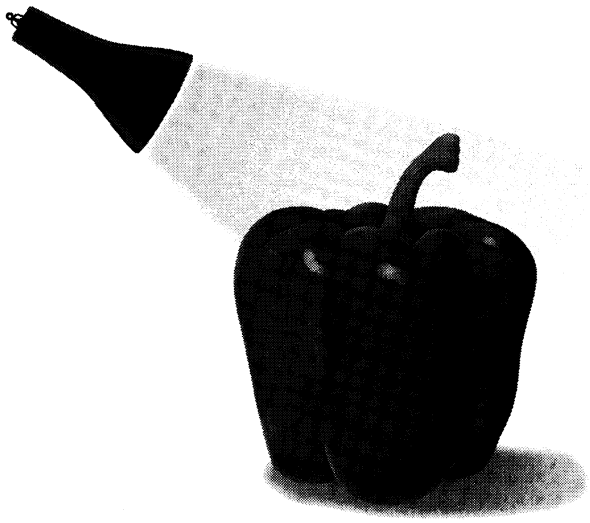
Use with textbook pages 288 to 291.

The colour of objects

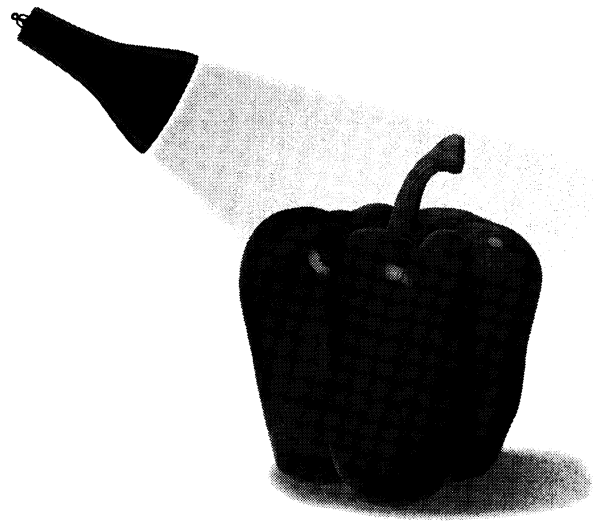
1. a) Is the pepper opaque, transparent, or translucent?

_____

b) Draw rays to explain why the pepper appears green under white light.



2. Suppose you shine a red light on this green pepper. What colour will the pepper be? Draw light rays to explain your answer.

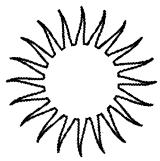


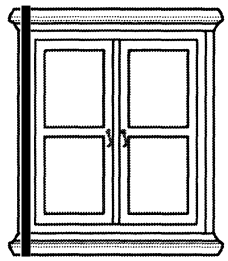
3. The window in this drawing is transparent and tinted yellow.

a) Draw light rays to show how sunlight behaves when it hits the window.

b) What colour will the tinted glass be?

_____



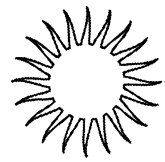


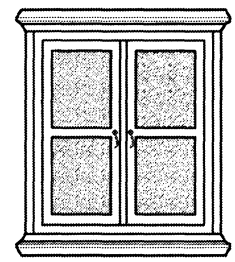
4. The window in this drawing is translucent and tinted yellow.

a) Draw light rays to show how sunlight behaves when it hits the window.

b) What colour will the tinted glass be?

_____





Name _____ Date _____

Assessment
Topic 4.2

Use with textbook pages 286 to 293.

How does light interact with objects to give them colour?

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

Term	Descriptor
1. _____ absorption	**A.** an arrow that shows which direction light travels.
2. _____ opaque	**B.** an object through which light travels without changing direction.
3. _____ ray	**C.** what happens when light bounces off an object.
4. _____ reflection	**D.** what happens when light energy hits an object and remains in it as heat.
5. _____ translucent	**E.** what happens when light travels through an object.
6. _____ transmission	**F.** an object thorough which light travels and changes direction.
7. _____ transparent	**G.** an object that does not transmit light.

8. a) Explain why you can see black print on a white paper.

_____

_____

_____

_____

b) Draw a ray diagram to show how the light travels.

9. Complete each statement with the words reflect(s), absorb(s), or transmit(s).

a) An opaque object's colour is determined by the colours that it _____ and _____ .

b) When a transparent object has a certain colour, it _____ and _____ that colour and _____ all other colours.

Name _____ Date _____

Topic **4.3** Summary

How can you mix colours to make different colours?

Textbook pages 294 to 303

Before You Read

How are different colours created? Record your ideas below.

_____

_____

Reading Check

1. What are the three additive primary colours?

   _____

   _____

   _____

2. What are the three secondary colours?

   _____

   _____

   _____

3. What are the three pairs of complementary colours?

   _____

   _____

Colours of light can be added together to form a variety of colours.

Your eyes contain only three types of cells, and with them you can see millions of colours. When you look at a coloured object, different combinations of these cells are stimulated, and your brain interprets them as the colours that you see. The **primary colours** can be mixed to produce any other colour.

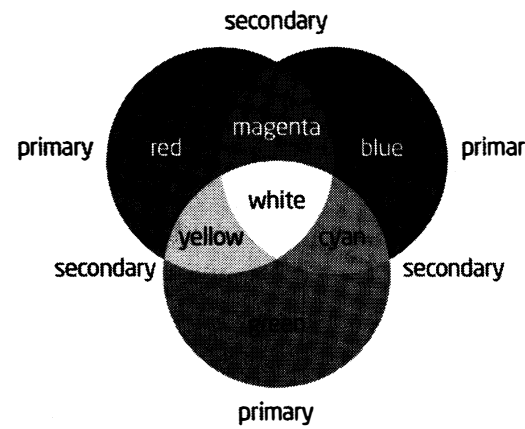
There are three additive primary colours.

There are three **additive primary colours:** red, green, and blue. When two primary colours combine, they produce a **secondary colour.** The three secondary colours are yellow, magenta, and cyan.

red + green = yellow,
red + blue = magenta
green + blue = cyan

All three primary colours combine to produce white.

red + green + blue = white



A primary colour and the secondary colour created when the other two primary colours are combined are **complementary colours**. Red and cyan are complementary colours. Green and magenta are complementary colours Blue and yellow are complementary colours.

Name _____ Date _____

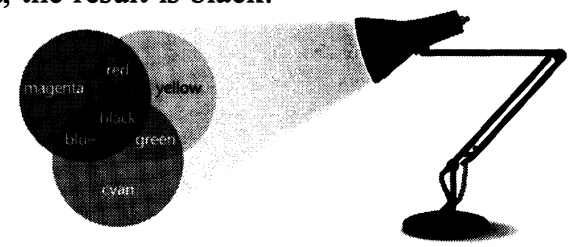
Topic **4.3** Summary

There are three subtractive primary colours.

There are three **subtractive primary colours:** cyan, magenta, and yellow. These colours produce other colours when mixed and placed under white light. This is because some colours are absorbed and some are reflected. When all three subtractive primary colours are subtracted from white light, the result is black.

Secondary colours are produced when subtractive primary colours are subtracted from white light. When complementary colours are subtracted from white light, the result is black.

white – (cyan + magenta) = blue
white – (cyan + yellow) = green
white – (magenta + yellow) = red ✔



✔ *Reading Check*

4. What are the three subtractive primary colours?

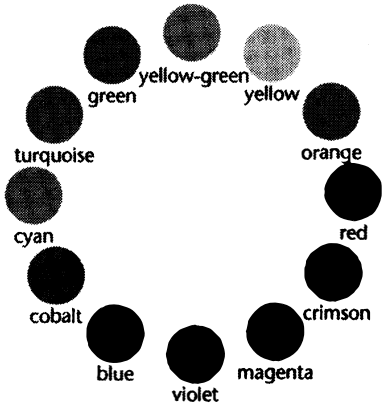
_____,
_____,
_____

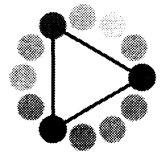
A colour wheel shows types of colours.

A colour wheel shows the additive and subtractive primary colours, secondary colours, complementary colours, and **tertiary colours**. Tertiary colours are produced when secondary colours are mixed.

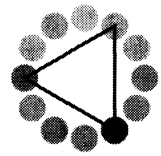
5. What are the three subtractive secondary colours?

_____,
_____,
_____

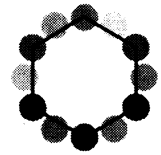




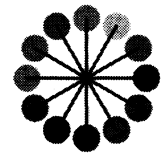
primary additive colours secondary subtractive colours



primary subtractive colours secondary additive colours



tertiary colours



complementary colours

The additive primary colours are the subtractive secondary colours. The subtractive primary colours are the additive secondary colours.

Combining additive primary colours

red + green + blue = white
red + green = yellow red + blue = magenta green + blue = cyan

Complementary colours

red—cyan, green—magenta, blue—yellow

Combining subtractive primary colours

white – (cyan + magenta + yellow) = black
white – (cyan + magenta) = blue
white – (cyan + yellow) = green
white – (magenta + yellow) = red

6. Where are pairs of complementary colours located on the colour wheel?

_____
_____

Name _____ Date _____

Comprehension
Topic 4.3

Use with textbook pages 296 to 299.

Additive and subtractive colours

Answer the questions below.

1. Complete each statement.

a) The additive primary colours are _____ , _____, and _____.

These colours are the same as the subtractive _____ colours.

b) The subtractive primary colours are _____ , _____, and _____. These colours are the same as the additive _____ colours.

2. Complete the following colour equations.

a) red + blue = _____

b) green + blue = _____

c) red + green + blue = _____

d) cyan + red = _____

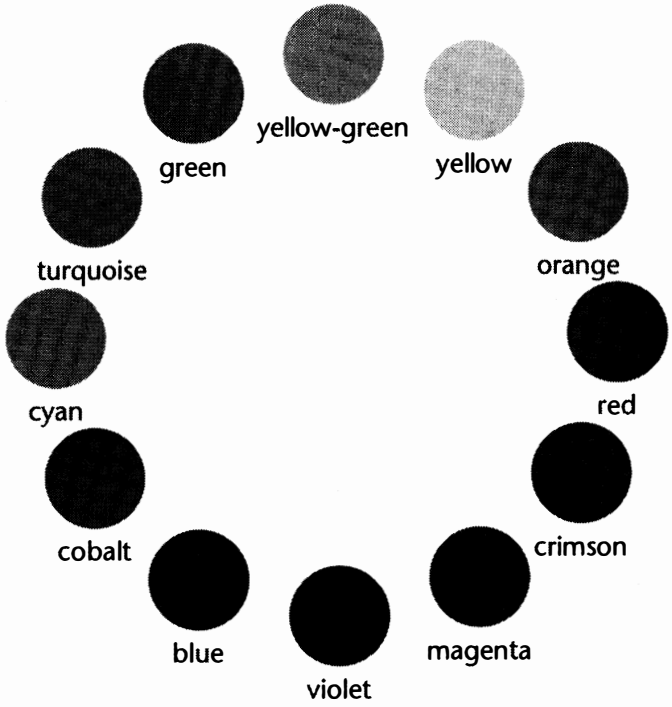
e) white – (cyan + yellow) = _____

f) white – (magenta + yellow) = _____

g) white – (cyan + magenta + yellow) = _____

h) white – (green + magenta) = _____

3. Connect each pair of complementary colours.



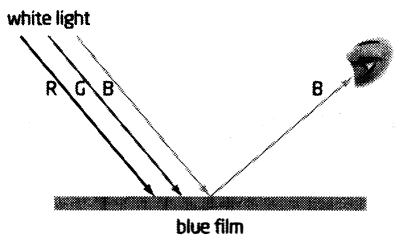
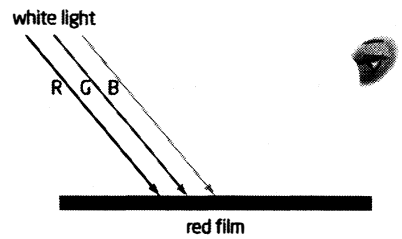
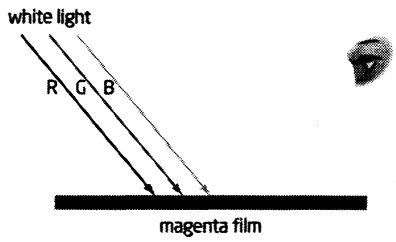
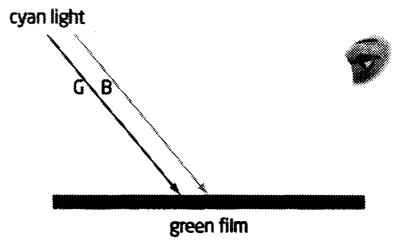
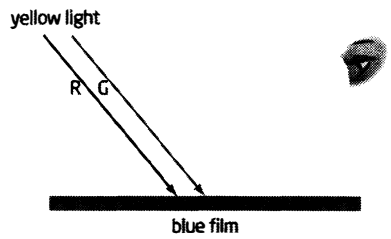
Name _____ Date _____

Illustrating Concepts
Topic 4.3

Use with textbook pages 296 to 299.

Absorption and subtractive colours

1. Complete the table, including drawing and naming the reflected light. Part a) is done for you as an example.

	Colour(s) absorbed	Colour(s) reflected	Colour equation
a) 	red, green	blue	W – (R + G) = B
b) 			
c) 			
d) 			
e) 			

Name _____ Date _____

Applying Concepts
Topic 4.3

Use with textbook pages 294 to 302.

Colourful spotlights

The stage crew for a rock band is setting up some coloured spotlights to light up the stage during a concert. There are red, blue, and yellow spotlights. A large white banner with the band's name in cyan will be hung on the back wall. The band has hired you to be the lighting consultant.

1. The band wants to begin with the stage lit in magenta. What combination of colours should be used?

_____

_____

_____

2. What sequence of lights is needed to make the band's name on the banner appear first blue, then green, and finally black?

_____

_____

_____

3. The band wants to make their grand entrance with a white spotlight aimed at the centre of the stage floor where they will rise from below. What combination of colours will produce white?

_____

_____

_____

4. The band plans to end the show with the lights changing from orange to yellow to orange. Which colour combinations are needed to achieve this?

_____

_____

_____

Name _____ Date _____

Assessment
Topic 4.3

Use with textbook pages 294 to 303.

How can you mix colours to make different colours?

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

Term	Descriptor
1. ____ additive primary colours	**A.** red, green, and blue.
2. ____ complementary colours	**B.** red, green, and yellow.
3. ____ secondary colours	**C.** cyan, magenta, and yellow.
4. ____ subtractive primary colours	**D.** generated by combining two primary colours.
5. ____ tertiary colours	**E.** generated by combining two secondary colours.
	F. a primary colour and the secondary colour created when the other two primary colours are combined.

6. Complete each equation.

a) red + blue = _____

b) green + blue = _____

c) magenta + green = _____

d) white – (cyan + yellow)

= _____

e) white – (magenta + yellow)

= _____

f) white – (green + magenta)

= _____

g) magenta – blue

= _____

7. Write two relationships between additive and subtractive colours.

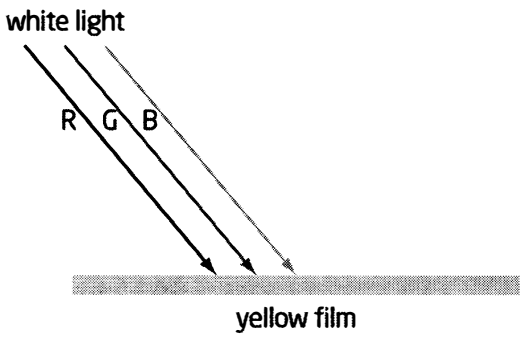
_____

_____

_____

_____

8. a) Draw, and label, which colour(s) of light will be reflected.



b) Write the colour equation.

_____

Name Date

Topic **4.4** Summary

What is the law of reflection and how do mirrors form images?

Textbook pages 304 to 331

Before You Read

How do mirrors form images? Write your ideas on the lines below.

_____

_____

Reading Check

1. According to the law of reflection, how does the angle of incidence compare with the angle of reflection?

_____

_____

_____

2. What four characteristics describe a mirror image?

_____

_____

_____

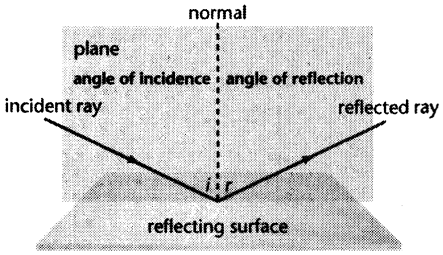
_____

The angle of reflection is equal to the angle of incidence.

Suppose you shine a light at a mirror. The **incident ray** is the light ray that travels toward the mirror. The reflected ray is the light ray that travels away from the mirror. The normal is an imaginary line drawn perpendicular (at right angles to) a surface.

The **Law of Reflection** states the following:

- The angle of reflection is equal to the angle of incidence.
- The reflected ray and the incident ray are on opposite sides of the normal.
- The incident ray, the normal, and the reflected ray lie on the same plane (flat surface).



An image has four characteristics.

The item in front of a mirror is called the **object** and its reflection is called the **image**. You can describe an image by four characteristics:

- **Location:** The distance between the image and the mirror may be shorter than, equal to, or longer than the distance between the object and the mirror. Also, the image may be behind the mirror or in front of it.
- **Orientation:**
  - An **upright** image has the same orientation as the object.
  - An **inverted** image has an orientation that is opposite or upside down compared with the object.
- **Size:** The image may be the same size as the object, or larger, or smaller.
- **Type:**
  - An image is **real** when the reflected rays meet in front of the mirror, so they do not need to be extended behind the mirror.

Name _____ Date _____

Topic **4.4** Summary

- An image is **virtual** when the reflected rays never reach the position of the image; they just appear to come from this position behind the mirror. ✔

There are three types of mirrors.

There are plane, concave, and convex mirrors.

- A **plane mirror** has a smooth, flat surface.
- A **concave mirror** caves inward at the centre.
- A **convex mirror** bulges outward at the centre.

These terms apply to concave and convex mirrors.

- The **principal axis** is a line drawn perpendicular to the centre.
- The **focal point** (*F*) is the point at which reflected rays meet when incident rays are parallel to, and near, the principal axis.
- The **centre of curvature** (*C*) is the centre of the sphere that the mirror fits on. The focal point is halfway between the centre of curvature and the mirror.
- The **focal length** (*f*) is the distance from the mirror to the focal point.

✔ ***Reading Check***

3. How are a plane mirror, a concave mirror, and a convex mirror different?

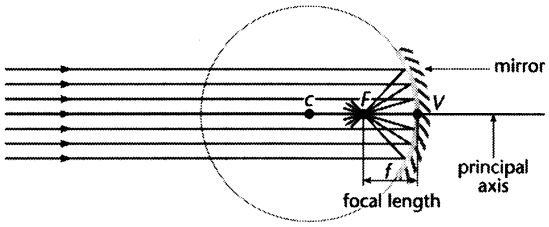
_____

_____

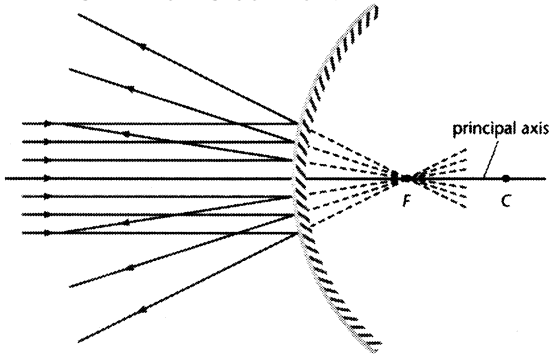
_____

_____

This mirror is concave.



This mirror is convex.



✔

Type of mirror	Image location	Image orientation	Image size	Image type
Plane	Image distance equal to object distance	Upright	Same size as object	Virtual
Concave (object between focal point and mirror)	Image distance is longer than object distance	Upright	Larger than object	Virtual
Concave (object between centre of curvature and focal point)	Image distance is longer than object distance	Inverted	Larger than object	Real
Convex	Image distance is shorter than object distance	Upright	Smaller than object	Virtual

Name Date

Cloze Activity
Topic 4.4

Use with textbook pages 304 to 331.

Plane, concave, and convex mirrors

Vocabulary

centre of curvature	normal
concave	plane
convex	principal axis
focal point	real
focal length	reflected ray
incidence	reflection
incident ray	virtual

Use the terms in the vocabulary box to fill in the blanks. You can use each term more than once. You will not need to use every term.

1. According to the law of reflection, the angle of _____ and the angle of _____ are equal.
2. The _____ is the light ray that travels toward a reflective surface.
3. The _____ is the line that is perpendicular to the surface.
4. The reflected ray and the incident ray are on opposite sides of the _____.
5. The image formed in a plane mirror is a _____ image.
6. A _____ mirror caves inward at the centre.
7. A _____ mirror bulges out at the centre.
8. A _____ mirror forms images that are identical to the objects.
9. A line that is normal to the centre of a spherical mirror and passes through the centre of curvature is called the _____ .
10. The _____ is the distance between the focal point and the mirror.
11. The focal point is located halfway between the _____ and the mirror.
12. A concave mirror forms a _____ image when the object is between the focal point and the mirror.
13. A concave mirror forms a _____ image when the object is between the centre of curvature and the focal point.

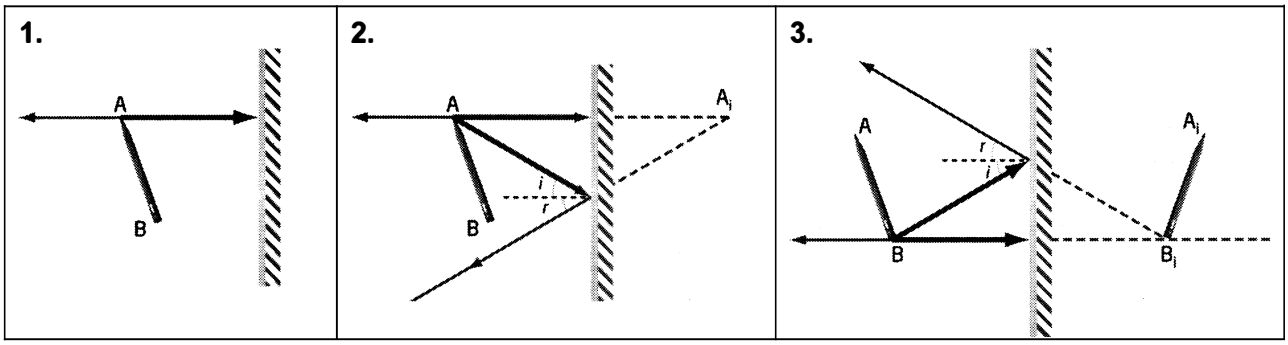
Name _____ Date _____

Illustrating Concepts
Topic 4.4

Use with textbook pages 308 to 311.

Ray diagrams for plane mirrors

These diagrams show how to locate the image of an object in a plane mirror. Refer to page 310 of your textbook for an explanation of these drawings.



1. Draw a plane mirror and an object 2 cm in front of it.
Locate the image and list its characteristics.

	Characteristics of image
	Location: _____
	Orientation: _____
	Size: _____
	Type: _____

2. Draw a plane mirror. Draw the same object as in question 1, but this time draw it 4 cm in front of the mirror. Locate the image and list its characteristics.

	Characteristics of image
	Location: _____
	Orientation: _____
	Size: _____
	Type: _____

3. Compare the images you drew. How did the change in the object's location affect the image's characteristics? _____

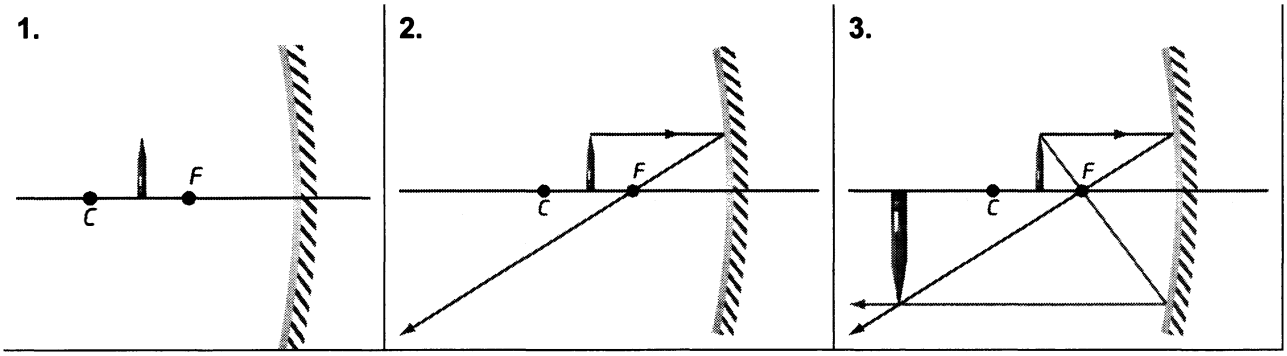
Name _____ Date _____

Illustrating Concepts
Topic 4.4

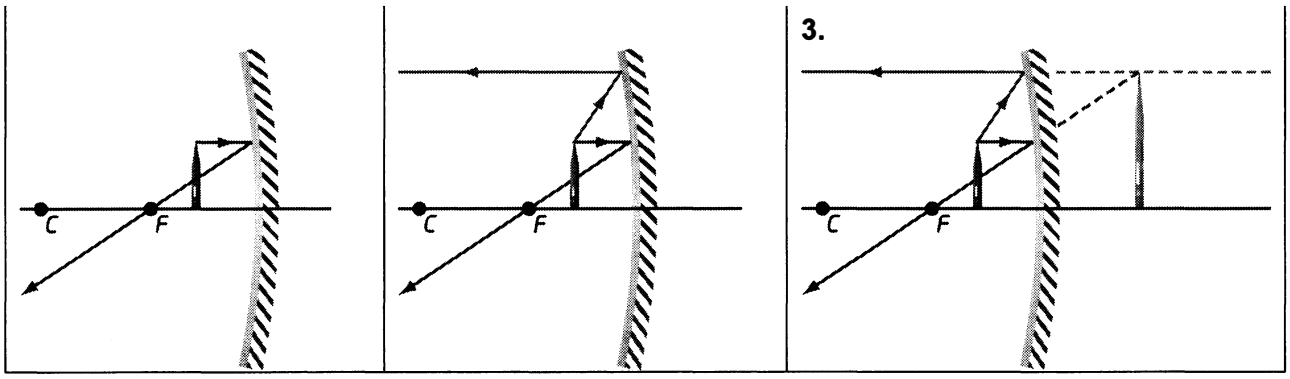
Use with textbook pages 312 to 317.

Ray diagrams for concave mirrors

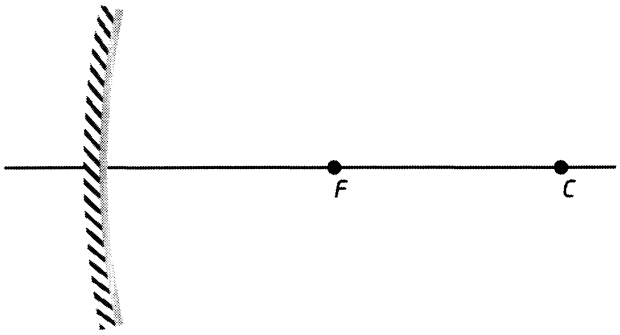
These diagrams show how to locate the real image of an object in a concave mirror. Refer to page 314 of your textbook for an explanation of these drawings.



These diagrams show how to locate the virtual image of an object in a concave mirror. Refer to page 317 of your textbook for an explanation of these drawings.



1. Draw an object 2 cm tall and 4 cm from this mirror.
Locate the image and list its characteristics.



Characteristics of image

Location: _____

Orientation: _____

Size: _____

Type: _____

2. The image in question 1 is real because the object is between the _____ and the _____. If it had been between the _____ and the _____, it would have been a virtual image.

Name _____ Date _____

Illustrating Concepts
Topic 4.4

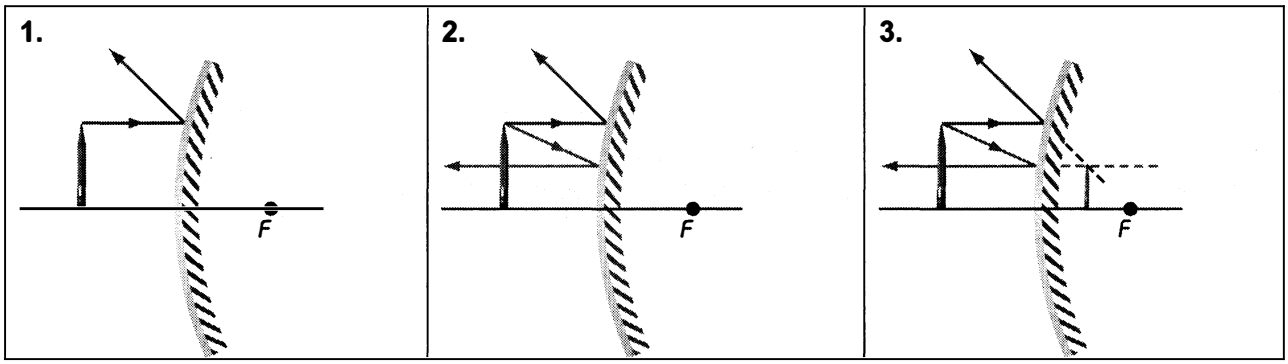
Use with textbook pages 318 to 321.

Ray diagrams for convex mirrors

The light rays that hit a convex mirror behave as follows:

- A ray parallel to the principal axis will reflect as though it were coming from the focal point.
- A ray that travels as though it were going toward the focal point will reflect back parallel to the principal axis.

These diagrams show how to locate the image of an object in a convex mirror. Refer to page 314 of your textbook for an explanation of these drawings.



1. Draw a convex mirror, its principal axis, and a focal point 4 cm behind the mirror. Draw an object 6 cm tall and 5 cm from the mirror.
Locate the image and list its characteristics.

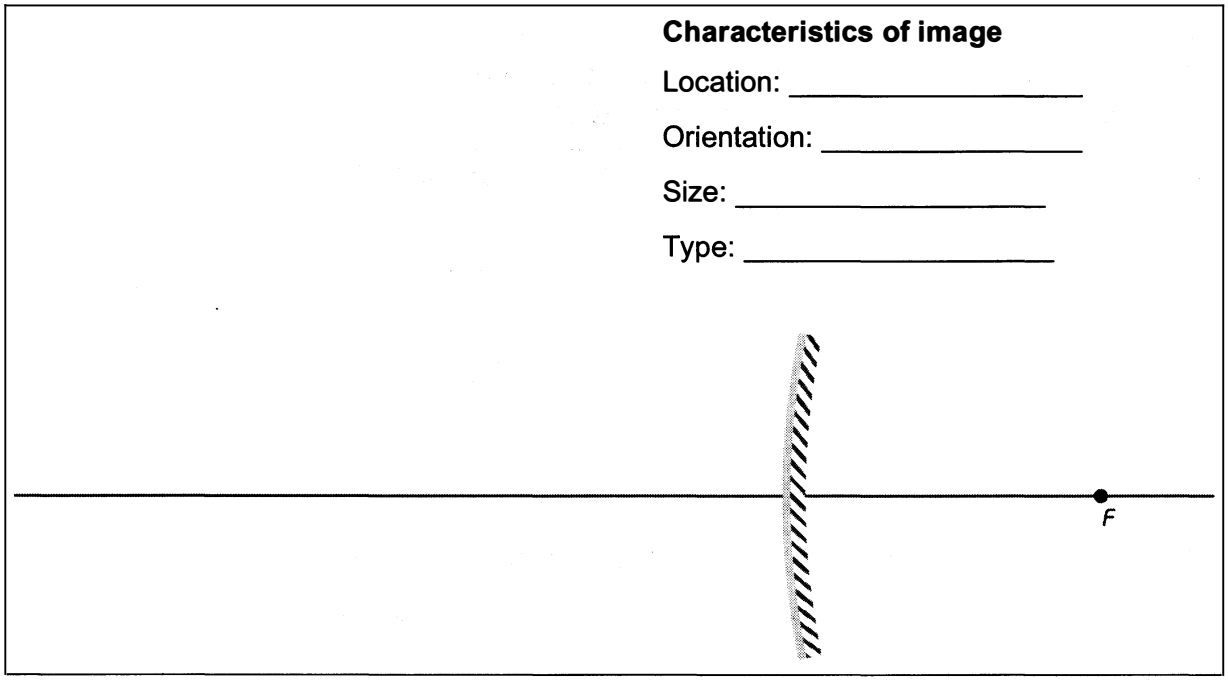
Characteristics of image

Location: _____

Orientation: _____

Size: _____

Type: _____



Name _____ Date _____

Applying Knowledge
Topic 4.4

Use with textbook pages 308 to 321.

Types of mirrors

1. Identify the type of mirror (plane, concave, or convex) that would give an image with each set of characteristics. If need be, say where the object is in relation to the focal point.

a) **location:** image distance is equal to object distance
size: same size as object
orientation: upright
type: virtual

_____
_____
_____

b) **location:** image distance is shorter than object distance
size: smaller than object
orientation: upright
type: virtual

_____
_____
_____

c) **location:** image distance is longer than object distance
size: larger than object
orientation: inverted
type: real

_____
_____
_____

d) **location:** image distance is longer than object distance
size: larger than object
orientation: upright
type: virtual

_____
_____
_____

2. Identify the type of mirror (plane, convex, or concave) that is best suited for each use. Briefly justify your answer.

a) dentist's mirror

_____
_____
_____

b) dressing room mirror

_____
_____
_____

c) safety/security mirror

_____
_____
_____

d) microscope

_____
_____
_____

e) car headlights

_____
_____
_____

f) side view mirror

_____
_____
_____

Name _____ Date _____

Assessment
Topic 4.4

Use with textbook pages 304 to 331.

What is the law of reflection and how do mirrors form images?

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

Term	Descriptor
1. _____ angle of incidence	**A.** a smooth, flat reflecting surface.
2. _____ angle of reflection	**B.** the point where reflected rays meet when incident rays are parallel to and near the principal axis.
3. _____ centre of curvature	**C.** the point that is the same distance from all points on the surface of a curved mirror.
4. _____ concave mirror	**D.** the angle between the incident ray and the normal.
5. _____ convex mirror	**E.** the angle between the reflected ray and the normal.
6. _____ focal point	**F.** an image that is formed when light rays meet and do not have to be extended backward.
7. _____ focal length	**G.** the distance from the mirror to the focal point.
8. _____ incident ray	**H.** a line drawn normal to the centre of a spherical mirror.
9. _____ normal	**I.** a line that is perpendicular to a surface.
10. _____ plane mirror	**J.** a light ray that "bounces" off a surface.
11. _____ principal axis	**K.** a light ray that is travels toward a mirror.
12. _____ reflected ray	**L.** a mirror that "caves-in".
	M. a mirror that bulges outward.

13. Draw and label a diagram that shows the law of reflection.

14. List the four characteristics used to describe mirror images.

_____

_____

_____

_____

Name Date

Topic **4.5** Summary

What is refraction and how can it be used?

Textbook pages 332 to 343

Before You Read

How can light refraction be used? Record your thoughts below.

_____

_____

Mark the Text

Identify Definitions

Highlight the definition of each word in bold type.

Reading Check

1. What causes refraction?

_____

_____

2. When does a refracted ray bend away from the normal?

_____

_____

3. Name a technology that uses refraction.

_____

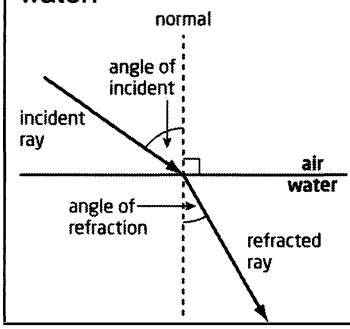
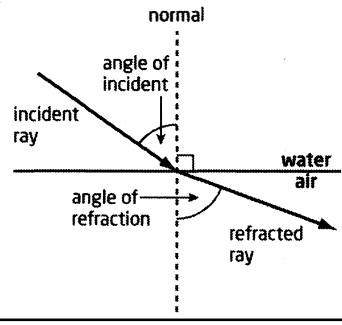
_____

_____

Refraction is light changing direction.

A material through which light travels is called a **medium**. When light passes from one medium to another, it changes direction. This change in direction, called **refraction**, occurs because light travels at different speeds in different media.

The **angle of incidence** is the angle between the **incident ray** and the normal. The **angle of refraction** is the angle between the **reflected ray** and the normal. These two angles are not equal.

Light bends toward the normal as it passes from a medium in which it travels quickly into a medium in which it travels slowly—for example from air to water. 	Light bends away from the normal as it passes from a medium in which it travels slowly into a medium in which it travels quickly—for example, from water to air. 

Refraction is used in communications technologies.

Refraction is used in fibre optics communications (telephone, cable television, high-speed Internet). Optical fibres can carry information for long distances at nearly the speed of light. They are more practical than copper wires because they are not affected by electrical storms. Also, fibre optic cables are smaller, are lighter, and can carry more signals over a longer distance.

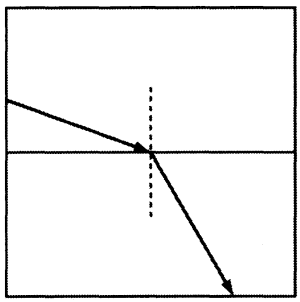
Name _____ Date _____

Illustrating Concepts
Topic 4.5

Use with textbook pages 334 to 339.

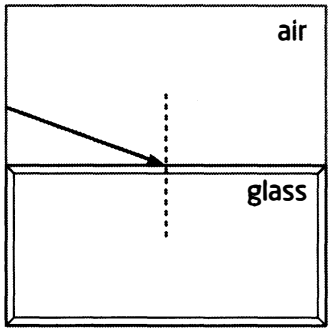
Bending Light

1. Label the incident ray, refracted ray, angle of incidence, and angle of refraction in this diagram.

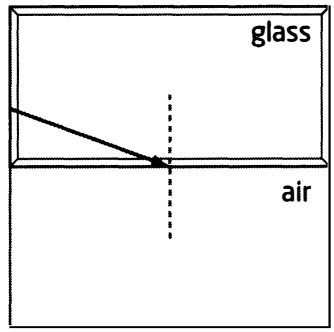


2. Draw the refracted ray in each diagram. Keep in mind light travels least quickly in glass, more quickly in water, and most quickly in air.

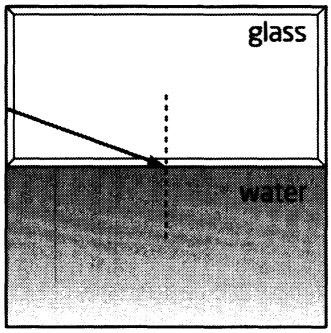
a)



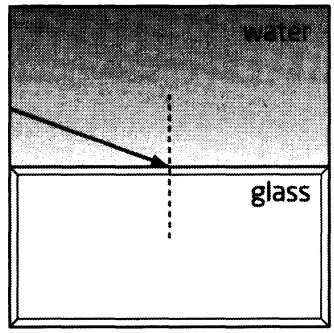
b)



c)

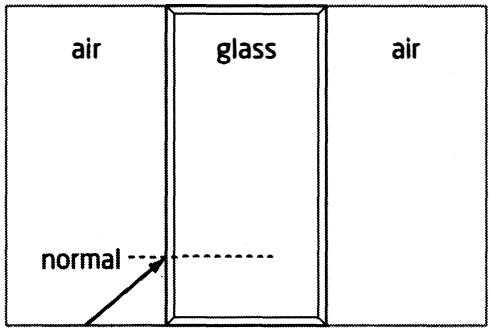


d)

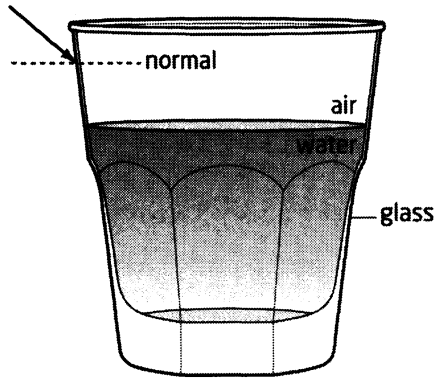


3. Complete the ray diagram to show the path that a light ray takes.

a)



b)



Name _____ Date _____

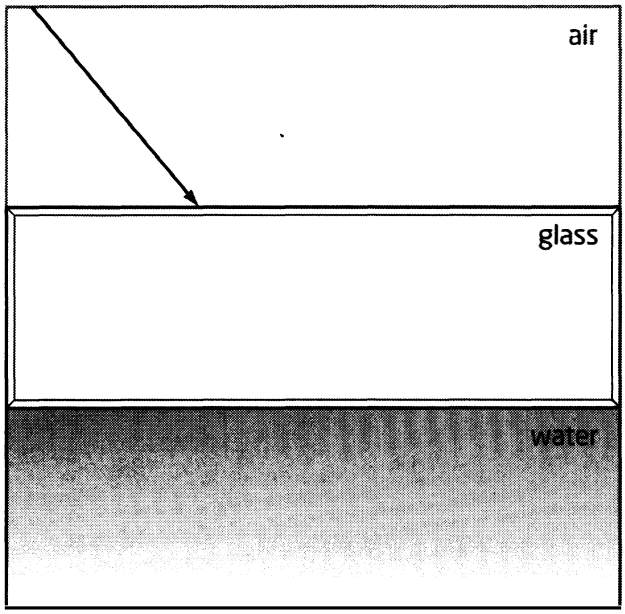
Applying Knowledge
Topic 4.5

Use with textbook pages 336 to 338.

Applications of refraction

1. The diagram shows a layer of air, glass, and water. A light ray from the air is about to enter the glass.
The speed of light in air is 3.0×10^8 m/s.
The speed of light in glass is 2.0×10^8 m/s.
The speed of light in water is 2.25×10^8 m/s.

a) Draw the light ray as it passes from the air, through the glass, and through the water.



b) Briefly explain why you drew the light's path as you did.

_____

_____

_____

2. You are given two sealed containers of liquid that look alike. Your classmate says the two liquids are actually different. You cannot unseal the containers. Describe an experiment you could try to determine whether the liquids might be different.

_____

_____

_____

_____

_____

Name _____ Date _____

Assessment
Topic 4.5

Use with textbook pages 332 to 343.

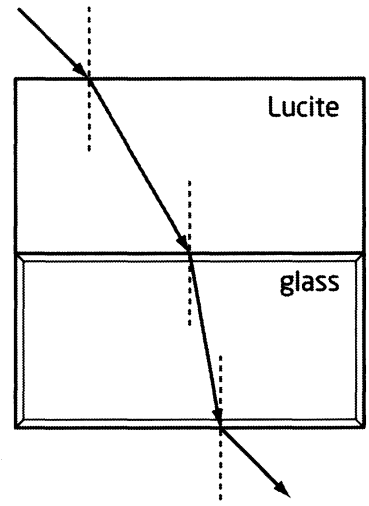
What is refraction and how can it be used?

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

Term	Descriptor
1. _____ angle of refraction	**A.** the change in direction light takes when it crosses a boundary between two media.
2. _____ medium	**B.** the angle of incidence for which the angle of refraction is 90°.
3. _____ refracted ray	**C.** the ray that has crossed a boundary between two media.
4. _____ refraction	**D.** the angle between the refracted ray and the boundary between the two media.
	E. the angle between the refracted ray and the normal at the point at which the ray crossed the boundary.
	F. the substance through which light travels.

5. Light travels more quickly in ice than in water. Draw a ray diagram of a light ray travelling through ice into water. Label the two different media, the boundary between them, an incident ray, a refracted ray, the normal, the angle of incidence, and the angle of refraction.

6. In this diagram a ray of light travels through air, Lucite, glass, and air again. Does light travel more quickly in Lucite or glass? Explain your reasoning.



Name Date

Topic **4.6** Summary

What are lenses and what are some of their applications?

Textbook pages 344 to 355

Before You Read

What are lenses and how can we use them? Record your thoughts below.

_____

_____

Mark the Text

Check for Understanding
As you read this section, stop and reread any parts you do not understand. Highlight the sentences that help you to understand better.

Reading Check

1. What is a lens?

_____

_____

_____

_____

2. What is the difference between a converging lens and a diverging lens?

_____

_____

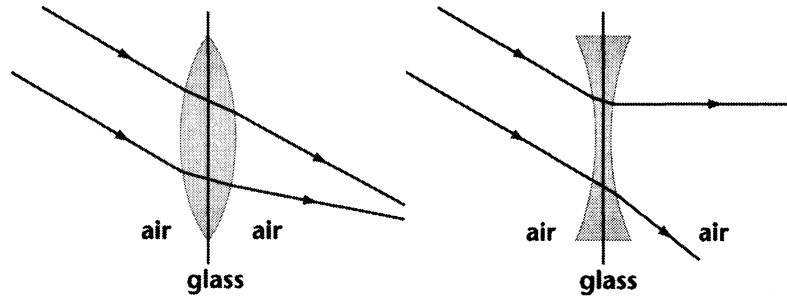
_____

_____

There are three types of lenses.

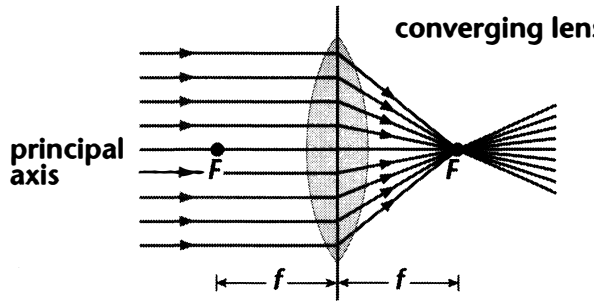
A **lens** is a thin, transparent piece of glass or plastic that has at least one curved side. The sides may be concave, convex, or plane. A **converging lens** (convex) makes light rays come together. A **diverging lens** (concave) make light rays move apart.

This is a converging lens. This is a diverging lens.



Converging lenses produce different types of images.

When parallel rays pass through a converging lens, they meet at one point, called the **focal point**. Each converging lens has two focal points, one on each side. The focal length is the distance between the focal point and the lens.



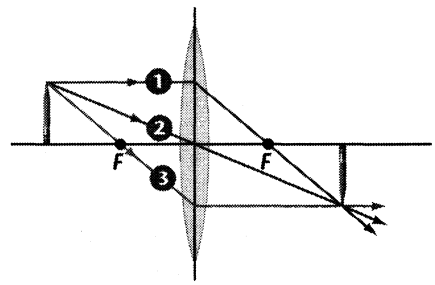
Name Date

Topic **4.6** Summary

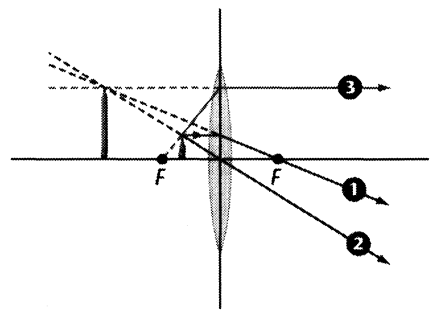
Here is how to draw a ray diagram for a converging lens.

1. Draw a ray parallel to the principal axis, which passes through the lens and refracts to pass through the focal point on the other side.
2. Draw a ray through the centre of the lens that continues on in the same direction.
3. Draw a ray that enters the lens from the focal point and exits the lens parallel to the principal axis.

When the object is beyond the focal point, as shown on the right, the image is real and inverted. The top of the image will be at the point at which the three rays meet. The bottom of the image will be on the principal axis.



When an object is between the focal point and the lens, as shown on the right, the image is virtual, upright, and larger than the object. The three rays spread apart and do not meet. They need to be extended until they meet, as the dotted lines show. The top of the image will be at the point at which the extended rays meet. The bottom of the image will be on the principal axis.



Reading Check

3. What factor determines the location and size of the image produced by a converging lens?

_____

_____

_____

4. When would you use extended rays to find the image produced by a converging lens?

_____

_____

_____

_____

Images Produced by a Converging Lens			
Object location	**Image orientation**	**Image size**	**Image type**
Beyond focal point	Inverted	Varies	Real
Between lens and focal point	Upright	Larger than object	Virtual

Name _____ Date _____

Comprehension
Topic 4.6

Use with textbook pages 346 to 351.

How a converging lens works

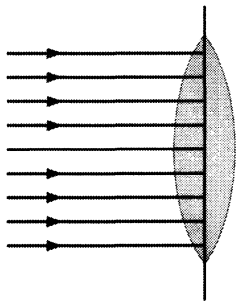
1. Explain why a lens has two focal points instead of one.

_____

_____

2. **(a)** Label the principal axis, axis of symmetry, focal point (*F*), and focal length (*f*) in this diagram.

   (b) Show how a beam of parallel rays would travel through the lens to the other side.



Converging lens

3. Complete the rules for drawing ray diagrams. Match the start of each sentence in column A with the correct ending in column B.

A	B
a) Any ray that enters the lens parallel to the principal axis will …	**i.** keep travelling in the same direction.
b) Any ray that travels through the centre of the lens will …	**ii.** leave the lens parallel to the principal axis.
c) Any ray that enters the lens from the focal point will …	**iii.** pass through the focal point on the other side of the lens.

4. Complete the table.

Images Produced by a Converging Lens			
Object location	**Image orientation**	**Image size**	**Image type**
Between lens and focal point			
Beyond focal point			

Name _____ Date _____

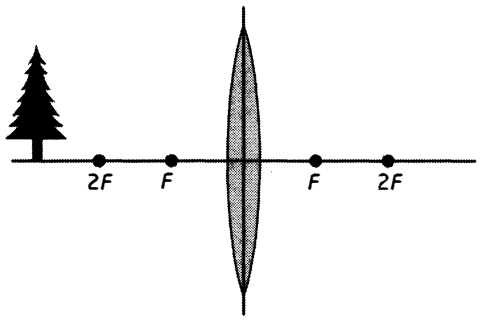
Illustrating Concepts
Topic 4.6

Use with textbook pages 350 to 353.

Images produced by a converging lens

1. Locate the image in each ray diagram. Then, list its characteristics.

a) The object is beyond 2F (twice the distance of the focal point).



Characteristics of image

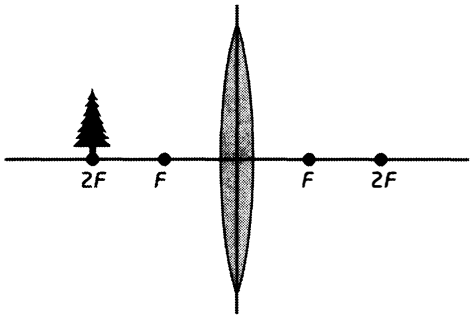
Location: _____

Orientation: _____

Size: _____

Type: _____

b) The object is at 2F.



Characteristics of image

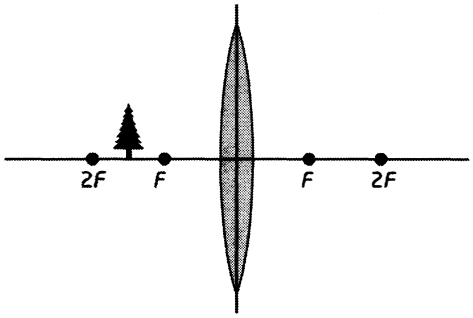
Location: _____

Orientation: _____

Size: _____

Type: _____

c) The object is between 2F and F.



Characteristics of image

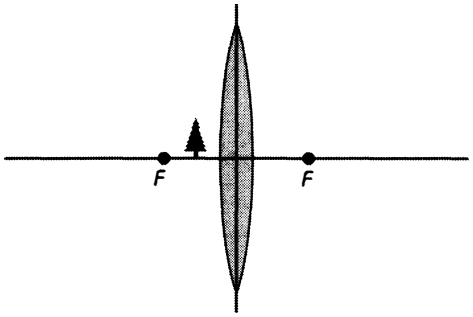
Location: _____

Orientation: _____

Size: _____

Type: _____

d) The object is between F and the lens.



Characteristics of image

Location: _____

Orientation: _____

Size: _____

Type: _____

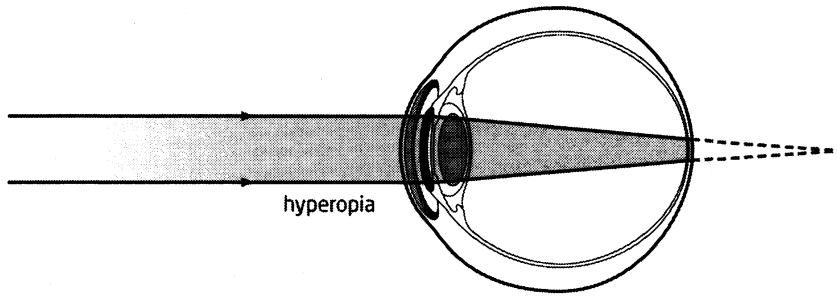
Name _____ Date _____

Applying Knowledge
Topic 4.6

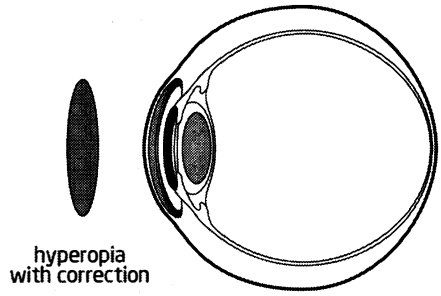
Use with textbook pages 346 to 353.

Devices that use a converging lens

1. The human eye normally focuses the image of an object on the retina. However, people who are farsighted find the image of a close object blurry because the image is focussed behind the retina.



Farsightedness can be corrected with a converging lens. Draw how this can be done in the diagram. The added converging lens helps to focus the image on the retina, instead of behind it.



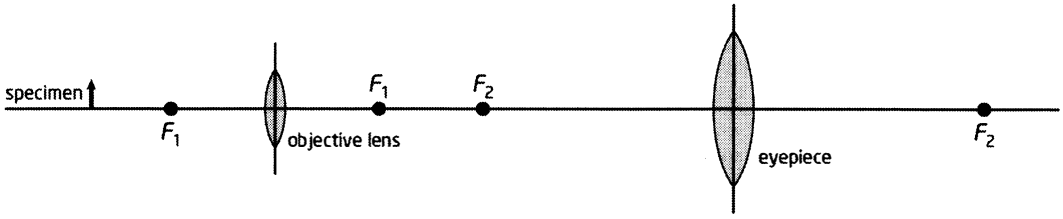
2. A compound microscope magnifies an object using two converging lenses: the objective lens and the eyepiece lens.

(a) On the ray diagram below, locate the image of the object formed by the objective lens. Describe the size and orientation of the image.

size of image: _____ orientation of image: _____

(b) Use the image you drew in part (a) as the object the eyepiece lens magnifies. Complete the diagram to locate the second image. Describe the size and orientation of the image.

size of image: _____ orientation of image: _____



Name _____ Date _____

Assessment
Topic 4.6

Use with textbook pages 344 to 355.

What are lenses and what are some of their applications?

Match each Descriptor on the left with the Lens on the right. Each Lens may be used more than once.

Descriptor	Lens
1. _____ the reading stone was this type of lens	**A.** converging lens
2. _____ The sides of this lens are concave.	**B.** diverging lens
3. _____ The sides of this lens are convex.	
4. _____ This lens makes light rays come together.	
5. _____ This lens makes light rays move apart.	

6. Suppose a light ray enters a converging lens parallel to the principal axis. How will it travel after it leaves the lens?

_____

_____

_____

_____

_____

7. a) Draw a principal axis and a vertical line through it to represent the centre of a converging lens. Draw a focal point on each side of the lens, 2 cm from the lens. Draw a 1 cm high object 3 cm from the centre of the lens. Locate the image.

b) Describe the image.

Size: _____

Location: _____

Orientation: _____

Type: _____

8. What happens to an image's size and orientation as the object moves closer to a converging lens?

Size: _____

Orientation: _____

9. How far must an object be from a converging lens for the lens to act as a magnifying glass that produces an image that is larger and upright?

_____

_____

_____

Name Date

Unit 4

Literacy Test Preparation

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

The Lights and Colours of Fireworks

With a resounding "BOOM!" bright lights explode in the night sky and a display of star patterns and colours awe the spectators below. From the time the firework is lit to the time it explodes in the sky, there is a well-timed sequence of events to produce the desired effect of lights and colours.

Fireworks have become a traditional part of holiday celebrations since they were invented almost a thousand years ago. When most people think of fireworks, they think of bright lights and colours exploding in the sky. These kinds of fireworks are called aerial shells, as opposed to fireworks that are used on the ground, such as sparklers.

Most aerial shells are launched and exploded using gunpowder. Gunpowder is a mixture of 75 percent potassium nitrate, 15 percent charcoal or sugar, and 10 percent sulfur. These substances react with one another when enough heat is supplied. When an aerial shell is lit, the burning gunpowder produces nitrogen and carbon dioxide. These gases propel the firework into the sky. A second package of gunpowder, oxide, and colourants explodes with a bang. The shape of the firework depends on how the components are packed into the firework shell. The colours of the firework depend on what metal salts are used.

Colour production in fireworks involves incandescence and luminescence. Incandescence is the light emitted by a heated object. As the object gets hotter, the light it emits changes colour, from infrared, to red, to orange, to yellow, and lastly to white light. Because of this colour change, it is possible to get a desired colour in a firework by controlling its temperature. For example, the incandescence of iron with carbon or charcoal produces a gold colour.

Luminescence is the light emitted by an unheated object. When the metal salts are heated, the electrons in the salts' atoms absorb the energy, and as a result they become excited and unstable. As these electrons return to their ground state, they release the energy in the form of photons (light). The energy of the photons determines the wavelength (colour) of the metal salts. The amount of energy released varies from element to element, so each metal salt produces its own colour. For example, calcium salts produce orange and barium compounds produce green.

At one time, we used fireworks that were harmful to the environment. For example, some fireworks used toxic metals to create colours, or burned carbon, which produced black smoke. Today we tend to use environmentally friendly fireworks. These fireworks use nitrogen-rich compounds and non-toxic metals to create colours. For example, lithium salts produce red, sodium compounds produce orange, and potassium produces violet.

Name _____ Date _____

Unit **4**

Multiple Choice

(Select the best or most correct answer.)

1. What determines a firework's colour?

A. the metal salts in the firework
B. the packing of the components in the firework shell
C. the type of firework used (sparkler or aerial shell)
D. the temperature of the night air

2. Which process(es) is (are) involved in the colour production of fireworks?

A. incandescence only
B. luminescence only
C. incandescence and luminescence
D. additive and subtractive colours

3. What happens to the excited electrons of metal salt atoms when they return to their ground state?

A. They release the energy in the form of photons (light).
B. They release the energy in the form of heat.
C. They react with other metal salt atoms to produce a gas.
D. They absorb more energy from the burning gunpowder.

4. Which colour-producing metals are in environmentally friendly fireworks?

A. barium compounds
B. calcium salts
C. sodium compounds
D. nitrogen-rich compounds

Short Answer

5. Summarize this selection. Include the processes used to produce colours in fireworks.

_____

_____

_____

_____

_____

_____

Name Date

Appendix

Periodic Table of the Elements

metal
metalloid
non-metal

Atomic Number → 22
Symbol → Ti
Name → Titanium
Atomic Mass → 47.9
Ion charge(s) → 4+ 3+

O natural
Db synthetic

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 1+ H Hydrogen 1.0																	2 0 He Helium 4.0
2	3 1+ Li Lithium 6.9	4 2+ Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 3– N Nitrogen 14.0	8 2– O Oxygen 16.0	9 1– F Fluorine 19.0	10 0 Ne Neon 20.2
3	11 1+ Na Sodium 23.0	12 2+ Mg Magnesium 24.3											13 3+ Al Aluminum 27.0	14 Si Silicon 28.1	15 3– P Phosphorus 31.0	16 2– S Sulfur 32.1	17 1– Cl Chlorine 35.5	18 0 Ar Argon 39.9
4	19 1+ K Potassium 39.1	20 2+ Ca Calcium 40.1	21 3+ Sc Scandium 45.0	22 4+ 3+ Ti Titanium 47.9	23 5+ 4+ V Vanadium 50.9	24 3+ 2+ Cr Chromium 52.0	25 2+ 3+ 4+ Mn Manganese 54.9	26 3+ 2+ Fe Iron 55.8	27 2+ 3+ Co Cobalt 58.9	28 2+ 3+ Ni Nickel 58.7	29 2+ 1+ Cu Copper 63.5	30 2+ Zn Zinc 65.4	31 3+ Ga Gallium 69.7	32 4+ Ge Germanium 72.6	33 3– As Arsenic 74.9	34 2– Se Selenium 79.0	35 1– Br Bromine 79.9	36 0 Kr Krypton 83.8
5	37 1+ Rb Rubidium 85.5	38 2+ Sr Strontium 87.6	39 3+ Y Yttrium 88.9	40 4+ Zr Zirconium 91.2	41 3+ 5+ Nb Niobium 92.9	42 2+ 3+ Mo Molybdenum 95.9	43 7+ Tc Technetium (98)	44 3+ 4+ Ru Ruthenium 101.1	45 3+ 4+ Rh Rhodium 102.9	46 2+ 4+ Pd Palladium 106.4	47 1+ Ag Silver 107.9	48 2+ Cd Cadmium 112.4	49 3+ In Indium 114.8	50 4+ 2+ Sn Tin 118.7	51 3+ 5+ Sb Antimony 121.8	52 2– Te Tellurium 127.6	53 1– I Iodine 126.9	54 0 Xe Xenon 131.3
6	55 1+ Cs Cesium 132.9	56 2+ Ba Barium 137.3	57 3+ La Lanthanum 138.9	72 4+ Hf Hafnium 178.5	73 5+ Ta Tantalum 180.9	74 6+ W Tungsten 183.8	75 4+ 7+ Re Rhenium 186.2	76 3+ 4+ Os Osmium 190.2	77 3+ 4+ Ir Iridium 192.2	78 4+ 2+ Pt Platinum 195.1	79 3+ 1+ Au Gold 197.0	80 2+ 1+ Hg Mercury 200.6	81 1+ 3+ Tl Thallium 204.4	82 2+ 4+ Pb Lead 207.2	83 3+ 5+ Bi Bismuth 209.0	84 2+ 4+ Po Polonium (209)	85 1– At Astatine (210)	86 0 Rn Radon (222)
7	87 1+ Fr Francium (223)	88 2+ Ra Radium (226)	89 3+ Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Uub* Ununbium (285)	113 Uut* Ununtrium (284)	114 Uuq* Ununquadium (289)	115 Uup* Ununpentium (288)	116 Uuh* Ununhexium (292)		118 Uuo* Ununoctium (294)

* Temporary names

58 3+ 4+ Ce Cerium 140.1	59 3+ 4+ Pr Praseodymium 140.9	60 3+ Nd Neodymium 144.2	61 3+ Pm Promethium (145)	62 3+ 4+ Sm Samarium 150.4	63 3+ 2+ Eu Europium 152.0	64 3+ Gd Gadolinium 157.3	65 3+ 4+ Tb Terbium 158.9	66 3+ Dy Dysprosium 162.5	67 3+ Ho Holmium 164.9	68 3+ Er Erbium 167.3	69 3+ 2+ Tm Thulium 168.9	70 3+ 2+ Yb Ytterbium 173.0	71 3+ Lu Lutetium 175.0
90 4+ Th Thorium 232.0	91 5+ 4+ Pa Protactinium 231.0	92 6+ 4+ 5+ U Uranium 238.0	93 5+ 3+ 4+ 6+ Np Neptunium (237)	94 4+ 6+ 3+ 5+ Pu Plutonium (244)	95 3+ 4+ 5+ 6+ Am Americium (243)	96 3+ Cm Curium (247)	97 3+ 4+ Bk Berkelium (247)	98 3+ Cf Californium (251)	99 3+ Es Einsteinium (252)	100 3+ Fm Fermium (257)	101 2+ 3+ Md Mendelevium (258)	102 2+ 3+ No Nobelium (259)	103 3+ Lr Lawrencium (262)

Based on mass of C-12 at 12.00.

Any value in parentheses is the mass of the most stable or best known isotope for elements that do not occur naturally.

Name Date

Balancing Chemical Equations

To balance a chemical equation, follow the steps below.

Step 1 Make a table with the reactants and products. Count and record how many of each type of atom are on each side of the equation.

$Na + CuCl_2 \rightarrow Cu + NaCl$

Reactants	Products
1 Na	1 Na
1 Cu	1 Cu
2 Cl	1 Cl

Step 2 Identify an unbalanced atom. *Multiply* the compound on the other side of the equation, which contains that atom, by a coefficient to balance this atom in the reaction. Change the numbers in your table to indicate the change.

$Na + CuCl_2 \rightarrow Cu + 2\ NaCl$

Reactants	Products
1 Na	**2** Na
1 Cu	1 Cu
2 Cl	**2** Cl

Chlorine is unbalanced. Since there is only 1 Cl atom on the product side, place the coefficient 2 in front of NaCl. (This means that you multiply NaCl by 2.) The coefficient must go in front of the whole compound, because it applies to the Na atoms and the Cl atoms in the whole compound.

Step 3 Repeat what you did in step 2 for any other unbalanced atoms, until all the atoms balance.

$2\ Na + CuCl_2 \rightarrow Cu + 2\ NaCl$

Reactants	Products
2 Na	**2** Na
1 Cu	1 Cu
2 Cl	**2** Cl

Now sodium is unbalanced. Since there are now 2 Na on the product side and there is only 1 Na on the reactant side, place the coefficient 2 in front of Na on the reactant side. (Multiply Na by 2.)

Step 4 Count the atoms on each side of the chemical equation to make sure that they are all balanced.

Name _____ Date _____

Glossary

How to Use This Glossary

This Glossary provides the definitions of the key terms that are shown in boldface type in the workbook. Definitions for other important terms are included as well. The Glossary entries also show the numbers of the topics where you can find the words.

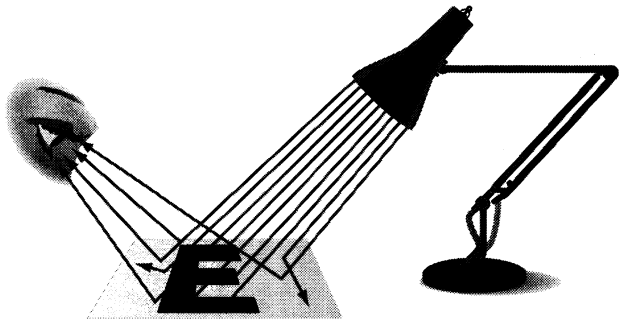
A pronunciation guide, using the key below, appears in square brackets after selected words.

a = mask, back	i = simple, this	uhr = insert, turn
ae = same, day	ih = idea, life	s = sit
ah = car, farther	oh = home, loan	z = zoo
aw = dawn, hot	oo = food, boot	zh = equation
e = met, less	u = wonder, Sun	
ee = leaf, clean	uh = taken, travel	

Emphasis is placed on the syllable(s) in CAPITAL letters.

A

absorption *In Biology:* the process by which nutrients diffuse or are moved from the digestive system to the blood; *In Optics:* the process in which light energy remains in the object that it hits, and the light energy is converted into heat; as shown here, black text on a white page appears black because all light is absorbed (1.4, 4.2) ▼

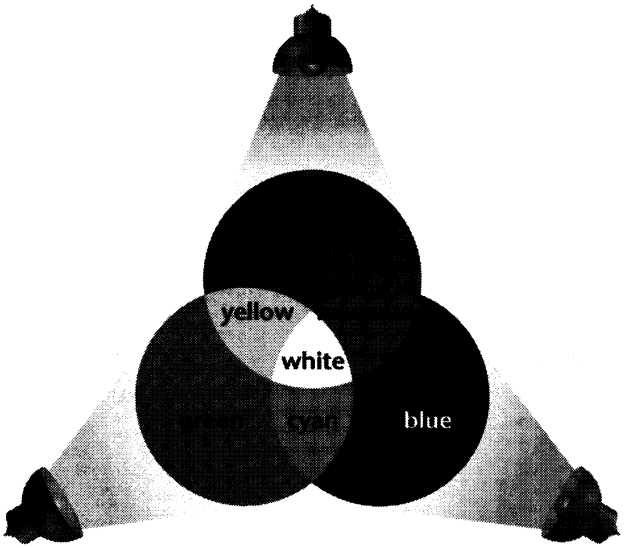


acid deposition more commonly known as acid rain; precipitation that has a pH less than 5.6 (2.4)

acid a compound that tastes sour, corrodes metals and tissue, and turns blue litmus paper red (2.4)

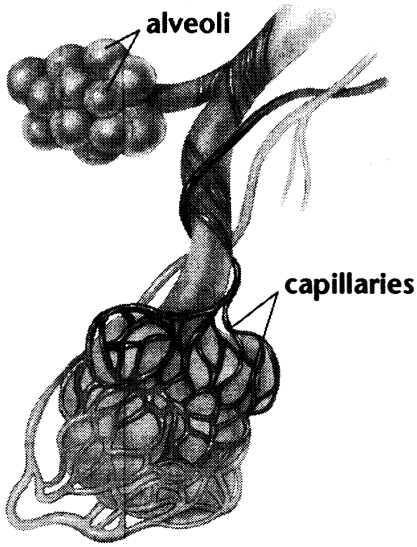
acid-base indicator a substance that changes colour when added to an acid or a base (2.4)

additive primary colours red, green, and blue; when these colours of light are combined, they produce the additive secondary colours; if all three additive primary colours are overlapped, they "add up" to form white, as shown (4.3) ▼

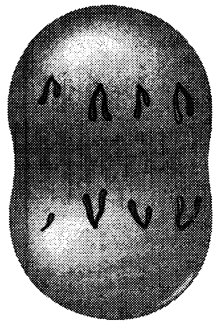


additive secondary colours cyan, magenta, and yellow; produced by combining the additive primary colours, as shown above (4.3) ▲

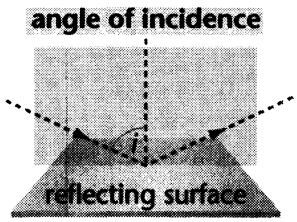
alveoli [AL-vee-OH-lih] air sacs in the lungs where gas exchange occurs (singular is alveolus) (1.4) ▼



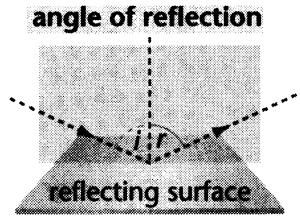
anaphase [AN-uh-faez] the third phase of mitosis, when the chromosomes separate and move to opposite ends of the cell (1.2) ▼



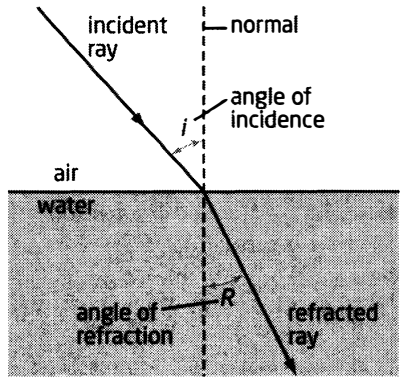
angle of incidence (*i*) the angle between the incident ray and the normal (4.4) ▼



angle of reflection (*r*) the angle between the reflected ray and the normal (4.4) ▼



angle of refraction (*R*) the angle between the refracted ray and the normal (4.5) ▼



antacid non-toxic base that is used to neutralize stomach acid; relieves the pain of excess stomach acid (acid reflux or heartburn) (2.4)

anthropogenic [AN-thruh-puh-JEN-ik] caused by humans (3.4)

anthropogenic greenhouse effect a process in which human-produced greenhouse gases in Earth's atmosphere absorb heat energy from the Sun and Earth's surface (3.4)

anus [AE-nus] part of the digestive system through which feces are eliminated (1.4)

arteries thick-walled, elastic blood vessels that carry blood away from the heart (1.4)

atmosphere the layer of gases above Earth's surface; helps to moderate (even out) temperatures so they are not too extreme; transfers heat around the globe (3.1, 3.3)

average global temperature an average calculated from air temperatures measured in numerous places worldwide (3.1)

B

balanced chemical equation represents a chemical reaction using coefficients (numbers in front of the reactants and products) that tell you how much of the reactants are used and how much of the products are made (2.3) ▼

$$2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2$$

The 2 in front of Na means two atoms of Na or Na Na

The 2 in front of H_2O means 2 sets of H_2O
2 × H_2 = H H H H
2 × O = O O

The 2 in front of NaOH means 2 sets of NaOH
2 × Na = Na Na
2 × O = O O
2 × H = H H

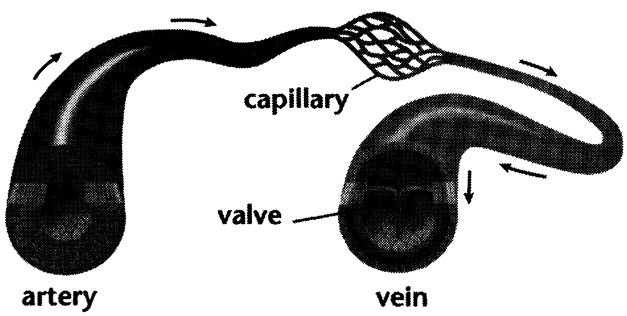
If there is no coefficient, it means a 1, so 1 set of H_2 = H H

base a compound that tastes bitter, has a slippery texture, corrodes tissue, and turns red litmus paper blue (2.4)

bioclimate profile a method for communicating climate-projection information; a graph of temperature and moisture conditions of a particular site over a period of time (3.5)

bioluminescence [BIH-oh-LOOM-in-E-sens] light that is released through biochemical processes in living organisms (4.1)

blood vessels elements of the circulatory system that transport blood; include arteries, veins, and capillaries (1.4) ▼

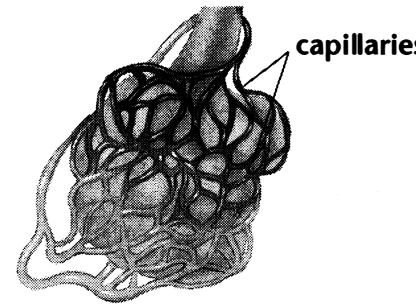


C

calcium carbonate commonly known as lime; a chemical that is added to lakes affected by acid rain to neutralize the water (2.4)

cancer cells with abnormal genetic material that are dividing uncontrollably and can spread to other parts of the body (1.2)

capillary [kuh-PIL-uh-ree] tiny blood vessels that play an important role in gas exchange (1.4) ▼



carbon dioxide second-most-abundant greenhouse gas; produced in and by the cells of most living organisms through cellular respiration (3.3)

carbon footprint the total amount of greenhouse gas emissions caused by an individual, company, or organization (3.5)

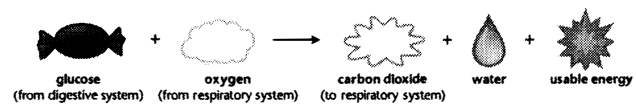
carbon sink a process that absorbs and stores carbon dioxide from the atmosphere (3.3)

cell cycle the continuous series of events in the life of a cell in which it is born, grows, reproduces, and dies (1.2)

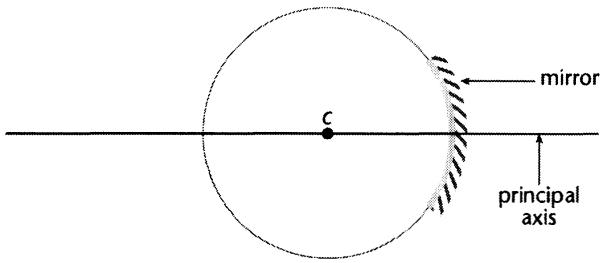
cell differentiation the series of events through which stem cells develop into specialized cells (1.3)

cell membrane semi-permeable membrane that separates the inside of the cell from the external environment; controls the flow of materials into and out of the cell (1.1)

cellular respiration a process in the cells of most living things that converts the energy stored in chemical compounds into usable energy; the word equation for the process is shown here (1.4) ▼

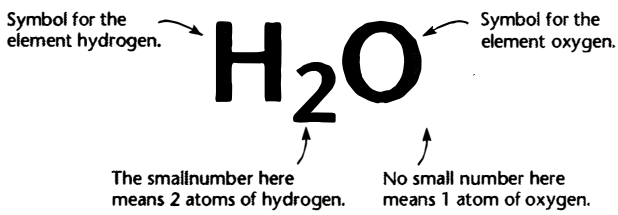


centre of curvature (*C*) the centre of the imaginary sphere that a curved mirror fits on (4.4) ▼



chemical equation an equation that uses chemical symbols to represent reactants and products in a chemical reaction (2.3)

chemical formula a group of letters and subscript numbers that represent the make-up of a chemical compound (2.2) ▼



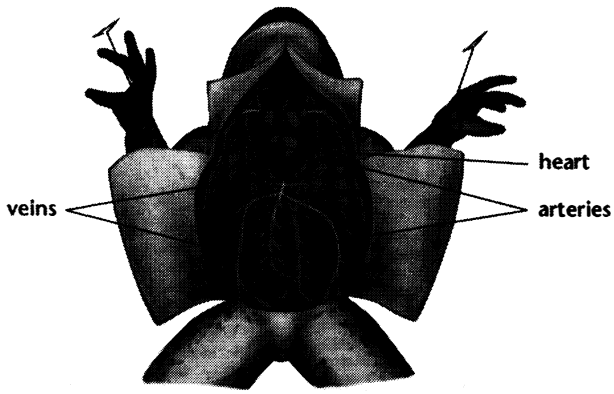
chemical reaction a change in matter that produces new substances with new properties (2.1)

chemiluminescence [KEM-ee-loo-min-ES-uhns] light that is released during chemical reactions; the process that allows glow sticks to give off light (4.1)

chlorofluorocarbons (CFCs) [KLOR-oh-FLUHR-oh-kar-buns] damaging greenhouse gases; used in the past as solvents and as coolants in refrigerators, but banned due to the damage they cause to the atmosphere's ozone layer (3.4)

chromosomes a super-condensed form of chromatin formed during cell division; because they are compact, they are a convenient way to pass on hereditary information when a cell divides. (1.2)

circulatory system transports blood, nutrients, gases, and wastes within the body; helps to control temperature, fluid balance, and acidity (1.3) ▼



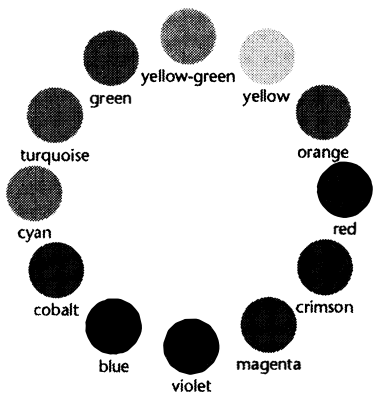
climate change a change in the weather conditions that a region experiences over a long period of time; refers not only to changes in temperature patterns, but also to changes to long-term patterns in other parts of weather such as precipitation (rain and snow), wind, and storms (3.1)

climate projection a prediction of how climate may change in the future, usually based on a global climate model (3.5)

climate the pattern of weather conditions within a region over a long period of time (3.1)

coefficient [KOH-ee-FI-shunt] the number in front of a product or reactant in a balanced chemical equation; tells you how much of the reactant or product is used (2.3)

colour wheel a graphic organizer that summarizes the additive and subtractive primary colours, the secondary colours, the complementary colours, and the tertiary colours (4.3) ▼



Name Date

complementary colours red/cyan, green/magenta, and blue/yellow; pairs of colours that can be combined to form white, or subtracted to form black; a primary colour and the secondary colour created by mixing the other two primary colours; colours that are directly across from each other on a colour wheel (4.3)

concave mirror a reflecting surface that curves inward or "caves in" in the centre (4.4) ▼

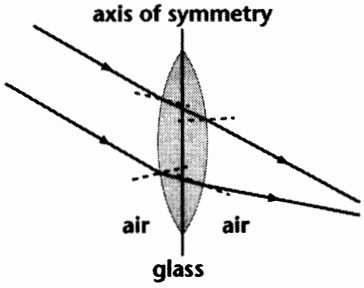
concentration the number of molecules of a substance in a given volume (1.1)

conductivity ability to conduct (transfer) electricity; can also refer to ability to transfer heat (2.2)

connective tissue strengthens, supports, or connects cells and tissues (1.3)

converge come together (4.6)

converging lens lens that makes light rays come together; curved outward on at least one side; also known as a convex lens (4.6) ▼

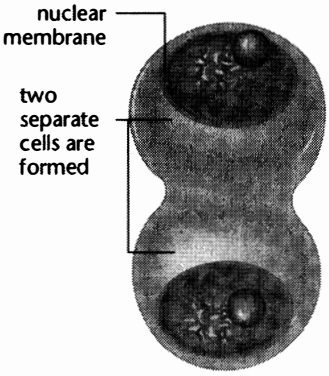


convex mirror a mirror that bulges out in the centre; shaped like the outside of a piece of a sphere (4.4) ▼

coral animal that lives in the ocean, in a close association with algae (3.2)

CT (computerized axial tomography) scan imaging technique that produces a 3-D image that looks like slices of the body; used to view hard tissue, such as bone, and to diagnose bone injuries and malformations (1.5)

cytokinesis [SIH-toh-kuh-NEE-sus] the stage in the cell cycle when the cytoplasm and organelles divide into two identical, separate cells (1.2) ▼



cytoplasm [SIH-toh-PLAZ-um] includes the organelles, and other life-supporting materials, such as sugar and water, all contained by the cell membrane (1.1)

cytoskeleton [SIH-toh-SKEL-uh-tuhn] filaments and tubules that provide a framework for the cell, helping it maintain its structure and providing "tracks" along which vesicles and organelles can move (1.1)

D

decomposition reaction a type of reaction in which one compound breaks down into two or more simpler compounds or elements (2.3) ▼

$$AB \rightarrow A + B$$

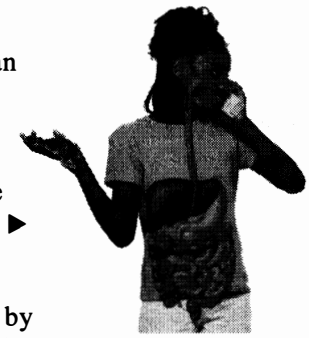
deforestation a practice in which large areas of forest are cleared of their trees; results in less carbon dioxide being removed from the atmosphere through photosynthesis (3.4)

desertification [duh-zuhr-tuh-fuh-KAE-shun] the spread of deserts; affects all organisms living in an area, including humans, due to lack of water for crops and drinking water (3.2)

diffusion the movement of molecules or other particles from an area of high concentration to an area of low concentration until they are evenly distributed (1.1) ▼

digestion process in which food is broken down into nutrients physically (through dissolving and breaking it into smaller bits) and chemically (through chemical reactions) (1.4)

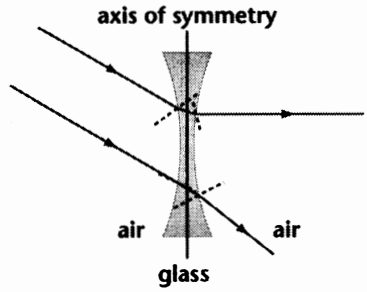
digestive system organ system responsible for taking in and breaking down food, absorbing nutrients, and ridding the body of solid waste (1.3) ▶



dilute [dih-LOOT] reduced in concentration by being mixed with a liquid, such as water (2.1)

diverge move apart (4.6)

diverging lens a lens that makes light rays move apart; curved inward on at least one side; also known as a concave lens (4.6) ▼



DNA (deoxyribonucleic acid) [dee-AWK-see-RIH-boh-noo-KLAE-ik A-sid] a unique molecule that stores the instructions that determine all of the details of an organism's life (1.2)

double displacement reaction a type of chemical reaction in which the metal ions of two different compounds exchange places (2.3) ▼

$$AB + CD \rightarrow AD + CB$$

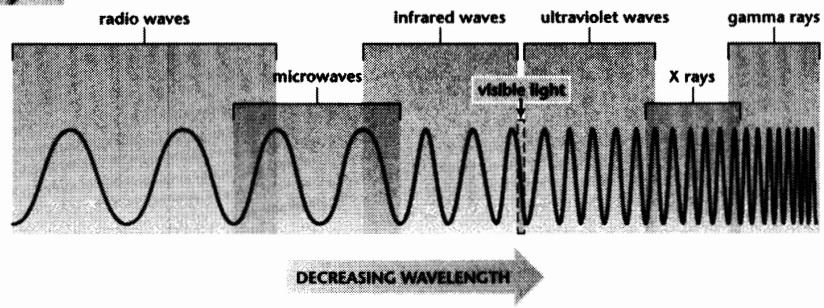
drunken forests groups of trees that have tilted or fallen over due to quickly thawing permafrost and shifting soil (3.2)

E

electric discharge a type of luminescence that occurs in a sealed glass tube; used in many street lights (4.1)

electromagnetic radiation energy that travels as waves that move outward in all directions from a source; includes infrared radiation, ultraviolet radiation, radio waves, X rays, gamma rays, and visible light (1.5)

electromagnetic spectrum a representation of the types of electromagnetic waves arranged according to wavelength (4.1) ▼



electromagnetic waves waves that carry electrical energy and magnetic energy (4.1)

elimination process in which solid waste passes from the digestive system out of the body (1.4)

endoscopy [en-DAWS-kuh-pee] an imaging process that is used to view internal body parts without cutting open the body; to diagnose diseases, take tissue samples, and perform surgeries (1.5)

epithelial tissue [e-pi-THEE-lee-uhl TI-shyoo] body tissue that covers the external and internal body surfaces (1.3)

esophagus [e-SAW-fuh-gus] tube-like organ that pushes the food into the stomach using wave-like muscular contractions (1.4)

excretory system [EX-kruh-TOH-ree or ex-KREE-tuh-ree SIS-tum] organ system that eliminates liquid waste from the body; helps to control fluid balance and acidity (1.3)

explosive used to describe a container that can explode if heated or punctured; flying pieces of metal or plastic from the container can cause serious injury, especially to eyes (2.1)

F

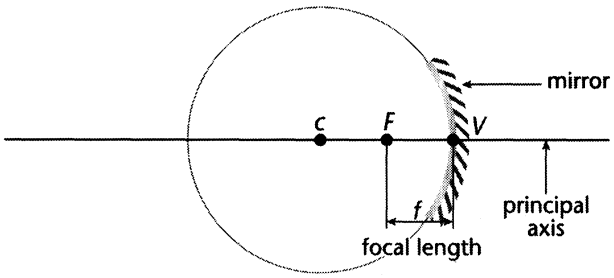
fibre optic a cable containing many optical fibres—tiny glass fibres that transmit light (4.5)

field of view the circle that you see through the eyepiece of a microscope (U1)

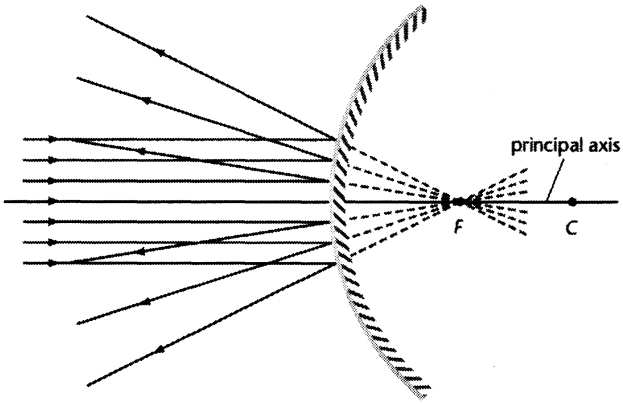
flammable used to indicate that a product or its fumes will catch fire easily if it is near heat, flames, or sparks; rags used with this product may begin to burn on their own (2.1)

fluorescence [flohr-E-sens] a form of electric discharge in which the gases emit ultraviolet light, which transfers energy to a phosphor coating on the inside of a fluorescent bulb; the phosphor releases the energy as light (4.1)

focal length (*f*) the distance from the vertex of a mirror or the centre of a lens to the focal point of the mirror or lens (4.4) ▼



focal point (*F*) the point where reflected rays meet when incident rays are parallel to and near to the principal axis; for a concave mirror, the focal point is in front of the mirror; for a convex mirror, extended rays meet at a focal point behind the mirror (4.4) ▼

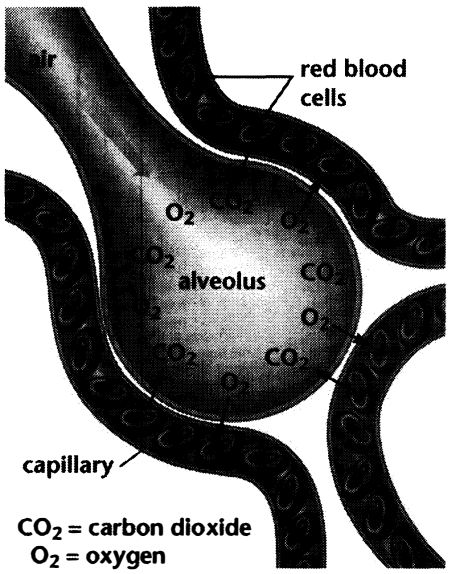


fossil fuels materials that are burned to carry out industrial processes, generate electricity, heat homes, and power vehicles; derived from once-living tissues; include coal, oil, and natural gas (3.4)

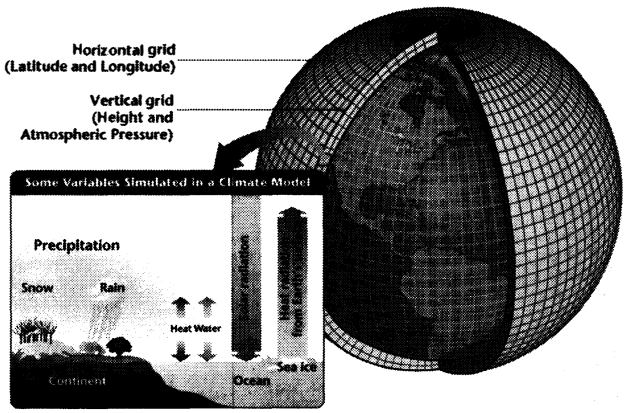
fossils remains of ancient organisms that are preserved in rock or other substances; the type of fossil in a certain place tells scientists what the climate must have been like there during that period (3.1, 3.5) ▼

G

gas exchange the process of taking in oxygen and releasing carbon dioxide (1.4) ▼



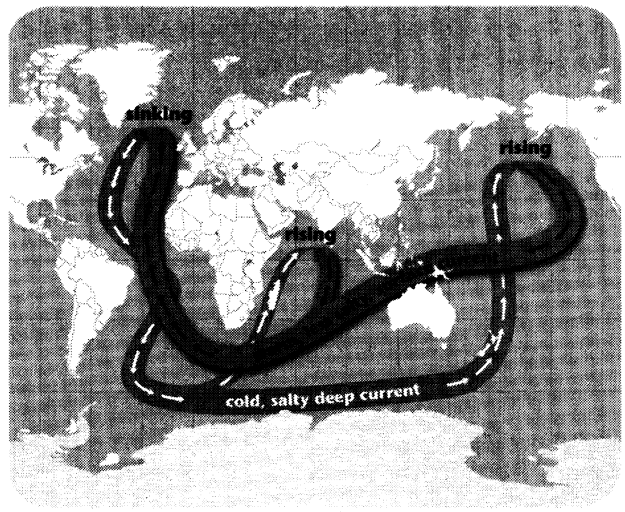
global climate model a computer program that uses mathematical equations to help scientists understand and estimate changes in Earth's climate (3.5) ▼



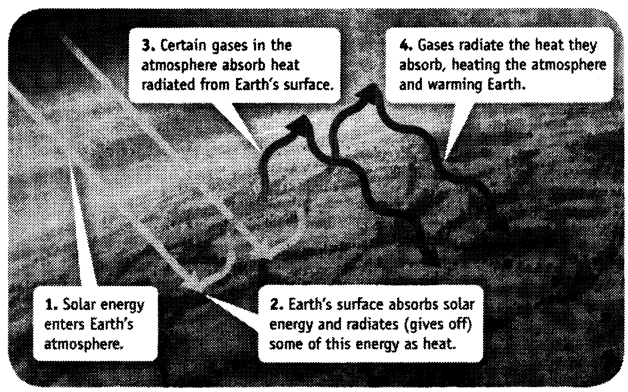
global warming an increase in average global (world-wide) temperatures; refers to an average increase in one part of weather—air temperature—as it affects the whole planet (3.1)

Golgi body [GOHL-jee BAW-dee] organelle that sorts and packages proteins and other molecules for transport out of the cell (1.1)

great ocean conveyor belt massive system of deep-water currents in the oceans that moves water and heat around the whole Earth; driven by differences in density arising from temperature and salt level (cold, salty water sinks; warm, less-salty water stays on the surface) (3.3) ▼



greenhouse effect a natural process in which certain gases in Earth's atmosphere absorb heat from the Sun as well as heat radiated from Earth's surface (3.3) ▼



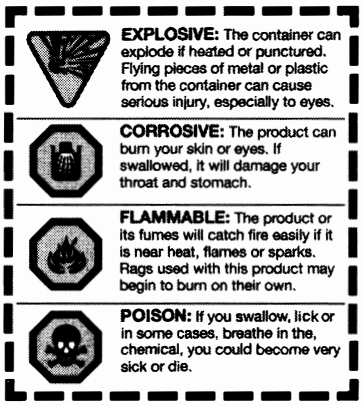
greenhouse gases gases in Earth's atmosphere that act like the air in a greenhouse, absorbing energy from the Sun and trapping heat in the atmosphere; major greenhouse gases are water vapour, carbon dioxide, methane, and nitrous oxide (3.3)

H

halocarbons [HAE-loh-KAR-buns] the only greenhouse gases produced solely by human beings; industrial chemical compounds such as chlorofluorocarbons (CFCs) (3.4)

halogens Group 17 non-metals; their outermost electron shell is one electron short of being full; the most reactive non-metals (2.2)

Hazardous Household Product Symbols (HHPS) icons that appear on household product labels to warn of possible danger; display some basic safety information about a product (2.1) ▼



heart the major organ of the circulatory system; pumps blood through the body (1.3)

heat sink something that can absorb heat and store heat (3.3)

hydrogen an element that has only one electron; unique because it can behave like a metal or a non-metal; has only one electron in its outer shell, but needs only one electron to complete its outer shell (2.2)

hydrosphere [HIH-drus-feer] water in all its different forms on Earth (3.3)

I

ice age a time period in Earth's history when glaciers covered a large part of Earth's surface; the last ice age began 26 000 years ago (3.1)

image distance the distance from a mirror or lens to the image (4.4) ▼

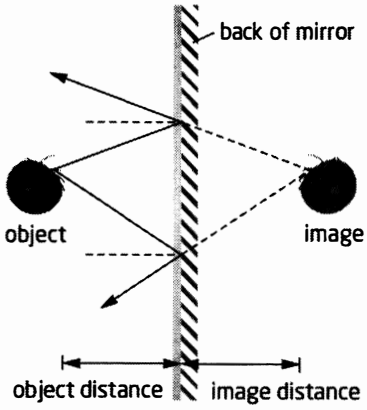
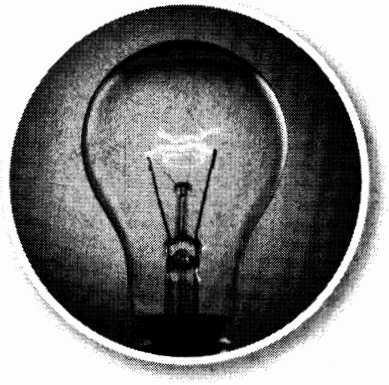


image the reflection of an object in the mirror (4.4)

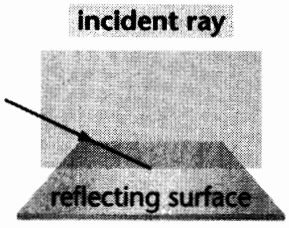
immune system an organ system that defends the body against infections (1.3)

incandescence [IN-kan-DES-uhns] light given off by an object because it is very hot (4.1) ▼



incandescent light bulb a bulb in which electrical current runs through a tiny metal filament, making the filament so hot that it glows (4.1) ▲

incident ray a light ray travelling toward a mirror or other surface (4.4) ▼

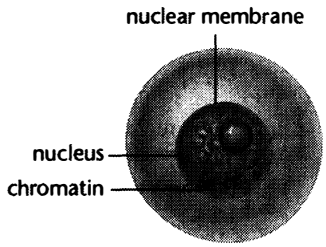


industrial revolution a period in history that started about 300 years ago, when people who lived in the countryside began moving to cities to work in factories; factories used steam engines fueled by the burning of coal (3.4)

ingestion [in-JES-chun] the process in which food is taken into the body (1.4)

integumentary system [in-TEG-yoo-MEN-tuh-ree SIS-tum] an organ system that includes the skin, hair, and nails; provides a protective barrier around the body; receives sensory information; helps to control body temperature (1.3)

interphase the stage in the cell cycle when a cell grows and carries out its usual functions, as well as making a copy of its DNA and organelles to prepare for cell division (1.2) -



inverted an image that is oriented opposite to the image; (the image is upside down compared with the object) (4.4)

ion [IH-uhn] an atom or a group of atoms that has an electrical charge, either positive or negative (2.2)

ionic compound a compound composed of oppositely charged ions; forms because the positively charged metal ions attract the negatively charged non-metal ions; is solid at room temperature, has a very high melting point, and conducts electricity when melted or dissolved in water (2.2)

i-pill "intelligent pill;" can deliver medication directly to where it is needed, and then electronically release a pre-measured amount at that location; contains a microprocessor, battery, pH sensor, temperature sensor, wireless transceiver, fluid pump, and reservoir for the medication (1.5)

K

kidneys organs that produce urine by filtering wastes and excess water from the blood (1.3)

krill tiny animals at the bottom of the aquatic food chain that feed on microscopic plants called plankton; declining numbers of krill have an impact on the many organisms that feed on them (3.2)

L

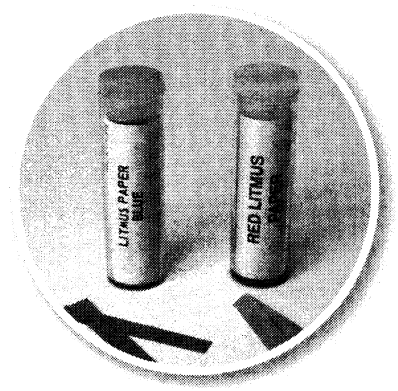
large intestine a tube-like organ in the digestive system; reabsorbs water and some nutrients from undigested food (1.4)

law of conservation of mass during a chemical reaction, the total mass and number of atoms of the reactants equal the total mass and number of atoms of the products (2.3)

law of reflection the angle of reflection is equal to the angle of incidence; the reflected ray and the incident ray are on opposite sides of the normal; the incident ray, the normal, and the reflected ray lie on the same plane (4.4)

lens a thin piece of glass or plastic that has at least one curved side (4.6)

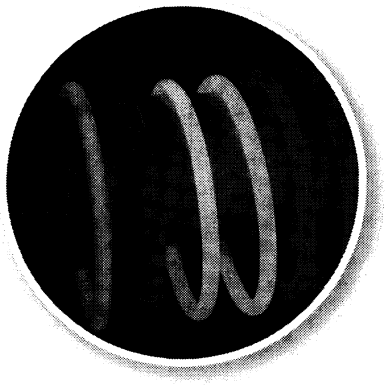
litmus paper an acid-base indicator that often comes in two colours—red and blue; acids turn blue litmus paper red, while bases turn red litmus paper blue (2.4) ▼



liver an organ that cleans the blood and stores substances such as certain vitamins and minerals (1.3)

location the position of an image relative to a mirror or lens (4.4)

luminescence [LOO-min-E-sens] light given off by an object that has not been heated; may be in the form of fluorescence, electric discharge, or chemiluminescence (shown here) (4.1) ▼



lungs respiratory organs that draw oxygen-rich air into the body and remove carbon-dioxide rich air from the body (1.3)

M

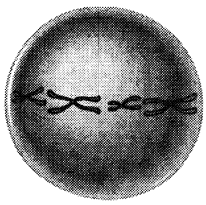
Material Safety Data Sheet (MSDS) information about the composition and properties of a chemical substance, as well as steps for handling and storing it safely (2.1)

medical imaging technologies technologies that are used to make images of cells, tissues, and organs (1.5)

medium the substance or material that light is travelling through (the plural of medium is *media*) (4.5)

metals elements left of the metalloid "staircase" on the periodic table; all metals except mercury are malleable, shiny, conduct heat and electric current, and are solids at room temperature (2.2)

metaphase the second phase of mitosis, when the chromosomes align in the centre of the cell (1.2) ▼



methane a foul-smelling gas released by bacteria in the digestive system as they break down food; also released by microorganisms that live in wetlands or melting permafrost; released by openings in Earth's crust; a major greenhouse gas (3.3)

microscopy [mih-KRAWS-kuh-pee] a group of techniques that are conducted using a variety of microscopes, including light microscopes and electron microscopes; used to view small objects, such as cells, and to diagnose various diseases (1.5)

mitochondria [MIH-toh-KAWN-dree-uh] organelles responsible for releasing energy from glucose to fuel cellular activities (singular: mitochondrion) (1.1)

mitosis the stage in the cell cycle when the contents of the nucleus separate into two identical copies (1.2)

molecular compounds compounds that form when non-metal atoms share electrons with each other; may be solids, liquids, or gases at room temperature; have lower melting points than ionic compounds; do not conduct electric current when they are melted or dissolved in water, except in the case of certain acids (2.2)

MRI (magnetic resonance imaging) scan a medical imaging technique that creates images of the body using radio waves and a magnetic field; used to contrast soft tissue (such as organs) and hard tissue (such as bones) and to diagnose disease in soft tissues and organs (1.5)

muscle tissue tissue that allows body parts to move, exert force, or change shape (1.3)

muscular system organ system that moves body parts, such as arms, and organs, such as the stomach; maintains posture (1.3)

mutation a change in the hereditary information carried in a cell's DNA (1.2)

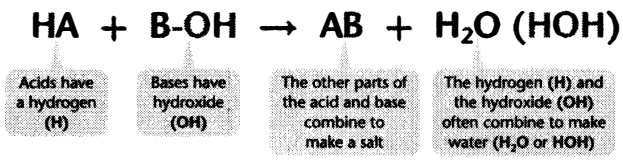
N

natural greenhouse effect a natural process in which certain gases in Earth's atmosphere absorb heat from the Sun as well as heat radiated from Earth's surface (3.4)

nervous system an organ system that gathers and interprets sensory information from outside and inside the body; coordinates all the functions of other organ systems (1.3)

nervous tissue senses, conducts, and transmits information (1.3)

neutralization reaction [NOO-truh-lih-ZAE-shun ree-AK-shun] a chemical reaction between an acid and a base that "neutralizes" their acidic and basic properties (2.4) -

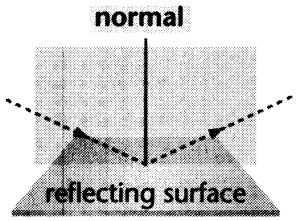


nitrate a negative ion that consists of one nitrogen and three oxygen atoms, and has one negative charge; the four atoms remain attached and act as a unit in many chemical reactions; has the chemical formula NO_3^- (2.3)

nitrous oxide greenhouse gas produced when certain species of bacteria break down nitrogen-rich compounds for food; absorbs 300 times more heat than carbon dioxide does (3.3, 3.4)

non-metals the elements on the right of the periodic table; are not malleable, do not conduct heat or electric current, and can be solids, liquids, or gases at room temperature (2.2)

normal a line perpendicular to a surface, such as a mirror, or a boundary between two substances, such as air and water (4.4) -



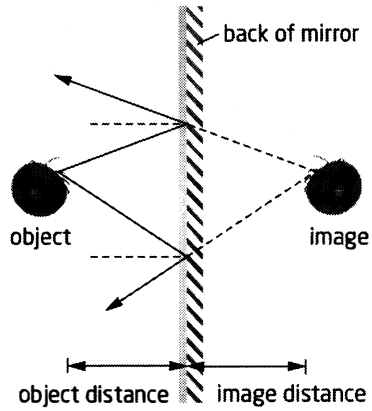
nuclear membrane a semi-permeable membrane that separates the nucleus from the rest of the cell and regulates the passage of substances into and out of the nucleus (1.2)

nucleus organelle that controls all cell activities (1.1)

numerical prefix a syllable that can be added to the beginning of a word to indicate the number of units present (2.2)

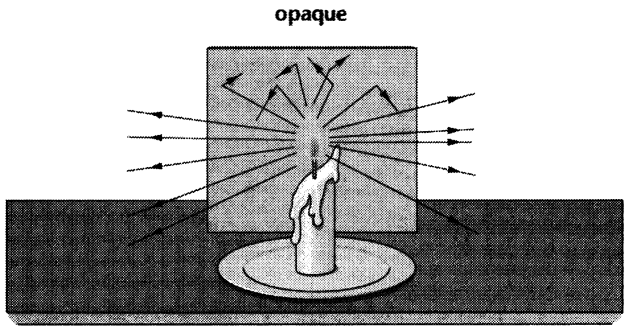
O

object distance the distance from a mirror or lens to the object (4.4) -



object the item in front of the mirror or lens (4.4)

opaque [oh-PAEK] a property of an object that will not allow any light to penetrate it (4.2) -

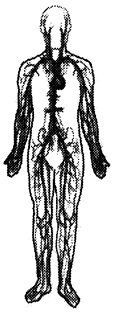


optical fibre made of a tiny glass fibre, called the core, which is about the size of a human hair, and a cladding (protective coating) made of a different type of glass, that covers the core; sends light in pulses, carrying information long distances at nearly the speed of light (4.5)

organ different tissues working together to perform a specific task; connective, nervous, and epithelial tissues make up the brain, shown below (1.3) ▼

organelle a structure within a cell that carries out specific functions to support the life of the cell; functions include bringing in nutrients, removing wastes, generating and releasing energy for the cell to use, making substances that the cell needs, and reproducing (1.1)

organ system a group of organs that interact with each other to perform a common task; the circulatory system (shown) includes the heart, arteries, and veins (1.3) ▼



orientation how an image is oriented vertically relative to an object; whether an image is oriented in the same direction as the object (right side up or upright) or in the opposite direction as the object (upside down or inverted) (4.4)

osmosis the movement of water molecules across a membrane in response to concentration differences (1.1)

P

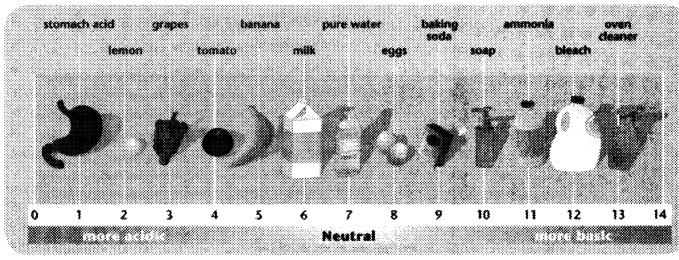
permafrost the permanently frozen layer of soil found in Canada's far north (3.2)

perpendicular at an angle of 90° (4.4)

pesticides chemicals that are used to control and kill weeds and insects (1.5)

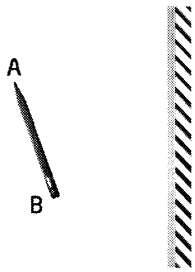
PET (positron emission tomography) scan an imaging technique that involves scanning small amounts of radioactive materials that have been taken into the body; reveals details of soft tissues and organs; used to diagnose cancer or track cancer treatments (1.5)

pH scale a scale from 0 to 14 that describes how acidic or basic a substance is (2.4) ▼



photosynthesis a process in the cells of plants, algae, and some bacteria that converts light energy from the Sun into stored chemical energy that can be used by organisms (2.1)

plane mirror any smooth, flat reflecting surface; often represented in diagrams as a straight line with hatch marks (short diagonal lines) on the non-reflecting side, as shown here (4.4) ▼



plane flat surface (4.4)

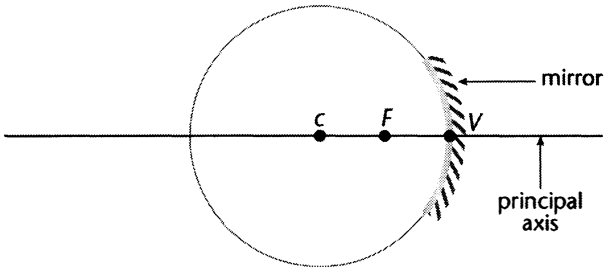
plankton microscopic plants that are a vital part of aquatic ecosystems; krill and larger organisms feed on plankton (3.2)

poison term used on product labels to indicate that you could become very sick or die if you swallow, lick, or, in some cases, breathe in the chemical (2.1)

prefix a syllable that can be added to the beginning of a word to change its meaning (2.2)

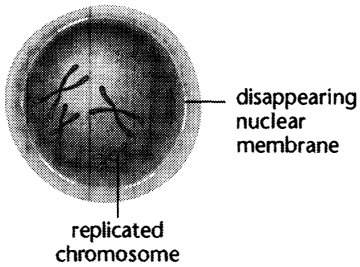
primary colours three colours which, when combined in different amounts, can generate any other colour (4.3)

principal axis a line drawn normal to the centre of a spherical mirror or a lens; always goes through the centre of curvature, *C* (4.4) ▼



products new substances produced in a chemical reaction (2.1)

prophase the first phase of mitosis, when the nucleus and nuclear membrane disappear and chromosomes form (1.2) ▼

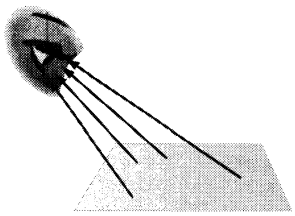


protractor device used to measure angles (4.4)

R

ray diagrams diagrams that demonstrate light rays, and allow you to make predictions about the way light behaves (4.2)

ray an arrow that shows the direction in which light is travelling (4.2) ▼



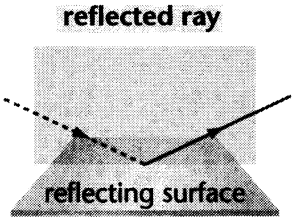
reactants substances that react together in a chemical reaction (2.1)

reactive describes the likelihood of an atom taking part in a chemical reaction and forming a compound (2.2)

real an image that is formed when light rays meet and do not have to be extended backwards; (if a screen is placed at the location of an image, the image will appear on the screen) (4.4)

red blood cells blood cells that carry oxygen and carbon dioxide in the blood (1.4)

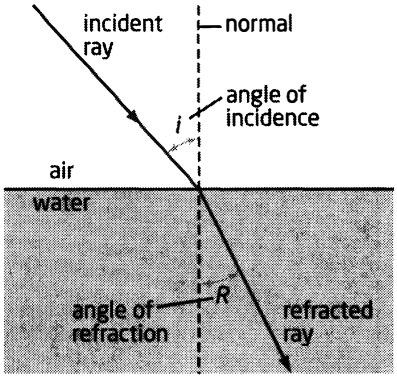
reflected ray a light ray that has "bounced" off a reflecting surface (4.4) ▼



reflection the process in which light "bounces off" the surface of an object and travels in another direction; can also refer to the image produced when this process occurs (4.2) ▼

refracted ray a light ray after it has crossed a boundary between two media (4.5)

refraction the change in the direction in which light is travelling when it crosses a boundary between two media (4.5) ▼

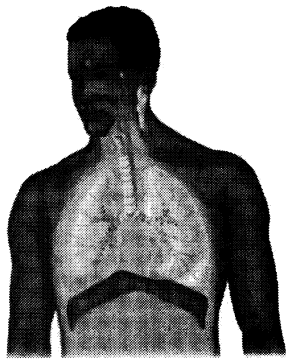


regeneration the ability to grow new cells to replace damaged or lost body components (1.2)

regenerative medicine [re-JEN-ruh-tiv MED-uh-sin] process of producing new cells, tissues, and organs to replace damaged body parts (1.5)

reproductive system organ system that produces eggs (in females) and sperm (in males); produces estrogen, testosterone, and the other sex hormones; in females, allows for the growth and delivery of offspring (1.3)

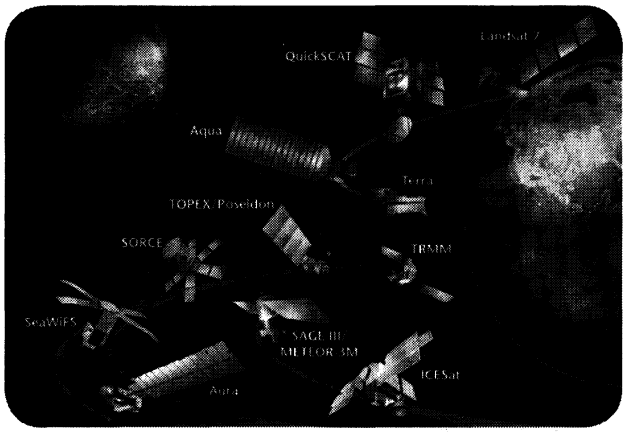
respiratory system organ system that controls breathing; delivers oxygen to the blood and removes carbon dioxide from the blood (1.3) ▼



ribosomes organelles that help to produce proteins, which make up much of a cell's structure and are required for activities necessary for the cell's survival; some ribosomes float in the cytoplasm, and others are attached to the endoplasmic reticulum (1.1)

S

satellite human-made object or vehicle that orbits Earth, the Moon, or other bodies in space; EOS (Earth Observing System) satellites can make detailed observations of the whole planet in a single day (3.5) ▼



secondary colours the colours generated by combining two primary colours; additive secondary colours are cyan, magenta, and yellow (4.3)

single displacement reaction a type of chemical reaction in which one element takes the place of another element in a compound (2.3) ▼

$$A + BC \rightarrow AC + B$$

$$D + BC \rightarrow BD + C$$

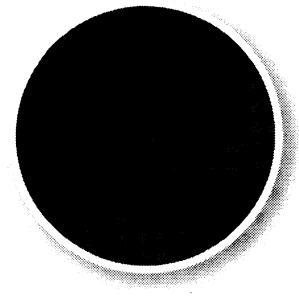
size whether an image is larger or smaller than an object; sometimes called the magnification of the image (4.4)

skeletal system organ system that provides a framework for muscles to attach to, protects the soft organs, makes blood cells, and stores minerals (1.3)

small intestine organ in the digestive system; nutrients from food are absorbed into the bloodstream here (1.4)

solar energy light and other forms of energy that the Sun gives off; can be converted into electrical energy (3.3)

specialized cells cells that have differentiated, or developed special characteristics that make them well suited to their function; red blood cells take on a flattened circular shape with a depression in the middle (1.3) ▼

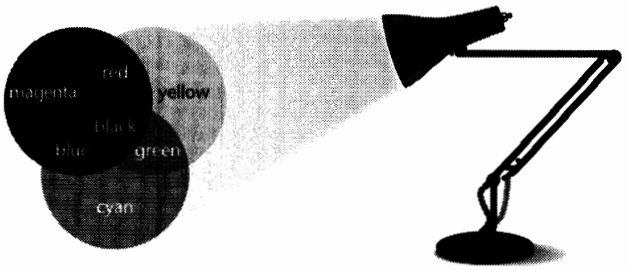


stomach digestive organ that churns and digests food (1.3)

subscript numbers small numbers at the base of larger letters; tell you how many atoms of these elements are in a compound; for example, in O_2, the subscript 2 indicates there are two atoms of oxygen (2.2)

Name Date

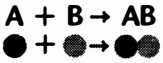
subtractive primary colours cyan, magenta, and yellow; a variety of combinations of these three colours can subtract light from white light to produce nearly any colour (4.3) ▼



subtractive secondary colours red, green, and blue; the colours produced by subtracting equal amounts of two of the three subtractive primary colours; same as the additive primary colours (4.3)

synthesis reaction a chemical reaction in which two or more reactants combine to produce a new product (2.3) ▼

A + B → AB

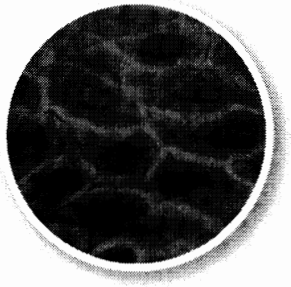


T

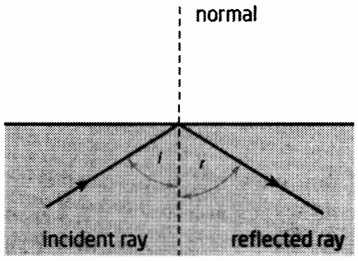
telophase: the fourth phase of mitosis, when the membrane surrounding the nucleus re-forms, creating two new nuclei (1.2) ▼

tertiary colour [TUHR-shee-ae-ree KUH-luhr] the colour that you get by mixing the secondary colours (4.3)

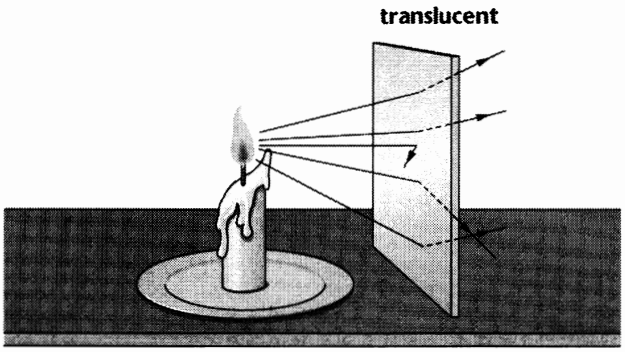
tissue specialized cells working together to perform a function; the four major types of human tissue are muscle tissue, connective tissue, nervous tissue, and epithelial tissue (shown here) (1.3) ▼



total internal reflection the condition in which no light can escape the medium because the angle of incidence is larger than the critical angle; all light is reflected within the medium (4.5) ▼

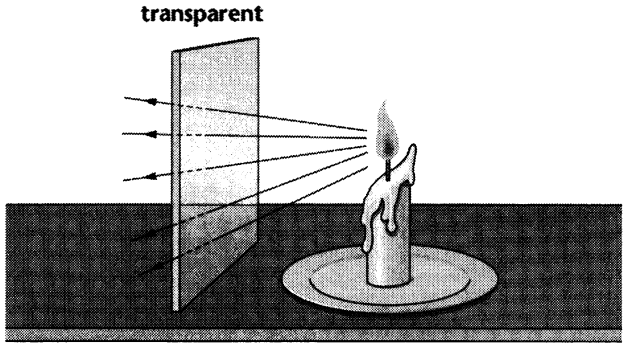


translucent [trans-LOO-sent] property of an object that allows light to pass through but scatters it in different directions (4.2) ▼



transmission the process in which light travels through an object and continues travelling; transparent and translucent objects transmit light, while opaque objects do not (4.2)

transparent property of an object that allows light to penetrate the object, making it possible to see objects from the other side (4.2) ▼



tumour an abnormal group or clump of cells (1.2)

type whether an image is real or virtual; if reflected rays do not meet, the image is virtual; if reflected rays do meet, the image is real; a real image can be viewed on a screen while a virtual image cannot (4.4)

U

ultrasound an imaging technique that involves directing sound waves at a body part and measuring reflected sound waves to make an image; used to view soft tissue, monitor fetal development, observe organ function, and detect cancer (1.5)

upright an image that has the same orientation as the object (4.4)

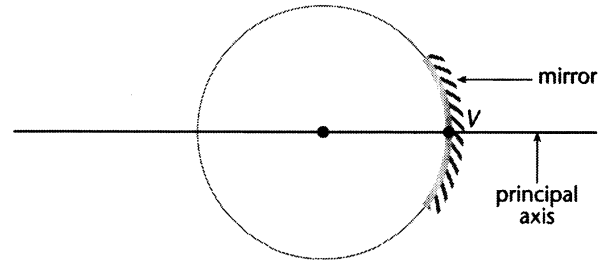
urbanization the spread of cities into rural areas; involves clearing land, building roads, and increased transportation; produces greenhouse gases (3.4)

V

vacuoles [VAK-yoo-uhls] organelles that contain water and other materials and are used to store or transport small molecules; plant cells tend to have one large vacuole; animal cells may have several smaller vacuoles (1.1)

veins thin-walled, inelastic blood vessels that have valves to keep blood from backing up as it is carried toward the heart (1.4)

vertex (*V*) the point where the principal axis meets the mirror (4.4) ▼



vesicles [VEE-zi-kuhls] membrane-covered sacs that transport and/or store materials inside the cell and sometimes help these materials cross the cell membrane to enter or exit the cell (1.1)

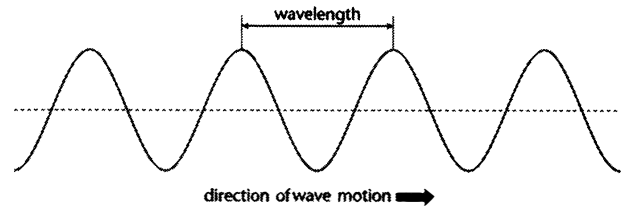
virtual image an image that is located where no light rays ever meet; occurs when reflected rays are separating and must be extended backwards to find out where they meet (4.4)

visible light a very small part of the electromagnetic spectrum; the longest wavelengths of visible light are red (7.0×10^{-7} m) and the shortest wavelengths are blue (4.0×10^{-7} m) (4.1)

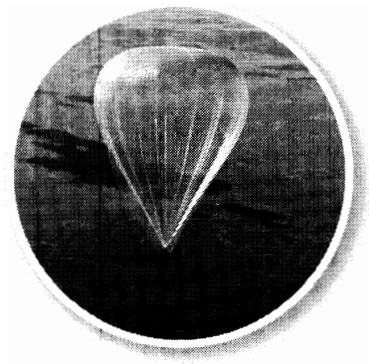
W

water vapour evaporation from water; given off by cellular respiration and certain plant processes; most abundant greenhouse gas (3.3)

wavelength the distance between peaks on a wave (4.1) ▼



weather balloon device that carries a mini weather station to measure the temperature, pressure, and humidity at different heights up to about 30 000 m; a small radio transmits the collected data back to the ground (3.5) ▼



weather the conditions of the atmosphere for a specific place at a specific time (3.1)

West Nile Virus a virus carried and transmitted by mosquitoes; causes a disease that can be fatal (3.2)

WHMIS (Workplace Hazardous Materials Information System) provides detailed information about how to store, handle, and dispose of chemical substances that are used in the workplace; also provides first aid information (2.1)

word equation uses words instead of chemical formulas to describe what happens to reactants and products during a chemical reaction (2.3) ▼

name of reactant 1 + name of reactant 2 → name of product 3 + name of product 4

X

X ray a form of electromagnetic radiation; can be sent through the body to make an image; used to view hard tissue, such as bone; used to diagnose bone injuries and malformations (abnormal structures) (1.5, 4.1)