**AL NOOR INTERNATIONAL SCHOOL**
**Riyadh, Saudi Arabia**

# Physical Science Workbook

Name: _____

Grade 8 - _____

Academic Year: _____

Name _____ Date _____ Class _____

# Chapter 5: Energy

# 1. What Is Energy?

## Understanding Main Ideas

Answer the following questions in the spaces provided.

1. How are work and energy related?

_____

2. How is power related to energy?

_____

3. What are the two basic kinds of energy?

_____

4. A girl who weighs 30 kg is inline skating at a speed of 5 m/s. What is the girl's kinetic energy?

_____

5. A hat that weighs 5 newtons is hanging from a hook 1.5 meters above the floor. How much gravitational potential energy does the hat have?

_____

## Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

6. ___ energy
7. ___ kinetic energy
8. ___ potential energy
9. ___ gravitational potential energy
10. ___ elastic potential energy

**a.** potential energy related to an object's height

**b.** the ability to do work or cause change

**c.** energy associated with objects that can be compressed or stretched

**d.** the energy an object has due to its motion

**e.** energy that results from an object's position or shape

Name _____ Date _____ Class _____

# 1. What Is Energy?

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The kinetic energy of an object is equal to one half its mass multiplied by its speed

A squared
B cubed
C to the fourth power
D to the fifth power

**2.** ___ The gravitational potential energy of an object is equal to its weight multiplied by its

A depth
B height
C volume
D diameter

**3.** ___ Energy is the ability to do work or cause

A events
B change
C friction
D explosions

**4.** ___ Energy and work are measured in

A newtons
B joules
C hertz
D kilograms

**Fill in the blank to complete each statement.**

**5.** When you do work on an object, some of your energy is _____ to that object.

**6.** Power is the rate at which energy is _____.

**7.** Potential energy results from the _____ or position of an object.

**8.** A stretched rubber band has _____ energy.

**9.** A change in an object's speed has a(n) _____ effect on its kinetic energy than a change in its mass.

**10.** A mountain climber at the peak has _____ energy.

Name _____ Date _____ Class _____

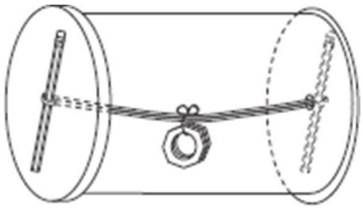
# 1. What Is Energy?

In even a simple action, energy is often transformed from one type into another (and back again). Follow the steps in the procedure. Then use a separate sheet of paper to answer the questions that follow it.

## The Come-Back Can

### Materials

coffee can with plastic lid
rubber band
metal nuts
2 nails
string
file



### Procedure

1. Use a nail to punch a hole in the center of the bottom of the can and another in the center of the lid. File down the rough edges.
2. Use string to tie several nuts to the middle of the rubber band.
3. Slip one end of the rubber band through the hole in the bottom of the can. Slide a nail through the rubber band to secure the rubber band to the can. Repeat this process with the lid. Put the lid on the can. The rubber band should just reach both ends of the can without being stretched too tightly.
4. Gently roll the can on a hard, level floor. Once the can reaches the end of its path, it will begin to roll back to you.

### Analyze and Conclude

1. When you roll the can along the floor, the rubber band twists. What kind of energy is in the twisted rubber band?

   _____

2. Why does the can stop before it begins to roll back to you?

   _____

   _____

3. What do you think happens to the rubber band as the can rolls back to you?

   _____

4. What kind of energy does the can gain as it rolls back to you?

   _____

5. What kind of energy are you adding to the can and rubber band when you first push the can?

   _____

6. If you were to push the can harder, what effect would this have on the energy in the rubber band?

   _____

   _____

Name _____ Date _____ Class _____

# 2. Forms of Energy

## Understanding Main Ideas

Answer the following questions in the spaces provided.

**1.** How can you determine an object's mechanical energy?

_____

_____

_____

**2.** Name two forms of energy associated with the particles that make up objects.

_____

_____

## Building Vocabulary

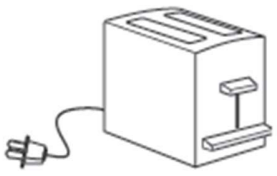
Match each illustration with the correct form(s) of energy by writing the letter or letters of the form(s) of energy on the line at the left.

**a.** mechanical energy
**b.** electrical energy
**c.** thermal energy
**d.** nuclear energy
**e.** chemical energy
**f.** electromagnetic energy

_____ **3.**

_____ **4.**

_____ **5.**



_____ **6.**

_____ **7.**

_____ **8.**

Name _____ Date _____ Class _____

# 2. Forms of Energy

**Write the letter of the correct answer on the line at the left.**

**1.** ___ To find an object's mechanical energy, you add its
- A kinetic and potential energy
- B kinetic and thermal energy
- C potential and thermal energy
- D kinetic and chemical energy

**2.** ___ A form of energy NOT associated with the particles of objects is
- A thermal energy
- B mechanical energy
- C nuclear energy
- D chemical energy

**3.** ___ Nuclear fusion reactions occur in
- A nuclear power plants
- B a microwave oven
- C a match that is struck
- D the sun

**4.** ___ The total potential and kinetic energy of the particles of an object is the object's
- A nuclear energy
- B electromagnetic energy
- C thermal energy
- D mechanical energy

**Fill in the blank to complete each statement.**

**5.** Mechanical energy is associated with the motion, position, or _____ of an object.

**6.** Electromagnetic energy travels through space in the form of _____.

**7.** Lightning is a form of _____ energy.

**8.** The breaking of _____ bonds in food releases energy for your body to use.

**9.** The _____ the temperature of an object, the lower its thermal energy.

**10.** Electrical energy is the energy of _____.

Name _____ Date _____ Class _____

# 2. Forms of Energy

Read the passage below. Then fill in the table, using $0.10 per kWh to calculate the cost of running each appliance for one day. Answer the questions that follow on a seperate sheet of paper.

## The Cost of Electrical Energy

You know that the watt (W) is a unit of power and that a kilowatt (kW) is 1,000 watts. The unit used by electric companies to measure the energy you use in your home is called the kilowatt-hour (kWh). One kilowatt-hour is 1,000 watts of electrical energy used for 1 hour.

Each electrical appliance in your home uses a different amount of electrical energy. The cost of operating an appliance is determined by the power rating of the appliance, the number of hours it is used, and the cost of the electrical energy.

To calculate the cost of operating an appliance, you must first determine the energy used in kilowatt-hours. To do this, multiply the power rating (watts) of the appliance by the number of hours you use the appliance, then divide that number by 1,000. For example, a 100-watt light bulb used for 5 hours a day would use 0.5 kWh per day

$$\left(\frac{100\ \text{W} \times 5\ \text{h}}{1{,}000} = 0.5\ \text{kWh}\right).$$

If you are paying $0.10 per kWh, then the cost of using that light bulb for 1 day would be 0.5 kWh × $0.10, or $0.05.

| Appliance | Estimated Time Used (h) | Cost ($) | Cost ($) |
|---|---|---|---|
| Microwave oven | 1,500 | | |
| Electric stove/oven | 12,000 | | |
| Clothes dryer | 5,000 | | |
| Vacuum cleaner | 600 | | |
| Clothes washer | 500 | | |
| Color television | 200 | | |
| Dishwasher | 1,300 | | |

**1.** What is the total cost of running all the appliances above for your family for one day? What is the total cost for one week?

_____

_____

**2**. Discuss three things that people in the family could do to reduce their electric bill.

_____

_____

Name _____ Date _____ Class _____

# 3. Energy Transformations and Conservation

## Understanding Main Ideas

Study the illustration below and then read the following statements. If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.


1. _____ An energy transformation is occurring only at point 3.
2. _____ In this example, the law of conservation of energy says that the ball never loses kinetic energy.
3. _____ As the ball rises from point 1 to point 3, it slows down.
4. _____ The ball has the most potential energy at point 3.
5. _____ The ball has the most kinetic energy as it leaves point 2.

## Building Vocabulary

Write a definition for each of these terms on the lines below.

6. energy transformation

_____

_____

7. law of conservation of energy

_____

_____

Name _____ Date _____ Class _____

# 3. Energy Transformations and Conservation

**Fill in the blank to complete each statement.**

1. All forms of energy can be _____ into other forms of energy.
2. A change from one form of energy to another is called a(n) _____.
3. When you use a match to light a candle, multiple _____ of energy occur.
4. The law of _____ of energy tells how much energy is present after electromagnetic energy changes to sound.
5. Whenever a moving object experiences friction, some of its kinetic energy is changed into _____ energy.
6. Your body changes chemical energy into _____ energy when you walk upstairs.

**Write the letter of the correct answer on the line at the left.**

7. ___ Fusion reactions in the sun change nuclear energy into
   A mechanical energy
   B chemical energy
   C electromagnetic energy
   D potential energy

8. ___ In a pendulum, a continuous change occurs between kinetic energy and
   A potential energy
   B electromagnetic energy
   C thermal energy
   D mechanical energy

9. ___ A baseball in play has its lowest gravitational potential energy
   A when it is at its highest point
   B before it hits the ground
   C when the bat contacts it
   D after it hits the ground

10. ___ Energy can be neither destroyed nor
   A created
   B transformed
   C changed
   D transferred

Name _____ Date _____ Class _____

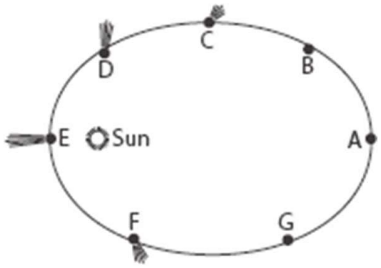
# 3. Energy Transformations and Conservation

In a swinging pendulum, potential energy is transformed to kinetic energy and back. The movement of planets and comets around the sun also shows the relationship between potential and kinetic energy. Read the passage. Then examine the diagram below it, and use the diagram to answer the questions that follow on a separate sheet of paper.

## Orbits, Ellipses, and Energy

Planets and comets orbit the sun in ellipse-shaped paths. While they orbit the sun, they respond to the sun's gravitational pull. The farther away from the sun an object is, the less the sun's gravity attracts it, and the slower that object moves in its orbit. The energy of a comet at its slowest position is similar to that of a pendulum at the very top of its swing. As the comet moves toward the sun, it gains speed until, at its closest approach to the sun, it is traveling at maximum speed. The energy of a comet at this position is similar to that of a pendulum at the bottom of its swing. Then, the comet moves past the sun, slowing down as it moves farther into space. A comet will follow the same orbit for many hundreds or thousands of years, speeding up and slowing down, orbiting the sun many times.

The diagram below shows the orbit of a comet around the sun. Point A is farthest from the sun and point E is closest to the sun. The comet moves counterclockwise.




1. At what point in its orbit does the comet have the greatest potential energy? At what point does it have the least potential energy?

   _____

2. At what point in its orbit does the comet have the greatest kinetic energy? At what point does it have the least kinetic energy?

   _____

3. Describe the energy transformations that are taking place as the comet moves from point B to point D.

   _____
   _____

4. Describe the energy transformations that are taking place as the comet moves from point F to point G.

   _____
   _____

5. What happens to the comet's total energy when it is closest to the sun?

   _____

6. What happens to the comet's total energy when it is farthest from the sun?

   _____

Name _____ Date _____ Class _____

# Chapter 6: Thermal Energy and Heat

## 1. Temperature, Thermal Energy, and Heat

### Understanding Main Ideas

Answer the following questions in the spaces provided.

1. Two glasses of water have the same thermal energy. Must they have the same temperature? Explain.

_____

_____

2. Describe what is meant by absolute zero.

_____

_____

3. List the three things that determine thermal energy.

_____

4. Compare the freezing point of water on the Celsius and the Fahrenheit temperature scales.

_____

5. Compare a change in temperature of 1°C to a change of 1°F.

_____

_____

### Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

| | |
|---|---|
| 6. ___ Celsius | **a.** on this scale, water boils at 100 degrees |
| 7. ___ temperature | **b.** a measure of the average kinetic energy of the individual particles in an object |
| 8. ___ heat | **c.** the transfer of thermal energy from a warmer object to a cooler one |
| 9. ___ absolute zero | **d.** the temperature at which no more thermal energy can be removed from an object |

Name _____ Date _____ Class _____

# 1. Temperature, Thermal Energy, and Heat

**If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.**

1. _____ At the freezing point, the particles in an object have no kinetic energy.
2. _____ On the Celsius temperature scale, there are no negative numbers.
3. _____ The more particles an object has at a given temperature, the more thermal energy it has.
4. _____ Object A is much larger than Object B, but both are made of the same material. If both objects are at the same temperature, the thermal energy of Object A is the same as the thermal energy of Object B.
5. _____ When heat is absorbed by an object, the speed of the particles in the object is unchanged.

**Fill in the blank to complete each statement.**

6. The transfer of thermal energy from a warmer object to a cooler object is called _____.
7. _____ is a measure of the average kinetic energy of the individual particles in an object.
8. Most of the world uses the _____ temperature scale.
9. On the _____ temperature scale, water boils at 212°.
10. The amount of thermal energy in an object depends on its _____, the number of particles in it, and how those particles are arranged.

Name _____ Date _____ Class _____

# 1. Temperature, Thermal Energy, and Heat

Read the passage and study the table.

## Converting Temperatures

In this section, you learned that most of the world uses the Celsius temperature scale, but that in the United States, the most common temperature scale is Fahrenheit. You are probably more familiar with one of these scales than the other. One way to become more comfortable with the unfamiliar temperature scale is to compare the numerical values of everyday temperatures in °C and °F.

| To convert °F to °C | To convert °C to °F |
|---|---|
| **1.** Subtract 32. | **1.** Multiply by 9. |
| **2.** Multiply by 5. | **2.** Divide by 5. |
| **3.** Divide by 9. | **3.** Add 32. |

**Convert the following temperatures using the methods described above.**

1. Normal body temperature is 98.6°F. _____°C
2. Room temperature is about 72°F. _____°C
3. The lowest temperature ever recorded on Earth was −89.4°C at Vostok, Antarctica. ____°F
4. The highest temperature ever recorded on Earth was 57.8°C at El Azizia, Libya. _____°F
5. −40°C = _____°F
6. The common temperature for baking a cake is 350°F. ___°C
7. Iron melts at 1535°C. _____°F

**Answer the following questions on a separate sheet of paper.**

8. Which is warmer −30°C or −30°F? Show your work.

   _____
   _____

9. You are riding to school on a bus in a snowstorm. Through the window, you see a lighted sign that gives the temperature as 26°, but you cannot make out whether the temperature scale is Celsius or Fahrenheit. Which is it, and how do you know?

   _____
   _____
   _____

Name _____ Date _____ Class _____

# 2. The Transfer of Heat

## Understanding Main Ideas

Fill in the spaces in the table below by writing whether the heat is transferred by convection, radiation, or conduction.

| Heat Transfer Example | Method of Heat Transfer |
|---|---|
| An entire lake is heated by water from a hot spring at the bottom of the lake. | **1.** |
| Sunlight melts a wax crayon left outside. | **2.** |
| A burner on a stove heats the bottom of a pan. | **3.** |
| The inside frame of your front door feels cold during winter. | **4.** |
| A kite rises high above a hot, sandy beach. | **5.** |
| You feel the warm glow of a bonfire. | **6.** |

## Building Vocabulary

Write a definition for each of these terms on the lines below.

**7.** convection

_____

_____

**8.** radiation

_____

_____

**9.** convection current

_____

**10.** conduction

_____

_____

Name _____ Date _____ Class _____

# 2. The Transfer of Heat

**Write the letter of the correct answer on the line at the left.**

**1.** ___ Water bubbles up through a hot spring at Yellowstone National Park. What method of heat transfer is this?

A conduction
B convection
C radiation
D specific heat

**2.** ___ On a sunny day, you return to your car after a ball game. The inside of the car is very hot. How did the car get so warm?

A conduction
B convection
C radiation
D specific heat

**3.** ___ The inside window pane in your house feels very cold to touch on a winter night. Why does it feel cold?

A The cold from the outside is flowing in by convection.
B The warm from the inside is flowing out by convection.
C The cold from the outside is being conducted to the inside.
D The warm from the inside is being conducted to the outside.

**4.** ___ Malia burned herself when she picked up a hot iron skillet from the stove. What method of heat transfer caused the burn?

A conduction
B convection
C radiation
D specific heat

**Fill in the blank to complete each statement.**

**5.** Heat is transferred directly from one particle of matter to another by the process of _____.

**6.** A circular flow of warmer fluid and cooler fluid is called a(n) _____.

**7.** Heat is always transferred from _____ areas.

**8.** _____ is the transfer of energy by electromagnetic waves.

**9.** Heat that is transferred by the movement of currents within a fluid is called _____.

**10.** The only form of heat transfer that does not require matter is _____.

Name _____ Date _____ Class _____

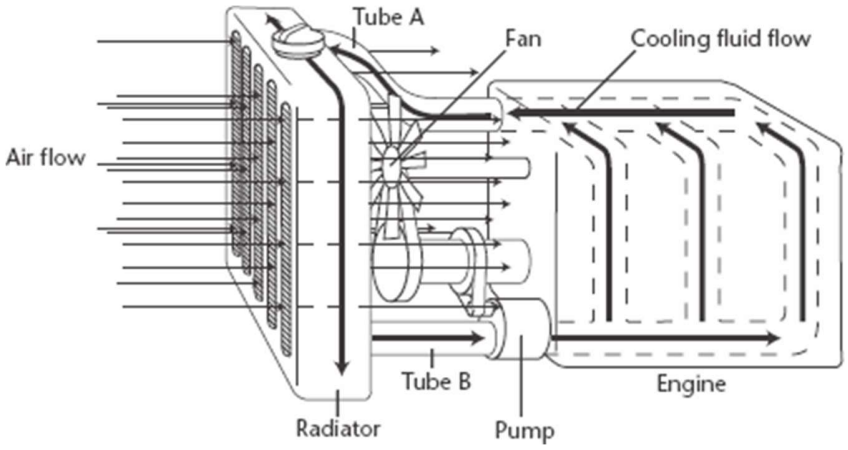
# 2. The Transfer of Heat

An automobile engine would not be able to run for very long if it did not have a cooling system. Read the passage and examine the diagram. Then use a separate sheet of paper to answer the questions that follow.

## Radiating Heat

Internal combustion engines transform thermal energy to mechanical energy. Unfortunately, not all of the thermal energy produced by the burning of the mixture of fuel and air can be used to move the pistons. Some of the heat produced just heats the engine, and that can create problems. If an engine gets too hot, the oil that lubricates the moving parts will burn. Also, engines have some parts that will be destroyed if they get too hot.

A solution is to build a cooling system to carry heat away from the engine. The simplified diagram below shows a cooling system for an automobile engine. Arrows indicate the direction of movement of cooling fluid. Internally, the radiator is a series of flattened pipes that the cooling fluid moves through. The flattened pipes provide a very large surface area over which outside air flows.




1. Where is the cooling fluid hotter, in tube A or in tube B? Why?

_____

2. Heat moves from material having more thermal energy to material having less thermal energy. Into what material does heat from the hot cooling fluid go?

_____

3. What is the function of the radiator?

_____

4. The pump moves fluid from the radiator into the engine. What might happen to the engine if the pump stopped working?

_____

Name _____ Date _____ Class _____

# 3. Thermal Properties

## Understanding Main Ideas

Answer the following questions in the spaces provided.

**1.** Use your knowledge of insulators and conductors to explain why cooking pots are usually made of metal with some sort of plastic handle.

_____

_____

_____

**2.** Listed are the specific heats of different substances, in J/(kg·K): Air is 1,005; glass is 840; and silver is 233. Explain which of the three substances is the best insulator and why.

_____

_____

**3.** Five kilograms of Substance A requires 500 J of energy to raise its temperature by 2 degrees. Five kilograms of Substance B requires 1,000 J of energy to raise its temperature by 2 degrees. How do the specific heats of the two substances compare?

_____

**4.** Gold has a specific heat of 126 J/(kg·K). A sculptor increased the temperature of a 0.5 kg block of gold by 10°C. How much energy did the sculptor add to the gold?

_____

## Building Vocabulary

On a separate sheet of paper, write a definition for each of these terms.

**5.** insulator

**6.** specific heat

**7.** thermal expansion

**8.** conductor

Name _____ Date _____ Class _____

# 3. Thermal Properties

**Fill in the blank to complete each statement.**

1. A material with a(n) _____ specific heat can absorb a great deal of thermal energy without a great change in temperature.
2. As the thermal energy of matter _____, its particles usually spread out.
3. If two objects of the same mass require different amounts of heat to raise their temperatures 10 kelvin, the objects have different _____
4. To keep food warm or cool, coolers are made out of materials that are _____.
5. Water has a specific heat of 4,186 J/(kg·K). To raise the temperature of a bathtub of water (220 kg) by 3 kelvin, it takes _____ Joules of energy.

**If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.**

6. _____ Specific heat is measured in joules.
7. _____ Most metals are good conductors of heat.
8. _____ The amount of energy required to raise 1 kg of material by 1 kelvin is called thermal energy.
9. _____ On a hot summer day, a metal door in a wood frame may stick and be hard to open due to specific heat.
10. _____ Insulators do not conduct heat well.

Name _____ Date _____ Class _____

# 3. Thermal Properties

Read the passage. Then use a separate sheet of paper to answer the questions that follow.

## Thermostats

A thermostat is a switch that is sensitive to changes in temperature. Thermostats are used to control the temperature of heating systems and cooling systems in homes, businesses, and vehicles. Thermostats also control the temperature of ovens, and turn on the fan of a computer when it becomes too warm.

A thermostat works on the principle of thermal expansion. When metals are heated, they expand, or become larger. Different metals expand at different rates. The amount of expansion depends on the length of the piece of metal and the temperature increase. For example, a one-meter length of steel expands 0.012 mm for every kelvin degree of temperature increase. A one-meter length of brass expands 0.019 mm for every kelvin degree of temperature increase.

A thermostat contains a bimetallic strip, a strip made of two metals, brass and steel, joined together. When the temperature increases, both metals expand. However, brass expands more than steel. Because the two pieces of metal are joined, the unequal expansion causes the strip to bend. The shorter steel is on the inside of the curve and the longer brass is on the outside of the curve.

In a heating system, when the room is cool, the bimetallic strip cools and contracts. As the strip straightens, it touches a contact in an electrical switch. This turns on the heating system. As the room warms, the bimetallic strip becomes warmer and expands. The strip curves and moves away from the contact. This turns off the heating system. Eventually, the room cools, and the strip straightens, starting the heating system again.

**1.** How could a bimetallic strip be used to make a thermometer?

_____

_____

**2.** Some thermostats have the bimetallic strip formed into a spiral. What is the advantage of this shape?

_____

_____

_____

_____

**3.** A one-meter length of nickel expands 0.012 mm for every kelvin degree of temperature increase. Why would a bimetallic strip made of nickel and steel not be a good choice for a thermostat?

_____

_____

Name _____ Date _____ Class _____

## Chapter 7: Characteristics of waves

# 1. What Are Waves?

### Understanding Main Ideas

Answer the following questions in the space provided.

1. What happens when a source of energy causes a medium to vibrate?

_____

2. What are the types of mechanical waves?

_____

### Building Vocabulary

Label the parts of the wave shown in the illustration.

3. _____

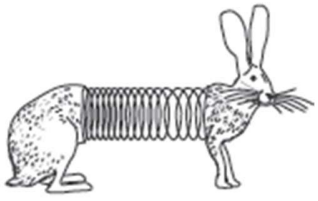
4. _____

**Answer the following questions in the spaces provided.**

5. What medium is the wave traveling through? _____
6. What is the source of energy causing the wave? _____
7. How do you know the wave is a mechanical wave? _____
8. What type of mechanical wave is this? _____

**Identify the type of wave shown in each illustration.**

9. _____



10. _____

Name _____ Date _____ Class _____

# 1. What Are Waves?

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The highest parts of a transverse wave are called
- A transversals
- B summits
- C troughs
- D crests

**2.** ___ The lowest parts of a transverse wave are called
- A transversals
- B summits
- C troughs
- D crests

**3.** ___ In longitudinal waves in a spring, the parts where the coils are close together are called
- A compressions
- B rarefactions
- C longitudes
- D contractions

**4.** ___ In longitudinal waves in a spring, the parts where the coils are spread out are called
- A compressions
- B rarefactions
- C longitudes
- D contractions

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ Waves that can travel with or without a medium are called <u>mechanical</u> waves.

**6.** _____ Mechanical waves form when a source of energy causes a medium to <u>compress</u>.

**7.** _____ The three types of mechanical waves are transverse waves, <u>latitudinal</u> waves, and surface waves.

**8.** _____ A(n) <u>surface</u> wave moves the medium in the same direction as the wave travels.

**9.** _____ Each particle of water in an ocean wave moves in a(n) <u>circle</u>.

**10.** _____ A transverse wave moves a medium at a(n) <u>obtuse</u> angle to the wave.

Name _____ Date _____ Class _____

# 1. What Are Waves?

Waves are all around you, even in plants and animals. Read the passage and study the diagrams. Then answer the questions that follow on a separate sheet of paper.

## Waves in the World around You

- The cowboy shown in Figure 1 is practicing his rope tricks. The whirling loop of the lasso spins in a circle just above the ground. As it spins, it develops a kink. This kink is a traveling wave.
- In Figure 2, the plastic frog "jumps" when the spring is compressed and then released. A wave travels through the spring with each jump the frog makes.
- The garden snake shown in Figure 3 is slithering across the ground. As it moves, two types of waves pass through its body. When the snake moves forward, its body makes an S-shaped wave. In addition, contractions ripple down the snake's body as it slithers along. Muscles underneath the snake's skin extend from its head down its body towards its tail. These muscles contract and relax in a steady pattern in the direction of the arrows. The periodic contraction and relaxation of the snake's muscles propel it forward through the grass.

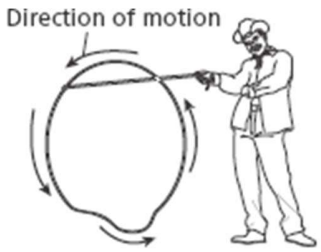


Figure 1

Figure 2

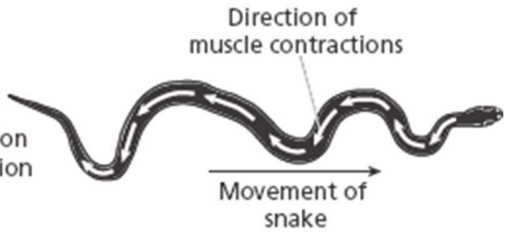


Figure 3

**1.** Does the kink in the lasso travel as a transverse or longitudinal wave? Explain your answer.

_____

_____

**2.** What type of wave passes through the spring in the frog toy? Explain.

_____

_____

**3.** What type of wave does the snake's body make as the snake moves forward? Explain your answer.

_____

_____

**4.** What type of wave do the contractions of the snake's muscles make as the snake moves forward? Explain.

_____

_____

**5.** Describe another plant or animal in which you can observe wave motion.

_____

_____

Name _____ Date _____ Class _____

# 2. Properties of Waves

## Understanding Main Ideas

Answer the following questions in the spaces provided. Use a separate sheet of paper if you need more room.

**1.** Name four properties of a wave. Tell what each property describes.

_____

_____

**2.** How are three of the properties in question 1 related?

_____

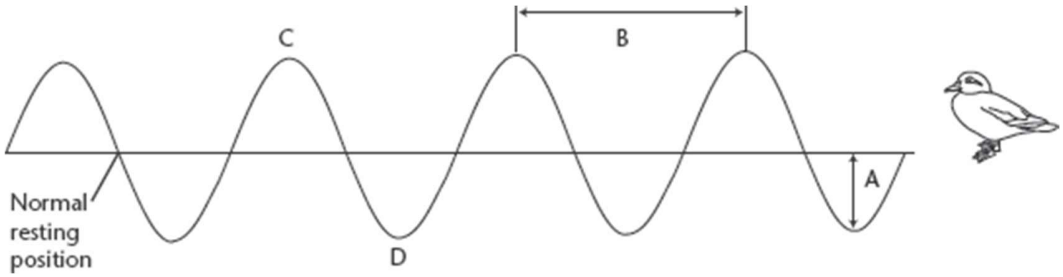
_____

**3.** What happens to the speed of a wave if the medium, temperature, and pressure do not change?

_____

## Building Vocabulary

Use the diagram to answer Questions 4–8. Fill in the blank to complete each statement.




**4.** Four complete waves pass the duck in one second. The frequency of this wave is _____.

**5.** The letter A represents the _____ of the wave.

**6.** The letter B represents the _____ of the wave.

**7.** The letter C represents a(n) _____ of the wave.

**8.** The letter D represents a(n) _____ of the wave.

Name _____ Date _____ Class _____

# 2. Properties of Waves

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The distance between two corresponding parts of a wave is its
- A trough
- B frequency
- C wavelength
- D amplitude

**2.** ___ How often a wave occurs is the wave's
- A crest
- B frequency
- C wavelength
- D amplitude

**3.** ___ The less energy a wave has, the smaller its
- A crest
- B frequency
- C wavelength
- D amplitude

**4.** ___ Frequency is measured in units called
- A periods
- B nanoseconds
- C hertz
- D eras

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ All waves have wavelength, frequency, <u>rest point</u>, and speed.

**6.** _____ The <u>frequency</u> of a wave remains constant if the medium, temperature, and pressure do not change.

**7.** _____ The speed, wavelength, and frequency of a wave are related by a <u>scientific theory</u>.

**8.** _____ The height of a wave's <u>wavelength</u> depends on its amplitude.

**9.** _____ The amplitude of a(n) <u>transverse</u> wave is a measure of how compressed or rarefied the medium becomes.

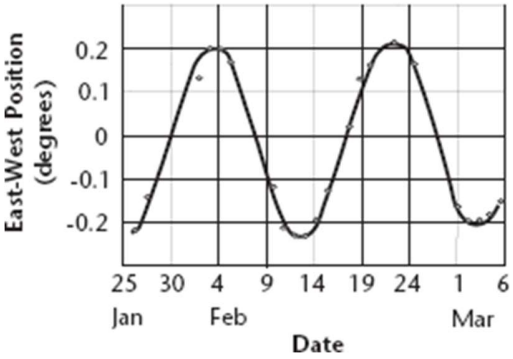
**10.** _____ Dividing the <u>distance</u> a wave travels by the time it takes to travel that distance gives you the wave's speed.

Name _____ Date _____ Class _____

# 2. Properties of Waves

The graph below shows data the Italian astronomer Galileo collected based on his observations of the position in Earth's sky of Callisto, one of Jupiter's moons. The *x*-axis shows the dates when the observations were made, and the *y*-axis indicates the east-west position of Callisto in the night sky. Study the graph, read the passage, and then answer the questions that follow on a separate sheet of paper.

## Moon Waves




This wavelike pattern of motion is due to the fact that Callisto is revolving around the planet Jupiter. The wavelength of this graph, about 17 days, represents the time it takes for Callisto to complete one orbit around Jupiter. (In most wave diagrams, wavelength is a measure of distance. Notice that in this case, wavelength is a measure of time.)

The amplitude of the wave diagram can be used to determine the diameter of Callisto's orbit around Jupiter. The amplitude of the motion is about 0.2 degree. Each degree corresponds to about 10,000,000 km. So, the diameter of Callisto's orbit is about 4,000,000 km (0.2 × 2 × 10,000,000).

1. Imagine that you have discovered a new moon of Jupiter. You observe the moon's position in the sky over a period of several nights. You use your data to make the graph at the right. How long does it take this moon to revolve around Jupiter?

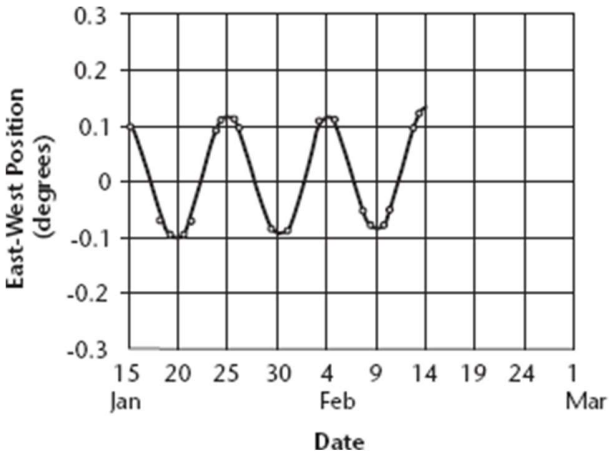
   _____

2. What is the amplitude of this moon's motion? What is the diameter of its orbit around Jupiter? (*Hint:* Remember that each degree equals 10,000,000 km.)

   _____

3. Predict the motion of this moon over the next few nights. Continue the line of the graph to show this motion.

   _____



Name _____ Date _____ Class _____

# 3. Interactions of Waves

## Understanding Main Ideas

If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.

**1.** _____ Waves change direction by diffraction, reflection, and <u>deflection</u>.

**2.** _____ <u>Constructive</u> interference is used in some headphones to block out distracting noises in a listener's surroundings.

**3.** _____ If an incoming wave and reflected wave have <u>a high-pitched</u> frequency, they combine to form a standing wave.

## Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

**4.** ____ diffraction

**5.** ____ interference

**6.** ____ constructive interference

**7.** ____ destructive interference

**8.** ____ standing wave

**9.** ____ resonance

**a.** interaction of two waves that results in a wave with a larger amplitude

**b.** a wave that appears to stay in one place

**c.** increase in amplitude that occurs when external vibrations match an object's own natural frequency

**d.** interaction of two waves that results in a wave with a smaller amplitude

**e.** the bending and spreading out of waves around the edge of a barrier

**f.** interaction between two waves that meet

Name _____ Date _____ Class _____

# 3. Interactions of Waves

**Write the letter of the correct answer on the line at the left.**

**1.** ___ Reflection occurs when a wave

A bends due to a change in speed

B hits a surface and bounces back

C passes through an opening

D bends around a barrier

**2.** ___ Refraction occurs when a wave

A bends due to a change in speed

B hits a surface and bounces back

C passes through an opening

D bends around a barrier

**3.** ___ Interference in which waves combine to form a wave with a larger amplitude than either wave originally had is called

A destructive interference

B amplitude enhancement

C constructive interference

D resonance

**4.** ___ Points of maximum amplitude on a standing wave are called

A crests

B incidence

C apexes

D antinodes

**Fill in the blank to complete each statement.**

**5.** Destructive interference in a standing wave produces points with zero amplitude called _.

**6.** Waves do not bend when entering a new medium at a(n) _____ angle.

**7.** A wave refracts because one side of the wave changes _____ before the other side.

**8.** A wave _____ and spreads out in diffraction.

**9.** When the crest of one wave overlaps the trough of another wave, _____can occur.

**10.** A standing wave is actually two waves _____ as they pass through each other.

Name _____ Date _____ Class _____

# 3. Interactions of Waves

Read the passage and study the diagrams. Then answer the questions that follow on a separate sheet of paper.

## Interference of Pulses

If you and a friend hold a rope between you and one of you flicks the rope, the wave that travels along the rope is called a pulse. If you and your friend each give an upward flick to the rope at the same time, two pulses will travel down the rope in opposite directions. Figure 1 shows what happens as the pulses travel through each other.

Figure 2 shows what would happen if you gave an upward flick to the rope at the same time as your friend gave a downward flick to the rope. When these two pulses travel through each other, their amplitudes also "combine." But in this case, the amplitude of the downward pulse is "subtracted" from the amplitude of the upward pulse.

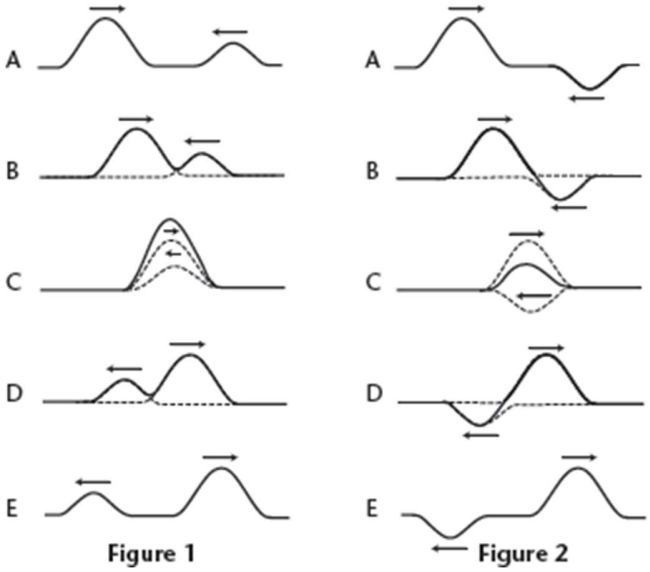



Figure 1 Figure 2

1. Does Figure 1 show constructive or destructive interference? Figure 2? Explain.

_____
_____
_____
_____

2. The pulse traveling toward the left in Figure 1A has an amplitude of 2 cm. The pulse traveling toward the right has an amplitude of 4 cm. What is the amplitude of the pulse in Figure 1C?

_____

3. Refer to question 2. What are the amplitudes of the pulses in Figure 1E?

_____
_____

4. The pulse traveling toward the left in Figure 2A has an amplitude of 3 cm. The pulse traveling toward the right has an amplitude of 5 cm. What is the amplitude of the pulse in Figure 2C?

_____

Name _____ Date _____ Class _____

## Chapter 8: Sound

# 1. The Nature of Sound

### Understanding Main Ideas

Answer the following questions in the space provided.

**1.** What is sound?

_____

_____

**2.** How does the vibration of a drumhead cause a sound wave to form?

_____

_____

_____

_____

_____

**3.** Do sound waves always travel in straight lines? Explain.

_____

_____

**Complete the following table.**

| Factor | Change in Factor | Effect on Speed of Sound |
|---|---|---|
| stiffness | increase in stiffness | **4.** |
| density | increase in density | **5.** |
| temperature | decrease in temperature | **6.** |

### Building Vocabulary

Write a definition for the term on the lines below.

**7.** density

_____

_____

Name _____ Date _____ Class _____

# 1. The Nature of Sound

**Write the letter of the correct answer on the line at the left.**

**1.** ___ Sound travels as a(n)

A medium

B energy

C wave

D particle

**2.** ___ When one part of a vibration causes air particles to spread out, they form a

A compression

B sound wave

C diffraction

D rarefaction

**3.** ___ When one part of a vibration pushes air particles together, they form a

A compression

B sound wave

C diffraction

D rarefaction

**4.** ___ Sound can travel through

A solids

B liquids

C gases

D all of the above

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ The quality of sound depends on the temperature, stiffness, and density of the medium the sound travels through.

**6.** _____ Sound travels more quickly at higher temperatures than at lower temperatures.

**7.** _____ Sound waves lose energy more quickly in stiff mediums than in less stiff mediums.

**8.** _____ The state of a medium helps determine the speed of sound passing through the medium.

**9.** _____ Weight is the amount of matter or mass there is in a given amount of space or volume.

**10.** _____ The speed of sound traveling through steel is much less than the speed of sound traveling through air.

Name _____ Date _____ Class _____

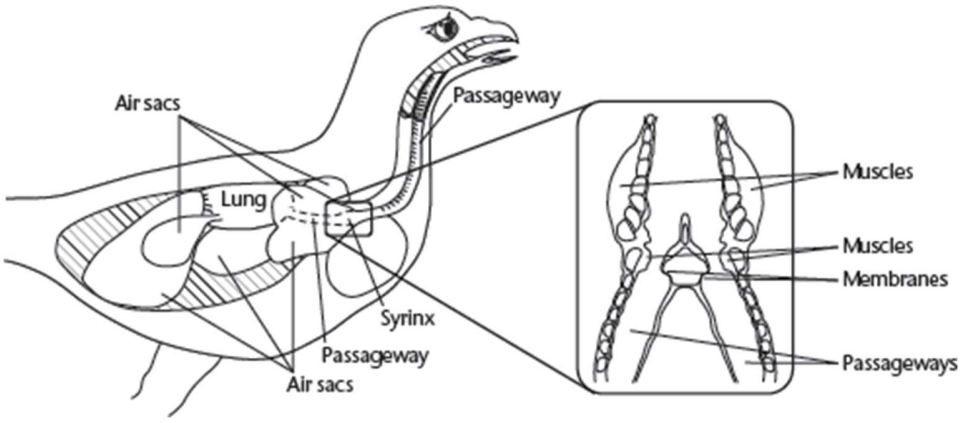
# 1. The Nature of Sound

The diagram below shows the body parts birds use to produce sounds. Read the passage and study the diagram. Then use a separate sheet of paper to answer the questions that follow.

## The Sound of Nature

Bird song is a very common sound of nature. The sound is actually made in the *syrinx*, but the air sacs, passageways, and lungs also affect the sound waves to produce different kinds of sounds.

When a bird begins to sing, it closes the two passageways between the lung and the syrinx. The muscles in the chest squeeze the air in the air sacs. Squeezing the air sacs surrounding the syrinx forces each of two small thin membranes in the syrinx into the passageways between the syrinx and the lung. This movement closes both passageways and does not allow air to travel through them. Then, the muscles around the syrinx contract, which tightens one of the membranes and pulls it out of one passageway. Now the air in that passageway can move, and it passes quickly over the membrane. The fast-moving air makes the membrane vibrate, producing sound waves.




Remember that there are two passageways between the bird's lungs and its syrinx. The bird can control each of these passageways separately. This allows a bird to sing two notes at the same time.

**1.** Through which medium does sound travel inside a bird?

_____

**2.** Could a bird sing if both passageways remained closed by the membranes? Explain your answer.

_____

_____

**3.** Why does the membrane tighten before air passes over it?

_____

**4.** The more muscles a bird has surrounding its syrinx, the more types of sounds it can make. Which kind of bird do you think has more of these muscles, a parrot or a dove? Explain your answer.

_____

_____

Name _____ Date _____ Class _____

# 2. Properties of Sound

## Understanding Main Ideas

Answer the following questions in the spaces provided.

**1.** What property of sound depends on the energy and intensity of the sound wave?

_____

**2.** What does the pitch of a sound depend on?

_____

**3.** What creates the Doppler Effect?

_____

_____

_____

## Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

**4.** ____ decibel (dB)

**5.** ____ pitch

**6.** ____ intensity

**7.** ____ loudness

**a.** energy a sound wave carries per second through a unit area

**b.** unit of comparison for loudness

**c.** how high or low a sound seems

**d.** awareness of the energy of a sound

Name _____ Date _____ Class _____

# 2. Properties of Sound

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The waves in front of a moving sound source have
- A longer wavelengths than trailing waves
- B a higher pitch than the waves behind it
- C different properties than trailing waves
- D the same amplitude as the waves behind it

**2.** ___ A 10-dB increase in loudness represents
- A a twofold increase in intensity
- B a fourfold increase in intensity
- C a tenfold increase in intensity
- D a hundredfold increase in intensity

**3.** ___ Loudness describes
- A the energy and intensity of a sound wave
- B the decibel level of a sound wave
- C a danger to public health
- D your awareness of a sound's energy

**4.** ___ When your vocal cords relax, you produce sound waves with
- A lower frequencies and lower pitches
- B lower frequencies and higher pitches
- C higher frequencies and higher pitches
- D higher frequencies and lower pitches

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ The loudness of different sounds is compared in units called Hertz (Hz).

**6.** _____ The farther apart a sound wave and its source are, the less energy the sound wave has in a given area.

**7.** _____ The diffusion theorem explains a change that occurs in the frequency of a wave as its source moves in relation to an observer.

**8.** _____ A sound source vibrating with a large amplitude produces a sound wave with a(n) small amplitude.

**9.** _____ The less energy a sound wave has, the softer it sounds.

**10.** _____ Sounds louder than 60 dB can cause damage to your ears.

Name _____ Date _____ Class _____

# 2. Properties of Sound

Read the passage and study the equations that appear within it. Then use a separate sheet of paper to answer the questions that follow.

## The Power of Sound

You learned in *Properties of Sound* that the intensity of a sound wave is the amount of energy the wave carries per second through a unit area. The unit for intensity is the watt per square meter ($W/m^2$). Because the watt is a unit of power, intensity can also be defined as the amount of power per unit area. Intensity can be calculated using the following formula:

$$\text{Intensity} = \frac{\text{Power}}{(4\pi)(\text{Distance from source}^2)}$$

Suppose you want to calculate the intensity of the sound waves from an orchestra playing at a distance of 15 m from you. The orchestra is playing its loudest, producing sound waves with a power of 76 W. You would use the formula above.

$$\text{Intensity} = \frac{76\ \text{W}}{(4 \times 3.14)(15\ \text{m}^2)}$$

$$= \frac{76\ \text{W}}{(12.56)(225\ \text{m}^2)}$$

$$(0.027)\ \text{W/m}^2$$

1. How can you increase the intensity of sound waves?

   _____

2. Calculate the intensity of sound waves from the conversations of a crowd of people at a distance of 10 m when the power of the sound is 50 W.

   _____

3. Calculate the intensity of sound waves from the conversations of a crowd of people at a distance of 20 m when the power of the sound is 50 W.

   _____

4. Which will have a greater effect on the intensity of a sound: doubling its power or halving its distance? Explain your answer.

   _____

Name _____ Date _____ Class _____

# 3. Music

## Understanding Main Ideas

The curves show the fundamental tone, first overtone, and second overtone of a sound. Identify the curves by filling in the blanks.

**1.** _____

**2.** _____

**3.** _____

**Answer the following questions.**

**4.** What does the sound quality of a particular instrument result from?

_____

_____

**5.** Why do a guitar and a trumpet sound different when they both play the same note?

_____

_____

**6.** Compare the different ways a musician changes the pitch while playing a stringed instrument or playing a wind instrument.

_____

_____

## Building Vocabulary

Fill in the blank to complete each statement.

**7.** A set of notes that combine in patterns that are pleasing is known as _____.

**8.** The lowest natural frequency of a standing wave is called the _____.

**9.** _____ have frequencies that are two, three, or more times the frequency of the fundamental tone.

Name _____ Date _____ Class _____

# 3. Music

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The lowest natural frequency in a standing wave is called the

A resonant note

B second overtone

C harmonic

D fundamental tone

**2.** ___ The sound quality of a musical instrument results from blending a fundamental tone with its

A opposite

B undertones

C overtones

D standing wave

**3.** ___ The flute is a

A percussion instrument

B stringed instrument

C brass instrument

D wind instrument

**4.** ___ To change the pitch of a stringed instrument, a musician

A plucks the strings

B changes the length of the vibrating string

C presses the bow harder against the strings

D blows harder

**If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ The three basic groups of musical instruments are stringed, <u>brass</u>, and wind.

**6.** _____ Music is a set of notes that combine in patterns that are <u>unusual</u>.

**7.** _____ Most instruments produce <u>several</u> natural frequencies simultaneously.

**8.** _____ The size, <u>density</u>, and material of an instrument determine which overtones are loudest.

**9.** _____ In a wind instrument, a shorter air column produces a <u>higher</u> pitch.

**10.** _____ A musician produces sound from a <u>percussion</u> instrument by blowing across a mouthpiece.

Name _____ Date _____ Class _____

# 3. Music

Wood is a good choice when making musical instruments. Wood can make sound when struck, and it can also absorb or strengthen sound waves that pass through it. Read the passage and study the figure below. Then use a separate sheet of paper to answer the questions that follow.

## Musical Wood

Researchers have been studying violins made in Italy during the late 1600s. They hope to discover what it is about these violins that produces such extraordinary sounds. They found that the wood used was floated down rivers from the mountains where it was cut and then stored in seawater until used to make the violins. Researchers believe that the soaking removed substances that would have made the wood produce poor sounds. Bacteria and minerals from the seawater soaked into the wood, helping the wood produce its beautiful, characteristic sounds.

Also, when wood is allowed to dry without soaking it first in seawater, the cells that make up the wood close as the wood dries. When wood that has been soaked in seawater dries, the cell openings stay open. The greater number of open structures in the wood, the faster the sound waves can travel through it.

Soaked wood

1. The more open structures of the dried, seawater-soaked wood makes that wood less dense. In what type of wood do sound waves travel faster, in less dense wood or more dense wood?

   _____

2. Chemicals applied to the violin's surface can affect the stiffness of wood in the finished violin. Would this affect the speed of sound waves traveling through the wood? Explain your answer.

   _____

   _____

   _____

3. How would the frequency of the sound waves affect the sound's pitch?

   _____

   _____

4. What other factors do you think would affect the sound quality of a violin?

   _____

   _____

Name _____ Date _____ Class _____

# 4. Hearing Sound

## Understanding Main Ideas

Answer the following question on a separate piece of paper.

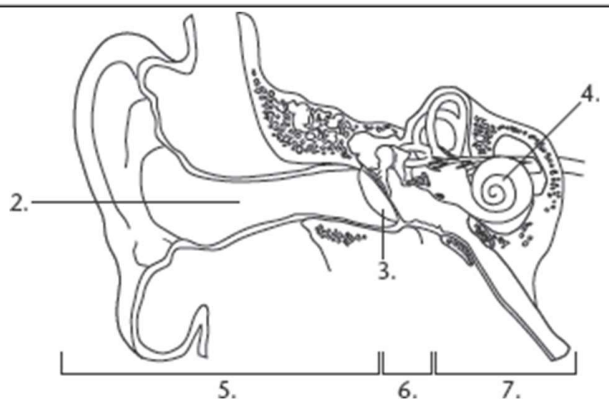
**1.** Describe two causes of hearing loss.

_____

_____

## Building Vocabulary

The diagram below shows the human ear. Write the name and function of each part of the ear next to the correct number.




**2.** _____

_____

**3.** _____

_____

**4.** _____

_____

**5.** _____

_____

**6.** _____

_____

**7.** _____

_____

Name _____ Date _____ Class _____

# 4. Hearing Sound

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The three smallest bones in the ear—and in your body—are the hammer, anvil, and
- A cochlea
- B spur
- C stirrup
- D auditory nerve

**2.** ___ The three sections of the ear are the
- A outer, middle, and inner ear
- B exterior, interior, and auditory ear
- C dermal, transdermal, and interdermal ear
- D intro, intra, and supra ear

**3.** ___ The outermost part of your ear looks like a
- A hammer
- B anvil
- C snail
- D funnel

**4.** ___ Sound waves are converted to a signal that travels from your ear to your
- A brain
- B lungs
- C nerves
- D muscles

**Fill in the blank to complete each statement.**

**5.** The hammer is attached to the _____, which makes it vibrate.

**6.** Aging is one cause of hearing _____.

**7.** Vibrations moving through the liquid of the _____ cause messages to be sent through the auditory nerve.

**8.** Extended exposure to _____ sounds can damage hair cells, so that they can no longer send signals to the brain.

**9.** A(n) _____ implant restores certain types of hearing loss.

**10.** Hearing loss can occur if the _____ is punctured.

Name _____ Date _____ Class _____

# 4. Hearing Sound

Figure 1 shows the change in a sound wave as it passes through a hearing aid. Read the passage and study the figure. Then use a separate sheet of paper to answer the questions that follow.

## Aid in Hearing

The human ear contains many small parts that must work together perfectly for us to hear well. A number of things can interfere with the workings of these parts, causing a loss of hearing. When hearing loss occurs, many people can be helped with hearing aids.

In general, a hearing aid works by making sounds louder. A microphone picks up sound waves and sends them to an amplifier. The amplifier increases the amplitude of the sound waves. The amplified waves are then channeled into the outer ear. A small battery supplies the electrical energy for the hearing aid.

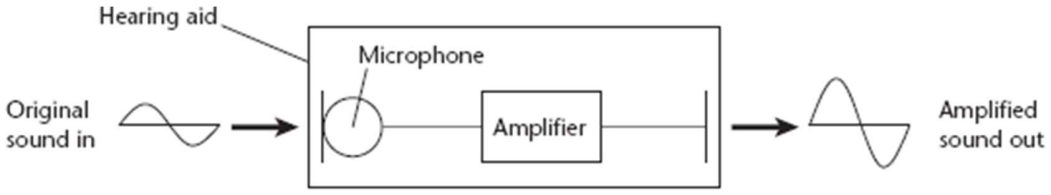



**Figure 1**

1. What is the amplitude of a sound wave?

   _____

2. Why does increasing the amplitude of a sound wave make the sound louder?

   _____

   _____

3. Some hearing aids can help the wearer pick out a single voice in a room full of people talking. This is not done by simply making sounds louder. What other sound quality would need to be controlled and how could this be done?

   _____

   _____

4. What other kinds of devices can you think of that might help alert a person with hearing loss to an important sound?

   _____

   _____

   _____

   _____

Name _____ Date _____ Class _____

# 5. Using Sound

## Understanding Main Ideas

Answer the following questions on a separate piece of paper.

1. How do bats use sound to navigate and to hunt?
2. What are two uses for sonar?
3. How does sonar work?
4. What is one way ultrasound is used in medicine?

## Building Vocabulary

Write a definition for each of these terms on the lines below.

5. echolocation

_____

_____

6. sonar

_____

_____

7. sonogram

_____

_____

Name _____ Date _____ Class _____

# 5. Using Sound

**Write the letter of the correct answer on the line at the left.**

**1.** ___ To find food and navigate, dolphins use

A radiotechnology

B aerodynamics

C echolocation

D sonar

**2.** ___ Through their jawbones, dolphins sense reflected

A sonograms

B light waves

C objects

D sound waves

**3.** ___ Animals and people gather information by using sound's ability to

A reflect off surfaces

B travel in a vacuum

C cut through steel

D form a transverse wave

**4.** ___ Sound waves with frequencies above the normal range of human hearing are called

A supersound

B ultrasound

C navigation sound

D echo sound

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ An ultrasound imaging device uses reflected sound waves to create a picture called a(n) <u>x-ray</u>.

**6.** _____ Different parts of the body reflect sound waves <u>differently</u>.

**7.** _____ Doctors use ultrasound imaging to <u>dissect</u> the human body.

**8.** _____ A sonar device produces <u>electromagnetic</u> waves.

**9.** _____ Animals such as bats can send out pulses of <u>radioactivity</u> to help them navigate in the dark.

**10.** _____ The word *sonar* comes from the words sound navigation and <u>rearrangement</u>.

Name _____ Date _____ Class _____

# 5. Using Sound

Read the passage and study the table below. Then use a separate sheet of paper to answer the questions that follow.

## Range of Hearing

Humans can hear sounds with frequencies as low as 20 Hz. Sound waves with frequencies below this limit are called infrasonic. Low-frequency sounds carry over longer distances than do higher-frequency sounds.

Elephants can hear sounds at infrasonic frequencies. Some zoologists believe that elephants can hear approaching thunderstorms. Thunderstorms contain rapidly moving columns of air. These air columns produce infrasonic waves that elephants may be able to hear even when a storm is still many kilometers away. Birds can also hear very low-frequency sounds. They may be able to find pockets of rising air by listening for the infrasonic waves that moving air columns produce.

Both elephants and hippopotamuses can produce infrasound. They use it to communicate with distant members of their own herd or of other herds several kilometers away.

| Animal | Lowest frequency heard (Hz) | Highest frequency heard (Hz) |
|---|---|---|
| Humans | 20 | 20,000 |
| Cats | 100 | 65,000 |
| Dogs | 40 | 50,000 |
| Horses | 31 | 40,000 |
| Elephants | 16 | 12,000 |
| Cattle | 16 | 40,000 |
| Bats | 1,000 | 120,000 |
| Whales and dolphins | 70 | 150,000 |

1. Which animals in the table can hear sounds at infrasonic frequencies?

   _____

2. Sound waves above the limit of human hearing are called ultrasonic. Which animals in the table can hear sounds at ultrasonic frequencies?

   _____

3. Waterfalls also produce infrasonic waves. Why would it be helpful for animals to be able to detect them?

   _____

4. Why do you think cattle's ability to hear infrasonic frequencies might contribute to a stampede?

   _____

   _____

Name _____ Date _____ Class _____

## Chapter 9: Electromagnetic waves

# 1. The Nature of Electromagnetic Waves

### Understanding Main Ideas

Answer the following questions in the spaces provided.

1. What are the two kinds of fields that make up an electromagnetic wave?

_____

_____

2. How does the photoelectric effect show that light has some properties of a stream of particles?

_____

_____

_____

_____

3. What model explains the behavior of light when light passes through a polarizing filter?

_____

### Building Vocabulary

Fill in the blank to complete each statement.

4. The energy transferred by electromagnetic waves is called_____.

5. The _____ occurs when light hits a certain metal and causes electrons in that metal to move.

6. A(n) _____ is a particle of light energy.

7. Light that passes through a polarizing filter is called _____.

8. A(n) _____ consists of changing electric and magnetic fields.

Name _____ Date _____ Class _____

# 1. The Nature of Electromagnetic Waves

**Write the letter of the correct answer on the line at the left.**

**1.** ___ Which of the following is **NOT** an electromagnetic wave?

A visible light

B sound

C X-ray

D gamma ray

**2.** ___ Each packet of light energy is called a(n)

A electron

B neutron

C photon

D proton

**3.** ___ Light that causes an electron to move so much that it is knocked out of a metal is called the

A photoelectric effect

B electromagnetic effect

C radiation effect

D polarization effect

**4.** ___ Electromagnetic waves are

A forms of matter

B forms of space

C longitudinal waves

D transverse waves

**If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ A filter with <u>vertical</u> slits allows only waves that vibrate from side to side to pass through.

**6.** _____ <u>Three</u> different models explain the behavior of electromagnetic waves.

**7.** _____ Light has many properties of a stream of <u>waves</u>.

**8.** _____ An electromagnetic wave is made up of <u>encased</u> electric and magnetic fields.

**9.** _____ An electromagnetic wave involves the transfer of electric and magnetic <u>devices</u> through matter or space.

**10.** _____ Electric and magnetic fields produce each other <u>repeatedly</u>.

Name _____ Date _____ Class _____

# 1. The Nature of Electromagnetic Waves

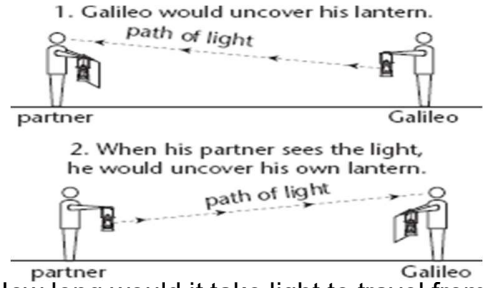
Read the passage and study the diagram. Then use a separate sheet of paper to answer the questions that follow.

## Measuring the Speed of Light

Galileo, an Italian scientist who lived from 1564 to 1642, may have been the first person to attempt to measure the speed of light. Before Galileo's time, it was believed that light traveled instantly from one place to another. For example, people noticed that thunder was often heard after a flash of lightning was seen. This was taken as evidence that the flash from lightning reached a person's eye the instant lightning struck. Galileo disagreed:

> ... the only thing I am able to infer from this familiar bit of experience is that sound, in reaching our ear, travels more slowly than light; it does not inform me whether the coming light is instantaneous or whether, although extremely rapid, it still occupies time.

To test his hypothesis, Galileo conducted an experiment. He and a partner stood on opposite sides of a field at night. Each held a covered lantern. Galileo planned to measure the time between the instant he uncovered his own lantern and the instant when he saw the light from his partner's lantern. He would use this measurement along with the distance between the two men to calculate its speed. However, light traveled between the two men so quickly that Galileo could not accurately measure the time it took.




Since then, many other methods—involving mirrors, microwaves, lasers, and even stars—have been used to measure the speed of light. In 1983, scientists established the speed of light as 299,792,458 m/s. This speed is usually rounded to 300,000,000 m/s.

1. Suppose that Galileo and his partner stood 100 m apart. How long would it take light to travel from Galileo to his partner and back again? *(Hint:* Divide the total distance the light travels by the speed of light.) Why couldn't Galileo measure this length of time?

   _____

2. Suppose that Galileo could have sent a flash of light to a planet 900,000,000 m away from Earth and that a mirror on that planet could reflect the flash of light back to Earth. Do you think that this experiment would have worked better than the one Galileo tried with lanterns? Explain your answer.

   _____

   _____

   _____

3. Did Galileo's experiment with the lanterns disprove his hypothesis? Explain your answer.

   _____

   _____

Name _____ Date _____ Class _____

# 2. Waves of the Electromagnetic Spectrum

## Understanding Main Ideas

Complete the table.

**The Electromagnetic Spectrum**

Increasing Wavelength →

| Type of Electromagnetic Radiation | Example of Use |
|---|---|
| **1.** | Radio Broadcasting |
| Microwaves | **2.** |
| Infrared rays | **3.** |
| Visible light | Seeing |
| Ultraviolet rays | **4.** |
| **5.** | Check for broken bones inside the body |
| **6.** | Diagnose and treat cancer |

## Building Vocabulary

Answer the following questions in the spaces provided. Use a separate sheet of paper if you need more room.

**7.** What is the electromagnetic spectrum?

_____

_____

_____

**8.** Why is too much exposure to ultraviolet radiation dangerous?

_____

**9.** What is a thermogram?

_____

_____

**10.** How can a person detect infrared rays without an instrument?

_____

_____

Name _____ Date _____ Class _____

# 2. Waves of the Electromagnetic Spectrum

**Write the letter of the correct answer on the line at the left.**

**1.** ___ Radar uses reflected microwaves to detect objects and measure their

A distance and speed

B weight and volume

C wavelength and frequency

D height and depth

**2.** ___ Visible light is a mixture of

A refraction and reflection

B atoms and molecules

C many colors

D ultraviolet and nonviolet rays

**3.** ___ The electromagnetic spectrum includes the complete range of electromagnetic waves placed in order of

A increasing amplitude

B increasing frequency

C increasing wavelength

D decreasing frequency

**4.** ___ A thermogram is an image produced by a special camera that, instead of visible light, records

A microwaves

B radar

C infrared rays

D X-rays

**Fill in the blank to complete each statement.**

**5.** Electromagnetic waves with the shortest wavelengths and highest frequencies are called _____.

**6.** Electromagnetic waves used in ovens and cell phone communications are called _____.

**7.** Electromagnetic waves used in broadcasting are called _____.

**8.** Electromagnetic waves that make your skin feel warm are called _____.

**9.** Electromagnetic waves that help your body produce vitamin D are called _____.

**10.** Electromagnetic waves used to examine broken bones inside the body are called _____.

Name _____ Date _____ Class _____

# 2. Waves of the Electromagnetic Spectrum

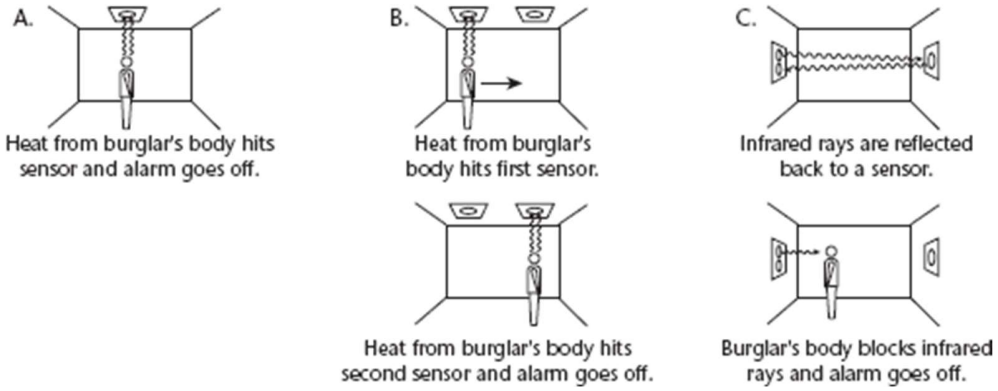
A *motion detector* is a device that can sense when a person or object moves through a room. Read the passage and study the figures. Then use a separate sheet of paper to answer the questions that follow.

## Motion Detectors

Many businesses have burglar alarms that are connected to motion detectors. One type of motion detector can sense the infrared rays given off by a person's body. An alarm is set off when infrared rays hit a sensor on the detector. This type of device is called a passive infrared (PIR) motion detector.

Another type of PIR motion detector involves two sensors in different parts of an office. This type of detector sounds an alarm only after both sensors have been hit by infrared rays from a person's body.

PIR motion detectors only sense infrared rays; they do not transmit them. By contrast, part of an active infrared (AIR) motion detector gives off infrared rays. A second part of the detector in another part of the room reflects these rays back to the first part where they hit a sensor. If someone walks through the path of the invisible infrared rays given off by the detectors, his or her body will prevent the rays from hitting the sensor. When this happens, the alarm is set off.




**1.** Label each of the motion detectors shown above as one-sensor PIR, two-sensor PIR, or AIR.

_____

**2.** Suppose a business has a nighttime alarm system with a one-sensor PIR motion detector. What do you think would happen if a lamp close to the sensor was left turned on overnight?

_____

_____

**3.** Suppose a business has a nighttime alarm system with a two-sensor PIR motion detector. What do you think would happen if a lamp close to one of the sensors was left turned on overnight?

_____

_____

_____

**4.** Do you think that a motion detector that used visible light instead of infrared rays would work very well? Explain your answer in terms of both passive and active detectors.

_____

_____

_____

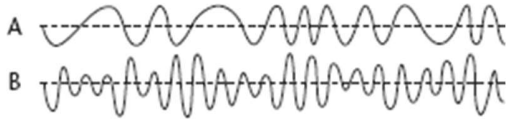
_____

Name _____ Date _____ Class _____

# 3. Wireless Communication

## Understanding Main Ideas

Use the diagram below to answer Questions 1 and 2.




1. Which wave represents an AM signal? How do you know?

_____

2. Which wave represents an FM signal? How do you know?

_____

**Answer the following questions in the spaces provided. Use a separate sheet of paper if you need more room.**

3. Which have higher frequencies, AM radio waves or FM radio waves?

_____

4. Which type of radio waves, AM or FM, produce better sound quality?

_____

5. What does GPS stand for?

_____

6. Who can pick up GPS signals?

_____

## Building Vocabulary

Write a definition for each of these terms on a separate sheet of paper.

7. amplitude modulation
8. frequency modulation

Name _____ Date _____ Class _____

# 3. Wireless Communication

**Write the letter of the correct answer on the line at the left.**

**1.** ___ Radio waves carry information from

A antenna to antenna

B amplitude to frequency

C AM to FM

D space to Earth

**2.** ___ Cell phones transmit and receive signals using

A radio waves

B ultraviolet waves

C microwaves

D gamma rays

**3.** ___ With a satellite phone system, you can call anywhere in the

A county

B state

C country

D world

**4.** ___ A satellite television system includes communications satellites and

A GPS receivers

B electromagnetic waves

C satellite dish antennas

D infrared cameras

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ AM radio waves have <u>longer</u> wavelengths than FM radio waves.

**6.** _____ AM radio waves travel a <u>shorter</u> distance than FM radio waves.

**7.** _____ Radio stations, police radios, and amateur radio operators use <u>the same</u> radio frequencies.

**8.** _____ The process of making cell phone calls happens almost at the speed of <u>sound</u>.

**9.** _____ The Global <u>Positioning</u> System (GPS) is a system of navigation that allows people with GPS receivers to pinpoint their location.

**10.** _____ Cell phones work only if they are in a <u>GPS</u> system.

Name _____ Date _____ Class _____

# 3. Wireless Communication

Read the passage and study the diagram. Then use a separate sheet of paper to answer the questions that follow.

## Galaxy IV

Computers on communications satellites normally keep the satellites' transmitters and receivers pointed toward Earth. However, in May 1998, a satellite named *Galaxy IV* turned away from its regularposition when a computer system on the satellite broke down. As a result, it could no longer relay electromagnetic signals to Earth. Almost 90 percent of the pagers in the United States relied on this satellite for receive messages. *Galaxy IV* also relayed signals for some television and radio broadcasts. Overall, about 40 million people were affected by the failure of *Galaxy IV.*

*Galaxy IV* was a geosynchronous satellite. For such a satellite, the time for a complete orbit around Earth is one day. From Earth, a geosynchronous satellite appears to be in the same location in the sky at all times, making it particularly useful for applications such as communications and weather forecasting.

When the computer on board *Galaxy IV* could not be repaired, the satellite was moved to a higher orbit called a graveyard orbit, where it would be out of the way of working satellites. Within a few days, another satellite that was already in orbit was moved into the old location of *Galaxy IV* and took over its role relaying signals.


**1.** What do you think would happen if a meteoroid were to hit and damage the satellite that replaced *Galaxy IV*?

_____

_____

**2.** Suppose an uplink to a communications satellite stopped working. Would this problem be more or less serious than if the satellite itself stopped working? Explain your answer.

_____

_____

**3.** Instead of rocketing supplies to geosynchronous satellites, scientists are investigating how supplies could be lifted in elevator fashion. Why do you suppose such space elevators are possible for geosynchronous satellites but not for all communications satellites?

_____

_____

Name _____ Date _____ Class _____

## Chapter 10: Light

# 1. Light and Color

### Understanding Main Ideas
Answer the following questions in the spaces provided.

1. What determines the color of an opaque object? _____

_____

2. What determines the color of a transparent object? _____

_____

3. What colors of light are combined in a television to produce thousands of different colors?

_____

4. As pigments are added together, what happens to the number of colors of light that are reflected? _

_____

**Fill in the table below.**

| Type of material | Example |
|---|---|
| Transparent | **5.** |
| Opaque | **6.** |
| Translucent | **7.** |

### Building Vocabulary
Fill in the blank to complete each statement.

8. Three colors that can combine to make any other color are called _____ colors.

9. When two primary colors combine in equal amounts, they produce a _____ color.

10. Any two colors that combine to form white light are called _____ colors.

Name _____ Date _____ Class _____

# 1. Light and Color

**Write the letter of the correct answer on the line at the left.**

**1.** ___ A material that reflects or absorbs all the light that strikes it is

A opaque

B transparent

C translucent

D primary

**2.** ___ Complementary colors are

A colors that combine to form secondary colors

B all the colors of the rainbow

C any two colors that combine to form white light

D colors that cannot be split into component colors

**3.** ___ The three colors that can be used to make any other color are

A universal colors

B complementary colors

C secondary colors

D primary colors

**4.** ___ Transparent or translucent materials are used to make

A stop signs

B suitcases

C color filters

D toothbrushes

**If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ Green and blue are primary colors that combine in equal amounts to produce cyan.

**6.** _____ Metal and tightly woven fabric are examples of translucent materials.

**7.** _____ A clear glass window is transparent, but a fogged-up glass window is opaque.

**8.** _____ In yellow light, a red scarf appears white.

**9.** _____ When white light shines through a green glass bottle, the bottle appears magenta.

**10.** _____ The color of ink that you see is result of the color that the pigment in the ink reflects.

Name _____ Date _____ Class _____

# 1. Light and Color

The figures below show white light striking a red glass filter and striking a solid green wall. Examine the figures and answer the questions that follow in the spaces provided.

## Colors: Reflected, Absorbed, Passed Through

Colored spotlights dart around a stage. The costumes of performers are colorful. But how are these colors created? The colors depend on the characteristics of the objects that the light strikes.

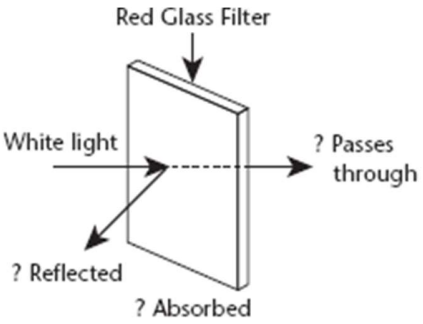


Figure 1

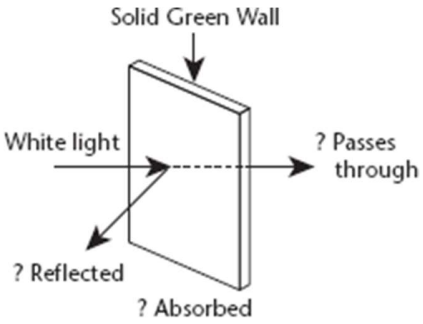


Figure 2

**1.** In Figure 1, of the colors that make up white light, which (if any) are reflected or absorbed? Which pass through?

_____

_____

**2.** In Figure 2, of the colors that make up white light, which (if any) are reflected or absorbed? Which pass through?

_____

_____

**3.** If the light transmitted through the red filter in Figure 1 shone onto the wall shown in Figure 2, what would you see? Explain.

_____

_____

**4.** What would you see if you shone green light on the wall in Figure 2?

_____

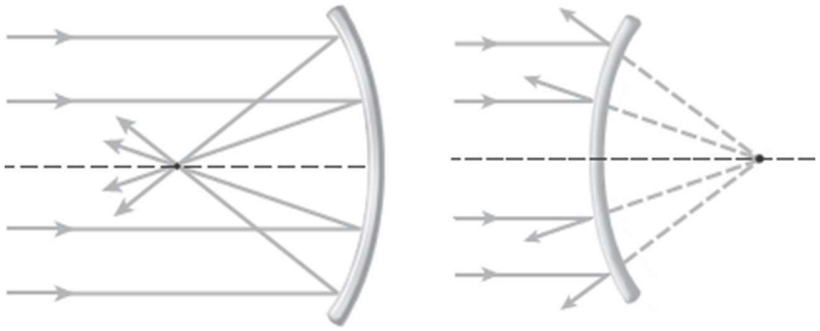
_____

Name _____ Date _____ Class _____

# 2. Reflection and Mirrors

## Understanding Main Ideas

Use the diagrams to answer Questions 1 and 2.



A B

**1.** Circle the focal point on mirror A. What type of mirror is it?

_____

**2.** Circle the focal point on mirror B. What type of mirror is it?

_____

## Building Vocabulary

Fill in the blank to complete each statement.

**3.** _____ reflection occurs when light hits an irregular surface.

**4.** _____ reflection occurs when light hits a smooth surface.

**5.** A(n) _____ image is formed when light rays meet.

**6.** The _____ is an imaginary line that divides a mirror in half.

**7.** The _____ is the point at which light rays parallel to the optical axis meet.

**8.** A(n) _____ image is right-side up.

**9.** A(n) _____ mirror is a flat glass with silver-colored coating on one side.

Name _____ Date _____ Class _____

# 2. Reflection and Mirrors

**Write the letter of the correct answer on the line at the left.**

**1.** ___ A plane mirror has a(n)
- A curved surface
- B focal point
- C diffuse reflection
- D flat surface

**2.** ___ Most objects reflect light
- A strongly
- B diffusely
- C smoothly
- D adequately

**3.** ___ A convex mirror can produce
- A virtual and real images
- B real images
- C convex images
- D virtual images

**4.** ___ A concave mirror can produce
- A virtual and real images
- B real images
- C concave images
- D virtual images

**Fill in the blank to complete each statement.**

**5.** A convex mirror curves _____.

**6.** The _____ divides a mirror in half.

**7.** A(n) _____ forms where light seems to come from.

**8.** A concave mirror curves _____.

**9.** Rays parallel to the optical axis meet at the _____.

**10.** The type of image formed by a concave mirror depends on whether a reflected object is located _____the focal point and mirror or beyond the focal point.

Name _____ Date _____ Class _____

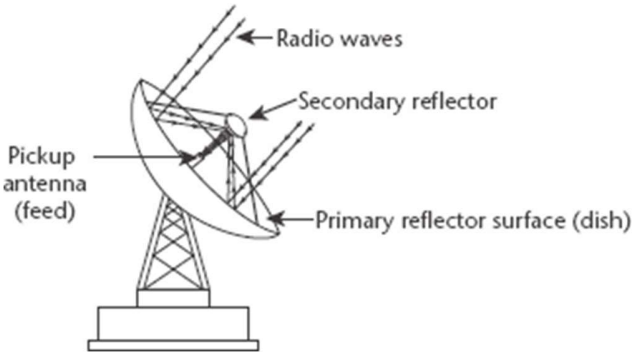
# 2. Reflection and Mirrors

Read the passage and study the diagram of a radio telescope. Then answer the questions that follow on a separate sheet of paper.

## Ear on the Sky

The kinds of telescopes you are probably most familiar with use lenses and mirrors to collect visible light. These kinds of telescopes are known as optical telescopes. But there is more in space than meets the eye. Many objects in space send out waves of electromagnetic radiation that are invisible. Among these are radio waves. Radio telescopes are used to gather radio waves from space. Astronomers learn much about the characteristics of objects such as stars and galaxies by studying the radio waves they give off. Radio telescopes are also used to search for evidence of intelligent life in space.

The largest mirror of an optical telescope is about 10 meters in diameter. The main collecting surface of a radio telescope is often much larger. The largest radio telescope in the world is at Arecibo in Puerto Rico. Its reflector surface, or dish, which functions in a similar way to a concave mirror, has a diameter of 305 meters. In spite of these differences, radio telescopes and optical telescopes function in much the same way.




**1.** Optical telescopes collect and reflect visible light. What do radio telescopes collect and reflect?

_____

**2.** How many reflector surfaces does a radio telescope have?

_____

**3.** Identify each reflector and its shape.

_____

**4.** Onto what objects are the signals focused?

_____

**5.** Is the image produced by a radio telescope the same as the image produced by a optical telescope? Explain.

_____

Name _____ Date _____ Class _____

# 3. Refraction and Lenses

## Understanding Main Ideas

The figures show two different types of lenses viewed from the side. Use the figures to answer questions 1–5 in the spaces provided.

A

B

**1.** Which lens is concave? _____

**2.** Which lens can produce a real image? _____

**3.** Which lens always produces an image that is upright? _____

**4.** Which lens can produce images that are either smaller or larger than the object? _____

**5.** Which lens is the type of lens that is used in a hand lens? _____

## Building Vocabulary

**6.** A(n) _____ is an image of a distant object caused by light refraction through air of varying temperature.

**7.** A(n) _____ is a curved piece of glass or other transparent substance that is used to refract light.

**8.** A(n) _____ lens is thicker in the center than at the edges.

**9.** A(n) _____ lens is thinner in the center than at the edges.

**10.** The _____ is a measure of how much a ray of light bends when it passes from one medium into another.

Name _____ Date _____ Class _____

# 3. Refraction and Lenses

**Write the letter of the correct answer on the line at the left.**

**1.** ___ A mirage forms when
- A regular reflection occurs
- B light rays are bent by water in the air
- C light passes into medium with greater density
- D light refracts as it moves from hot air near the ground to cooler air above

**2.** ___ As a rainbow is formed, light
- A refracts and forms a virtual image
- B refracts and forms a real image
- C reflects as from a plane mirror
- D refracts and reflects

**3.** ___ The type of image formed by a lens is determined by
- A the index of refraction of the object
- B the brightness of the light passing through it
- C the shape of the lens and position of the object
- D the surface onto which the image is projected

**4.** ___ The type of image formed by a convex lens is determined by the object's
- A transparency or opaqueness
- B translucence or transparency
- C position relative to the focal point
- D position relative to the optical axis

**If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ When white light enters a prism, each wavelength is <u>reflected</u> by a different amount.

**6.** _____ A lens is a curved piece of glass or other <u>opaque</u> material that refracts light.

**7.** _____ The <u>faster</u> light travels through a medium, the lower is the medium's index of refraction.

**8.** _____ Parallel light rays passing through a concave lens <u>always</u> meet.

**9.** _____ Light rays passing through a <u>convex</u> lens parallel to the optical axis are bent toward the center of the lens.

**10.** _____ <u>Refraction</u> could not occur if light traveled at the same speed in every medium.

Name _____ Date _____ Class _____

# 3. Refraction and Lenses

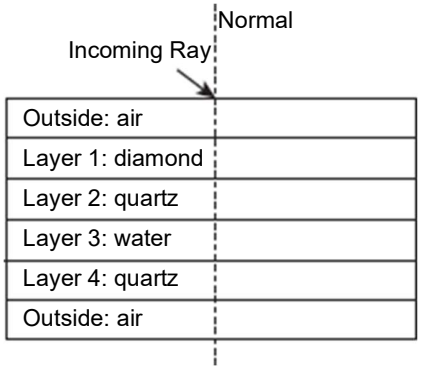
Read the passage and study the table and figure below. Then answer the questions that follow on a separate sheet of paper. You may want to use a calculator.

## Light Benders

The index of refraction of a material is a measure of how much light bends as it passes from a vacuum into that material. The value of the index of refraction is always greater than or equal to 1. The angle of refraction is measured by finding the angle between the refracted beam of light and a line called the normal. The normal is a line perpendicular to the surface; normal is a word that means perpendicular. If the angle between the incoming ray and the normal is greater than the angle between the refracted ray and the normal, the light has bent towards the normal. If the angle between the incoming ray and the normal is less than the angle between the refracted ray and the normal, the light has bent away from the normal.

How can you tell if light will bend toward the normal or away from it? You divide the index of refraction of the second material by the index of refraction of the first material. If the ratio is greater than 1, the light will slow down and bend toward the normal. If the ratio is less than 1, the light will speed up and bend away from the normal.

| **Index of Refraction** | |
|---|---|
| Air | 1.00 |
| Water | 1.33 |
| Quartz | 1.54 |
| Diamond | 2.42 |




1. What is the ratio of the indices of refraction when light passes from quartz to water?

   _____

2. What is the ratio of the indices of refraction when light passes from water to diamond?

   _____

3. In order to get light to bend toward the normal when passing between layers of diamond and water, which of the two materials should the light travel through first? Explain.

   _____

   _____

4. Draw a line in the diagram above, showing how light will bend as it passes through the layers from air into diamond, quartz, water, quartz, and back into air.

   _____

   _____

   _____

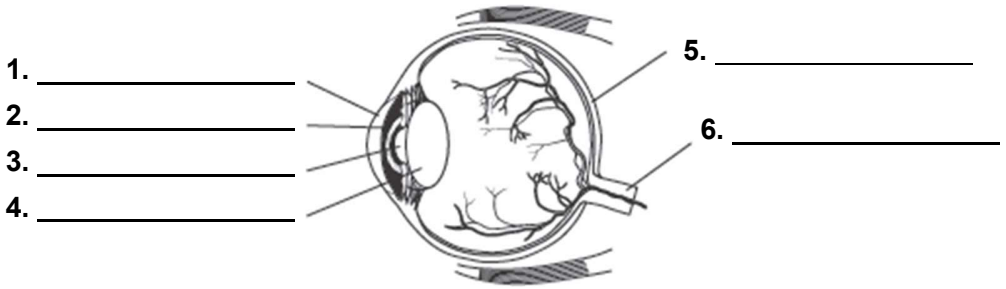
   _____

Name _____ Date _____ Class _____

# 4. Seeing Light

## Understanding Main Ideas

For items 1–6, label the parts of the eye by filling in the spaces in the diagram below. Then answer the questions that follow on a separate sheet of paper.




7. What two organs work together in the process through which you see objects?
8. Compare and contrast two vision problems that occur if the eyeball is slightly too long or slightly too short.

## Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

9. ____ cornea
10. ____ optic nerve
11. ____ pupil
12. ____ rods
13. ____ iris
14. ____ retina
15. ____ cones
16. ____ nearsighted
17. ____ farsighted

**a.** see distant objects clearly, but nearby objects blur

**b.** transparent front surface of the eye

**c.** carries signals from the eye to the brain

**d.** ring of muscles that contracts and expands to change size of pupil

**e.** see nearby objects clearly, but distant objects blur

**f.** cells in the retina that respond to small amounts of light

**g.** layer of cells that line the inside of the eyeball

**h.** opening through which light enters the inside of the eye

**i.** cells in the retina that respond to color

Name _____ Date _____ Class _____

# 4. Seeing Light

**Write the letter of the correct answer on the line at the left.**

**1.** ___ The transparent front surface of the eye is called the
- A retina
- B pupil
- C iris
- D cornea

**2.** ___ A nearsighted person
- A can see distant objects clearly
- B can see near objects clearly
- C needs eyeglasses to read a book
- D should wear eyeglasses with convex lenses

**3.** ___ The lens of the eye is held in place by the
- A ciliary muscles
- B optic nerve
- C rods and cones
- D brown, blue, green, or hazel iris

**4.** ___ The pupil becomes smaller in
- A an eye with astigmatism
- B a nearsighted eye
- C bright light
- D dim light

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ The cornea gives the eye its color.

**6.** _____ Nearby objects appear blurry to a nearsighted person.

**7.** _____ The process of sight involves three organs: your two eyes and your optic nerve.

**8.** _____ Both the cornea and the lens refract light.

**9.** _____ Wearing glasses or convex lenses can correct nearsightedness and farsightedness.

**10.** _____ Convex lenses enable a farsighted person to see more clearly.

Name _____ Date _____ Class _____

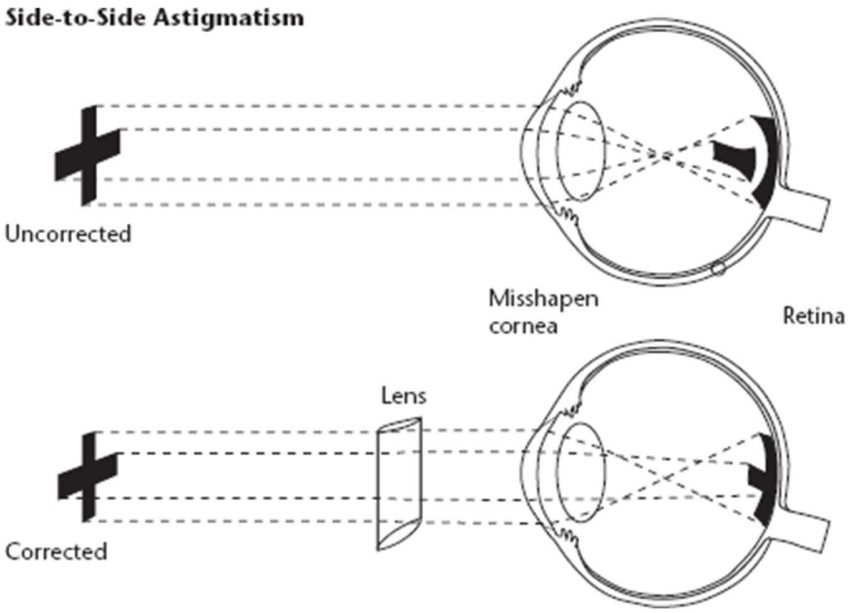
# 4. Seeing Light

Read the passage and study the diagram, which shows one kind of astigmatism, side-to- side astigmatism, and how it is corrected. Then answer the questions that follow on a separate sheet of paper.

## A Better View

Astigmatism is a common vision problem. It is usually caused by a cornea that is partly misshapen. The eye of a person who is nearsighted or farsighted causes the focused image to be in front of or behind the retina. The eye of a person with astigmatism can focus only part of an image properly. Other parts of the image are blurred.

As with nearsightedness and farsightedness, astigmatism can often be corrected with lenses. Specially ground lenses shaped like flattened cylinders are used to bend incoming light rays in a way that corrects the effect of the misshapen part of the cornea without affecting the way light passes through the normal parts.




1. Describe the general effect of side-to-side astigmatism.

_____

2. What focusing problem does the misshapen cornea cause in a person with side-to-side astigmatism?

_____

3. What shape of lens is used to correct side-to-side astigmatism?

_____

4. How does such a lens correct side-to-side astigmatism?

_____

Name _____ Date _____ Class _____

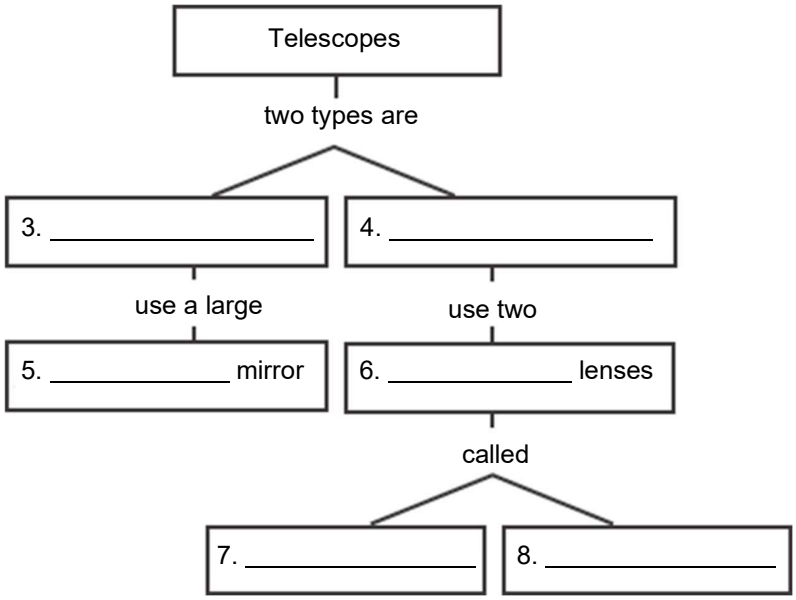
# 5. Using Light

## Understanding Main Ideas

Answer the following questions on a separate sheet of paper.

1. How do the shutter release and lenses of a digital camera work together to form an image?
2. What does a microscope use to produce and magnify images?

**Fill in the blanks to complete the concept map.**




## Building Vocabulary

Fill in the blank to complete each statement.

9. A(n) _____ focuses light and records an image on film or on a sensor.

10. The _____ in a telescope magnifies the image so you can see it clearly.

11. To observe an insect's wings, you could use a(n) _____.

12. To study the moon, you could use a(n) _____.

13. A(n) _____ forms enlarged images of tiny objects.

Name _____ Date _____ Class _____

# 5. Using Light

**Write the letter of the correct answer on the line at the left.**

**1.** ___ An optical instrument that magnifies tiny objects such as cells is a
- A telescope
- B microscope
- C camera
- D concave mirror

**2.** ___ As light rays pass through the lenses of a camera, they
- A refract
- B spread out
- C continue in the same direction
- D reflect

**3.** ___ An optical instrument that uses either a combination of lenses or a combination of a lens and mirrors is a
- A microscope
- B camera
- C telescope
- D magnifying glass

**4.** ___ An optical instrument that records an image of an object is a
- A microscope
- B tape recorder
- C telescope
- D camera

**If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.**

**5.** _____ The lenses in a camera form a(n) <u>virtual</u> image in the back of the camera.

**6.** _____ A(n) <u>camera</u> helps you see nearby objects; whereas, a telescope helps you see objects that are faraway.

**7.** _____ The film in a film camera performs the same function as the <u>lenses</u> in a digital camera.

**8.** _____ You could see Saturn's rings through a(n) <u>camera</u>.

**9.** _____ A(n) <u>microscope</u> has its own light source; whereas, a telescope gathers light.

**10.** _____ The <u>digital</u> camera stores the final image that can be transferred to a computer.

Name _____ Date _____ Class _____

# 5. Using Light

The magnification, or power, of a lens or a microscope refers to how much larger than normal the instrument makes the viewed objects appear. Read the passage and study the table. Then use a separate sheet of paper to answer the questions that follow the table.

## Big, Bigger, Biggest

The magnification of a microscope depends on the magnifications of its eyepiece lens and objective lens. The symbol used to indicate magnification is x. For example, a 100x microscope makes objects appear 100 times larger than normal. Other characteristics of microscopes, such as field of view and brightness, also change as the magnification of the microscope changes.

The table below shows the magnification of a microscope with the various combinations of 12x and 15x eyepieces with 15x, 43x, and 97x objectives. It also shows how the field of view and brightness change. Field of view is how much you can see, top to bottom and side to side. In general, the wider the field of view, the better. You want brightness to be high so that details can be seen easily.

| Power | | | | |
|---|---|---|---|---|
| **Eyepiece Lens** | **Objective Lens** | **Magnification** | **Field of View** | **Brightness** |
| 12x | 15x | 180x | wide | bright |
| 12x | 43x | 516x | less wide | less bright |
| 12x | 97x | 1,164x | least wide | least bright |
| 15x | 15x | 225x | wide | bright |
| 15x | 43x | 645x | less wide | less bright |
| 15x | 97x | 1,455x | least wide | least bright |

**1.** How do you calculate the magnification of a microscope from the magnification of the eyepiece and objective?

_____

_____

**2.** How does the field of view change as magnification changes?

_____

**3.** How does brightness change as magnification changes?

_____

**4.** Compare the magnification, field of view, and brightness of a microscope that has a 12x eyepiece and a 50x objective lens with a microscope that has a 10x eyepiece and a 43x objective lens.

_____

_____