Name _____

7—Pushing and Pulling Forces

A [1]Think about how you would move a wagon up a hill. [2]A wagon will not move by itself. [3]You must either push or pull it to change its position. [4]In science, a push or a pull is called a **force**.

B [5]Force is needed to start an object moving. [6]Force is also needed to stop an object. [7]For example, to move a bicycle you must push down on its pedals. [8]To stop the bike, you must put pressure on the brakes. [9]Forces start and stop a bicycle.

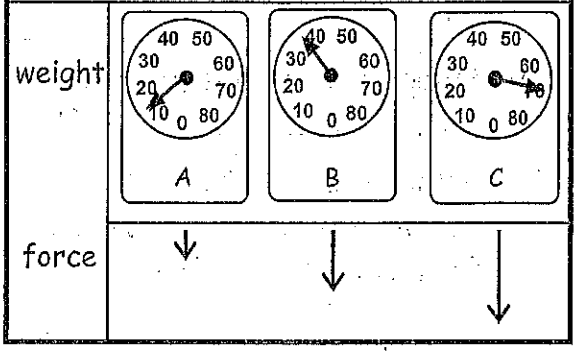
C [10]Forces are needed not only to start and stop an object's motion. [11]They are also needed to change the motion of an object that is already moving. [12]Whenever you steer your bicycle, you are applying a force to its handlebars.

D [13]Sometimes the force that makes an object move cannot be seen. [14]Think of an iron nail and a magnet. [15]When the magnet gets close to the nail, they attract each other. [16]Do you see any force pushing or pulling the nail? [17]No, because the force produced by a magnet is invisible. [18]This invisible force that pulls on metal objects is called **magnetism**.

E [19]What about other invisible forces? [20]Think of an apple falling from a tree. [21]You can't see any forces pushing or pulling it down, can you? [22]**Gravity** is the invisible force that pulls objects down toward the earth.

F [23]The force of gravity pulling on an object is **weight**. [24]The weight of an object is given in pounds or in Newtons. [25]Weight is measured with a **scale**.

Measuring the Force of Gravity



G [26]Look at the diagram above. [27]How much do you think each object weighs? [28]Notice how the arrows change. [29]The length of the arrow is related to the object's weight. [30]Scientists often use arrows to represent forces. [31]An arrow that shows a force is called a **vector.**

H [32]The diagram below compares some familiar forces. [33]Can you name other examples of forces?

Comparing Forces

	small force	large force
pedaling a bicycle	→ flat road	→ uphill
hitting a baseball	→ bunt	→ home run
the wind blowing	→ breeze	→ hurricane

1. For each statement, circle T or F for true or false. In the blanks, write the number(s) of the SENTENCE(s) that give the best evidence for your answer.

   a. Pulling a sled is an example of a force. T F ____

   b. A steel pin falling to a magnet below it is being pulled by only one force. T F ____ , ____

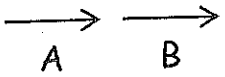
   c. The longer the vector, the larger the force. T F ____

2. Is each conclusion supported by the *Comparing Forces* diagram in the lesson? In each blank, write Y or N for yes or no.

   a. Pedaling uphill takes more force than pedaling on flat land. ____

   b. Wind is invisible. ____

   c. Below, force A is greater than force B. ____

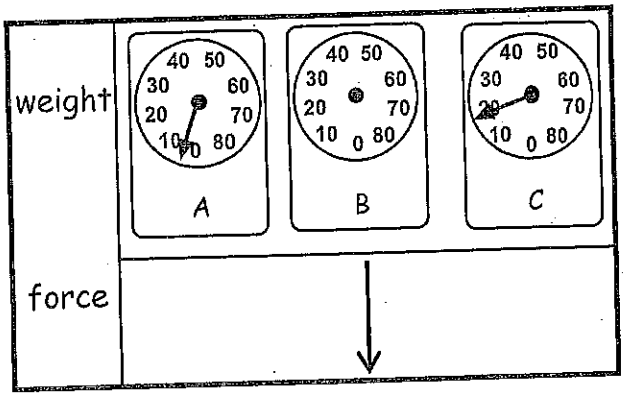
3. Which vector shows the force of gravity? (See the *Measuring the Force of Gravity* chart.)

   a. → c. ↓

   b. ← d. ↑

   Write the number of the sentence in paragraph E that gives the best evidence for your answer. ____

4. Complete the diagram below. Draw vectors to show force for A and C, and draw an arrow to show weight on the scale for B.



5. Fill in the blanks in the diagram below. Be sure to include vectors that represent the forces you select (the first one is drawn for you).

	small force	large force
using a hammer	→ tapping	
	ripple	tidal wave
sounds		scream

6. Think about how a driver slows down a car. Describe the force that slows the car and why it works.

   _____

   _____

   Write the letter of the paragraph that gives the best evidence for your answer. ____

8—Sound, Hearing, and Force

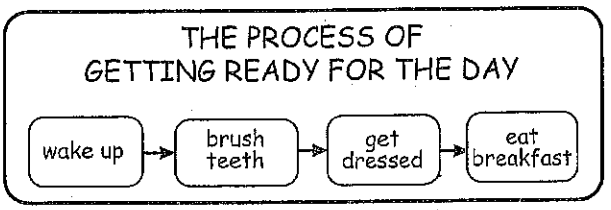
A [1]You know that forces are produced by pushing or pulling. [2]Did you know that forces can produce sound?

B [3]A **vibration** is a back-and-forth motion. [4]Objects vibrate when they move very quickly back and forth. [5]Stretch a rubber band between your thumb and index finger. [6]Pull back one side of the loop, and let go. [7]How would you describe the motion of the rubber band after you release it? [8]Does it vibrate?

C [9]Whenever an object vibrates, it pushes the air around it. [10]If the object vibrates slowly, it will push the air around it slowly. [11]If it vibrates quickly, it will push the air around it quickly.

D [12]A vibrating guitar string makes air particles vibrate. [13]The vibrations form air waves, which reach your ear. [14]The ear is a machine that changes the vibrating air waves into electrical signals. [15]The electrical signals travel to the brain, where they are *converted* into sounds you hear. [16]**Sound** is the way the brain understands vibrations entering the ear. [17]Sound is not the vibrating guitar string, the vibrating air, or the vibrating inner ear. [18]**Hearing** is the series of actions by which vibrating forces are received by the ear and understood by the brain.

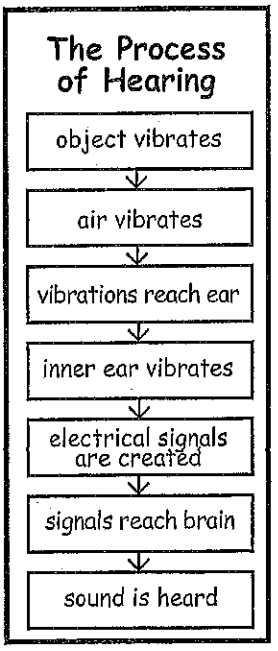
E [19]A series of actions that happen in order is called a **process**. [20]For example, getting ready for school or work each day is a process. [21]A **flow chart** is a diagram that makes it easier to understand the steps in a process.



F [22]Look at the diagram above. [23]It is a flow chart showing the steps you might go through in the morning. [24]Would it make any sense to reverse the order of the steps?

G [25]Another term for steps that are taken in a particular order is **sequence**. [26]You follow a sequence of steps when you get up in the morning.

H [27]Hearing is a process that follows a sequence of steps. [28]The first step is an object that vibrates. [29]The last step is a sound being heard. [30]What are the steps in between?



1. For each statement, circle T or F for true or false. In each blank, write the letter of the PARAGRAPH that gives the best evidence for your answer.

   a. Sound depends on vibrations. T F ____

   b. Hearing occurs within a vibrating object. T F ____

   c. The ear can make electrical signals. T F ____

2. For each conclusion below, decide if it is supported by the *Process of Hearing* flow chart in the lesson. In each blank, write Y or N for yes or no.

   a. Vibrating air causes the inner ear to vibrate. ____

   b. The process of hearing follows a sequence of steps. ____

   c. Sounds are heard in the brain. ____

   d. Electrical signals make the inner ear vibrate. ____

3. In sentence 15, the word *converted* most likely means

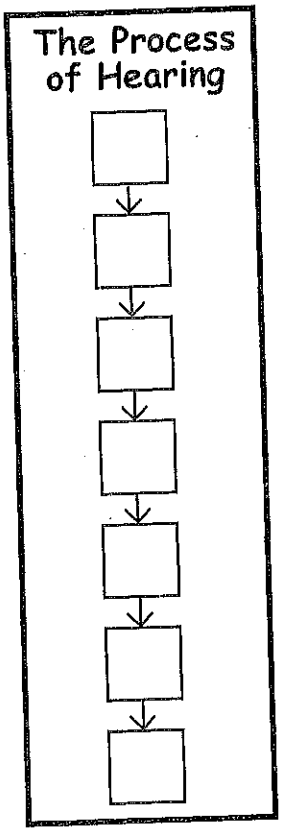
   a. heard.
   b. changed.
   c. stretched.
   d. vibrated.

4. Normally, we hear sounds when air particles vibrate against the ear. If you hear sounds under water, it is probably because

   a. air particles are vibrating over your head.
   b. water particles are vibrating against your ear.
   c. air is coming out of your ears.

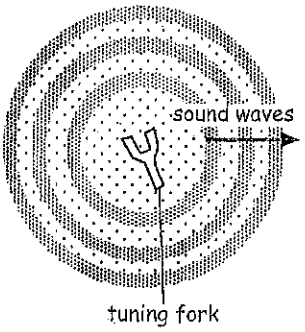
5. The following steps are out of order. Put the letters of the steps in the boxes of the flow chart to show the correct sequence as shown in the lesson.

   A. vibrations reach ear
   B. electrical signals are made
   C. sound is heard
   D. air vibrates
   E. object vibrates
   F. signals reach brain
   G. inner ear vibrates

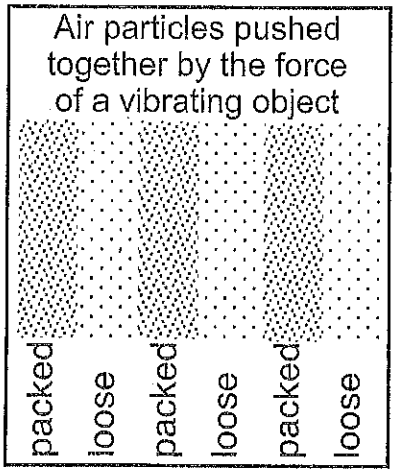


9—Characteristics of Sound

A [1]Sounds are caused by objects that vibrate. [2]As an object vibrates, it pushes against surrounding air particles. [3]Vibrations spread out and away from the object as sound waves.



B [4]Each vibration forces air particles closer together and then farther apart. [5]The diagram at the right shows these areas of packed and loose air particles. [6]Areas of tightly packed air particles are called **compressions**.

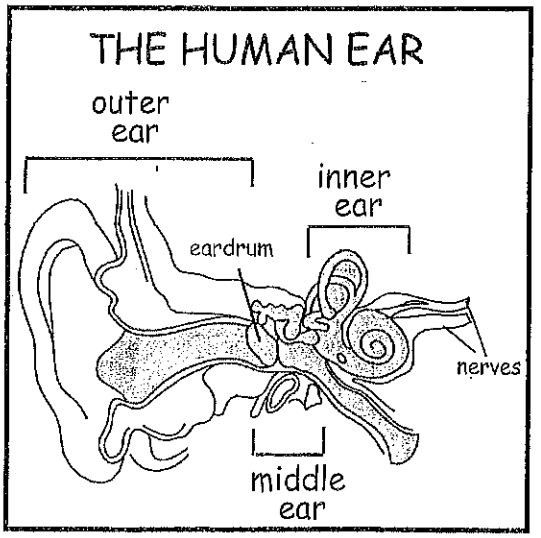


C [7]The faster an object vibrates, the more often air particles are pushed tightly together. [8]Objects that vibrate slowly produce fewer compressions than objects that vibrate quickly. [9]It is the number of compressions reaching your ear every second that makes a sound high or low. [10]A slowly vibrating object, like a fog horn or a bass drum, produces low sounds. [11]A quickly vibrating object, like a whistle or a violin, produces high sounds.

D [12]A sound's **tone** is how high or low the sound is. [13]If a great number of compressions reach the ear each second, does the sound have a high or low tone? [14]That's right, it's a high tone.

E [15]Besides tone, in what ways can sounds be different? [16]Sounds can be very soft like a whisper or very loud like a scream. [17]What makes a sound loud or soft? [18]The force of air hitting the eardrum in your middle ear produces sound. [19]The greater the force, the louder the sound. [20]The loudness of a sound is its **volume**.

F [21]The diagram below shows the three sections of the human ear. [22]The outer ear takes in sound compressions as air beats against the eardrum. [23]The middle ear changes sound compressions into electrical signals. [24]The inner ear *transfers* these electrical signals to a nerve that connects to the brain. [25]Sound is heard only after the brain receives electrical signals from the inner ear. [26]The brain turns these signals into the sounds we hear.



1. For each statement, circle T or F for true or false. In each blank, write the letter of the PARAGRAPH that gives the best evidence for your answer.

   a. A squeaky wheel is an example of a low tone. T F ____

   b. Sounds are heard after an object vibrates. T F ____

   c. The greater the amount of air moved by a vibrating object, the louder the sound. T F ____

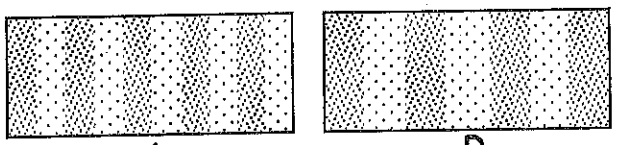
   d. The vocal cords of a bear vibrate faster than the vocal cords of a mouse. T F ____

2. Write the letter of the diagram below that could show each sound described.

   a. the higher tone ____

   b. the sound of a ship's horn ____

   c. the sound of a whistle ____



A B

3. Imagine that you could see the air particles compressed by a whistle and the air particles compressed by a vibrating tuba. Use complete sentences to tell how they would look different.

_____

_____

_____

_____

4. Imagine the roar of a lion and the squeak of a mouse. Use the words *tone* and *volume* to describe the differences between the two sounds. Fill in the rest of the chart to help you.

	Tone	Volume
Lion	Low	
Mouse		

_____

_____

_____

5. Which part of a telephone carries electrical signals like a nerve?

   a. earpiece

   b. mouthpiece

   c. telephone cord

   d. telephone dialer

6. In sentence 24, what is the most likely meaning of the word *transfers*?

   a. changes

   b. slows down

   c. sends

   d. attaches

7. If you tighten a guitar string, it will sound higher when played. Use a complete sentence to tell what the string does that causes the sound to change.

_____

_____

_____

10—Characteristics of Light: Reflection and Refraction

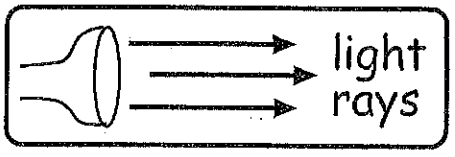
A [1]**Energy** is necessary to make anything happen. [2]We do not hear sounds unless air particles are packed together using the energy of a vibrating object. [3]So, hearing uses energy. [4]Without energy, there is no sound.

B [5]Seeing also depends on energy. [6]What we see is created in the brain by light energy reaching the eye. [7]Without light, *images* cannot be seen. [8]Therefore, vision, like hearing, depends on energy.

C [9]**Light** is a form of energy. [10]Light normally travels in a straight line. [11]Think about using a flashlight at night. [12]The beam of light does not bend around corners. [13]Think about making shadow figures with your hands on a wall. [14]If the light were to bend around your hand, there would be no shadow.

D [15]Where does light come from? [16]Light comes from many places. [17]For example, fire, lightning, and light bulbs produce light. [18]In all cases, energy is needed to create light.

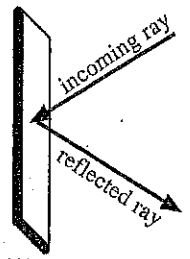
E [19]Scientists call a beam, or thin line of light, a **ray**. [20]Rays of light are drawn as thin straight lines, usually with arrowheads.



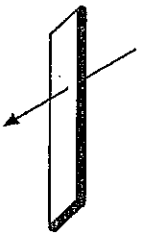
F [21]When a ray of light hits an object, the light ray can do one of three things:

1) bounce off the object,
2) pass through the object unchanged, or
3) be changed by the object.

G [22]The bouncing of light rays off an object is called **reflection**. [23]If you shine a flashlight on a mirror, you will see the light beam reflect off the mirror by going in a different direction.



H [24]A ray of light could pass through an object unchanged. [25]Light can pass directly through a glass window.



I [26]Finally, when a light ray hits an object, the ray could be changed.

[27]For example, put a pencil in a half glass of water and observe it through the side of the glass. [28]The *distorted* image of the pencil is an example of refraction. [29]**Refraction** is the bending of light as it passes from one material to another. [30]In this example, light is bent as it passes through glass and water.

J [31]Refraction is a useful property of matter. [32]A **lens** is a tool that takes advantage of this property. [33]Lenses bend light. [34]We use lenses in telescopes, microscopes, and eyeglasses to see more and to see more clearly.

1. For each statement, circle T or F for true or false. In the blanks, write the letter(s) of the PARAGRAPH(s) that give the best evidence for your answer.

   a. Vision requires energy. T F ____

   b. Shadows are created by bending light rays. T F ____

   c. Your image in a mirror is an example of refracted light. T F ____, ____

   d. Lenses depend on reflected light to make an image bigger. T F ____

2. A pencil whose image is *distorted*, as described in sentence 28, probably looks

   a. broken.

   b. unchanged.

   c. straight.

   d. yellow.

3. Is it reasonable to conclude that smelling takes energy? _____ Use complete sentences to explain your answer.

   _____

   _____

   _____

   Write the letters of the two paragraphs that give the best evidence for your answer.

   ____, ____

4. Which statements are supported by evidence you have read in the lesson? Circle the letters of all correct answers.

   a. Light moving from the air into the ocean is probably bent.

   b. Light rays never change direction.

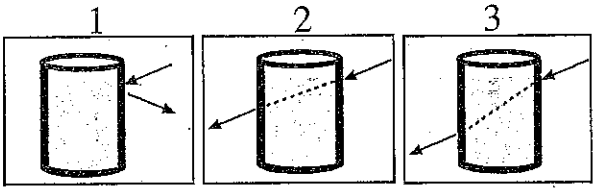
   c. Light rays are refracted after they hit a chalkboard.

   d. The directions of reflected rays is different from the direction of incoming rays.

5. Beside each statement, write the number of the picture it describes.

   a. Refraction _____

   b. Reflection _____



6. Explain why a pencil sitting partly in water looks the way it does. Use complete sentences.

   _____

   _____

   _____

7. As used in sentence 7, *images* probably means things that you can

   a. touch. c. hear.

   b. see. d. smell.

11—Heat, Sources of Heat, and Heat Conduction

A [1]**Heat** is the flow of energy from one object to another. [2]When matter changes from one phase to another, heat is added or taken away. [3]To boil water, heat energy must be added. [4]To freeze water, heat energy must be removed.

B [5]Think about what heat does. [6]When heat flows, it makes things warmer. [7]Heat flows in one direction only: from a warmer object to a cooler object.

C [8]Heat energy makes atoms vibrate faster. [9]The atoms in a hot object vibrate much faster than the atoms in a cool object. [10]When heat is added to a cool object, its atoms begin to vibrate faster and it gets warmer. [11]Heat is the flow of energy that makes atoms vibrate faster.

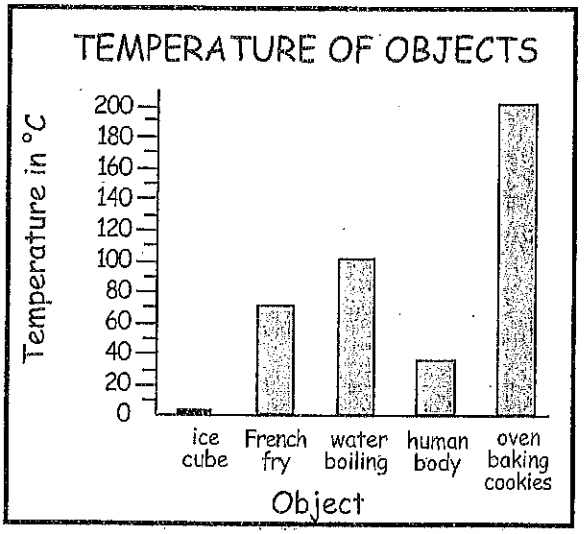
D [12]Do you know where heat comes from? [13]Heat comes from the sun, fire, heaters, the center of the earth, and many other *sources*. [14]Even living organisms, like people, dogs, and plants, make heat.

E [15]If an object is a source of heat, its atoms must be vibrating fast. [16]For example, the atoms of a heated iron vibrate very quickly. [17]**Cooling** results from losing heat. [18]As heat flows away from an object, its atoms vibrate more and more slowly. [19]After a hot iron is unplugged, it cools down as its heat flows into the cool room air. [20]Do you think heat will flow from the iron to the air forever? [21]Why not?

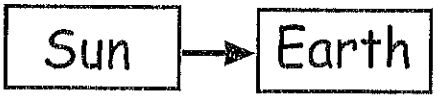
F [22]Heat flows when a warmer object comes in contact with a cooler object. [23]Think about what happens when ice cubes come in contact with warm water. [24]The ice melts and the water gets cooler. [25]Heat has flowed from the warmer object to the cooler object. [26]The flow of heat between objects that are touching is called **conduction**.

G [27]**Temperature** is the measure of how hot or cold an object is. [28]In other words, temperature is a measure of how fast the atoms of an object are vibrating. [29]The faster atoms vibrate, the warmer the temperature of the object.

H [30]Look at the *Temperature of Objects* bar graph below. [31]What do the numbers along the left side tell you? [32]What is the temperature of the coolest object on the graph?



I [33]Remember what you have learned about heat. [34]Then look at the simple flow chart below. [35]Think about the purpose of the arrow and why it points from the sun to the earth instead of the other way.



1. For each statement, circle T or F for true or false. In the blanks, write the number(s) of the SENTENCE(s) that give the best evidence for your answer.

   a. Atoms of hot and cold objects vibrate at the same speed.

   T F ____

   b. Heat flows from a cold floor to warm feet. T F ____

   c. Temperature and heat are the same thing. T F ____, ____

2. In sentence 13, the word *sources* probably means

   a. places in between.

   b. places things go to.

   c. places on fire.

   d. places things come from.

3. If the atoms of two snowballs are vibrating at the same speed, what can you conclude about their temperatures? Use one or more complete sentences to answer.

   _____

   _____

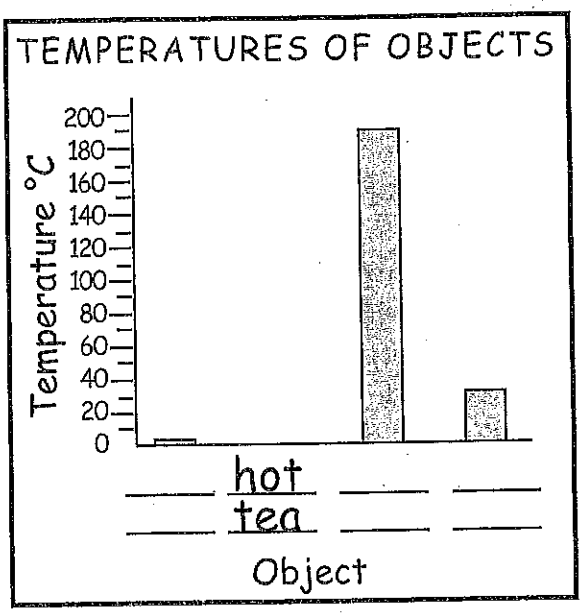
   _____

   _____

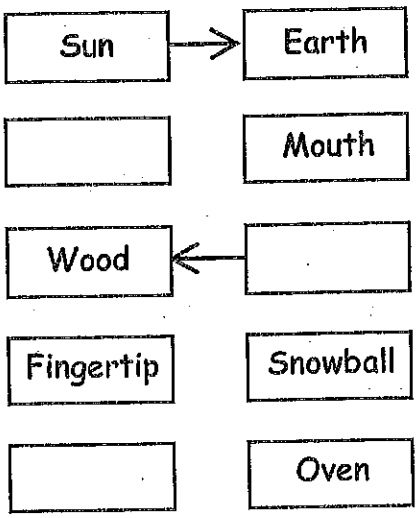
   Write the letter of the paragraph that gives the best evidence for your answer. ____

4. Finish the graph below by adding the correct labels and drawing the missing bar. Use the information in the table at the right.

Object	Temperature
hot tea	70°
candle flame	190°
ice cream	5°
summer day	30°



5. Finish writing names and drawing arrows to show the direction of heat flow between objects in each pair. Use these names:
   Ice Cream, Fire, TV Dinner.



12—Electricity, Electrical Circuits, and Energy

A [1]Can you think of three different sources of energy that help to do work? [2]Your list probably includes heat from a stove or a fire. [3]You may also have listed wind or the burning of fuels like coal or gasoline. [4]Another source of useful energy is electricity.

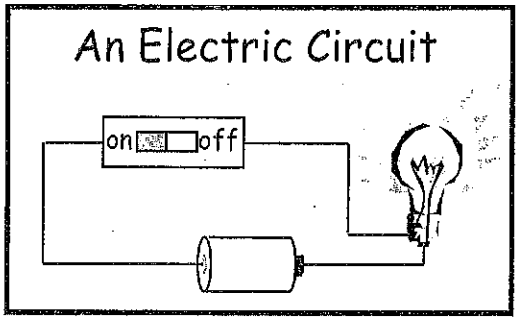
B [5]**Electricity** is a form of energy that produces a force that can be used to do work. [6]Electricity is often used to make heat. [7]The heat is then used to do work. [8]Think of small particles moving through a wire. [9]These particles are called *electrons*. [10]The movement of electrons through a wire is used to make the heat produced by an electric stove.

C [11]The amount of work that can be done by electricity depends upon the number of electrons moving through a wire. [12]As more electrons move through the wire, more work can be done. [13]These electrons move through a wire like water moving through a pipe. [14]In fact, we say they form a *current*. [15]The thicker the wire, the greater the current it can carry. [16]The term **electric current** is used to describe the number of electrons moving through a wire every second. [17]A material that lets electrons pass through it easily is called a **conductor**.

D [18]If you have a source of electrons and a pathway for them to follow, you can do work. [19]Think about a flashlight. [20]What is the source of its electrons? [21]What kind of work do the electrons do when the flashlight is turned on?

E [22]When electrons flow through the flashlight bulb, they pass through a thin wire that is called a filament. [23]A filament is a poor conductor because it blocks, or *resists*, the flow of electrons. [24]As they are forced through the filament, they produce friction, and friction produces heat. [25]Forcing electrons through a filament produces so much heat that the wire gets white hot and *emits* light.

F [26]In order for electrons in the flashlight to do work, they must be able to flow from the battery to the bulb and back to the battery. [27]The pathway of a circular flow is called a circuit. [28]An **electric circuit** is the pathway through which an electric current flows.



G [29]The diagram above shows all the parts of an electric circuit in a flashlight. [30]The parts are

1) a source of electrons (battery),
2) a pathway (wire),
3) a *device* that does work (bulb), and
4) an on/off switch.

1. For each statement, circle T or F for true or false. In each blank, write the letter of the PARAGRAPH that gives the best evidence for your answer.

   a. Energy is used to do work. T F ____

   b. A thinner wire can carry more electric current than a thicker wire. T F ____

   c. Electrons flowing through a good conductor produce more heat than electrons flowing through a poor conductor. T F ____

   d. Good conductors are used to make filaments. T F ____

2. What is the most likely meaning of *emits*, as used in sentence 25?

   a. closes

   b. holds in

   c. opens up

   d. gives off

3. Electric current is measured in amperes (amps). One amp is the number of electrons that pass through a wire every second. Which of the following will require the thickest wire?

   a. 10 amp current

   b. 20 amp current

   c. 30 amp current

   d. 40 amp current

   Write the number of the sentence in paragraph C that gives the best evidence for your answer. ____

4. Two wires have the same electric current running through them. One wire is much hotter than the other. Can you conclude that the hotter wire resists the flow of electrons more?
   Use one or more complete sentences to explain your answer.

   _____

   _____

   _____

   Write the letter of the paragraph that gives the best evidence for your answer. ____

5. Draw a diagram showing a circuit with a battery, a switch, and three light bulbs. Use the diagram in the lesson to help you.