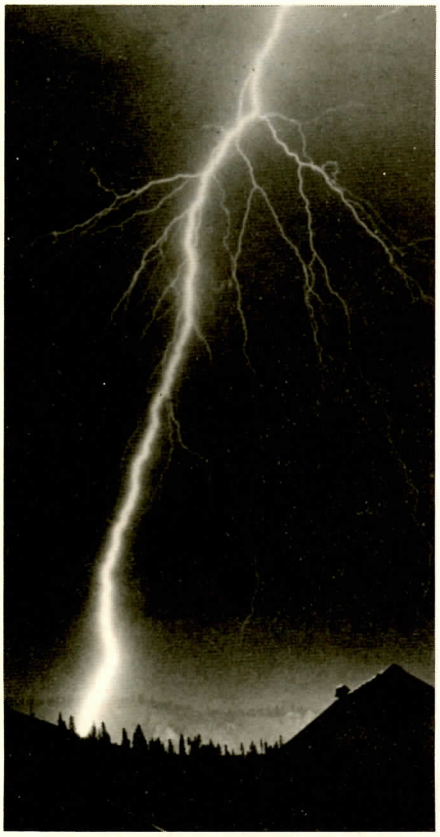
UNIT 5 · Magnetism and Electricity

What Is Electricity?



Negative electrons moving from clouds to Earth caused this flash of lightning.

Electricity is an important part of our lives. Electric lights help us see at night. Television gives us entertainment and news. Washers, refrigerators, and telephones make our lives easier.

Electricity is caused by matter that has an electric charge. You know that matter is made of atoms. Atoms are made of protons, neutrons, and electrons. The protons and neutrons are in the nucleus. Protons have a positive electric charge. Neutrons have no charge. So the nucleus has a positive charge. Electrons move around the nucleus. They have a negative charge. Things with opposite electric charges attract each other. So the electrons are attracted to the nucleus.

As long as an atom has the same number of protons and electrons, the atom has no charge. But an atom can lose electrons. When you comb your hair, electrons from your hair may come off onto the comb. Because your hair has lost electrons, it has a positive electric charge. Because the comb has gained electrons, it has a negative electric charge. Your hair and the comb attract each other. Your hair seems to follow the comb into the air.

Electrons can also move from one object to another. During a thunderstorm, tiny particles in clouds can rub together and separate electrons from their atoms. Earth has a positive charge. So the negative electrons move from the cloud to Earth. The moving electrons cause a flash of light. The flash of light is lightning.

A. Answer True or False.

1. Electricity is caused by matter that has an electric charge. _____
2. Atoms are not made of any smaller particles. _____
3. The electrons are in the nucleus. _____
4. Things with opposite electric charges attract each other. _____
5. An atom cannot lose electrons. _____
6. Electrons can move from a cloud to Earth. _____

B. Use the words below to complete the sentences.

atoms	matter	particles
Electricity	opposite	same

1. _____ is an important part of our lives.
2. Electricity is caused by _____ that has an electric charge.
3. Matter is made of _____.
4. Things that have _____ charges attract each other.
5. As long as an atom has the _____ number of protons and electrons, it has no charge.

C. Draw lines to match each particle with its description.

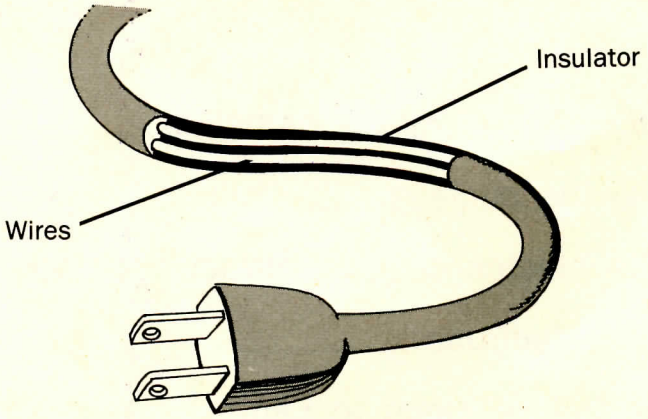
1. proton	no electric charge
2. neutron	attracted to a positive charge
3. electron	attracted to a negative charge

D. Name four things that use electricity. _____

_____

_____

Electric Currents



Inside an Electric Cord

You have learned that when electrons leave their atoms, matter becomes electrically charged. The charged particles in electrically charged matter usually move in all directions. The movement of charged particles in many directions is called **static electricity.** Electrically charged matter whose particles all move in the same direction is called **current electricity.**

Most of the electricity we use every day is current electricity. Current electricity is made by a generator. The generator gathers electrons. Then it pushes them all in the same direction. It forces electrons to move through a **conductor.**

A conductor is a kind of matter that electrons can move through easily. Metal wire is the conductor we use most to carry electricity. Matter that electrons cannot move through easily is an **insulator.** Rubber is a good insulator. Electric wires are often covered with rubber to keep the electrons moving along in the wire.

There are two kinds of current electricity. **Direct current** happens when the electrons flow in the same direction all the time. Batteries produce direct current electricity. **Alternating current** happens when the electron flow changes directions. The electric outlets in your house provide alternating current electricity.

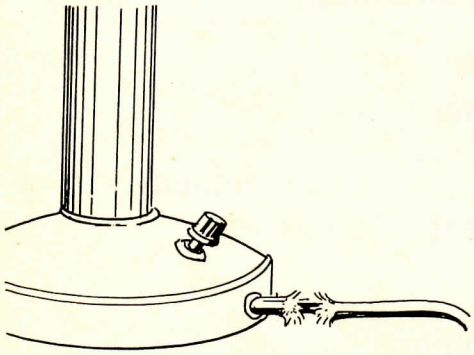
A. Write the letter for the correct answer.

1. The movement of charged particles in many directions is called _____ electricity.
   (a) current (b) static (c) regular
2. Electrically charged matter whose particles all move in the same direction is called _____ electricity.
   (a) current (b) static (c) regular
3. Most of the electricity we use every day is _____ electricity.
   (a) static (b) regular (c) current
4. Current electricity is made by a _____.
   (a) generator (b) pump (c) comb
5. A generator forces electrons to move through _____.
   (a) an insulator (b) a rope (c) a conductor
6. Matter that electrons cannot move through easily is _____.
   (a) a conductor (b) a metal (c) an insulator
7. _____ happens when the electron flow changes direction.
   (a) Alternating current (b) Regular current (c) Direct current

B. Answer True or False.

1. Rubber is the conductor we use for most of our needs. _____
2. Batteries produce direct current electricity. _____
3. The electric outlets in your house provide direct current electricity. _____
4. Alternating current happens when the electrons flow in the same direction all the time. _____
5. When electrons leave their atoms, matter becomes electrically charged. _____
6. Charged particles moving in many directions is called static electricity. _____

Electric Circuits and Volts



Broken insulation is dangerous.

The path taken by an electric current is called an electric **circuit.** Electric current flows from the source of the electricity through a wire. At the end of the wire is something that uses electricity. It may be a bulb in a lamp. The bulb is lighted by the electric current. But an electric circuit must be a two-way path. If the electric charge cannot return to its source, it may build up somewhere along the circuit. If it builds up, the circuit will not work.

Most electric circuits have a switch. When the switch is off, the circuit is open. The current's path is broken. The current cannot get back to its source. When the switch is on, there are no breaks in the path. It is a closed circuit. The current can complete its path.

Sometimes, insulation wrapped around the wires wears out and breaks. Wires that should be kept separate may touch each other. Then electrons can move from wire to wire. They can take a shortcut in the path through the circuit. The shortcut is called a **short circuit.** Short circuits are dangerous. They can start fires.

Electric current is measured in **amperes.** The number of amperes tells how strong the current is. The amount of push a source of electricity gives the electricity is measured in **volts.** The number of volts tells how easily the current can move through the circuit. Some electricity always changes to heat energy. So a source must have enough volts to produce extra electricity.

A. Underline the correct words.

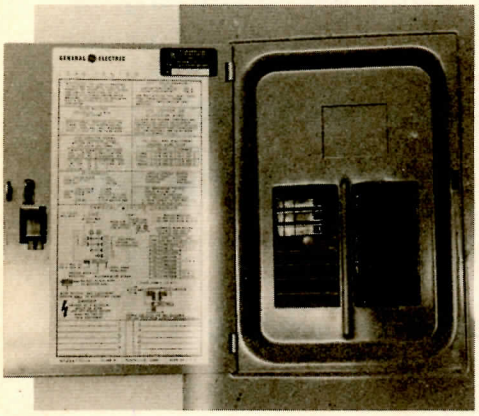
1. The amount of push a source of electricity gives the electricity is measured in (volts, circuits).
2. Short circuits can (increase the number of volts, start fires).
3. When a lamp switch is (on, off), there are no breaks in the path.
4. Electric current is measured in (volts, amperes).
5. The path taken by an electric current is called an electric (source, circuit).
6. When a lamp switch is off, the current's path is (broken, not broken).

B. Use the words below to complete the sentences.

amperes	closed	path
builds	current	short circuit
circuit	open	volts

1. The path taken by an electric current is called an electric _____.
2. An electric circuit must be a two-way _____.
3. If an electric charge _____ up somewhere along a circuit, the circuit will not work.
4. When there are no breaks in the path, the circuit is _____.
5. When a switch is off, the circuit is _____.
6. When electrons can move from wire to wire, the shortcut is called a _____.
7. The amount of push a source of electricity has is measured in _____.
8. Electric current is measured in units called _____.

Fuses and Circuit Breakers



Circuit Breakers

You have learned that when electricity flows through a circuit, some electricity changes into heat. Sometimes too much current goes through a circuit. For instance, lightning can cause too much current in a circuit. When this happens, the device that is using the electricity can break. The wires of the circuit get very hot. The heat can start a fire.

To keep fires from starting, **fuses** are put in circuits. A fuse is like a little light bulb. It has a wire inside that melts easily. When the circuit has too much current, the wire heats up. The wire becomes so hot that it melts. The circuit is broken. The current cannot complete its path. The path is an open circuit. No more electricity can flow through it.

Every circuit usually has its own fuse. When a fuse breaks a circuit, a fresh fuse must be put in the place of the burned-out fuse. Otherwise the circuit will not work.

Circuit breakers are sometimes used instead of fuses. A circuit breaker has a switch that works like a fuse. If the electric current is too great, a switch opens and stops the current. When a circuit breaker breaks a circuit, it does not have to be replaced. The switch can be closed, and the circuit will work again.

Without fuses and circuit breakers, people would have no way of knowing if there were too much current in a circuit. There would be many more fires started by electricity. Fuses and circuit breakers help make electricity safe to use.

A. Answer True or False.

1. When electricity flows through a circuit, some electricity changes into heat. _____
2. If a circuit is open, the current can complete its path. _____
3. When a fuse breaks a circuit, a fresh fuse must be put in the place of the burned-out fuse. _____
4. A circuit breaker has a switch that works like a fuse. _____
5. When a circuit breaker breaks a circuit, it has to be replaced. _____

B. Use the words below to complete the sentences.

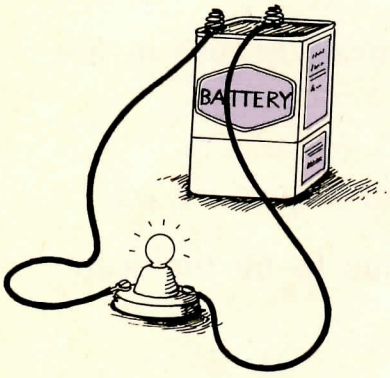
breakers	fuse	lightning
circuit	heat	safe

1. _____ can cause too much current in a circuit.
2. A _____ is like a little light bulb.
3. Every _____ usually has its own fuse.
4. Circuit _____ are sometimes used instead of fuses.
5. Fuses and circuit breakers help make electricity _____ to use.

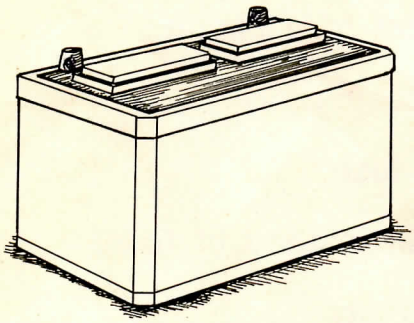
C. Write the letter for the correct answer.

1. When electricity flows through a circuit, some electricity changes into _____.
   (a) steam (b) heat (c) smoke
2. When there is too much current in a circuit, the wires of the circuit get very _____.
   (a) hot (b) cool (c) hard

Dry Cells and Batteries



Dry Cell



A Battery for a Car

If you have a television set at home, it is easy to make it work. You just plug the end of the electric cord into an outlet and turn on the TV. The electric current you need comes from the outlets in your home.

But when you are away from home, there may not be electric outlets around. Where do you get electricity to run your radio or your flashlight? **Dry cells** and **batteries** store electricity. If you have a dry cell or a battery, you can take electric energy with you wherever you go.

Dry cells are not really dry. The outside of one kind of dry cell is made of the metal zinc. Inside the cell is a paste of chemicals. The chemicals react with the zinc, which loses some electrons. As the chemicals react, a flow of electrons forms an electric current. So chemical energy becomes electric energy.

A dry cell has two posts called **terminals.** One terminal is positive. The other is negative. A wire can be put between the terminals to make a circuit. You can make something that uses electricity, such as a light bulb, a part of the circuit. The flow of electric current will light the bulb.

A battery is two or more dry cells working together. A battery can give more volts than a dry cell. The more cells in a battery, the more volts it can give. A battery is used in most cars. The battery itself does not make the car run. The engine makes the car run. But the battery gives the current to start the engine.

A. Write the letter for the correct answer.

1. Dry cells and batteries store _____.
   (a) electricity (b) mechanical energy (c) outlets
2. Inside a dry cell is a paste of _____.
   (a) metals (b) batteries (c) chemicals
3. Chemicals in dry cells react with zinc to make _____.
   (a) terminals (b) electricity (c) more dry cells
4. A dry cell has two posts called _____.
   (a) outlets (b) electric currents (c) terminals
5. A battery is two or more _____ working together.
   (a) terminals (b) dry cells (c) volts
6. A battery in a car gives the current to _____.
   (a) make the car run (b) ring a bell (c) start the engine

B. Use each word to write a sentence about dry cells and batteries.

1. terminals _____

   _____

2. volts _____

   _____

C. Answer True or False.

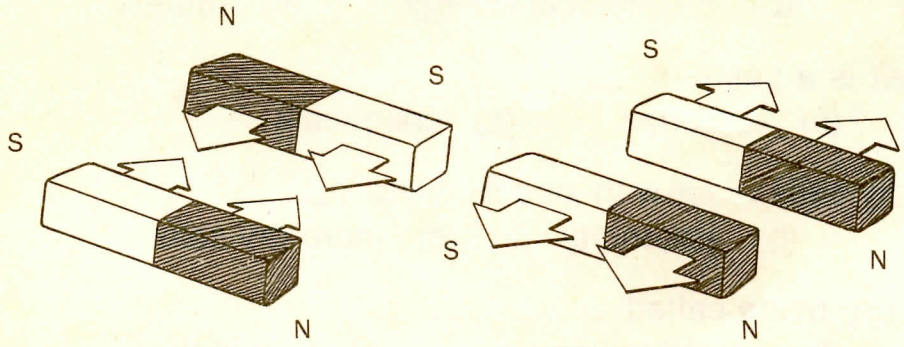
1. At home, the electric current you need comes from outlets.

   _____

2. Dry cells are really dry. _____
3. A wire can be put between the terminals of a dry cell to make a circuit. _____
4. A dry cell can give more volts than a battery. _____
5. One terminal of a dry cell is positive and the other is negative.

   _____

What Is Magnetism?



Different poles attract, and the same poles repel.

What keeps a refrigerator door closed? Most refrigerator doors are kept closed by **magnetism.** Magnetism is a pulling force that certain metals have. These metals, called **magnets,** attract and repel other pieces of metal. Attract means that two objects pull toward each other. Repel means that two objects push away from each other.

All magnets have two ends called **poles.** Each magnet has a north pole and a south pole. The north pole of one magnet attracts the south pole of another magnet. But the north pole of one magnet repels the north pole of another magnet. Two south poles also repel each other.

In some ways, Earth acts like a magnet with two poles. You can tell by using a magnetic compass. A magnetic compass is an instrument with a magnetized needle. One end of the needle always points to the magnetic north pole of Earth. Sailors use compasses to tell what direction they are going.

Magnets do not have to touch a piece of metal to attract it. There is an attracting area around every magnet called the **magnetic field.** When a piece of metal comes near a magnet, it is attracted by the magnetic field. The attraction gets stronger as the metal gets closer to the magnet.

A. **Draw >< to show when two magnetic poles attract. Draw ⟷ to show when two magnetic poles repel.**

1. north pole _____ south pole
2. south pole _____ south pole
3. south pole _____ north pole
4. north pole _____ north pole

B. **Use the words below to complete the sentences.**

Attract	Magnetism	Repel
compass	metal	stronger
magnetic field	poles	weaker

1. _____ is a pulling force that certain metals have.
2. Magnets attract and repel other pieces of _____.
3. _____ means that two objects push away from each other.
4. _____ means that two objects pull toward each other.
5. All magnets have two ends called _____.
6. You can tell that Earth acts like a magnet by using a magnetic _____.
7. There is an attracting area around magnets called the _____.
8. The attraction of a piece of metal gets _____ as the metal gets closer to the magnet.

C. **Answer the question.**

What is magnetism? _____

_____

Electromagnets

As long as the electricity is turned on, an electromagnet can lift tons of metal.

You have learned that a magnet has a magnetic field around it. This field is the area in which the magnet acts on other objects. Magnetism is related to electricity. When electricity flows through a wire, it makes a magnetic field around the wire.

Suppose an electric wire is bent into a coil. When electricity flows through the wire, a magnetic field forms around the whole coil. The coil becomes a kind of magnet. It has north and south poles, just like a magnet.

If an iron bar is placed inside a coil of wire when electricity flows through it, an **electromagnet** is formed. An electromagnet is a much more powerful magnet than a coil of wire alone. When more wire is looped around the iron, the electromagnet becomes even stronger.

Doorbells are made from a tiny electromagnet. A large electromagnet is so powerful it can lift tons of iron. It can lift cars in junkyards, and even trains. But as soon as the flow of electricity is turned off, an electromagnet loses its magnetism. Then it drops whatever it was holding.

Not only can electricity make magnetic fields, magnetic fields can make electricity. If a magnet is moved in and out of a coil of copper wire, electricity begins to flow through the coil. This way of making electricity is called **electromagnetic induction.** Generators, which supply electricity, make their electricity by electromagnetic induction.

A. Answer True or False.

1. Magnetic fields can make electricity. _____
2. Electricity cannot make magnetic fields. _____
3. As soon as the flow of electricity is turned off, an electromagnet gets stronger. _____
4. If a magnet is moved in and out of a coil of copper wire, electricity begins to flow through the coil. _____

B. Fill in the missing words.

1. Magnetism is related to _____. (electricity, fuses)
2. A magnet has a magnetic field _____ it. (inside, around)
3. When electricity flows through a wire, _____ forms around the wire. (electromagnetic induction, a magnetic field)
4. If an electric wire is bent into a _____, and electricity flows through it, the coil becomes a kind of magnet. (square, coil)
5. If an iron bar is placed inside a coil of wire when electricity flows through it, _____ is formed. (an electromagnet, a wire)
6. An electromagnet is a much _____ powerful magnet than a coil of wire alone. (more, less)
7. Generators make electricity by _____. (electromagnetic induction, magnets)

C. Use each pair of words to write a sentence about electromagnets.

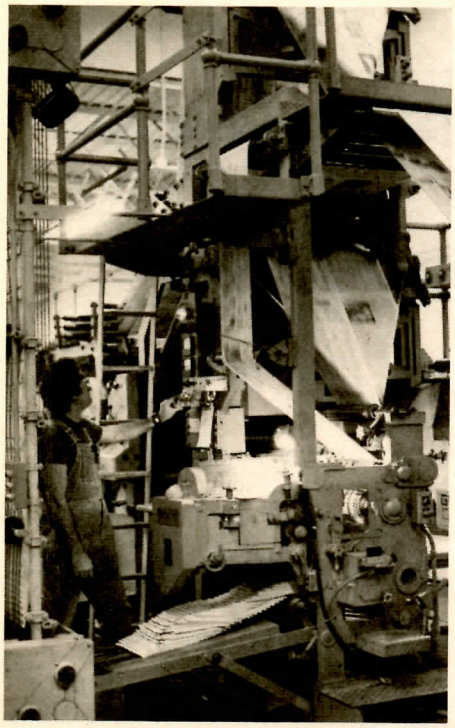
1. iron bar _____

   _____

2. copper coil _____

   _____

Electric Motors



This printing press is run by an electric motor.

Whether you know it or not, there are electric motors all over your home. Electric motors are in clocks, in hair dryers, and in record players. They are in air conditioners, refrigerators, and washing machines. Outside your home, there are much bigger electric motors in many kinds of machines, such as trains and printing presses.

What is an electric motor? An electric motor is a machine that changes electric energy into mechanical energy. As you know, mechanical energy is needed to make anything move.

Electric motors use electromagnets and regular magnets. An electric current passed through the electromagnet keeps changing directions. This makes the poles of the electromagnet change. The north pole becomes the south pole, and the south pole becomes the north pole. Because of this change, its north pole is always lined up with the north pole of the regular magnet. The two north poles repel, making the electromagnet keep turning. As the electromagnet turns, it turns a rod that can run a machine. Belts can be attached to the rod. The belts can move machine parts.

In today's world, it would be difficult to find a machine that is not run by an electric motor. Even an electrically run generator that makes electricity and supplies it to a large area needs an electric motor to keep working.

A. **Make a list of six machines that are run by electric motors.**

_____

_____

_____

_____

B. **Fill in the missing words.**

1. An electric motor is a machine that changes electric energy into _____ energy. (mechanical, solar)
2. _____ energy is needed to make anything move. (Motor, Mechanical)
3. Electric motors use electromagnets and _____. (regular magnets, generators)
4. The electromagnet in an electric motor keeps changing _____. (size, direction)
5. Even an electrically run generator needs _____ to keep working. (an electric motor, like poles)

C. **Answer the questions.**

1. What is an electric motor? _____

_____

_____

2. What do electric motors use? _____

_____

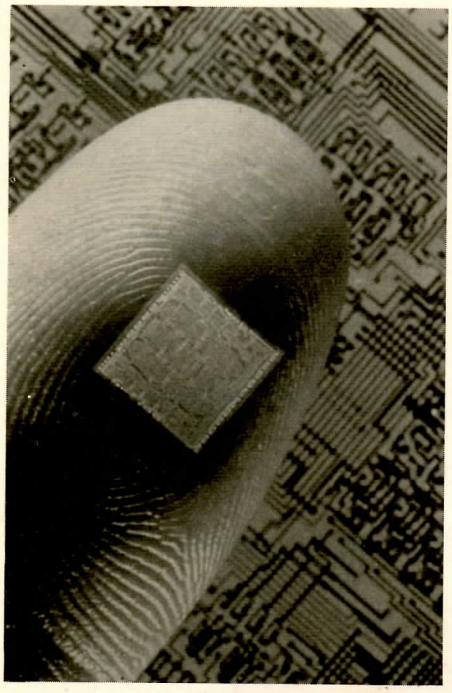
_____

3. In an electric motor, what is the north pole of the electromagnet always lined up with? _____

_____

_____

Electronics



A microchip can have hundreds of transistors and other electronic devices.

Electronics is the branch of science that makes things such as radios, stereos, televisions, calculators, and computers. You have learned about machines that use electricity for energy. But electronic devices use electricity in another way. Electronic devices change electricity into signals. These signals can represent sounds, pictures, and numbers.

Transistors are tiny devices used to change current electricity into signals. Transistors do three main jobs. Some transistors change alternating current into direct current. All electronic devices use direct current. Other transistors make signals stronger. A third kind of transistor changes the signal's frequency.

A regular electric current flows through a conductor. But the current in electronic devices flows through a **semiconductor.** A semiconductor is a kind of matter that is not a very good conductor or insulator. But it can control an electric current. Many electronic devices use the semiconductor **silicon.**

You may have heard of something called a **microchip.** Most microchips are made of silicon. A tiny microchip much smaller than your fingernail can hold enough transistors to run a watch.

Without electronics, our lives would be very different. We could not listen to the radio or stereo. We could not watch television. We would depend on newspapers to know what was happening in the world.

A. Use the words below to complete the sentences.

different	microchips	silicon
direct	semiconductor	transistors
Electronics	signals	

1. _____ is the branch of science that makes things such as radios, televisions, calculators, and computers.
2. Electronic devices change electricity into _____.
3. Electronic devices use _____ to change current electricity into signals.
4. All electronic devices use _____ current.
5. The current in electronic devices flows through a _____.
6. Many electronic devices use the semiconductor _____.

B. Answer True or False.

1. Electronic devices use electricity only for energy. _____
2. Electronic devices can change electricity into signals that can represent sounds, pictures, or numbers. _____
3. All electronic devices use direct current. _____
4. One kind of transistor makes the signals weaker. _____
5. A semiconductor can control an electric current. _____

C. Answer the question.

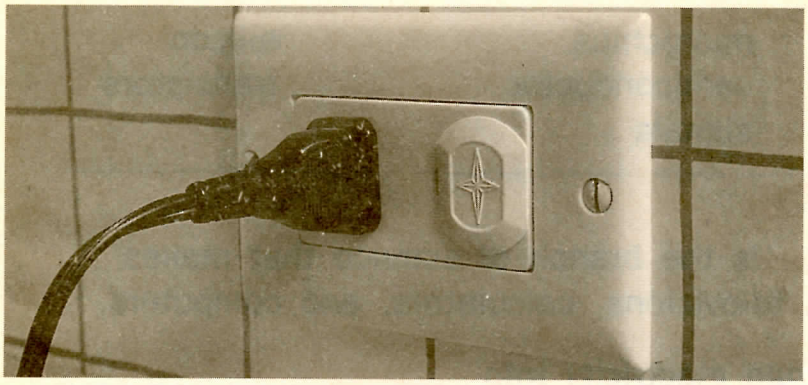
What are the three main jobs that transistors do? _____

_____

_____

_____

Using Electricity Safely



Cover an outlet when it is not being used.

Machines run by electricity make life easier. But any machine or tool run by electricity must be used safely. Electricity can be dangerous.

People should take care when using electric outlets. Outlets are meant for plugging in electric cords only. Never put anything else into an electric outlet. An object put into an outlet can carry electricity. Electricity can burn the hand of the person holding the object. When cleaning or fixing an appliance, be sure to pull the plug out of the outlet. An appliance that is still plugged in can give a bad shock.

Water is a good conductor of electricity. Keep electric appliances away from water. For example, never wash or bathe with a hair dryer near you. If the appliance fell into the water, the electric shock could kill you instantly.

Answer the questions.

1. Why should you not keep a radio near a person bathing? _____

_____

_____

2. Why should you never put anything other than a plug into an outlet? _____

_____

Review

Part A

Fill in the missing words.

1. Magnetism is a pulling force that certain metals, called _____, have. (compasses, magnets)
2. If an iron bar is placed inside a coil of wire when electricity flows through it, an _____ is formed. (electric generator, electromagnet)
3. Electronic devices change electricity into _____. (signals, volts)
4. The path taken by an electric current is called _____. (a volt, an electric circuit)
5. An electric motor is a machine that changes electric energy into _____ energy. (chemical, mechanical)
6. Dry cells and batteries store _____. (magnetism, electricity)
7. To keep fires from starting, _____ are put in circuits. (volts, fuses)

Part B

Read each sentence. Write True if the sentence is true. Write False if the sentence is false.

1. A volt measures the amount of push a source of electricity gives the electricity. _____
2. The north pole of one magnet attracts the north pole of another magnet. _____
3. A battery is two or more dry cells working together. _____
4. A kind of matter that electrons can move through easily is an insulator. _____
5. Electric motors use electromagnets and regular magnets. _____

UNIT 5 • Test

Fill in the circle in front of the word or phrase that best completes the sentences. The first one is done for you.

1. A dry cell has two posts called
   - ● terminals.
   - ⓑ circuits.
   - ⓒ batteries.

2. The measure of the push a source of electricity has is
   - ⓐ electrons.
   - ⓑ a shock.
   - ⓒ volts.

3. Generators get electricity by
   - ⓐ circuit breakers.
   - ⓑ electric outlets.
   - ⓒ electromagnetic induction.

4. The attracting area around every magnet is
   - ⓐ electricity.
   - ⓑ a magnetic field.
   - ⓒ a terminal.

5. Electric motors change electric energy into
   - ⓐ mechanical energy.
   - ⓑ magnetism.
   - ⓒ chemical energy.

6. Short circuits can
   - ⓐ make a closed circuit.
   - ⓑ start fires.
   - ⓒ make an open circuit.

7. Tons of iron can be lifted by
   - ⓐ north and south poles.
   - ⓑ fuses.
   - ⓒ electromagnets.

8. People should take care when using
   - ⓐ electric outlets.
   - ⓑ magnetism.
   - ⓒ compasses.

9. The electric current in electronic devices flows through
   - ⓐ a semiconductor.
   - ⓑ a conductor.
   - ⓒ an insulator.

10. Alternating current
    - ⓐ moves in the same direction all the time.
    - ⓑ is made by batteries.
    - ⓒ happens when the electron flow changes directions.

Just for Fun

Use the clues to solve the puzzle. Use the words below.

another	electricity	lift	rid
atom	good	magnetism	safely
charged	iron	one	terminals
compasses			

Across

1. The north pole of one magnet attracts the south pole of _____ magnet.
4. An electromagnet can _____ tons of iron.
6. When electrons leave their atoms, matter becomes electrically _____.
7. The force that magnets have is _____.
9. As long as an _____ has the same number of protons and electrons, the atom has no charge.
10. An electromagnet has an _____ bar inside a coil of wire.
12. It is important to use electricity _____.

Down

2. The electric outlets in your house provide alternating current _____.
3. An atom that loses, or gets _____ of electrons, has a positive charge.
5. A dry cell has two posts called _____.
6. Sailors use _____ to tell which direction they are going.
8. Rubber is a _____ insulator.
11. A magnet has a north pole at _____ end and a south pole at the other end.