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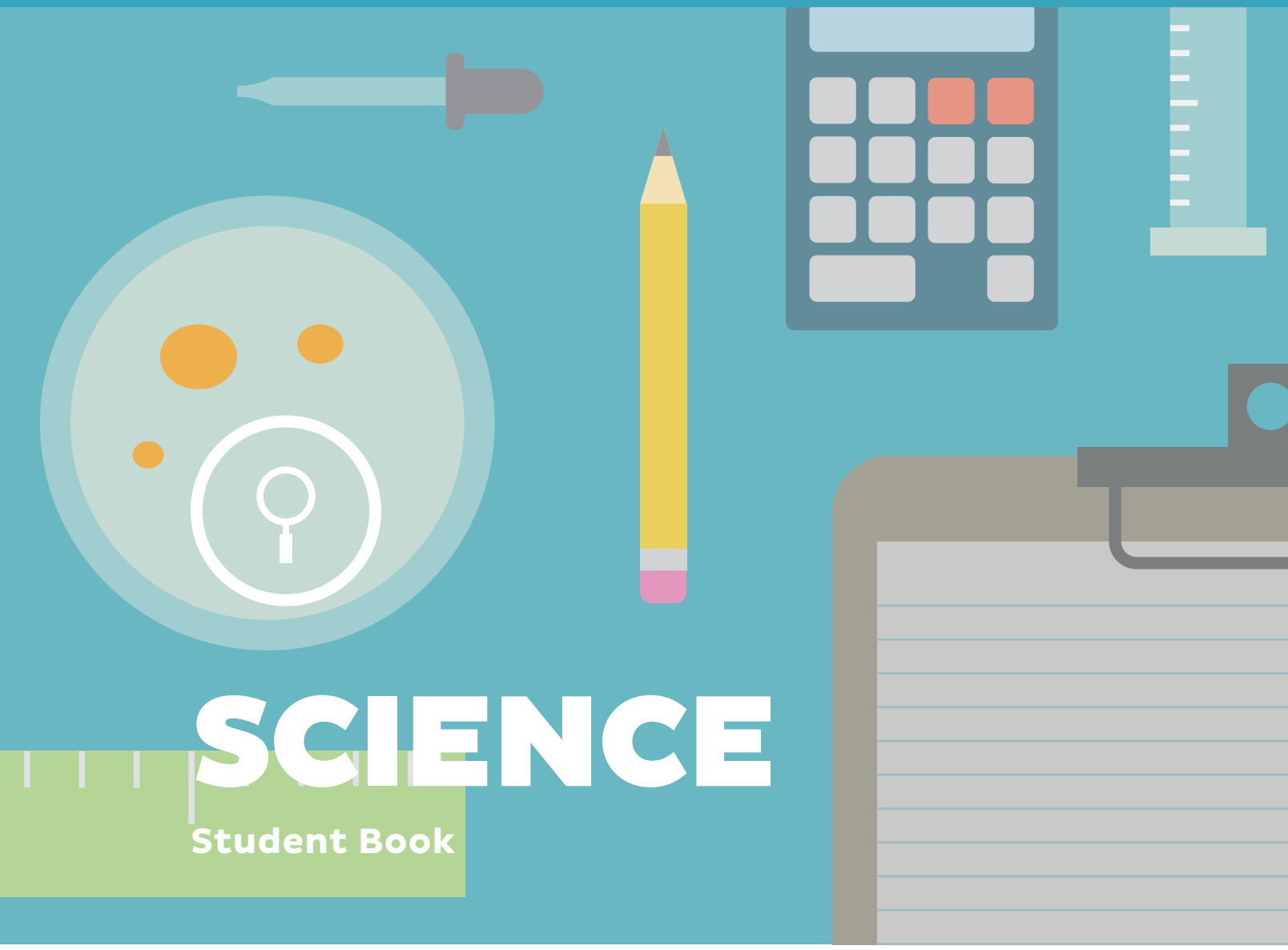


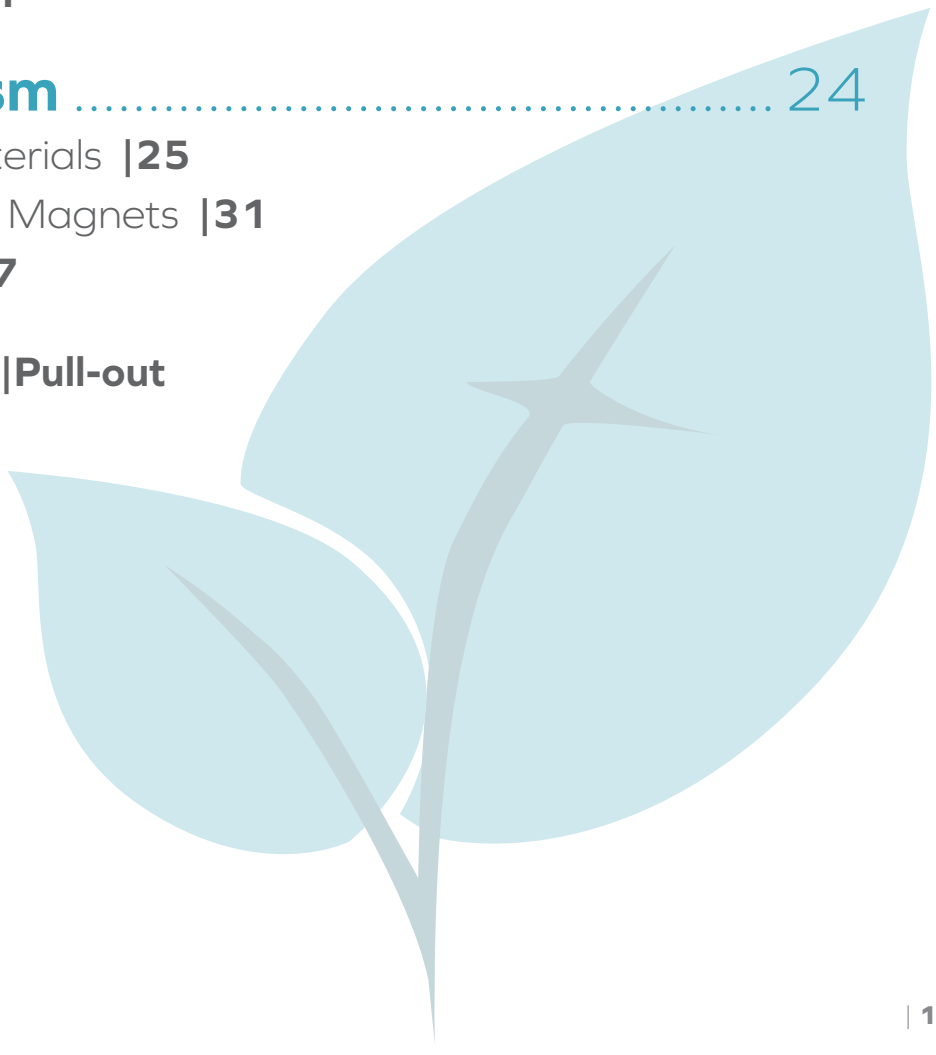
SCIENCE

Student Book

4th Grade | Unit 5

Alpha Omega
PUBLICATIONS

SCIENCE 405
ELECTRICITY AND MAGNETISM



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Alpha Omega
PUBLICATIONS

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ELECTRICITY AND MAGNETISM

Have you ever combed your hair on a cold day and heard the snap of electricity? Your hair may have stood on end! Maybe you discovered that your comb would pick up bits of paper right after you combed your hair. Have you helped your mother take clothes out of the dryer, and seen them cling together? Have you shuffled your feet across a rug, and then taken hold of a doorknob? Did you feel a tingle or a shock? You may have seen a spark. In each case, some things were rubbed together. If an object can attract other objects to itself after it has been rubbed, it is said to be *charged*, or made electric.

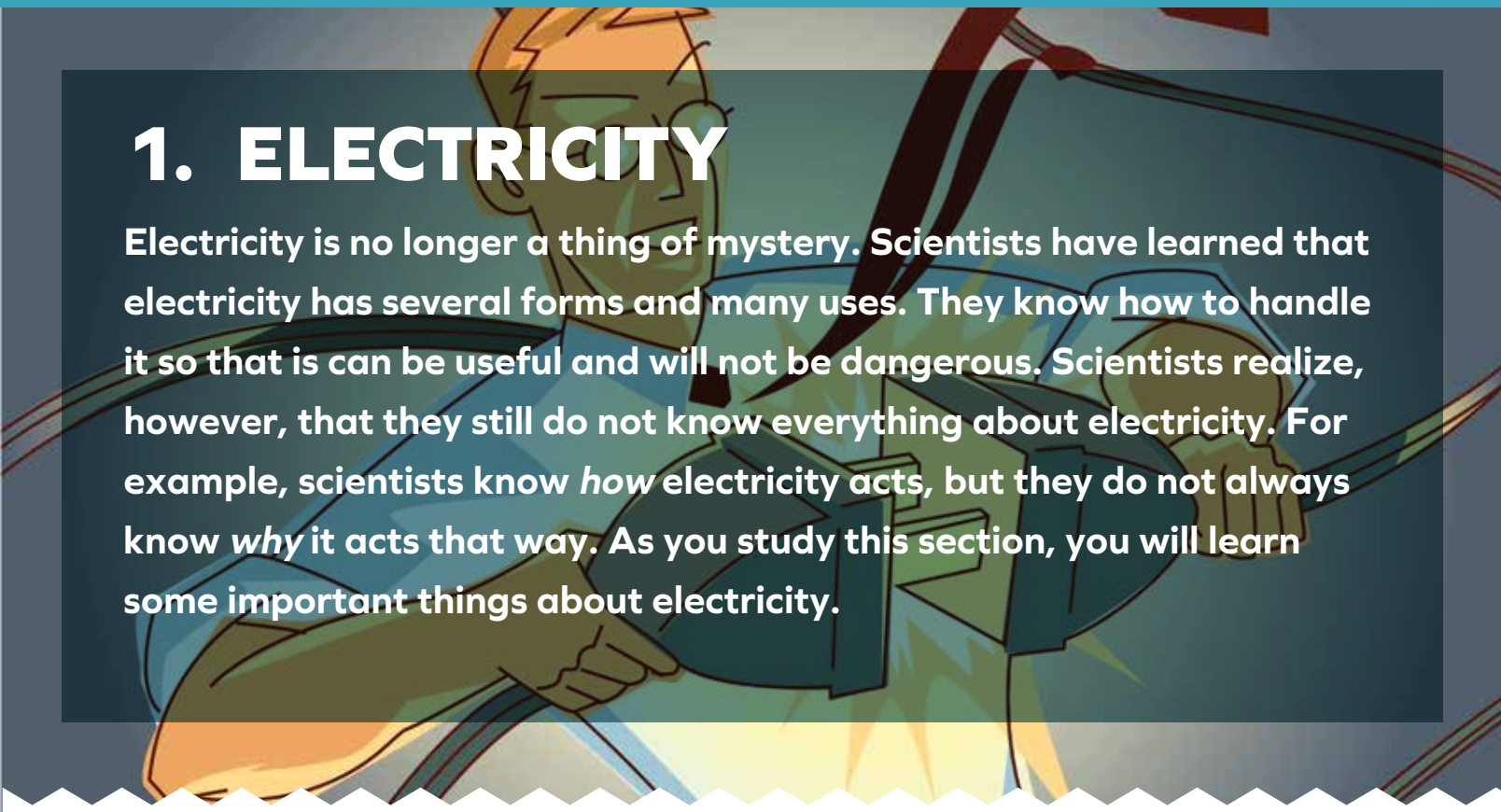
In this LIFEPAC® you will study about electricity. You will read about some men and their discoveries. You will also make discoveries of your own. When you have finished the LIFEPAC, you will have learned some amazing things. You will also know how to make use of electrical power.

You use electricity in many ways in your daily life. You are comfortable using it, but you still must respect its power. You know that you must use this gift from God carefully and safely.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. Each section will list according to the numbers below what objectives will be met in that section. When you have finished this LIFEPAC, you should be able to:

1. Explain how objects, atoms, electrons, and electricity relate to each other.
2. Tell what an electrical conductor does.
3. Tell what an insulator does.
4. List three ways in which electricity can be used.
5. List two ways electricity is made safe to use.
6. Tell what a magnet will do.
7. Name two magnetic materials.
8. Describe the way a magnet is made electric.
9. Tell two ways electromagnets are important in our world.



1. ELECTRICITY

Electricity is no longer a thing of mystery. Scientists have learned that electricity has several forms and many uses. They know how to handle it so that is can be useful and will not be dangerous. Scientists realize, however, that they still do not know everything about electricity. For example, scientists know *how* electricity acts, but they do not always know *why* it acts that way. As you study this section, you will learn some important things about electricity.

Objectives

Review these objectives. When you have completed this section, you should be able to:

1. Explain how objects, atoms, electrons, and electricity relate to each other.
2. Tell what an electrical conductor does.
3. Tell what an insulator does.
4. List three ways in which electricity can be used.
5. List two ways electricity is made safe to use.

Vocabulary

Study these new words. Learning the meanings of these words is a good study habit and will improve your understanding of this LIFEPAC.

acid (as' id): Liquid with a sour taste like that of vinegar.
atom (at' um): The smallest part of any object.
attract (u trakt'): To draw toward oneself.
circuit (sėr' kit): The track on which electric current flows.
conductor (kun duk' tur): Any material through which electricity will flow.
connect (ku nekt'): To join one thing to another.

current electricity (kėr' unt i lek tris' u tē): Electricity that flows without stopping.

electrical (i lek' tru kul): Having to do with electricity

electron (i lek' tron): A particle in an atom that can travel out of the atom.

fuse (fyüz): A safeguard to prevent an overload of electricity in a circuit.

galvanometer (gal vu nom' u tur): A machine that will find and measure small amounts of electricity.

insulator (in' su lā tur): Any material through which electricity cannot flow.

negative (neg' u tiv): The kind of electricity that is in an object with an extra amount of electrons.

neutral (nü' trul): Having neither a positive nor a negative electrical charge.

neutron (nü' tron): One of three kinds of particles found in atoms.

particle (pär' tu kul): A very tiny bit.

positive (poz' u tiv): Electricity that is made when electrons travel out of an object.

proton (prō' ton): A particle in an atom that does not travel out of the atom.

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.*

Pronunciation Key: h**a**t, **ā**ge, c**ă**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /ŦH/ for **th**en; /zh/ for mea**s**ure; /u/ or /ə/ represents /a/ in **a**bout, /e/ in tak**e**n, /i/ in penc**i**l, /o/ in lem**o**n, and /u/ in circ**u**s.

From Electrons to Electric Current

Atoms, **electrons**, and electricity are all related to each other. Many hundreds of years were needed for man to understand how they are related. One of the keys to understanding this relationship was learning to understand lightning. Another key was learning about the atom.

Lightning. When you look at the sky and see the clouds piling up in heaps, what do you expect to happen? You know that it will probably rain. If the clouds are really dark and heavy, you may expect thunder and lightning.

Lightning is one of God's wonders of nature. Lightning has both frightened and puzzled men from the very beginning of time. In the book of Job, lightning is mentioned at least six times. Job always described lightning with great respect. He knew it came from God, but he did not understand it.

Many times, Bible writers used the example of lightning to describe the power of God. God used thunder and lightning with hail as one of the troubles He sent to Egypt. You can read that story in Exodus, chapter 9.

Men have tried for thousands of years to discover the secret of the power of lightning.

Within the storm clouds are stored strong **electrical** charges. When some of these electrical charges move from cloud to cloud or from a cloud to the ground, we see a spark. We call the spark lightning.

Benjamin Franklin did a famous experiment with lightning. He attached a key to the end of a kite string and succeeded in getting his kite to fly in the rain. The kite soon became charged with electricity. An electrical charge moved down the string to the key. When Franklin held his finger near the key, a spark jumped from the key to his finger.

Do not try Franklin's experiment. It was very dangerous. He was fortunate that he was not killed. If you have ever seen a tree that has been struck by lightning you can imagine what could have happened to Benjamin Franklin.

You must be sure that lightning will go into the ground instead of damaging people or objects.

| Ben Franklin with kite and key.

Do this activity.

1.1 Thomas Alva Edison did many things with electricity. Find out all you can about him and the things he invented. Pretend that you are a newspaper or television reporter, and write a news story about him. Write your story on other paper, but put it in your LIFEPAC when you are finished.

Teacher check:

Initials _____ Date _____

Protons and electrons. All objects are made of atoms. Each atom has three kinds of **particles**. The particles are called **protons**, electrons, and **neutrons**.

Protons are found in the center of the atom. In chemical reactions the protons never move out of the center of the atom.

Only electrons can travel out of the object. What happens when some of the electrons are moved from object to object? When electrons are either removed from or added to an object, that object becomes electrically charged.

If one object loses electrons, that object has more protons than electrons. The object is positively charged. The object that received the electrons is negatively charged.

When an object has an equal number of **positive** and **negative** particles, the object is **neutral**.

As you learn about positive and negative charges remember, charges that are alike push each other away. Unlike charges **attract** each other.

Answer *true* or *false*.

1.2 _____ Atoms are made of objects.

1.3 _____ In chemical reactions, protons do not move out of the center of the atom.

1.4 _____ Only electrons can travel out of an object.

1.5 _____ When an object has more protons than neutrons, the object is neutral.

1.6 _____ Charges that are alike push each other away.

Answer these questions.

1.7 What happens when an object becomes charged? _____

_____

1.8 When an atom has an equal number of negative and positive particles, it is _____ .

1.9 What happens between two objects with like electrical charges when they are brought close together?_____

1.10 What happens between two objects with unlike electrical charges when they are brought close together? _____

Match these items.

1.11 _____ Benjamin Franklin

1.12 _____ Job

1.13 _____ lightning

1.14 _____ charged

1.15 _____ protons

1.16 _____ electrons

a. made electric

b. book of Bible that mentions lightning

c. kite experiment

d. do not leave center of the atom

e. one of God's wonders

f. travel out of an atom

g. volts

CHARGE SOME OBJECTS

These supplies are needed:

string
two balloons
a woolen sweater or piece of woolen cloth
a rubber comb or a hard rubber rod

Follow these directions and answer the questions. Put a check mark in the box when each step is completed.

- ☐ **1.** Blow up both balloons and tie them shut.
- ☐ **2.** Tie a string to each balloon.
- ☐ **3.** Rub the balloons with the wool.
- ☐ **4.** Hold both strings in one hand so that the balloons are hanging side by side.
  The balloons have now collected electrons and are negatively charged.

1.17 What happens? _____

1.18 Why? _____

- ☐ **5.** Rub the rubber comb or hard rubber rod with wool.
- ☐ **6.** Turn on the faucet gently so that a very thin stream of water is flowing.
- ☐ **7.** Hold the charged comb or rod close to the stream of water.
- ☐ **8.** Move the comb or rod slowly away.
  The water is neutral so it is attracted by the charged object.

1.19 What happens to the water? _____

Teacher check:

Initials _____ Date _____

From Current to Circuit

We know that lightning is a form of electricity. We still do not know how to make use of lightning. Lightning comes and goes in a split second. To be useful, electricity must flow, not come and go. Electricity that flows without stopping is **current electricity**.

| A dry cell.

Electric cells. In the late eighteenth century, an Italian scientist named Alessandro Volta made a discovery. Volta discovered that when two different metals were placed in certain liquids, an electric charge would flow. The charge would flow through a wire **connecting** the metals.

The two pieces of metal were called electrodes. The liquid was called an electrolyte. Volta had made an electric cell. He used copper and zinc as the electrodes for the electric cell. He used an electrolyte of salt water. Volta's cell was called a wet cell. Today a dry cell is used.

Electric cells are used to make current electricity. Current electricity is made in very large amounts to supply our lights, toasters, washing machines, and other everyday equipment. Current electricity is also used to run factories of many kinds.

Complete the following sentence.

1.20 The three parts of an electric cell are one a. _____ and two b. _____ .

WET CELLS

View 405 Electric Current: Grade 4 Science experiments video

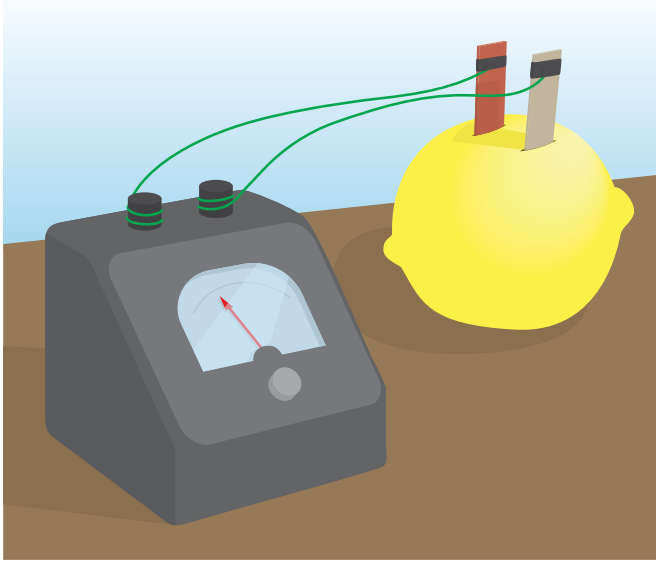
Try your hand at making each of the wet cells described here. You will need a simple instrument called a **galvanometer**, which will show you when electric current is flowing. Plans for making a simple galvanometer from a compass and some insulated wire can be found online. Your teacher may decide to discuss this experiment with you rather than have you perform it. Check before you proceed.

Teacher check:

Initials _____ Date _____

These supplies are needed:

three strips each of copper and zinc (15 x 3 cm) four lengths of covered copper wire, each about 50 cm long.
a glass of vinegar
a galvanometer
a juicy lemon
a sharp knife



Follow these directions. Check the boxes as you do each step. Answer the questions.

- ☐ **1.** Roll the lemon firmly on a hard surface to make it soft and juicy.
- ☐ **2.** Cut two slits in the lemon about 3 cm apart.
- ☐ **3.** In one slit put a strip of copper, and in the other slit put a strip of zinc.
- ☐ **4.** Attach a length of covered copper wire to the top of each strip.
- ☐ **5.** Attach the other ends of the wires to the posts of the galvanometer. (Have your teacher show you how to strip the covering off the end of the wire before you try to attach it to the galvanometer.)

1.21 How much current is flowing in this cell? _____ .

1.22 What is the electrolyte? _____ .

1.23 What are the electrodes? a. _____ and b._____ strips.

- ☐ **6.** In the glass of vinegar, insert zinc and copper strips with copper wire attached.
- ☐ **7.** Connect the loose ends of wire to the galvanometer.

1.24 Measure the flow of the current. _____ .

- ☐ **8.** In the glass of vinegar, put two strips of copper.

1.25 Is there any flow of electric current? _____ .

1.26 Why? _____

- ☐ **9.** In the glass of vinegar, put two strips of zinc together.

1.27 Is there any flow of electric current? _____ .

1.28 Why? _____

Conductors and insulators. Now that you have electric current, you must find a way to control it. You will provide a track for it to travel on by using some covered wire.

The wire is a **conductor**. Conductors are materials that can carry electricity from place to place. Most metals are good conductors, but some are better than others. Copper is an especially good conductor. Probably many of the electric wires in your home are made of copper. Aluminum wires are often used for heavy electric lines.

The covering on the wire prevents the electric current from flowing out of the wire into

the wrong places. This covering is called an **insulator**. Another name for the covering is a nonconductor. Electricity will not flow through an insulator. Insulation on wires protects you from the current. Insulation protects your home from damage that would be done if electricity were not controlled.

Electricity is never used without insulation. Electricity would not be safe without insulation. Some of the materials most often used for insulators are glass, cloth, and rubber.

Do this activity. In general, metals and mixtures with salt and **acids** are good conductors. Water is also a conductor of electricity. Nonmetals and other solutions are nonconductors. Tell what kinds of materials are the best and the poorest conductors by writing each material under the proper heading.

1.29

MATERIALS	CONDUCTORS	NONCONDUCTORS
metal spoon		
screwdriver handle		
screwdriver blade		
chalkboard eraser		
glass dish		
tin can		
rubber ball		
paper		
paper clip		
wood		
silk		
wool		
chalk		
lemon juice		
vinegar		

pencil lead	_____	_____
pure water	_____	_____
salt water	_____	_____

Answer in a few words.

1.30 What is a conductor? _____

1.31 What is an insulator? _____

Circuits. When studying the electric cell, you learned that electric current will flow only when the metals are connected by a wire. This wire is the track along which the current flows.

Such a track is called a **circuit**. Electricity will not flow unless its track is a complete circle, or complete circuit. Electricity must always have a round-trip ticket. That is, electricity must always start and must always end at the electric cell. If at any place the circuit becomes broken, the electricity is cut off.

A switch is used to break into the track, or circuit, to stop the flow of electricity.

Open the switch and the current comes to a halt. For the current to flow again, simply close the switch.

Many different kinds of switches are used. All of these switches do the same job. Current travels through the switch when the metal bar is pressed down. However, when the bar is lifted, the circuit is broken, and the flow of current must stop.

Always be sure your hands are dry before you touch a switch, electric cord, fuse, or any electrical equipment. No part of your body should be in water or touching a water pipe or faucet. Water is a good conductor and you could receive a bad shock. You might even be killed if the current is strong enough.

Do this activity.

1.32 How many objects in your home require electric current to make them operate? Make two columns as shown and be sure that each object is in the correct column. Some objects may fit into both columns.

	Battery Operated	**"Plug-in"**
Example:	cell phone	toaster
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Answer these questions.

1.33 What is a complete circuit? _____

_____

1.34 What is usually used to break a circuit? _____

_____

From Circuit to Service

Electricity has many uses today. Electricity is helpful, but it can be harmful if it is not used correctly. Safety and electricity must go together.

Uses of electricity. We depend upon having electricity to use. In the modern world electricity is used in many ways. When the power fails and an electrical blackout occurs, the need for electricity is felt. Sometimes after a bad storm, lives depend upon having electrical power. Electricity is used not only in homes but also in schools, churches, hospitals, libraries and stores.

Fresh vegetables and dairy goods come to stores in electrically cooled trucks or railroad cars. Other goods are displayed in electrically cooled units in the grocery stores. These

goods are taken home and put into refrigerators or freezers until they are either eaten or cooked. When they are cooked, they are often prepared on an electric stove or in a microwave.

If electricity were suddenly to disappear, your ways of eating might change.

Answer these questions. You may have to do some research to find the answers.

1.35 If you had no electricity, how would you get your food? _____

_____

1.36 If you had no electricity, how would you prepare your food? _____

_____

1.37 If you had no electricity, how would you store your food so that it would not spoil? _____

_____

_____

Safety with electricity. When electric wires are brought into the house, some safeguards must be taken. Someone in the house might try to connect too many cords into one outlet. Then the wire could overheat from carrying too much current. A fire could start inside the walls of the house, and both property and lives might be lost.

One way to prevent an accident from happening is to route the circuit through a **fuse**. A fuse is a small insulated container through which a thin piece of metal is stretched.

| Fuses

To complete its circuit, the current must run through this metal piece. The strip will melt at a very low temperature. If too much current is present the piece of metal will melt. The circuit will be broken. The wires in the house will be kept from getting hot enough to cause a fire. Fuses help in this way to protect homes.

A burned out fuse should always be replaced with a new fuse. The new fuse should have the same number on the metal strip as did the burned-out fuse. This number tells how much current can safely pass through the fuse.

A circuit breaker also prevents electrical wires from carrying too much current. A circuit breaker is a metal switch that is pulled open by a magnet if too much current flows through the circuit. Ask your parents to show you the "breaker box" if your home has one. A circuit breaker does the same job as a fuse in protecting the house. The circuit breaker, however, does not have to be replaced as the fuse does. Simply return the breaker switch to its closed position.

Electric cords must be checked before plugging them into the wall outlet. Be sure their insulation is not broken or worn thin. If any electric cords around the house have the insulation worn thin or broken, show them to your parents. These cords need to be repaired before the bare wires cause a fire. Someone might touch one of them by accident and receive a bad shock.

Be sure electric cords are in sight and not covered by rugs. The cords could be damaged by heavy furniture and cause a fire. Always turn off electrical equipment when it is not being used. The equipment might become overheated and cause a fire. Stay away from electrical poles or boxes. Never go near a fallen or hanging wire.

| This wire is unsafe.

Answer the following questions.

1.38 What are two ways to keep a circuit from being overloaded?

a. _____ and b. _____

1.39 How does a fuse work to protect wires in a house from becoming too hot?

_____

_____

_____

_____

1.40 What is the danger of electric cords being covered by furniture?

_____

_____

_____

Do these activities.

Prefixes are syllables which, when placed at the beginning of a word, change the meaning of the word.

The prefix *un-* means *not* or *opposite of*.

Examples:	unbroken	not broken
	unkind	not kind

The prefix *re-* means *back* or *again*.

Examples:	reread	to read again
	return	to go or come back again

The prefix *ex-* means *out*.

Example:	express	to speak out

The prefix *in-* means *not* or *in*.

Example:	incorrect	not correct, wrong

Add *re-* and *un-* prefixes to the following root words. Write the meaning beside the word.

1.41 _____ cover _____

1.42 _____ cover _____

1.43 _____ load _____

1.44 _____ load _____

1.45 _____ wind _____

Write the words in the following blanks. Each answer will have a prefix.

1.46 The opposite of leave _____

1.47 The opposite of correct _____

1.48 The opposite of safe _____

1.49 The opposite of certain _____

1.50 The opposite of load _____

1.51 The opposite of cover _____

Review the material in this section to prepare for the Self Test. The Self Test will check your understanding of this section. Any items you miss on this test will show you what areas you will need to restudy in order to prepare for the unit test.

SELF TEST 1

Match these items (each answer, 3 points).

1.01 _____ to charge

1.02 _____ protons, electrons, neutrons

1.03 _____ electricity that flows

1.04 _____ conductors

1.05 _____ insulators

1.06 _____ fuse

1.07 _____ circuit

1.08 _____ lightning

1.09 _____ water

1.010 _____ galvanometer

a. current electricity
b. good conductor
c. track for current
d. make electric
e. one of God's wonders
f. will carry electricity from place to place
g. safeguard
h. machine to find and measure electricity
i. Volta
j. particles of an atom
k. will not carry electricity

Write the letter for the correct answer in each blank (each answer, 3 points).

1.011 When an object is electrically charged, ____ have been added to or removed from the object.

a. protons b. electrons c. neutrons

1.012 If you hold a charged object near a stream of water, the water will ____ .

a. bend toward the object b. move away from the object

1.013 An electric cell must have _____ .

a. only an electrolyte
b. 3 electrodes
c. 2 electrodes and 1 electrolyte

1.014 An instrument used to find and measure small electric currents is called a ____.

a. galvanometer b. electron c. proton

1.015 A switch is a _____ .

a. fuse b. circuit breaker c. insulator

1.016 Benjamin Franklin experimented with lightning when he used a _____ .

a. lightning rod b. fuse c. kite and key

1.017 Electric cells are used to make _____ .

a. lightning b. current electricity c. toasters

1.018 A good conductor of electricity is _____ .

a. water b. rubber c. glass

1.019 The track along which electricity flows is called _____ .

a. the round trip b. the circuit c. the railroad

Answer *true* or *false* (each answer, 2 points).

1.020 _____ Benjamin Franklin made the electric cell.

1.021 _____ Protons do not move out of the center of the atom.

1.022 _____ Charges that are alike push each other away.

1.023 _____ Job is a book in the Bible.

1.024 _____ Electricity that flows without stopping is current electricity.

1.025 _____ A galvanometer shows when electric current is flowing.

1.026 _____ Electricity will not flow through a conductor.

1.027 _____ Metals and liquids with salt and acid in them are poor conductors.

1.028 _____ Electricity is important to our world.

Answer these questions (each answer, 5 points).

1.029 How does a fuse work to protect wires in a house from becoming too hot?

_____

_____

_____

1.030 How would your ways of eating change if electricity were to suddenly disappear?

_____

_____

_____

1.031 What should be done about broken or worn-out electrical cords?

_____

_____

_____

Choose the right prefix to make each sentence correct. Use only the prefixes *un*-, *re*-, *ex*-, and *in*- (each answer, 2 points).

1.032 You must have an _____ broken circuit for electric current to flow through.

1.033 A weak battery may be _____ charged.

1.034 Each paragraph should be _____ dented.

1.035 The teacher _____ pressed her wish that the students work hard.

1.036 Come _____ side the school building.

Teacher check: Initials _____

Score _____ Date _____

80/100

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