

I Can Become An™

Electro Wiz™

Electricity



Penny Norman, Ph.D.

*I Can Become An*TM
*Electro Wiz*TM
Electricity



**By Penny Norman, Ph.D.
Computer generated 3D art
by Art Huff**

**NORMAN AND GLOBUS, INC.
El Sobrante, California 94803**

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Art Huff created the computer generated 3-D artwork.

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Additional Copies

Additional copies of this book and replacement parts, as well as a free catalog of our other books and materials are available. Comments are welcome.

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Parent's Choice Seal of Approval, 1996

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**Scientific American
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Note to Parents

This book is recommended for children five years and older.

Kindergarten-First Grade: This is a "read-with" book for kindergarten through first grade. Let your child work with the materials as independently as you can. Give them time to think things through and experiment on their own. The steps in each project are presented pictorially. Pre-readers are brilliant at following visual directions.

Second Grade and Older: Sometime during second or third grade, many children can read these books on their own. There are some new words for them to learn. Parental proximity is still recommended for occasional help and guidance with safety.







Batteries: All the components in the kit will work with 1.5 volt batteries. This means that any AA through D-cell alkaline battery will work; they are all 1.5 volts. A D-CELL battery is what we recommend, because it lasts the longest. The battery is not included.

Most Common Error: The easiest mistake to make in working with these materials is the accidental connection of one end of the battery directly to the other end of the battery with a wire. When this occurs, the alligator clips, the wires and the battery will heat. This shorting-out of the battery can happen inadvertently when one alligator clip or metal connection crisscrosses with another and makes a new path straight back to the battery. If this happens, uncross the touching wires or disconnect the battery.

SAFETY RULES

This book contains small parts intended for use by children five years of age or older. The materials may present a hazard to children younger than five. There is a choking hazard with small parts. Puncture wounds are possible if the materials are misused. There is a flashlight sized glass light bulb that parents should be sure is treated with care to avoid breakage. The spinning motor and all moving objects must be kept away from the eyes. Read the battery labels for proper usage. Parental supervision is necessary for safety.

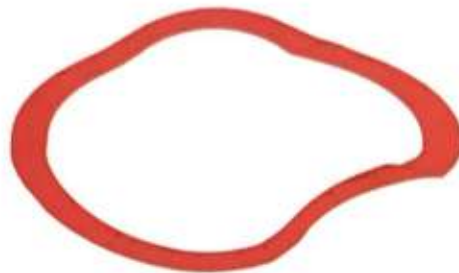
LIST OF ACTIVITIES

1. Making a Loop..... page 1
Electricity flows in a LOOP.
Make a loop and light the lights!

2. Motor Mania..... page 6
Insert a motor in the loop and spin pinwheels, colored disks and ribbons.

3. Batteries and Buzzers..... page 9
Explore batteries and ONE WAY components with buzzers and LEDs.

4. Making a Switch..... page 16
Make your own switch-- get ready to send coded messages.

5. Sending Messages..... page 18
Great fun for two or more.
YES

6. Test It..... page 20
Test what conducts and what doesn't. Even the youngest are amazing testers.

7. Brain Teaser..... page 24
One loop or two? Very creative combinations.
8. Word Play..... page 26
Word Finds, Unscramble and a Crossword for older children.



MAKING A LOOP

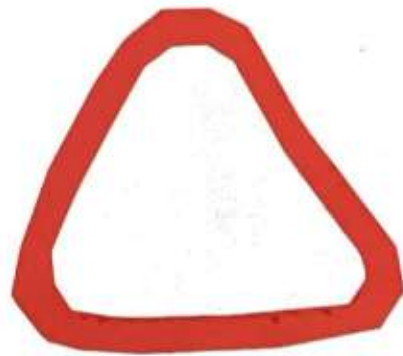
Look in the kit and find the potholder loop made of brightly colored cloth.



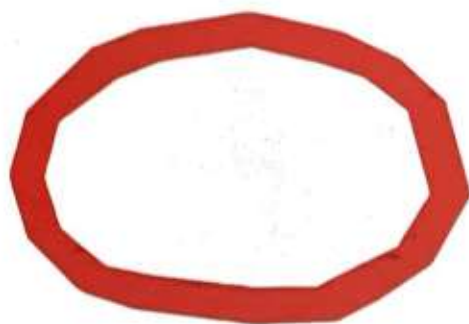
You can use **4** fingers to make the loop into a square.



You can use **3** fingers to shape the loop into a triangle.



If you lay it flat on a table, you can almost shape it into a circle or an oval.



No matter what the shape is-- it's still a LOOP.

You can remember the word loop by rhyming it with other words:

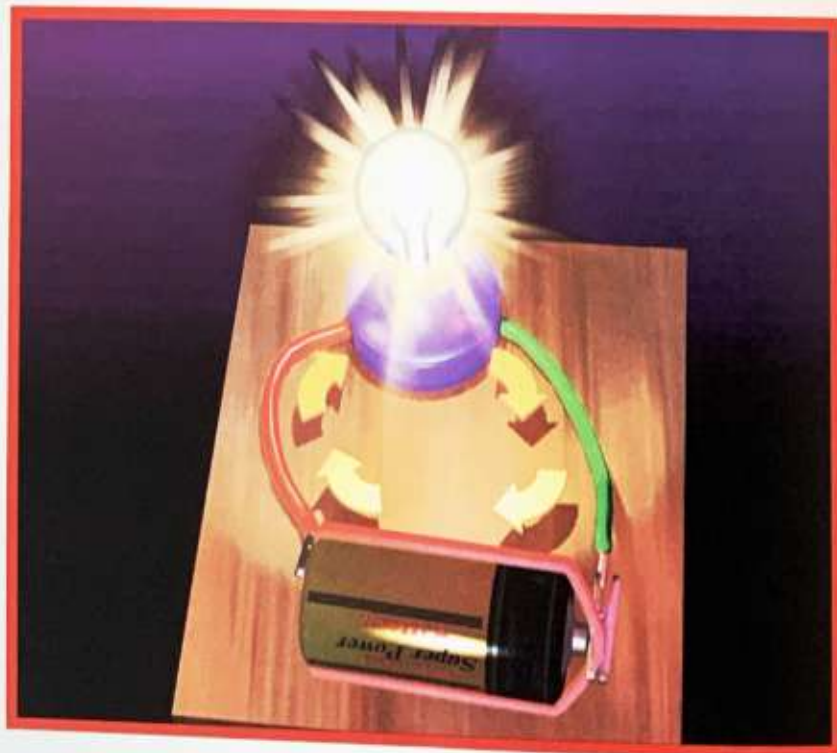
hoop or *stoop* or *troop*

Can you think of another word to rhyme with loop?

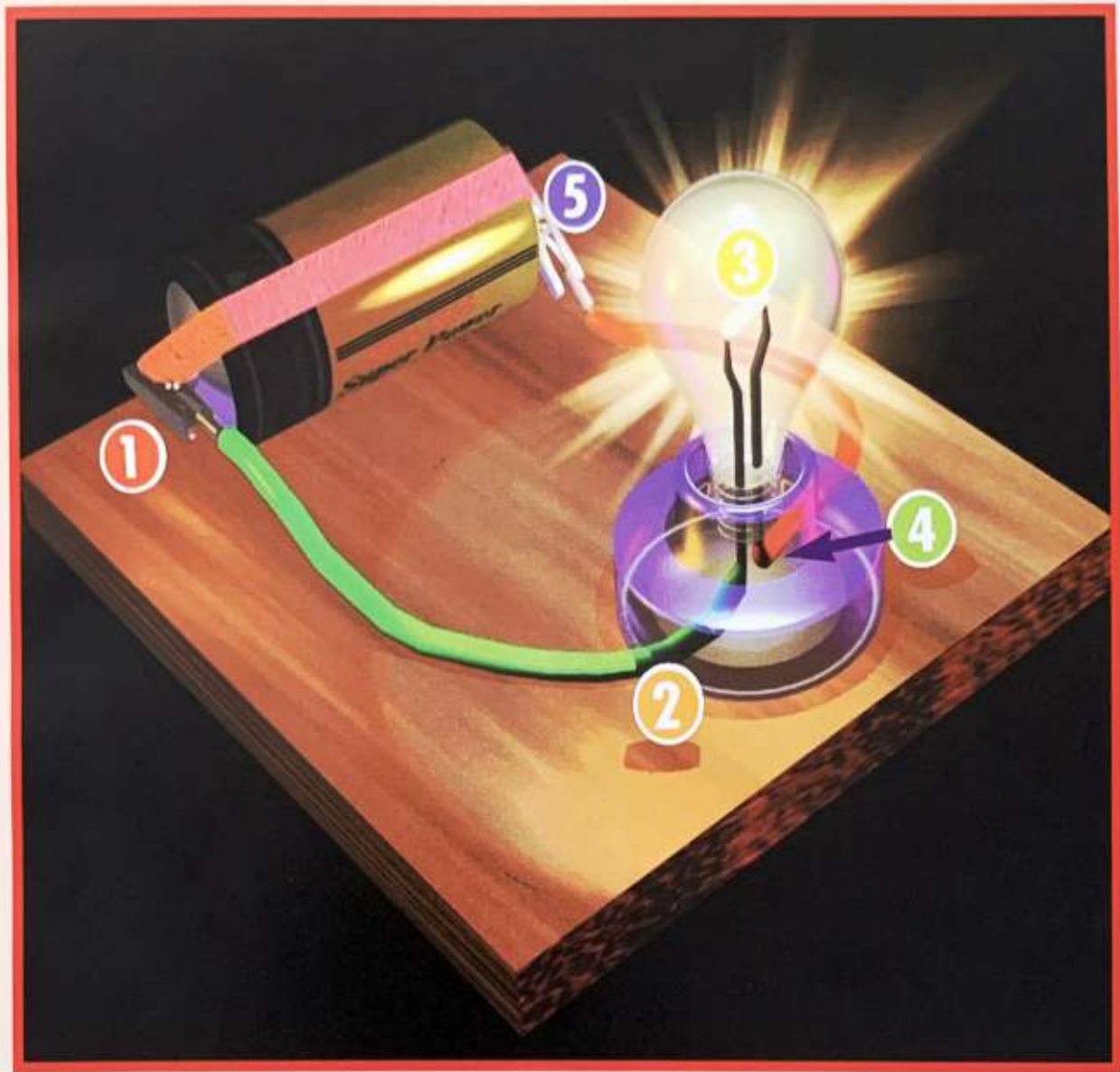
Loop spelled backwards is .

There is a reason for concentrating on the word LOOP.

ELECTRICITY FLOWS IN A LOOP.



Trace the loop in the picture with your finger.



One: Trace from the battery to

Two: the light bulb holder through

Three: the filament inside the bulb to

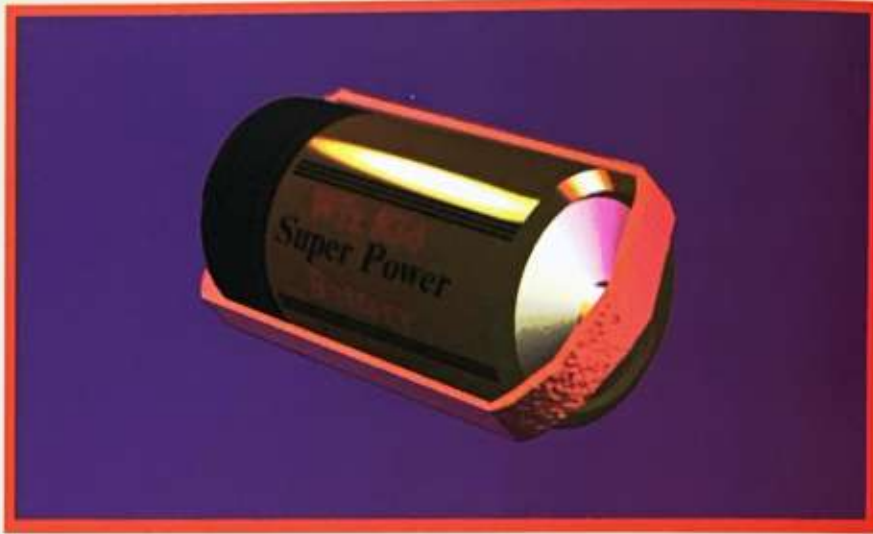
Four: the bulb holder back to

Five: the other end of the battery.

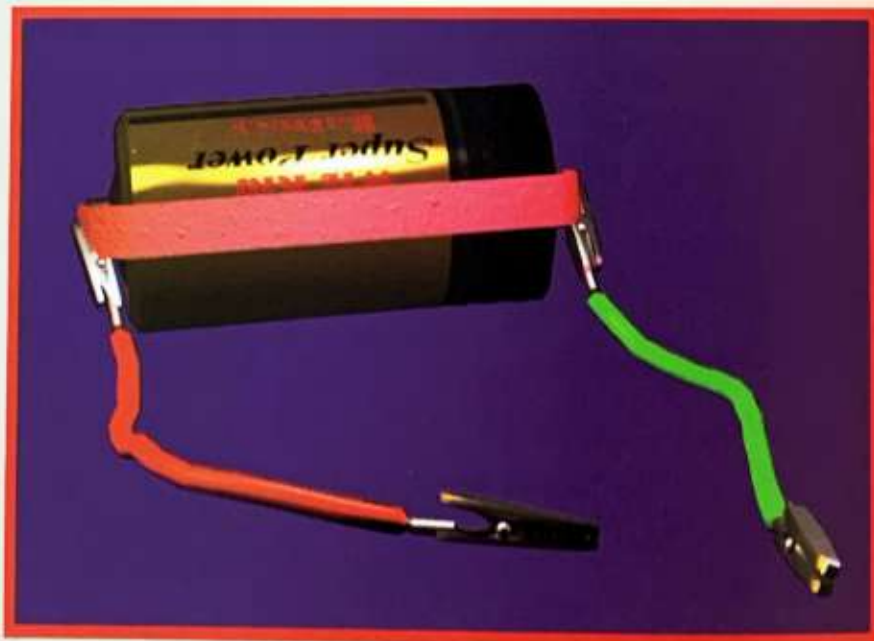
YOU HAVE JUST TRACED A LOOP.

Build your own loop with the materials in the kit to light the bulb.

- 1 Wrap the rubber band around a battery.

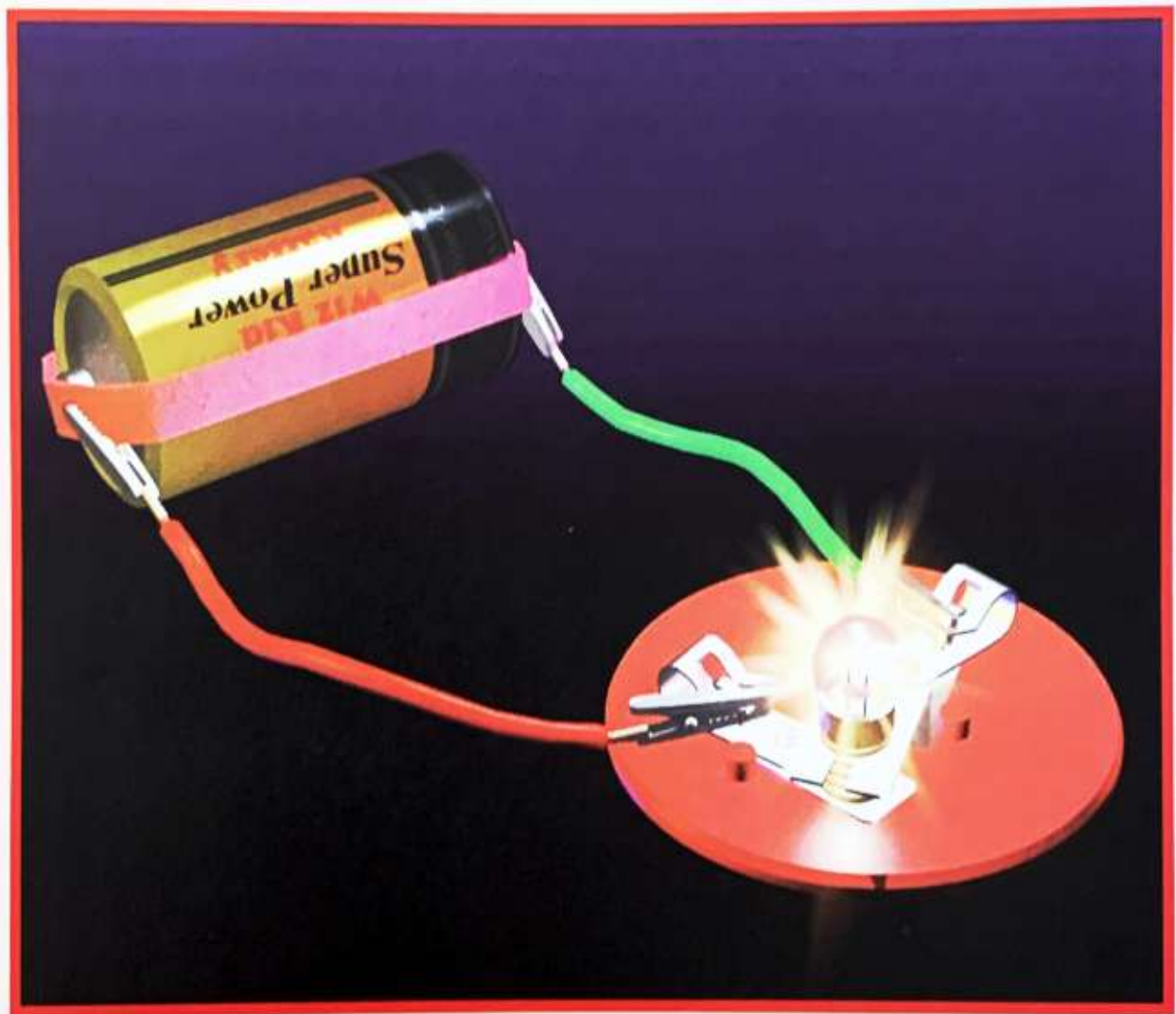


- 2 Attach the alligator clips to the battery.



3

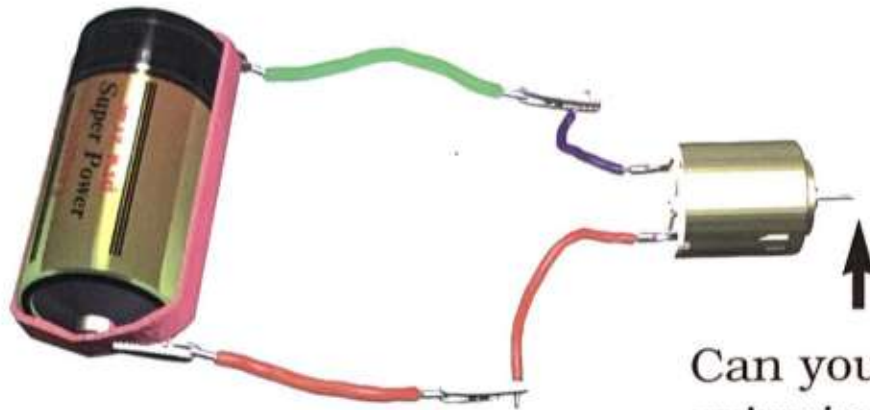
Connect the free alligator clips to the bulb holder.



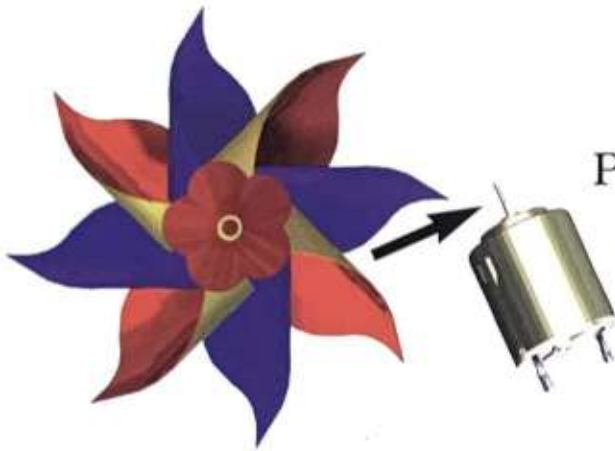
WHEN THE LOOP IS COMPLETE, THE LIGHT SHINES.

MOTOR MANIA

Remove the light bulb holder from the loop and connect the motor in its place.



Can you feel the shaft spinning?



Put the pinwheel on the motor.

Turn it on and watch it twirl.

Color a disk on the page of cutouts with markers, crayons or paint.



Cut out the disk and push it carefully onto the motor shaft. Turn it on. Experiment with other colors and designs.

THERE ARE ELECTRIC MOTORS ALL AROUND YOU:

In the blender and electric mixer in the kitchen.



In a tape recorder.



In the windshield wipers of your car.

In an electric fan.



There are electric motors:

In a record player or CD player.

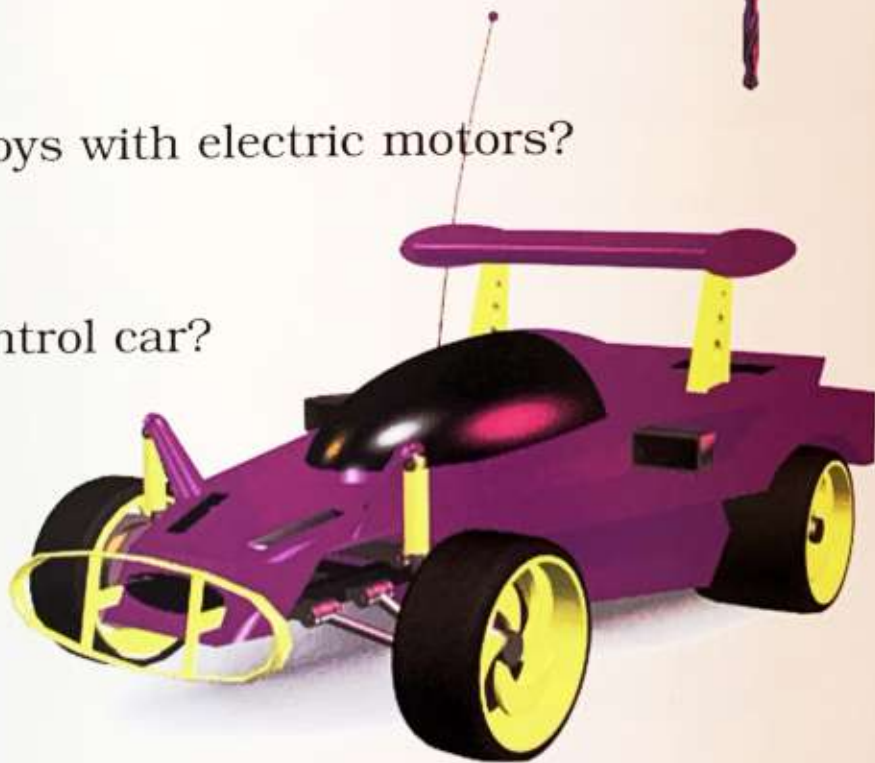


In an electric drill.

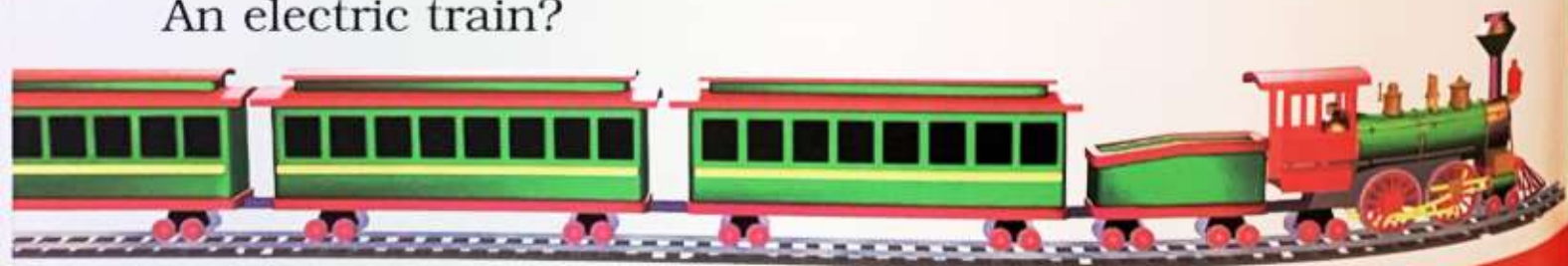


Do you have any toys with electric motors?

A remote control car?



An electric train?



BATTERIES AND BUZZERS

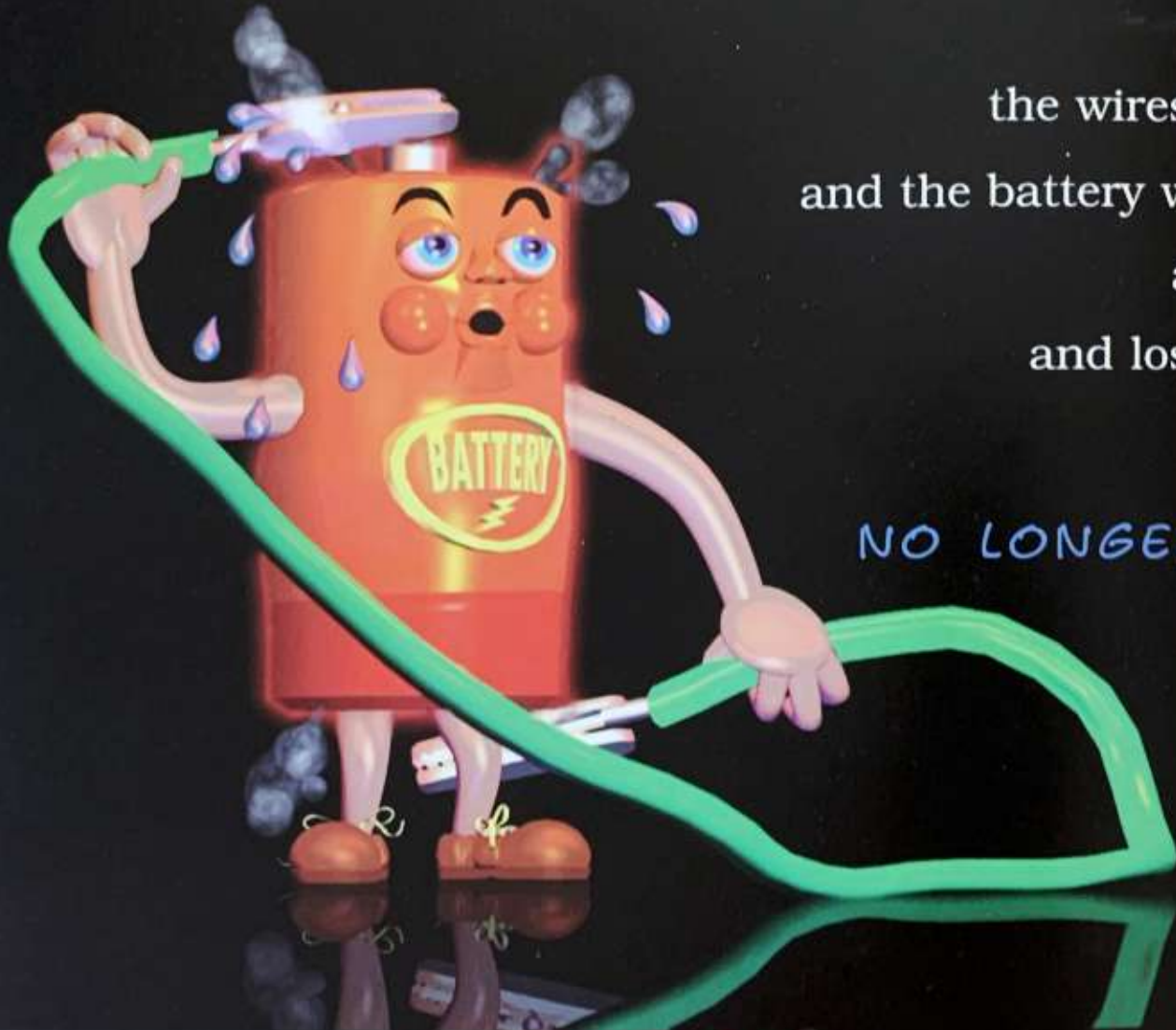
THE BATTERY IS THE SOURCE OF ELECTRICAL ENERGY.



WARNING!

NEVER

WIRE one end of the battery
DIRECTLY to the OTHER
end of the battery.



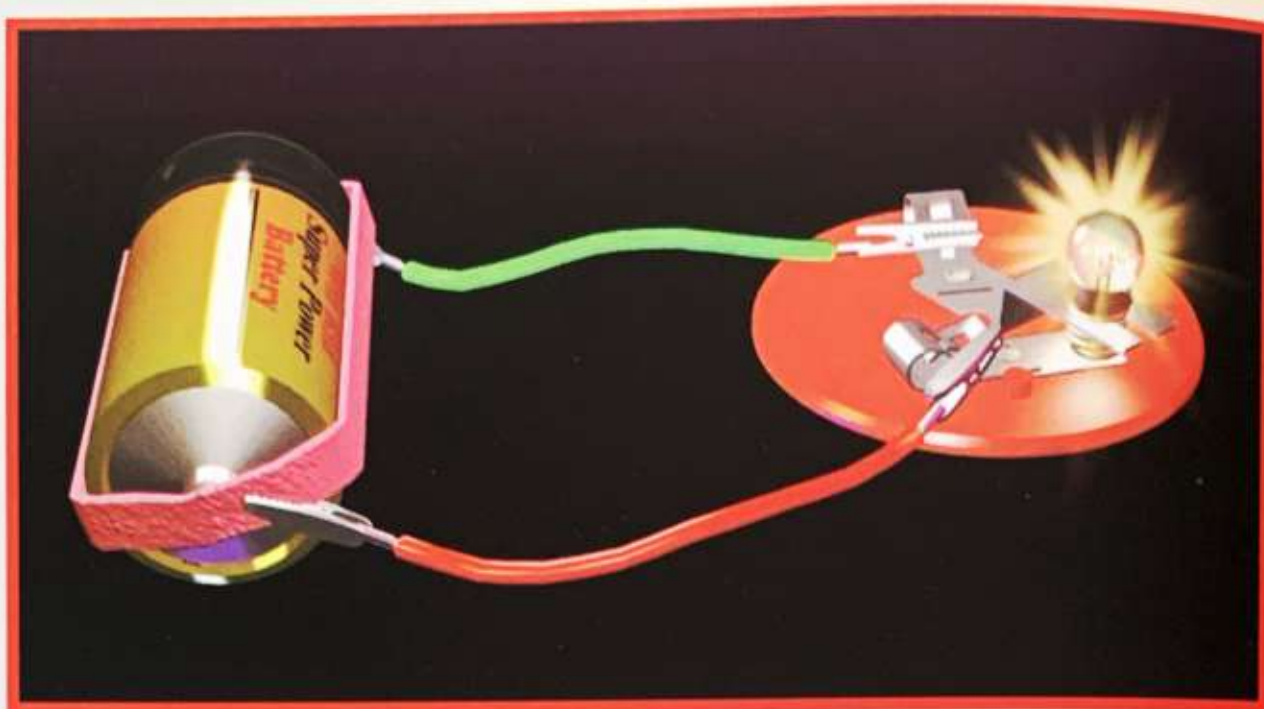
If you do--
the wires will **HEAT**
and the battery will get **HOT**
and **STINK**
and lose its energy
AND
NO LONGER WORK.

Don't **SHORT OUT** the battery.

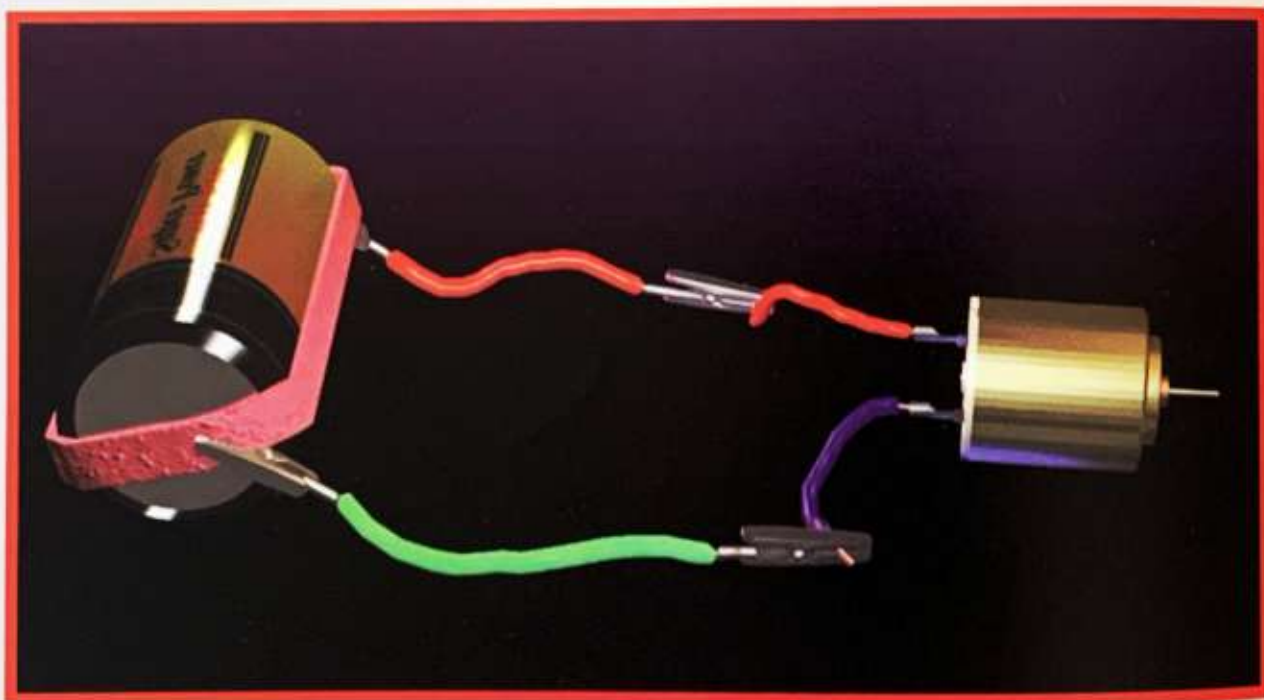
THE BATTERY NEEDS A LOAD.



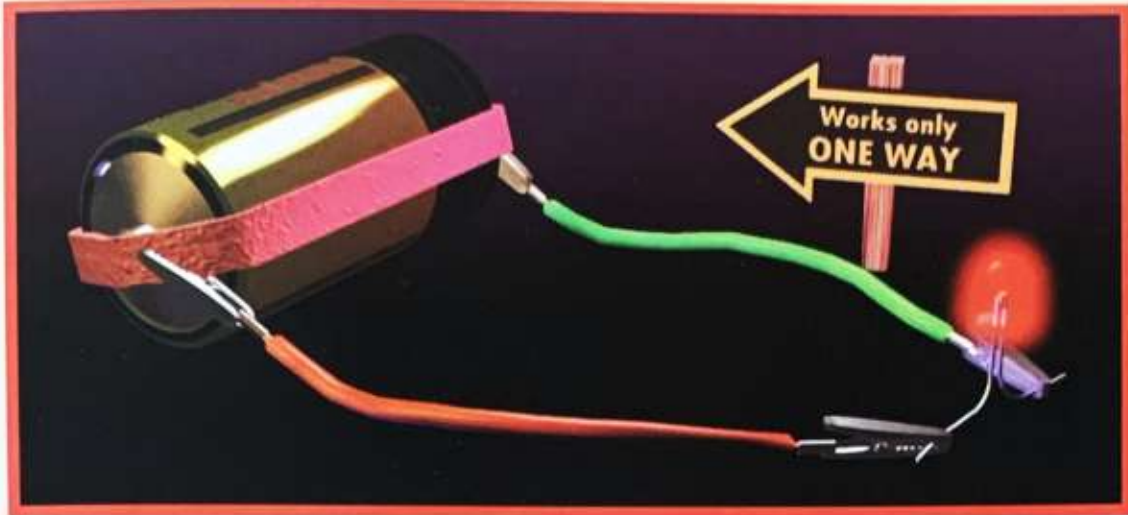
The **load** can be a light bulb.



The **load** can be a motor.



The **load** can be an LED (EL EE DEE).



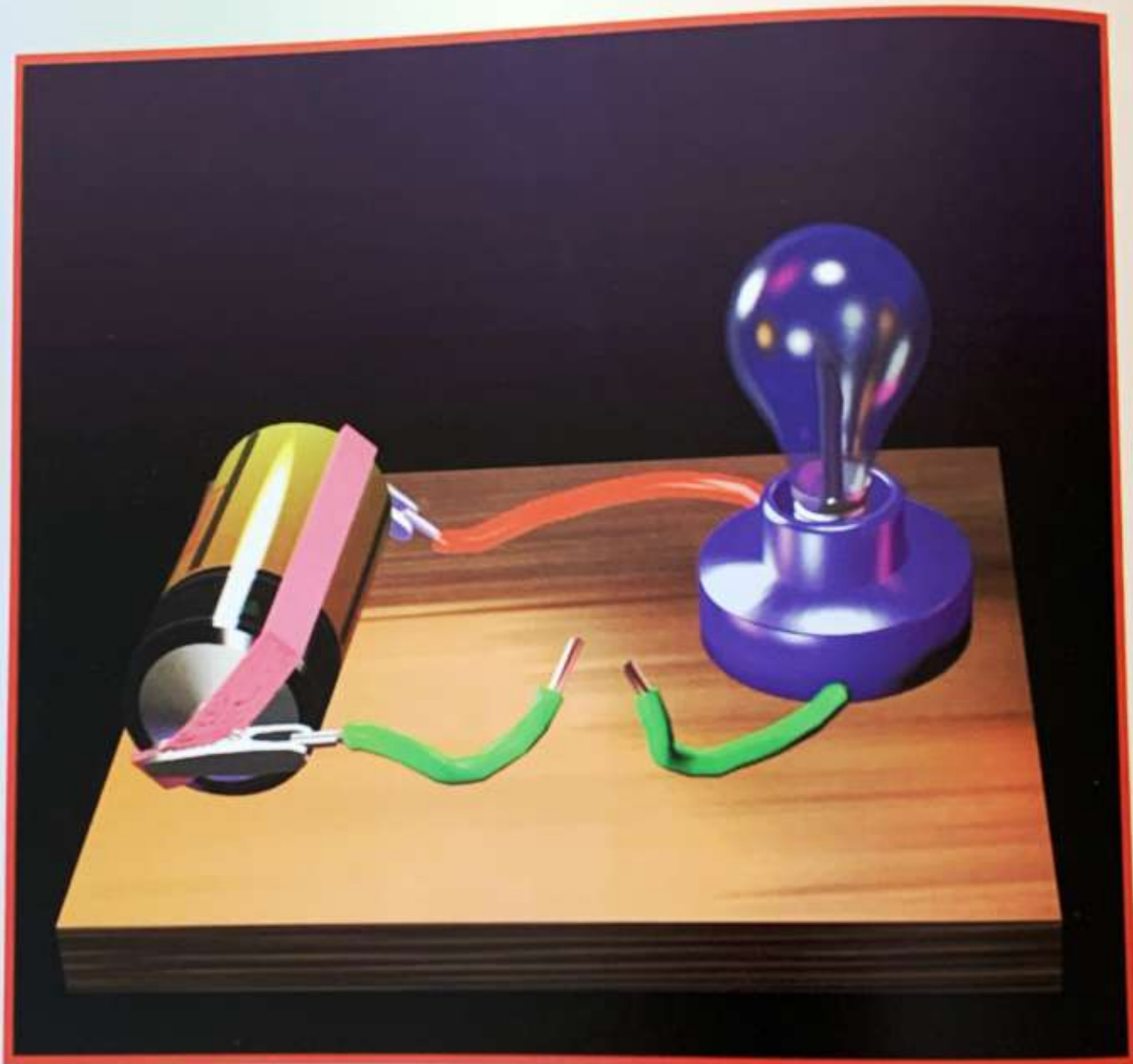
The LED will only work in one direction. Reverse the connections if it doesn't work the first time.

A buzzer can be a **load**. Try it too.



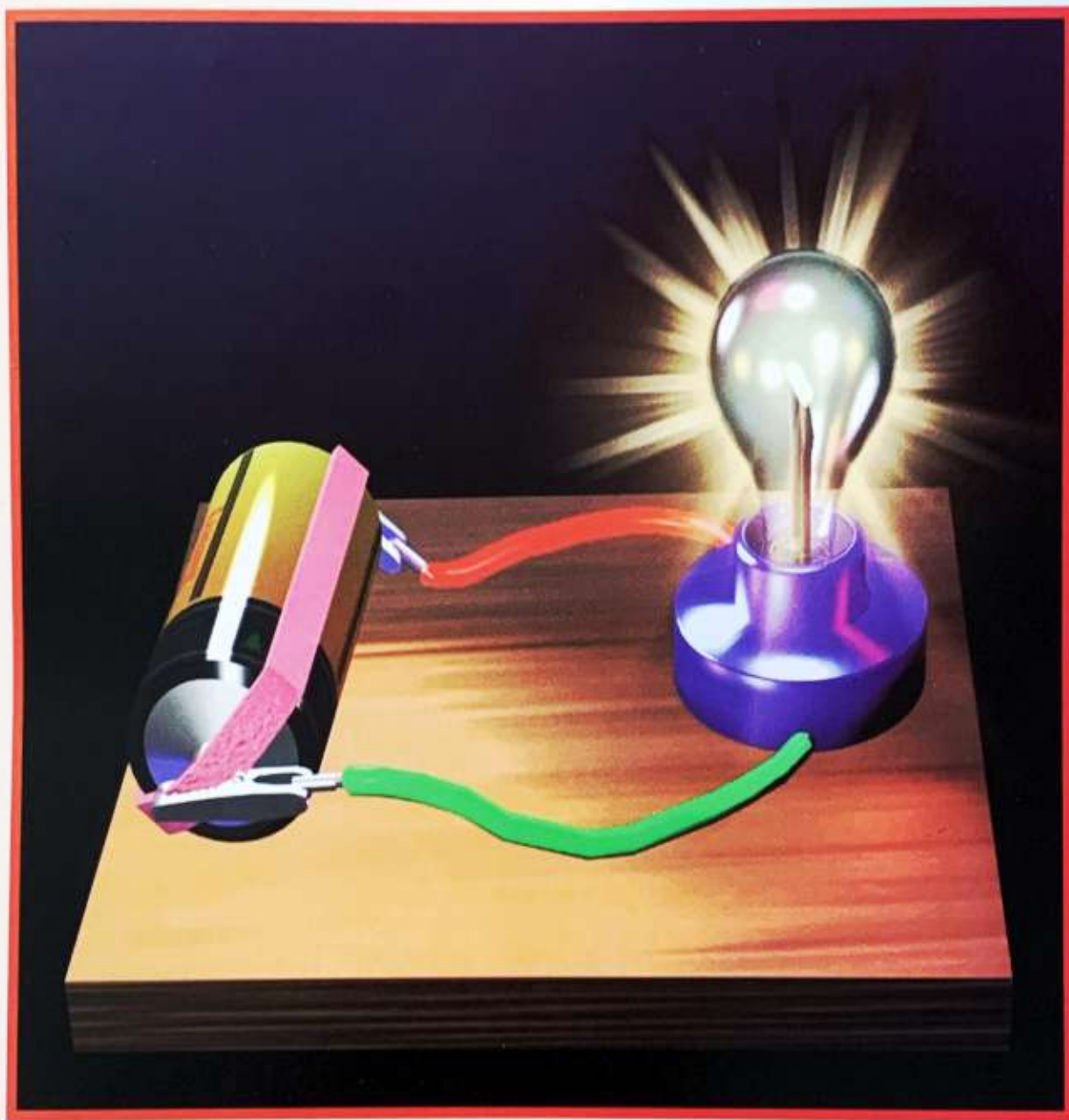
The buzzer will only work in one direction. Reverse the connections if it doesn't work the first time.

OPEN: When the loop is **OPEN** the bulb is out.



OPEN

CLOSED: When the loop is **CLOSED** the light shines.



CLOSED

Electrical current flows through the **closed** loop.

MAKING A SWITCH

You can open and close a circuit loop with a switch.

To make a switch:

- 1** PUSH the paper fasteners through the two holes in the cardboard.



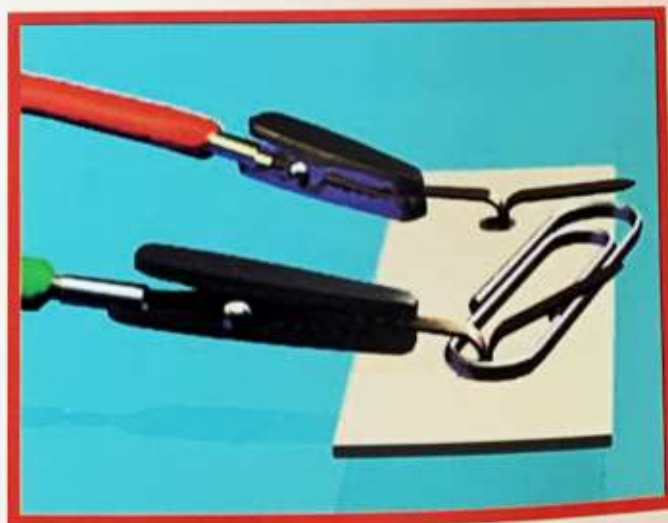
- 2** Turn over the cardboard and push one fastener through a paper clip.



- 3** Bend open the paper fasteners.

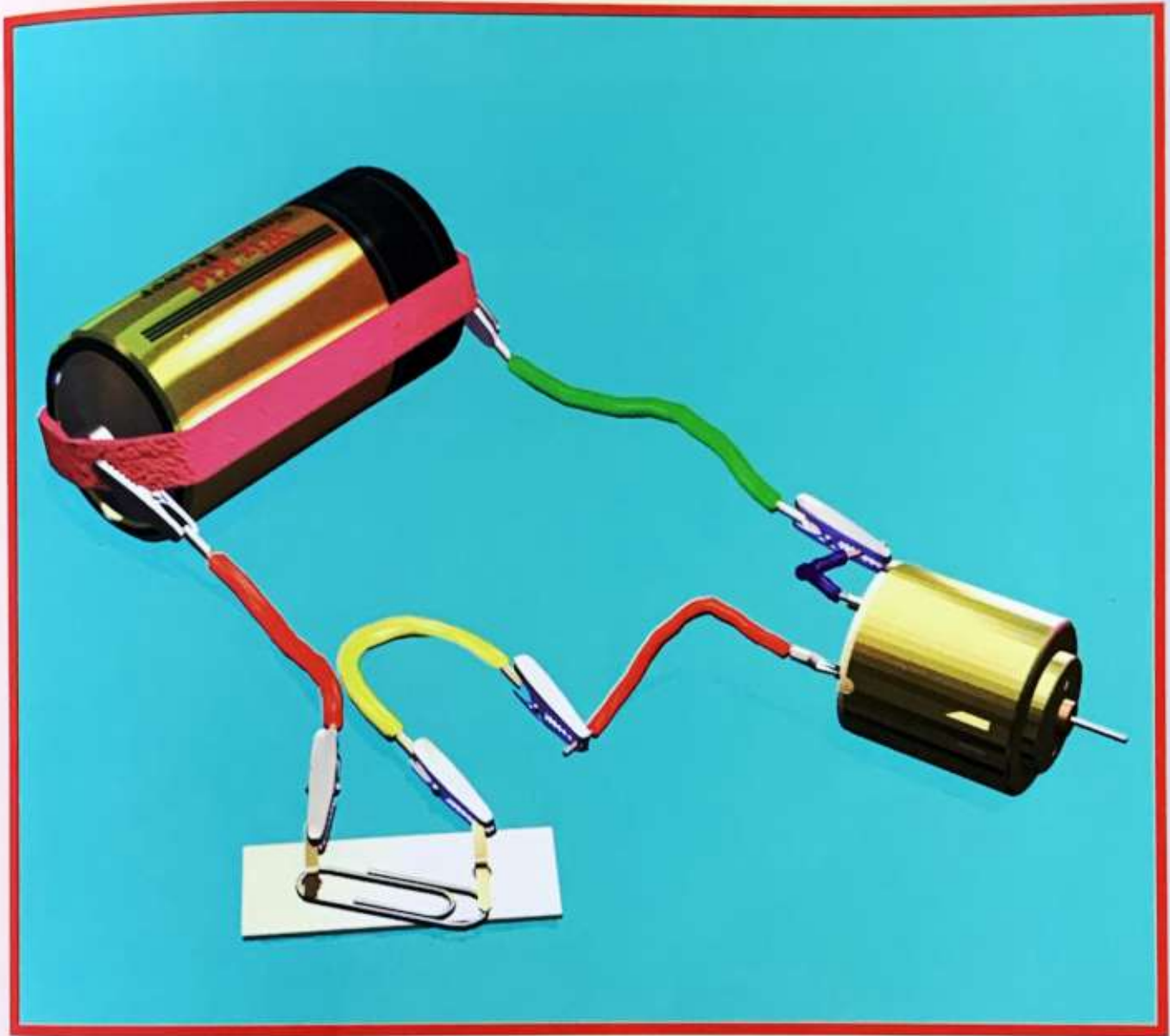


- 4** Connect an alligator clip to each paper fastener.



5

Connect the switch to the motor.



Push the paper clip against the brass paper fastener to close the loop and turn on the motor.

SENDING MESSAGES

If you insert the buzzer instead of the motor, you can send coded messages to a friend.

Try one beep for YES and two beeps for NO.



Can you make up your own code? You might make different beeps stand for letters in the alphabet.

Samuel Morse made a simple code for the alphabet to send messages over long distances before there were telephones.

There are two types of signals in Morse Code.

DI - a short beep, written as a short dot (.)

DA - a long beep, written as a long line (_)

Close and open the switch to make a quick short **DI** sound with the buzzer.

Make the longer **DA** sound by holding the switch closed longer. Practice making these two sounds.

One way to call for help is **SOS**. Ships at sea send this message to other ships when they need **HELP**. **SOS** stands for "Save Our Ship".

You can send your own SOS message in Morse Code.

Look in the chart below for the two letters **S** and **O**. (**S** is a ... and **O** is a _ _ _). Send the SOS message with your circuit.

[DI DI DI] **[DA DA DA]** **[DI DI DI]**
 (short)(short)(short) (long)(long)(long) (short)(short)(short)

The International Morse Code

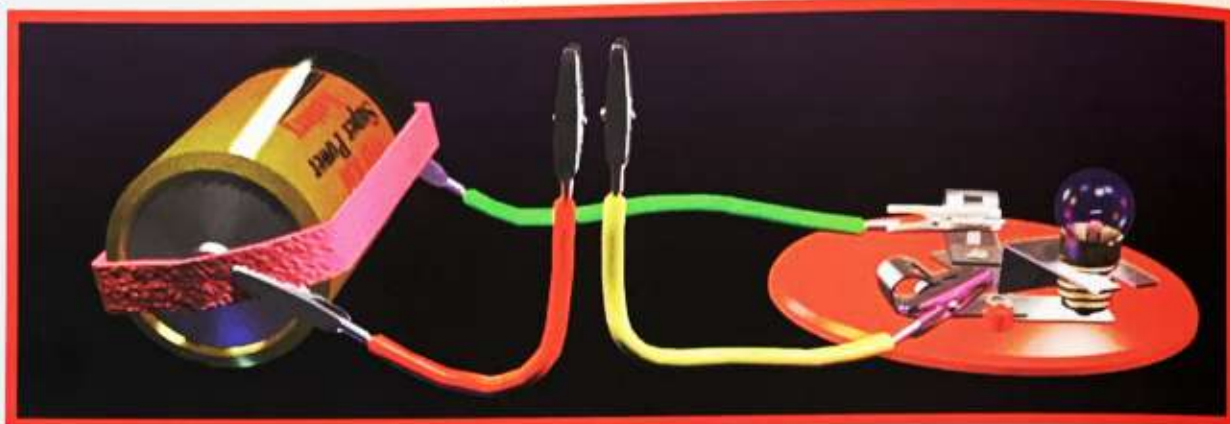
A . _	I ..	Q _ _ . _	Y _ . _ _	6 _
B _ ...	J . _ _ _	R . _ .	Z _ _ ..	7 _ ...
C _ . _ .	K _ . _	S ...	0 _ _ _ _ _	8 _ _ _ ..
D _ ..	L . _ ..	T _	1 . _ _ _ _	9 _ _ _ _ .
E .	M _ _	U .. _	2 .. _ _ _	, _ _ .. _ _
F .. _ .	N _ .	V ... _	3 ... _ _
G _ _ .	O _ _ _	W . _ _	4 _	over _ . _
H	P . _ _ .	X _ .. _	5	out . _ . .

TEST IT

Electricity does not flow through everything.

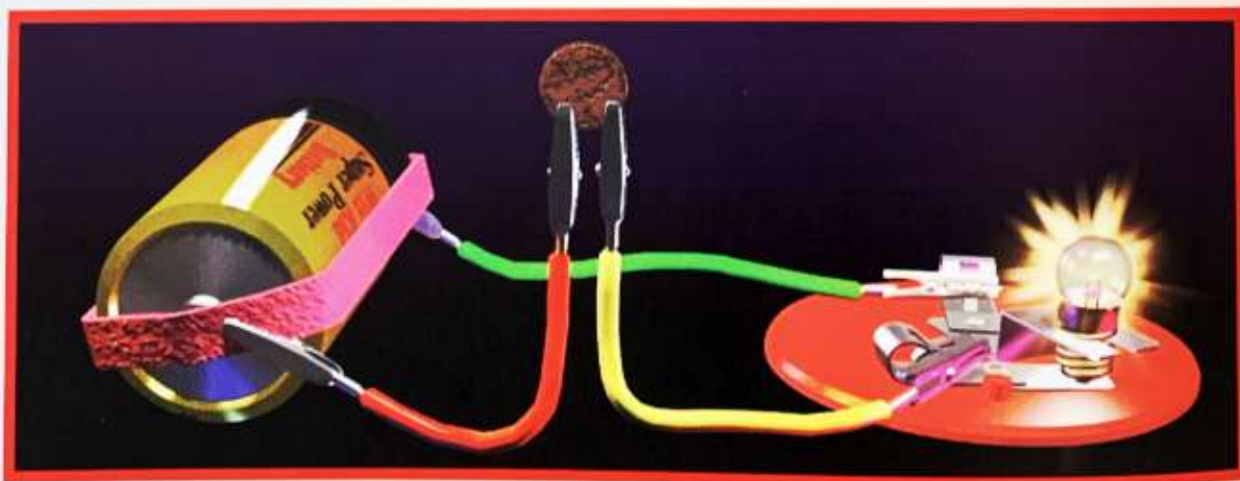
To test what will **CONDUCT** electricity, make a loop, but this time add in an extra test lead.

(The wires with the alligator clips are called "test leads".)



If the two free alligator clips touch, the light shines.

Separate the alligator clips. Bite the copper penny with the two alligator clips. Did the light shine?



The copper penny **CONDUCTS** electricity.

NOTE: Be sure that the two alligator clips do not touch each other. If they do touch, the light will shine no matter what you put in the circuit. You will have made a "**shunt**" and by-passed the object.

Remove the penny and try some of the other objects in the plastic bag in the kit.

Test objects around your house.

Separate the things that conduct electricity from the things that don't.



What kinds of objects **CONDUCT** electricity?

Metals conduct electricity. Lets say that again.

METALS CONDUCT ELECTRICITY.



The nail is made of iron. Iron is a metal.
Metals **CONDUCT** electricity.

The bottle cap is made of iron. Iron is a metal.
Metals **CONDUCT** electricity.



The penny is made of copper. Copper is a metal.
Metals **CONDUCT** electricity.

The nickel is made of nickel and copper.
These metals **CONDUCT** electricity.



The foil is made of aluminum, a flexible metal.
It **CONDUCTS** electricity.



Did you try the brass paper fastener?
Brass is made of copper and zinc.
These metals **CONDUCT** electricity.

Did you try jewelry made of gold? Gold is a metal.
It **CONDUCTS** electricity.



Did you test jewelry made of silver?

Silver is a metal. It **CONDUCTS** electricity.



A can is made of either aluminum or steel (a form of iron). These are metals.

METALS CONDUCT ELECTRICITY.

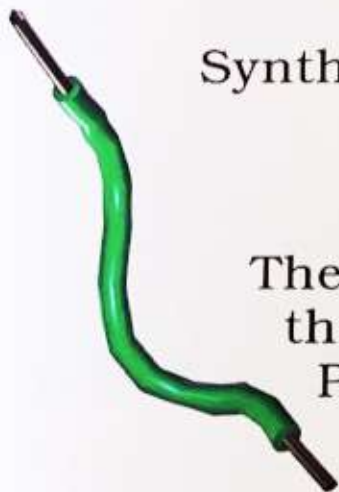
Most non-metals do not conduct electricity but some do. **YOU** know how to test any object to see if it does or does not conduct electricity.

Materials that do NOT conduct electricity, are called:

INSULATORS



The crayon doesn't conduct electricity. The wax in crayons is an **INSULATOR**.



The rubber band does not conduct electricity. Synthetic rubber is an **INSULATOR**.



The plastic coating on the outside of the wires does not conduct electricity. Plastic is an **INSULATOR**.

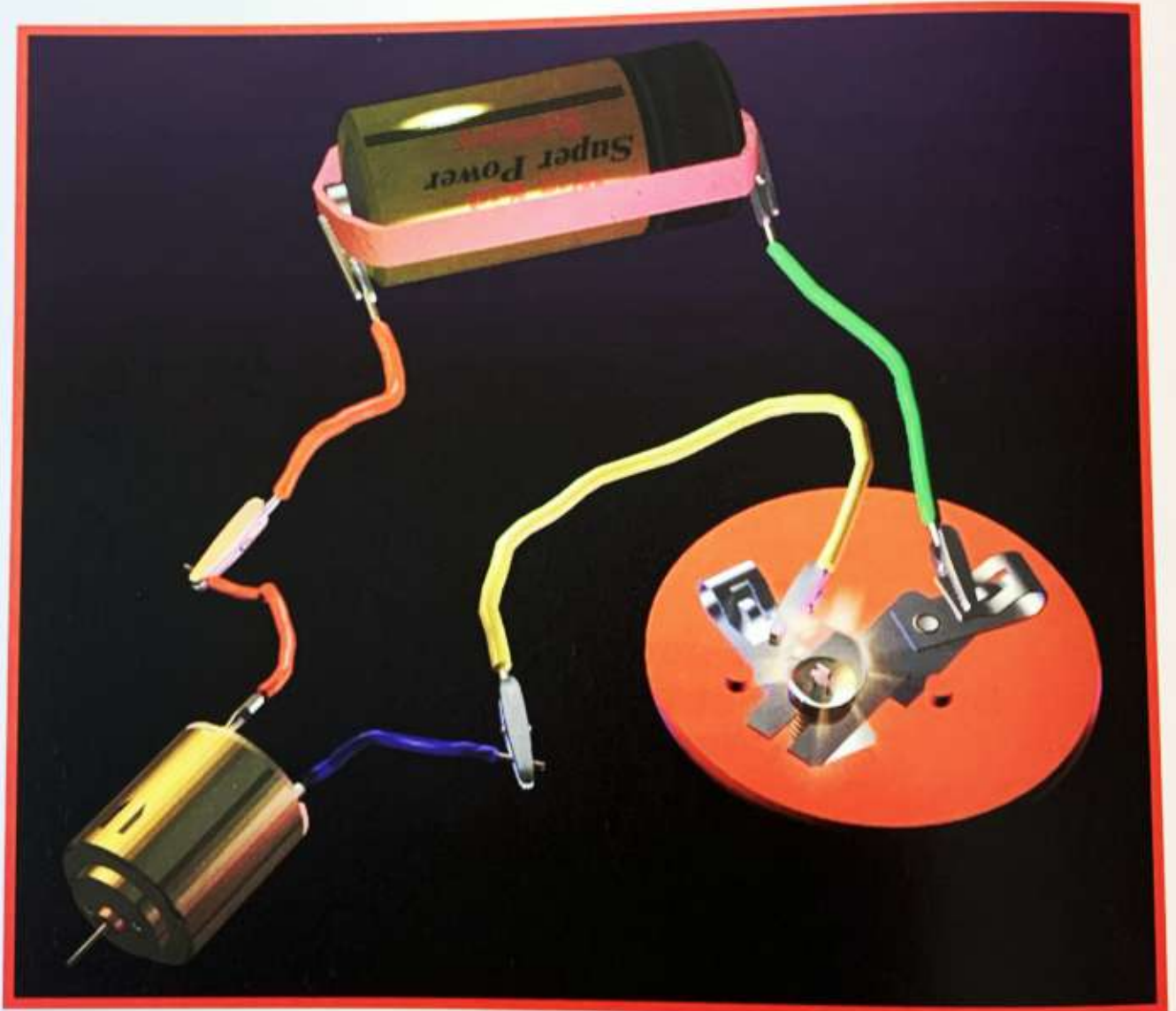
The clothes pin does not conduct electricity. Wood is an **INSULATOR**.



BRAIN TEASER

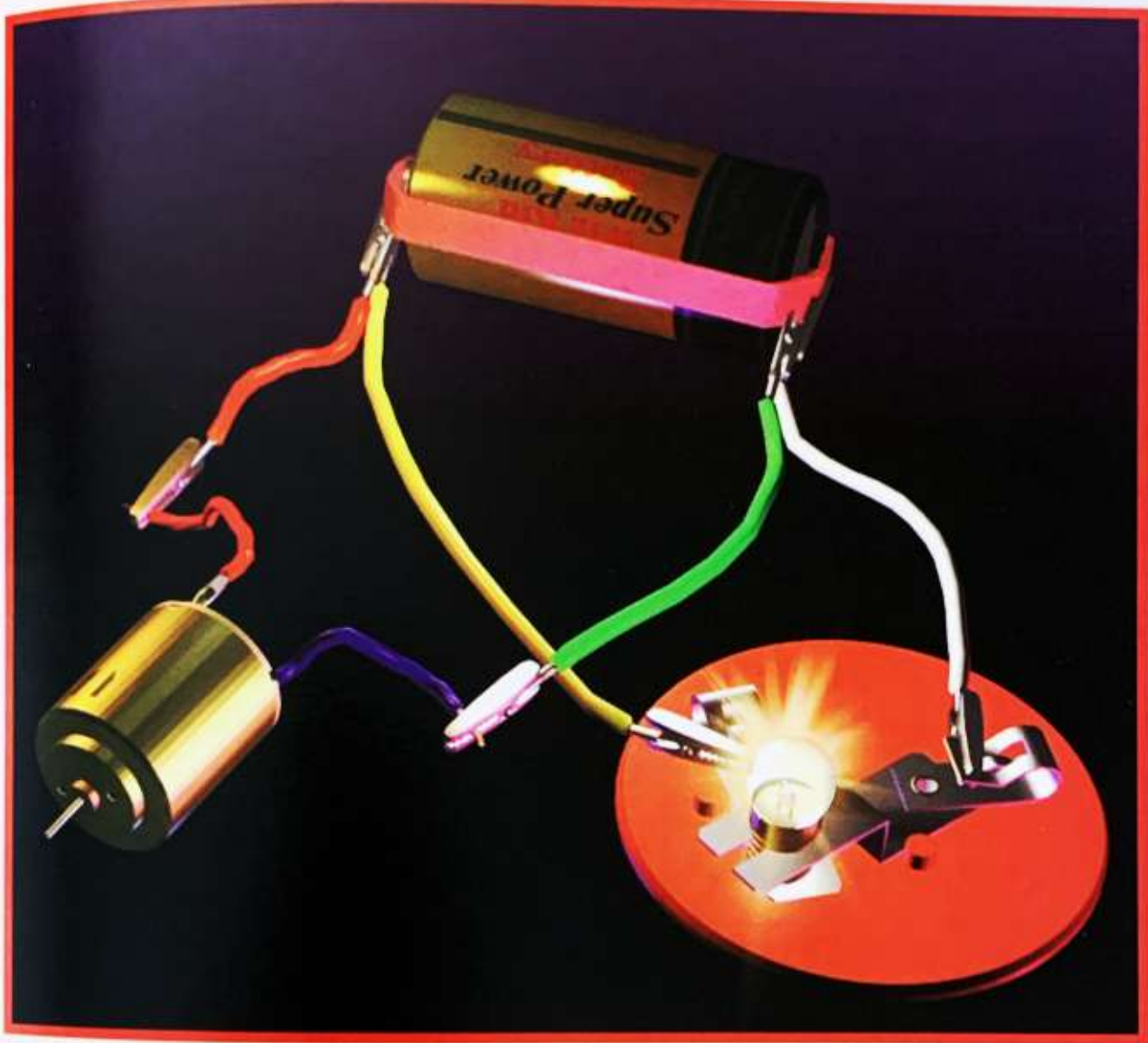
ONE LOOP OR TWO ?

Connect the bulb and the motor in **ONE** big loop.



This is called a **SERIES** circuit. The bulb and motor are connected one after another in a single loop. Electricity flows through each part in turn. If one part in the loop goes out, so will all the others.

Connect the bulb and motor in a **TWO** loop circuit.



The parts in the two loop circuit are connected in **PARALLEL**. If the bulb goes out, the motor will still run in this two loop or parallel setup

Is the light brighter in **ONE LOOP OR TWO ?**

WORD PLAY

1. MOTOR
2. LOAD
3. LOOP
4. SWITCH
5. LED (Find these words in the grid below- across, down or diagonally.)
6. OPEN
7. CLOSED
8. BATTERY
9. CONDUCT
10. ELECTRICITY
11. INSULATOR
12. SHUNT
13. SHORT

W	E	E	L	T	O	A	R	K	M	N	C
A	S	L	O	O	P	U	J	U	M	C	A
T	F	E	E	E	E	P	D	H	C	L	S
O	N	D	K	C	N	F	C	U	O	O	T
M	R	H	O	P	T	T	R	N	S	S	C
O	I	N	C	A	I	R	R	T	T	E	O
T	L	N	N	W	K	Y	I	G	Q	D	N
O	O	O	S	H	U	N	T	C	L	M	D
R	A	B	E	U	Y	C	I	A	I	O	Y
R	D	A	D	L	L	K	N	T	Z	T	P
L	S	H	O	R	T	A	L	O	S	P	Y
I	N	S	R	S	W	I	T	C	O	U	V
C	O	N	D	U	C	T	B	O	I	X	F
D	C	E	A	B	A	T	T	E	R	Y	B

UNSCRAMBLE

Unscramble these words and use the circled letters to decode the mystery word in the box below:

1. toorm

○

6. tabyret

○

11. peno

2. odal

7. tcudcon

○

12. sroht

○

3. oopl

8. locsde

○

4. chtiws

○

9. rotisunla

○

5. EDL

○

10. tnuhs

○

5 8 5 7 10 1 4 7 9 12 6

CROSSWORD

List of Words

Loop	Battery
Motor	Load
Short	Insulator
Switch	Conduct
Shunt	Electricity
Open	LED

INSTRUCTIONS:

Fill in the words to the crossword puzzle using the clues below.

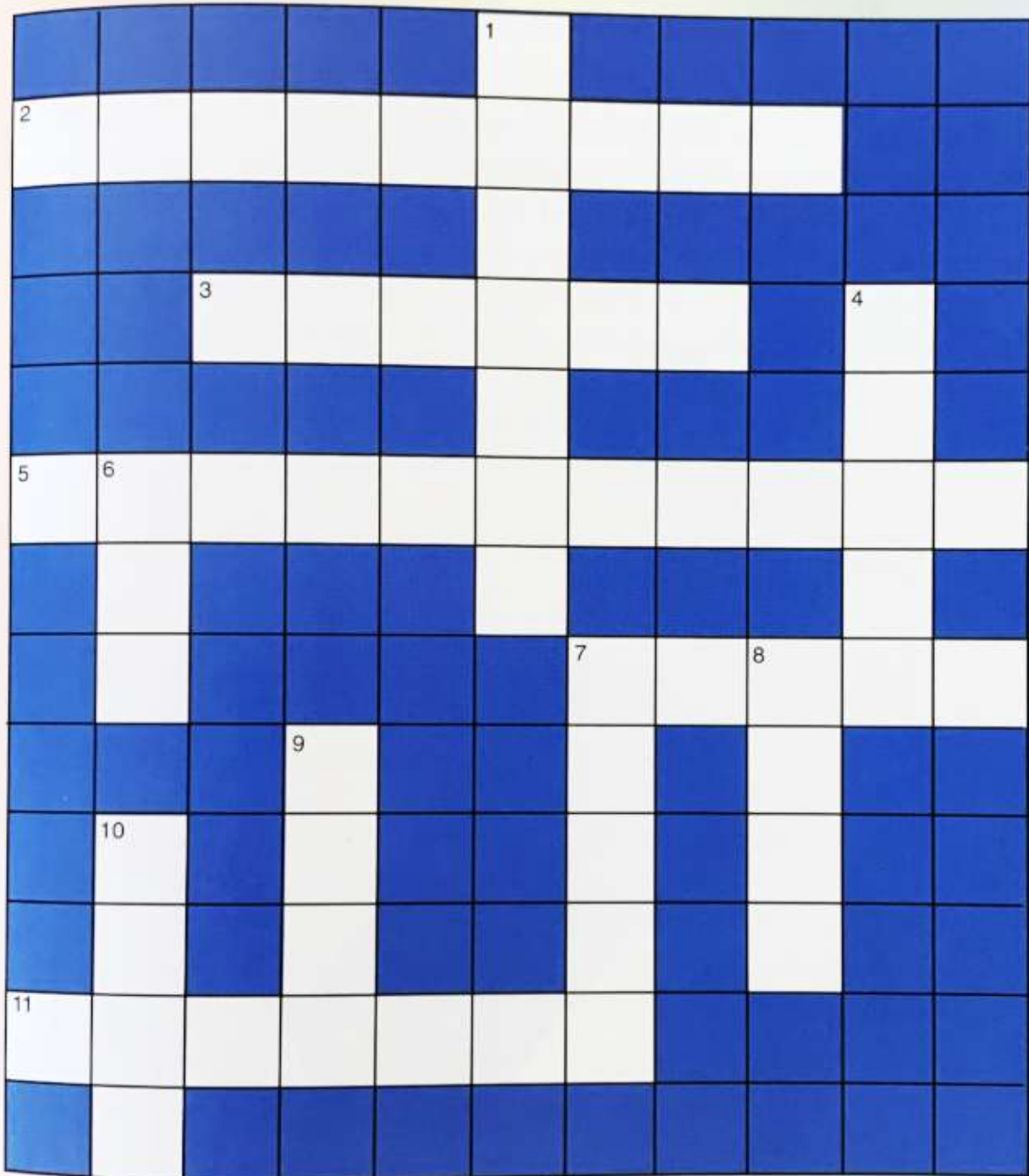
Across

2. An _____ does not conduct electricity.
3. A _____ is used to open and close a loop.
5. _____ flows in a loop.
7. A _____ happens when one end of a battery is connected directly to the other end.
11. All metals _____ electricity.

Down

1. A _____ is a source of electrical energy.
4. A _____ spins.
6. An ___ is a small light that connects one way.
7. A _____ by-passes the object you are testing.
8. A broken loop is _____.
9. A battery needs a _____.
10. Electricity flows in a _____.

CROSSWORD





WHEN THINGS DON'T WORK:

Most Common Boo Boo: The easiest mistake to make in working with these materials is the accidental connection of one end of the battery directly to the other end of the battery. When this occurs the alligator clips, the wires and the battery will heat up. This is called shorting-out of the battery. Page eleven explains the problem. This shorting-out of the battery can happen inadvertently when one alligator clip or metal connection crisscrosses with another and makes a new path straight back to the battery. If this happens, uncross the touching wires or disconnect the battery.



➡ The **general rule** for getting ANY circuit to work is to

USE SUBSTITUTION.

You can show that a part is working if it functions in a simple loop.

THINGS THAT CAN GO WRONG:

1. **The battery is low.** Try a new battery.
2. **You have bad contact.** Make sure that the alligator clips are making direct contact to the metal ends of the battery, the metal ends of the wires and the metal contacts on the components.
3. **The loop is not connected.** Check all connections. Be sure the loop is complete.
4. **The bulb is burned out** or some other part such as the motor fails to work. Substitute other components to see if they still work. If they do, replace the defective item.
5. **Connections are rusted or corroded.** Clean off the rust or order a new component.
6. **One of the alligator leads is defective.** Substitute one lead with another to see if one alligator is failing.

Glossary

Battery - The battery supplies electricity or electrical current to a circuit. (page 9)

Circuit - An electrical circuit is usually made of electrical components such as motors or light bulbs connected with wires. Electrical current flows through the circuit. (page 15)

Closed - A closed electrical pathway allows electricity to flow. (page 15)

Conduct - Metals conduct or allow electricity to flow in an electrical circuit. (page 20 - 23)

Conductor - Materials that allow electricity to flow easily through them are called conductors. (pg 22)

Current - Electric current is the flow of electricity through a circuit. (page 15)

Insulator - An insulator is a material that blocks the flow of electricity. Wood, plastic and rubber are insulators. (page 23)

LED - Pronounced EL EE DEE, it stands for light emitting diode. LEDs are often used as indicator lights to show when an electrical appliance such as a VCR or computer is turned on. (page 13)

Load - A load changes electrical energy into another form of energy. The light bulb turns electrical energy into light and heat. The buzzer changes electrical energy into sound vibrations. The motor changes electrical energy into mechanical energy. (pgs.12-13)

Loop - is a single closed path for electricity. (pgs.1-6)

Motor - An electrical motor changes electrical energy into mechanical energy or the energy of motion. (pages 6-8)

Open - A broken loop is called an open circuit. (pg 14)

Parallel - A parallel circuit splits electrical current into two or more pathways or loops. (page 25)

Series - In a series circuit, each component is connected, one after the other, in a single loop. (page 24)

Short Circuit - An electrical circuit that doesn't have a load. (pages 10 and 30)

Shunt - is an alternate pathway in a circuit. (page 19)

Switch - is used to open and close a circuit loop. (pages 16-17)

Test Lead - The wires connected to the alligator clips are called test leads because they are often used to test circuits. (page 20)

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