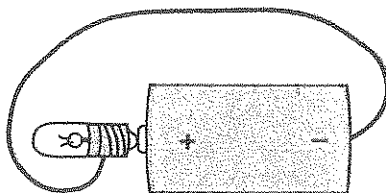


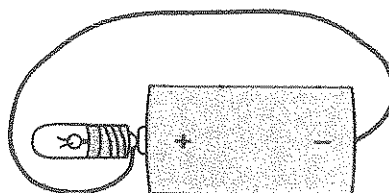
Simple Circuits

1. Think of three ways that you could light a bulb using a bulb, a piece of wire, and a battery. Draw your ideas in the space below. Then use the materials to test each circuit. Circle the ones that worked.

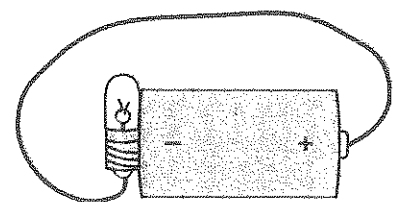
2. Predict whether Circuits A, B, and C will light the bulb. Then build the circuits. Record which bulbs glow and which do not.



Circuit A



Circuit B

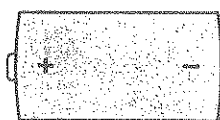


Circuit C

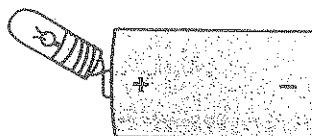
Prediction _____ Prediction _____ Prediction _____

Observation _____ Observation _____ Observation _____

3. Draw the missing wire or wires that would make the bulb glow in Circuits D, E, and F. Then, build each circuit to see whether the bulb lights. Keep trying different arrangements until you get the bulb to light.



Circuit D









Circuit E



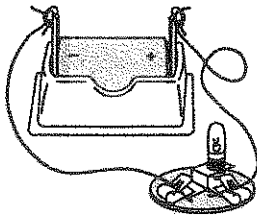
Circuit F

Electrical Symbols

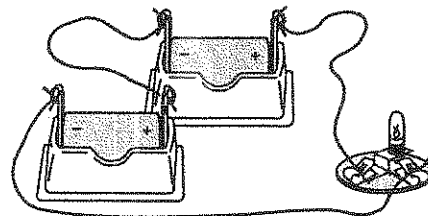
These symbols are used to draw circuit diagrams.

	battery	wire	bulb
material			
symbol			

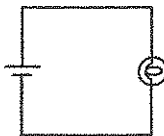
Circuits A and B also may be shown by Circuit Diagrams A and B.



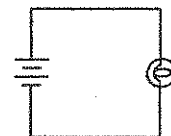
Circuit A



Circuit B



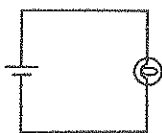
Circuit Diagram A



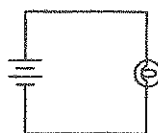
Circuit Diagram B

1. Draw a circuit diagram of a circuit that contains two batteries and two bulbs.

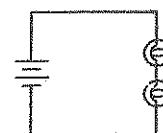
2. Circuit diagrams often will be used in the rest of the activities. Practice reading them. Then build Circuits A, B, and C.



Circuit A



Circuit B

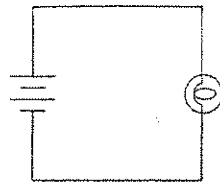


Circuit C

Which circuit had the brightest bulb? _____

Series and Parallel Batteries

Series Circuit



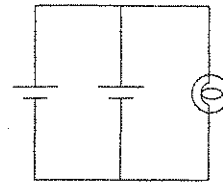
1. Do you think that the bulb will glow brighter when you use two batteries wired in **series** than when you use just one battery?

2. Build the two circuits and record your observations.

3. Do you think that the bulb will glow brighter after you add two more batteries in series?

4. Build the circuit and record your observations.

Parallel Circuit



5. Do you think that the bulb will glow brighter when you use two batteries wired in **parallel** than when you use just one battery?

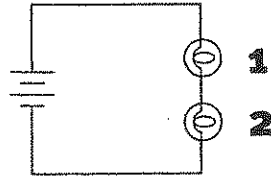
6. Build the two circuits and record your observations.

7. Do you think that the bulb will glow brighter after you add two more batteries in parallel?

8. Build the circuit and record your observations.

Series and Parallel Bulbs

Series
Circuit



1. Do you think that both bulbs in this circuit will glow? _____
2. Build the circuit and record your observations.

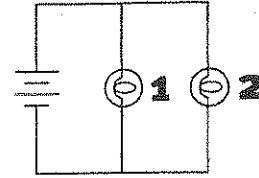
3. Do you think that Bulb 2 will stay lit if you remove Bulb 1? _____
4. Remove the bulb and record your observations.

5. Replace Bulb 1. Remove Bulb 2. Does Bulb 1 stay lit? _____
6. Combine materials with other teams. See how many bulbs can be wired together in series. How many bulbs can you make glow?

7. What happened to the brightness of the bulbs as you added more bulbs in series to your circuit?

8. Do you think that two bulbs wired in series will glow with the same brightness as two bulbs wired in parallel? _____

Parallel
Circuit



9. Do you think that both bulbs in this circuit will glow? _____
10. Build the circuit and record your observations.

11. Do you think that Bulb 2 will stay lit if you remove Bulb 1? _____
12. Remove the bulb and record your observations.

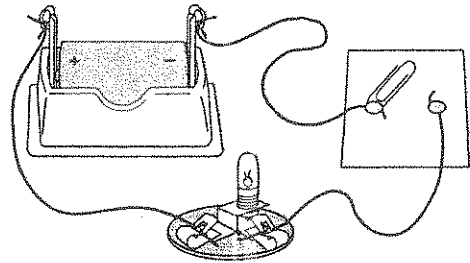
13. Replace Bulb 1. Remove Bulb 2. Does Bulb 1 stay lit? _____
14. Combine materials with other teams. See how many bulbs can be wired together in parallel. How many bulbs can you make glow? _____
15. What happened to the brightness of the bulbs as you added more bulbs in parallel to your circuit?

16. Did the two bulbs wired in parallel glow with the same brightness as the two bulbs wired in series? _____

A Paper-Clip Switch

1. Use the materials to build a one-battery, one-bulb circuit. Then follow these directions to add a switch to the circuit.

- Disconnect the wire from the clip on one side of the battery. Wrap the end of the wire around the head of a paper fastener.
- Poke two small holes in the cardboard with a pencil. Make the holes 3 cm (about 1.2 in.) apart.
- Push the fastener through one of the holes. Spread the ends of the fastener.
- Connect one end of a new wire to the empty clip on the battery. Wrap the other end around another paper fastener.
- Push the fastener through one end of the paper clip and then through the other hole in the cardboard. Spread the ends of the fastener.



2. Swing the paper clip so that it touches the other paper fastener. What do you observe? _____

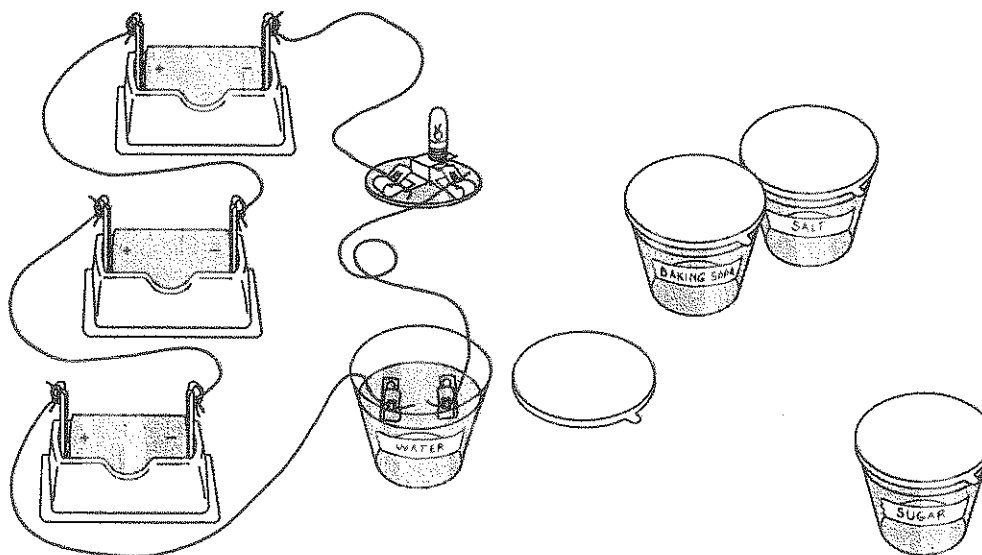
3. Swing the paper clip so that it no longer touches the other paper fastener. What do you observe? _____

4. Take apart the circuit. Reposition the switch to the other side of the battery. What do you observe when you close and open the switch?
- _____
- _____

5. Explain what happens to the electric current in the circuit when the switch is closed and opened. On the back of this paper, draw your circuit and the path that the current follows.
- _____
- _____
- _____
- _____

Liquid Conductors

1. Use your materials and follow the diagram below to make a circuit tester for liquids.



2. Predict whether or not each liquid will conduct electric current. Record your predictions. Then test each liquid and record your observations.

Liquid	Prediction		Observation	
	will conduct	will not conduct	did conduct	did not conduct
plain tap water				
baking soda solution				
salt solution				
sugar solution				

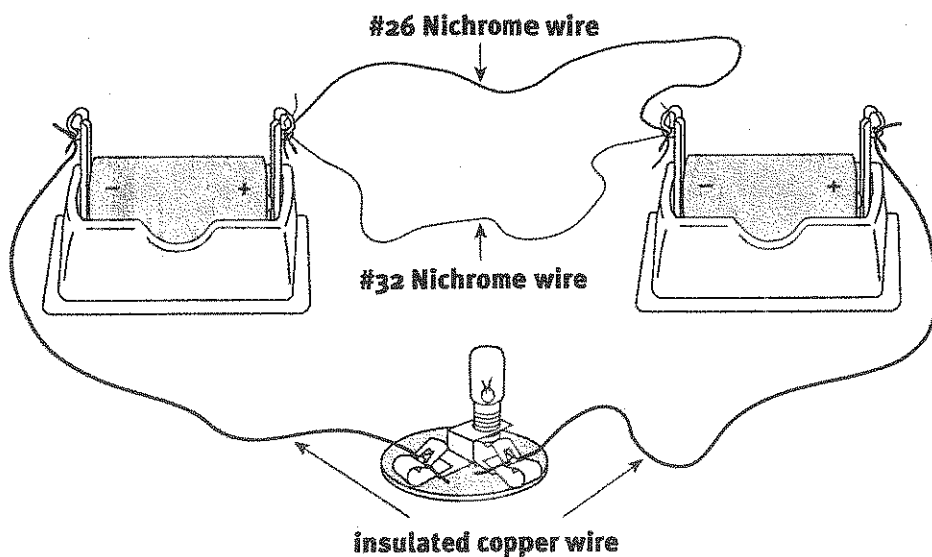
3. Which liquid was the best conductor? _____

4. Was the bulb's brightness different with the best solid conductor than it was with the best liquid conductor? Why do you think this was so?

Electrical Resistance

Session I

- Build the two-battery setup shown below.
Which wire do you predict will offer more resistance?



- What happens to the brightness of the bulb when the **thin** wire is disconnected?

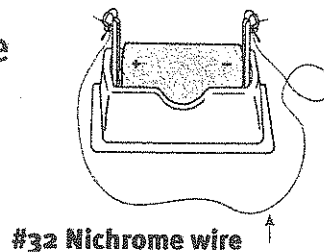
- What happens to the brightness of the bulb when the **thick** wire is disconnected?

- What do you notice about the flow of electric current through the thick and the thin wires?

Electrical Resistance

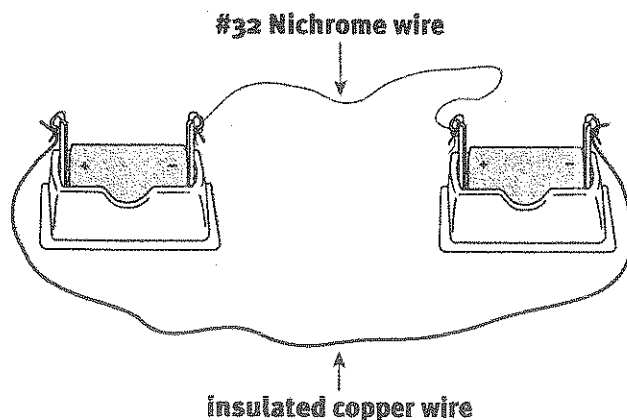
Session II

5. Build the one-battery circuit shown using one piece of thin Nichrome wire.



6. Close the circuit and carefully touch the Nichrome wire. What do you observe?

7. Add a second battery to the circuit. Close the circuit and carefully touch the Nichrome wire. What do you observe?



8. What happens to the thin Nichrome wire as more current is forced through by adding more batteries?

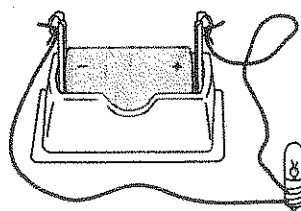
How Do Bulbs Work?

1. Draw each bulb. Write a description of what you see inside.

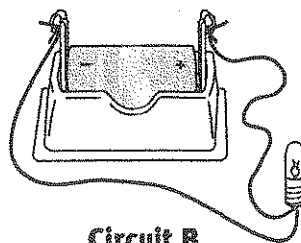
#41 bulb

#48 bulb

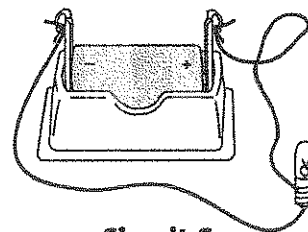
2. Predict which circuit(s) will make the bulb glow. _____



Circuit A



Circuit B



Circuit C

3. Build Circuits A, B, and C. Which circuit(s) made the bulb glow?

4. On the picture(s) above, draw the path of current flow in the circuit(s) that has (have) the glowing bulb.

a. Did the bulb glow in Circuit A? Why? _____

b. Did the bulb glow in Circuit B? Why? _____

c. Did the bulb glow in Circuit C? Why? _____

5. On the back of this page, draw how a bulb is constructed. Remember to show the filament and where the support wires contact the metal case and the tip at the base.

Making a Bulb

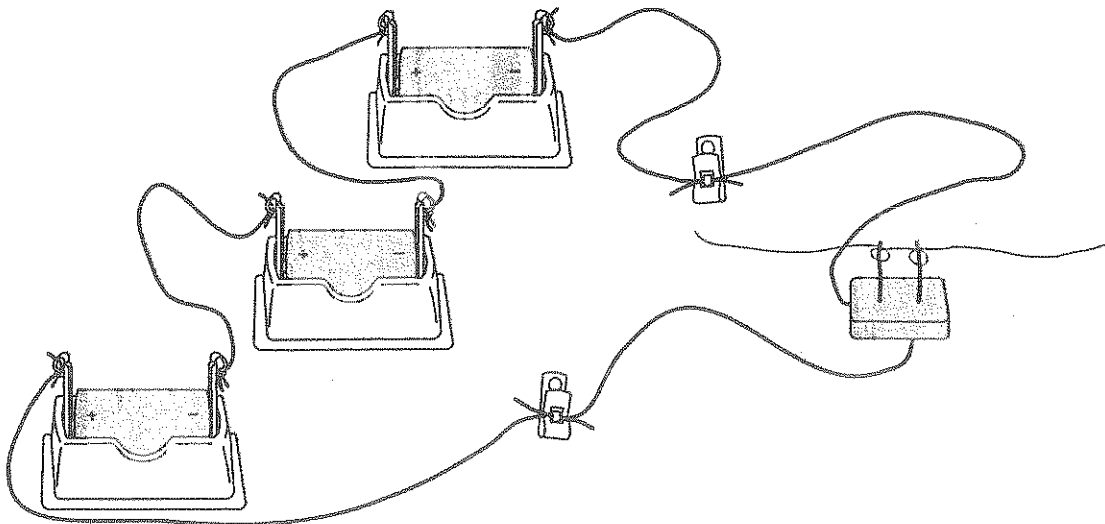
Use your materials to make a bulb.

1. Push one end of a copper wire through the block of modeling clay so that 2.5 cm (about 1 in.) sticks out the other side.

Do the same with a second copper wire so that they are 1 cm (about 0.5 in.) apart.

Bend the wires so that the clay block sits flat on a desktop.

2. With your partner helping, attach the Nichrome wire to the ends of the two wires sticking up. Attach a Fahnestock clip to the other end of each copper wire.
3. Connect three batteries in series. Attach one copper wire from the batteries to one of the Fahnestock clips.



Safety Note: Never touch the hot, glowing Nichrome wire.

Making a Fuse

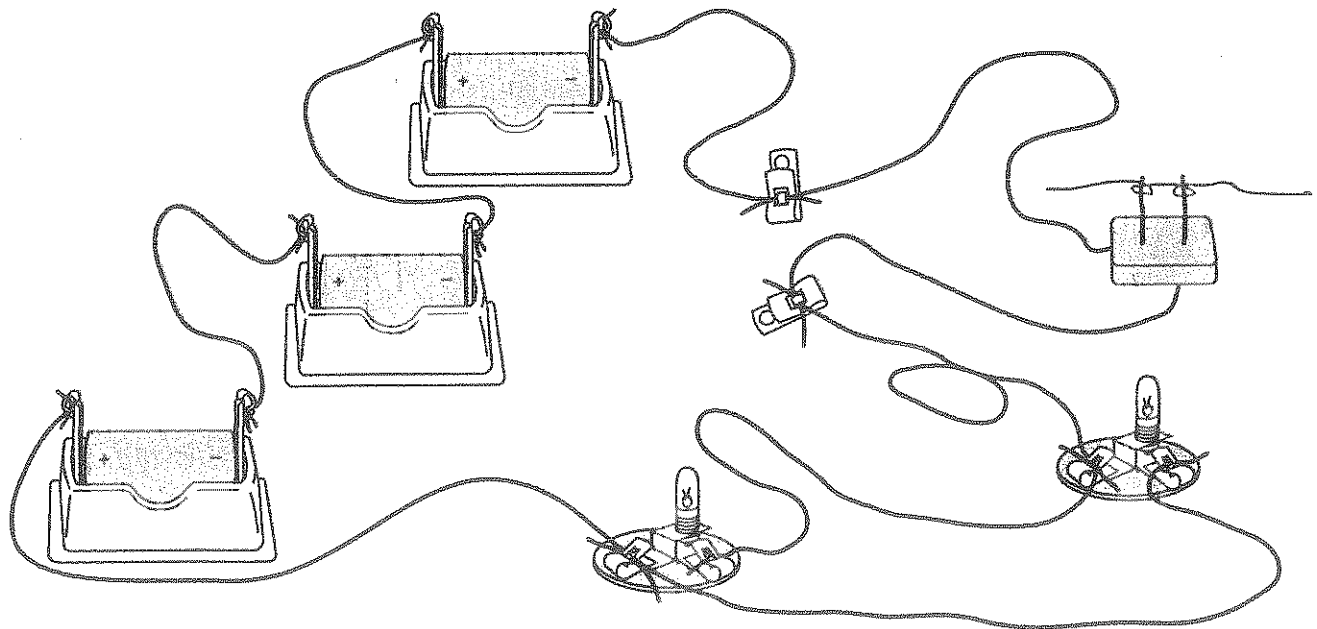
Use your materials to make a fuse.

1. Push one end of a copper wire through the block of modeling clay so that 2.5 cm (about 1 in.) sticks out the other side.

Do the same with a second copper wire so that they are 1 cm (about 0.5 in.) apart.

Bend the wires so that the clay block sits flat on a desktop.

2. Attach the strand of steel wool to the two wires sticking up. Attach a Fahnestock clip to the other end of each copper wire.
3. Connect three batteries in series with two bulb holders in parallel. Attach one copper wire from the batteries to one of the Fahnestock clips. Put a #48 bulb in each bulb holder.



Making a Fuse

4. Close the circuit by connecting the copper wire from the bulb holder to the other Fahnestock clip. What do you observe?

5. Open the circuit and remove one of the #48 bulbs. Close the circuit again. What do you observe?

6. Open the circuit. Insert a #41 bulb in the empty bulb holder. Close the circuit again. What do you observe?

7. Open the circuit and replace the #48 bulb with another #41 bulb. Close the circuit again. What do you observe?

8. What was the fuse in your circuit?

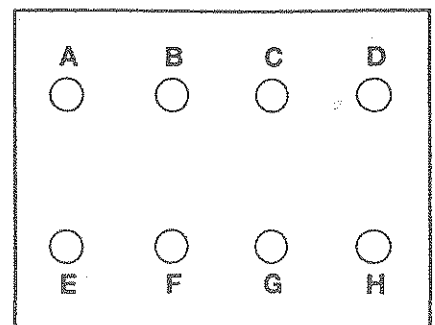
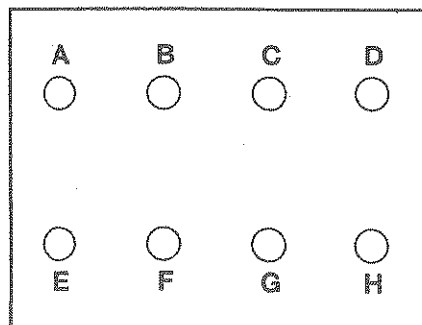
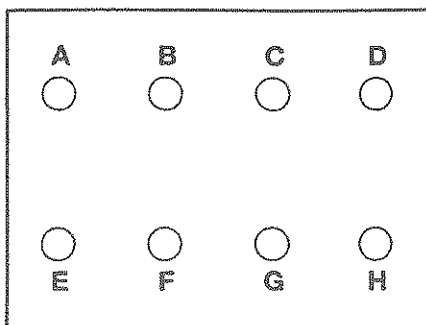
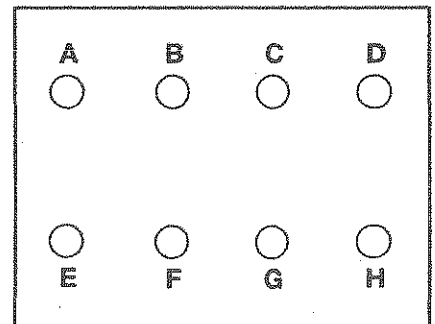
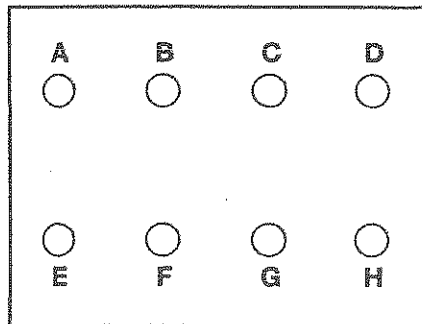
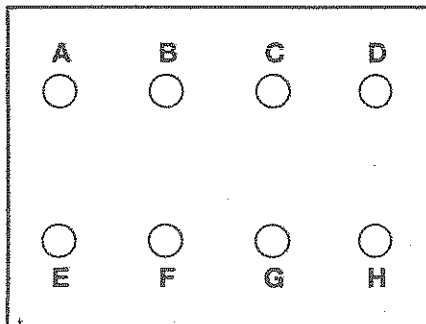
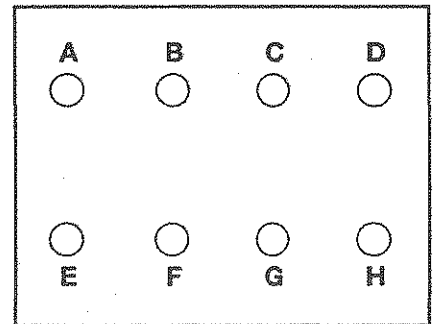
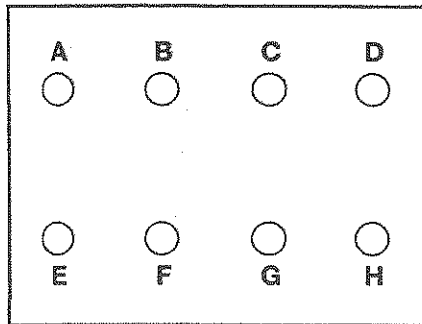
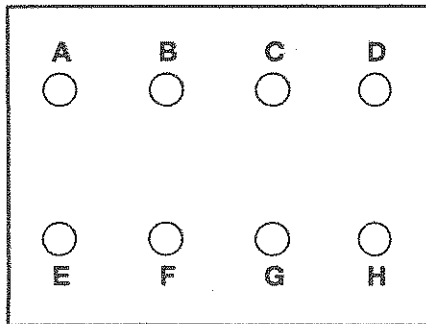
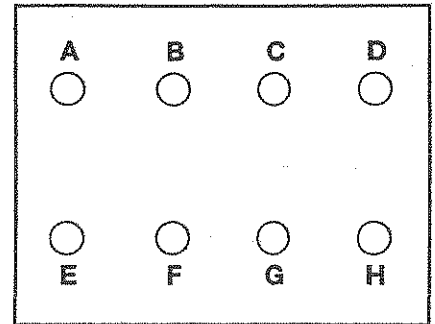
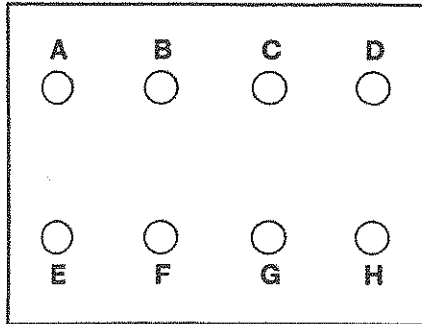
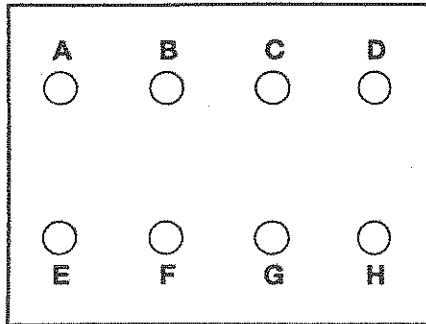
9. How did it protect the bulbs in the circuit?

10. What if your circuit contained Nichrome wires instead of bulbs?

11. How is a fuse a safety device?

Circuit Puzzles

Use your circuit tester to determine which holes are connected by a conductor. Draw a line that connects the holes that you think are connected by a conductor. Then, remove the paper clips and open the card to see if you were correct.



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4th grade Study Guide for Electrical Circuits

VOCABULARY

Battery- a source of electrical energy

Circuit- a path along which electric current flows

Conductor- material through which electric current passes easily

Electric charge- can be positive or negative

Filament- a small coiled wire that glows when electric current passes through it

Insulator- material through which electric current does NOT pass easily

pole- a place on a magnet where magnetism is strongest

Resistance- measure of how well electric current flows through a material

switch- device used to stop and start the flow of electric current in a circuit

Voltage- push needed to move electric charges

Know these facts:

Terminals are the points where electric current leaves and enters a battery.

Examples of **static electricity** would be lightening, a cat's fur sparking when you pet it or your fingers getting a shock when you to touch a doorknob after rubbing your feet on carpet.

When the N poles on two magnets are near each other they **repel** each other.

When the N poles on two magnets are away from each other they **attract** each other.

On a circuit diagram, a long line and a short line side-by-side (||) are the symbol for a **battery**.

Electric current can flow only through a circuit that is **closed**.

Wires are often made of copper because copper is a **good conductor**.

Electric current flows through more than one path in a **parallel circuit**.

Many wires are covered with rubber or plastic because these materials are **good insulators**.

The glow of a fluorescent light bulb is caused by a **coating on the inside of a tube**.

A **series circuit** is when all the circuit parts are connected one after the other.