

Questacon at HOME

Activity sheet

Paper Circuits

BACKGROUND

It would be hard to imagine what our lives would be like without electricity. But moving electrical energy from where it is generated to where it is needed is a complicated task! In this activity, we will experiment with simple circuits to learn more about how circuits function.

MATERIALS

- Scissors
- Sticky tape
- Paper and/or card stock
- CR2032 Coin-cell batteries (note – other batteries will make the LEDs burn out unless you attach a resistor)
- 5 mm LEDs (available at electronics stores or online)
- Conductive materials, e.g. copper tape, alfoil, lead pencil
- Multimeter (optional)
- Craft supplies, e.g. crayons, pipe cleaners, glitter (optional)

SAFETY

Take care not to cut yourself when handling scissors. The materials in this activity are very small and may present a choking hazard. Only use electrical components with batteries – do not attempt to connect them to mains power. Adult supervision is recommended for young experimenters.

PROCEDURE

Make a basic circuit: Take your battery and place it in the corner of a piece of paper or card stock. Fold the corner of the paper over so that it covers your battery. Trace an outline of your battery on either side of the fold and label one side + (positive) and the other – (negative). Using copper tape (or another conductive material), create a path between the two circles, leaving a 1-2 cm gap. Tape your LED in the gap, making sure the positive and negative sides match the + and – paths of your circuit (see tips and tricks). Place your battery on your paper – when you fold the corner over your LED should light up!

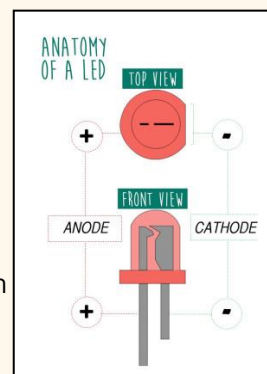
Try multiple LEDs: Try adding another LED to the same circuit. What happens to the luminosity of the LEDs? What about if you made a different pathway for each LED?

Play: Now you know the basics, play with different circuit arrangements and conductive materials. Do some materials work better than others?



TIPS & TRICKS

- If your circuit isn't working the following tips may help:
 - LEDs will only work one way! Ensure the positive side (anode) connects to the positive side of your battery. The positive side is rounded, and has a longer leg than the negative side (see picture).
 - Check your battery is working by testing it out on a single LED.
 - Check your circuit – does it follow a complete path? Make sure to look closely at any connections in case something has come loose.
 - The adhesive on copper tape can sometimes block electricity flow. If this happens, try folding the end of the tape over itself so you have copper on both sides, and secure with regular sticky tape.
 - A multimeter is useful to help you determine if your circuit isn't working.



WHAT'S THE SCIENCE?

Electrical energy is often described as a **current** because in order for electricity to work - it needs to be able to move. When we create a **circuit**, we are simply creating a pathway for electricity to flow. Electricity will flow more easily through some materials than others due to their **resistance**.

Conductors like copper or aluminium have low resistance, whereas **insulators** like plastic or rubber have high resistance.

There are different ways to arrange components in a circuit. If the components are in **series**, they are all placed on the same path one after the other. Series circuits are easy to construct and use fewer materials, so they are cheaper. However, there are a couple of big disadvantages. Did you notice that your LEDs became dimmer when placed in series? This is because each LED had to share the voltage – so for our 3V coin batteries, 2 LEDs placed in series only receive 1.5V each. Another disadvantage is that if a single component breaks the whole system will stop working.

When components are arranged in **parallel** each component will have its own pathway across the circuit. This means that your LEDs won't need to share voltage and will all glow brightly, and if a component in parallel breaks, it won't affect any of the others. However, parallel circuits are more complicated and costly. They also draw more current, which means your batteries will drain faster.

WHAT QUESTIONS COULD I ASK?

- Which of these circuits uses more copper tape?
- What other ways could we make these circuits?

WHAT'S NEXT?

- **Add a switch:** Create a way to turn your circuit on and off. Note – you don't need any extra components to do this. Remember, a switch is just a break in a circuit that you can control!
- **Draw your circuits:** Look up how to draw a circuit diagram and try and draw a schematic for your circuits. Can a friend build the same circuit based off of your drawing? You can draw circuits by hand or use a free program like [Fritzing](#) to do it digitally.
- **Get creative:** Use your paper circuits to make light-up craft like greeting cards, pop-up books or puppets. What other things could you create with your paper circuits?

