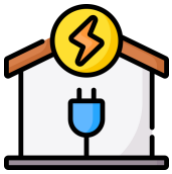


3Dux|Design

Electricity and Circuits 101

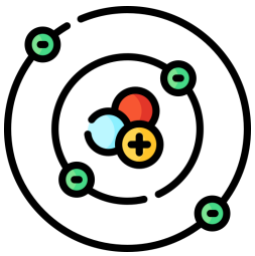
Welcome!

Learning about electricity, renewable energy, and circuits is much more fun when you work together to build your own house and electrify it. In this lesson, you will have the opportunity to create circuits and then work as a team to design and build a wintery arctic village.

What is electricity?

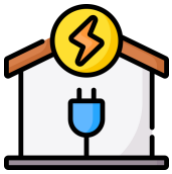
Electricity is a type of energy that can flow from one place to another. It is a huge part of your everyday life. For starters, it keeps your home and school warm in the winter and cool in the summer. It is used to make your lights, microwave, and hair dryer work.

To understand electricity, you have to first understand what an **atom** is because electricity comes from atoms. Everything in the universe is made of atoms. Atoms are tiny particles (way too small to see without special microscopes). They are so small a single ant is made of billions of atoms!



Atoms have three parts. The center (called the **nucleus**) is made of **protons** (which have a positive charge) and **neutrons** (which have no charge). The outer part of an atom has **electrons** which have a negative charge. Electrons can float and spin (or **orbit**) around the nucleus, but they typically stay close because the negatively charged electrons are attracted to the positively charged nucleus. But electrons can also float from away from one atom to another. The flow of electrons from one material to another is called **current electricity**.

Electricity is made from releasing energy stored in materials and other natural sources by the flow of electrons to another material. Some materials that store energy include coal, natural gas, nuclear and oil.



Energy can also be from **renewable** (or reusable) environmental sources like the sun, wind, and water.

You can discuss as a group what sources of electricity are used in your own community, which are, and which are not renewable. Examples may include electric cars, gas powered cars, windmills, or solar panels along highways or dams.

Where does electricity come from?

The easy answer is that it comes from a socket in the wall. But that's not where it *really* comes from. It starts with an energy source like wind or solar power. This energy is then **converted** into electricity as electrons flow along wires and ultimately travel to your home. Electricity can be stored at your community energy station and flow along wires to get to your home. It can also be stored in a **battery**. We will be creating circuits with batteries in our project.

When electrons flow from the negative side of a battery, through a conductor (metal wire) and then to the positive side, that is a complete circuit, or a **closed circuit**. This creates **current electricity**. If you connect a conductor directly to both sides of a battery, it's called a **short circuit.** When you create a short circuit, two things happen…

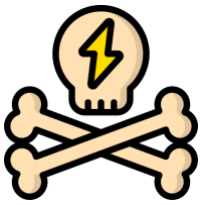
1. you waste the electricity because this will drain all the energy out of the battery
2. the wires will get **REALLY hot and burn you or create a fire!** A short circuit is something that should NEVER create. It can cause severe burns and fires.

The same is true for the electricity that comes through the wires in your home.

But if you put a **resistor** somewhere along the circuit, the electricity can be used to power something. A resistor (also called **a load**) can be a light bulb, a motor, an appliance in your home, a car and lots of

other things. If there is a load along the circuit, much of the energy is used by it so there is less energy being released as heat. The wires won't get quite as hot (but they can still burn you). When you add a light bulb, the energy is seen as light. When you add a motor, the energy is used to spin the motor.

Have you ever noticed that all electrical wires in your home are covered in plastic or rubber? Metal is a **conductor**, so electricity can flow through it. But conductors that have current electricity going through them can get very hot. Plastic is called an **insulator**; electricity cannot flow through it. When you touch the plastic-covered wire, you will not get a shock or hot. If you were to put uninsulated metal wire into a socket, you would get electrocuted!



Independent work

Create a collage from magazine, internet images, or drawings of five sources of electricity you use in your home or community. Review the bold vocabulary words from the paragraphs above

The Simple Circuit

We know you are excited to power up your project. We are too. But first we need to review a few things about electricity first.

Electricity, as you know, is a form of energy. It can flow through conductive wires or stored in one place, like in a battery. When it stays in one place, it is called **static** electricity, and when it flows, it is called a **current** (like water flowing in a river). For this activity, you will be making the electricity flow from the battery to the load that you want to power up (like a light) and then back to the battery. You will be creating a loop, or a closed circuit.

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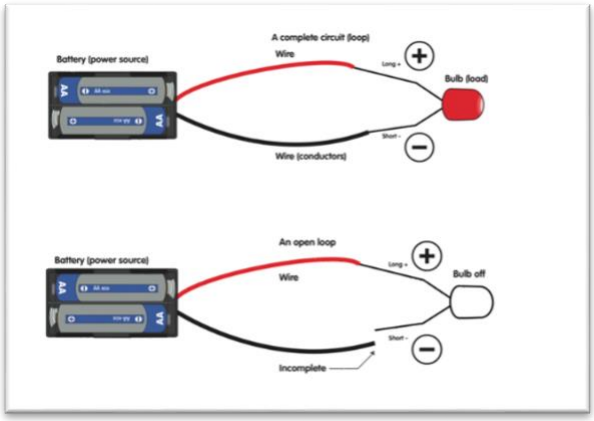
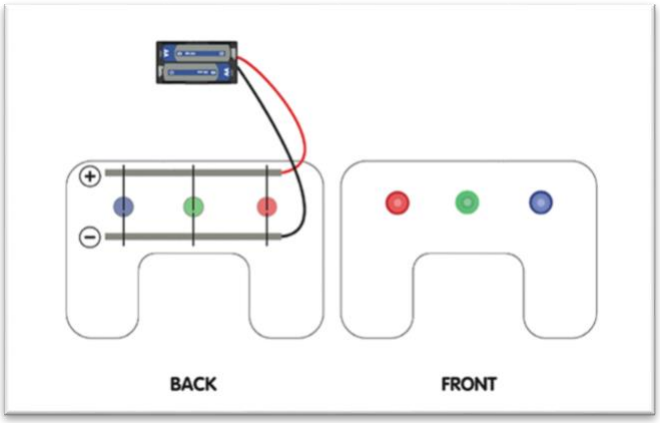
We will be using a special kind of light called an LED light. LED lights are a bit more complex. They are like a one-way street; they only work when hooked up to the battery in one direction. Here's how do it. Note the longer side of the LED is the positive side and it connected to the positive side of the battery. In a parallel circuit, all the positive ends of the LED are on the same side.

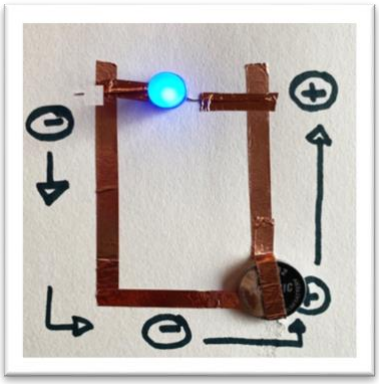
Simple circuit open/closed



Parallel circuit with 3 LEDS



Simple circuit with button battery. Note the positive side is labelled with a + and the negative side is bumpy.

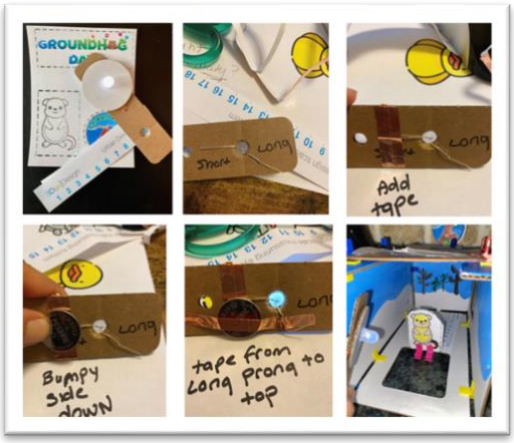


FUN FACT 1: LED light bulbs are a new kind of light. They are better for the environment because they don't get hot. Some other kinds of

bulbs get hot and waste electricity. LEDs also won't catch fire — that is why most Christmas lights are now LEDs.

Activity: Let's make a flashlight

Use you 3DuxDesign kit to build a flashlight with a simple circuit. Here's one we made for our Groundhog Day project. There are many ways to set it up so get creative, draft out your design below, test it, and expect to try a bunch of times before you get the light to work. Thomas Edison (the man who invented the electric light *and* 1092 other things) said, "I have not failed. I've just found 10,000 ways that won't work."



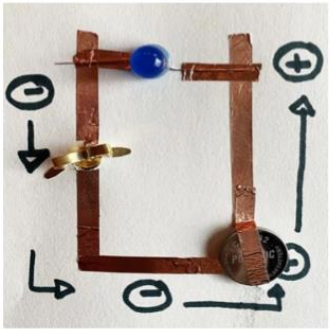
FUN FACT 2: The amount of energy stored in a battery is called a **volt.** A battery needs to have enough volts to power different loads. Each AA battery is 1.5 volts and if you have two, like in the image below,

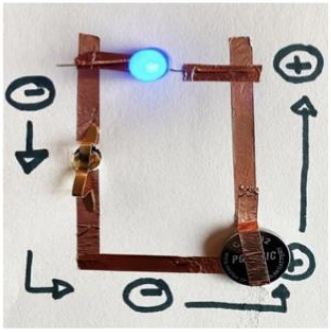
that equals 3 volts in total. Your LED lights need about 3 volts. When you add lights in parallel, the same 3 volts goes to each light so they all light up. If you set up your circuit in a series, each bulb uses the power it needs before moving the electrons down the line, so with a 3-volt battery there isn't enough power to light 2 bulbs in series. None of the lights will work!

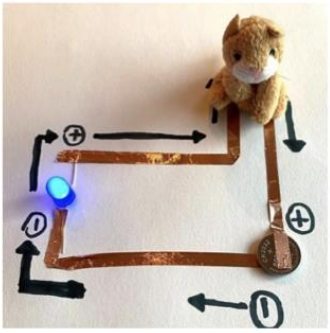
It gets complicated!

Below, you will see some more complex circuits with switeches, more than one light and even a kitty-activated circuit. Try some of these or come up with another lighting innovation. Draft out your idea, test it and if it works, be sure to share with the 3DuxDesign team (ask you teacher how)!

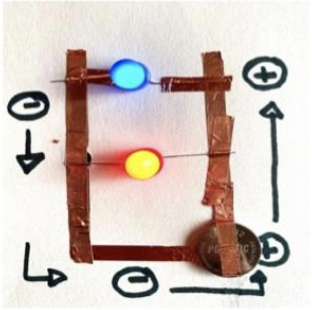
Simple circuit with switch off/on/conductive kitty (copper on bottom)



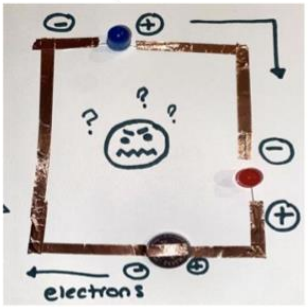


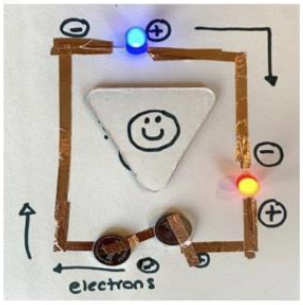


Parallel



series off/on with extra voltage.





***Super STEM challenge:** Can you design a circuit to get 2 LED lights in series to light up? (Hint – the setup below will not make the lights go on if you are using a AA like the image or a 5V lithium)

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