

**SNAP CIRCUITS**

ELENCO

**myHome**  
Snap Circuits® Plus

**Your Home  
Your Power  
Know How It Works**

**Projects  
1 - 53**

**Find out**  
How electricity works  
in your home.

**Ages 8 to 108**

Three (3) "AA" batteries not included



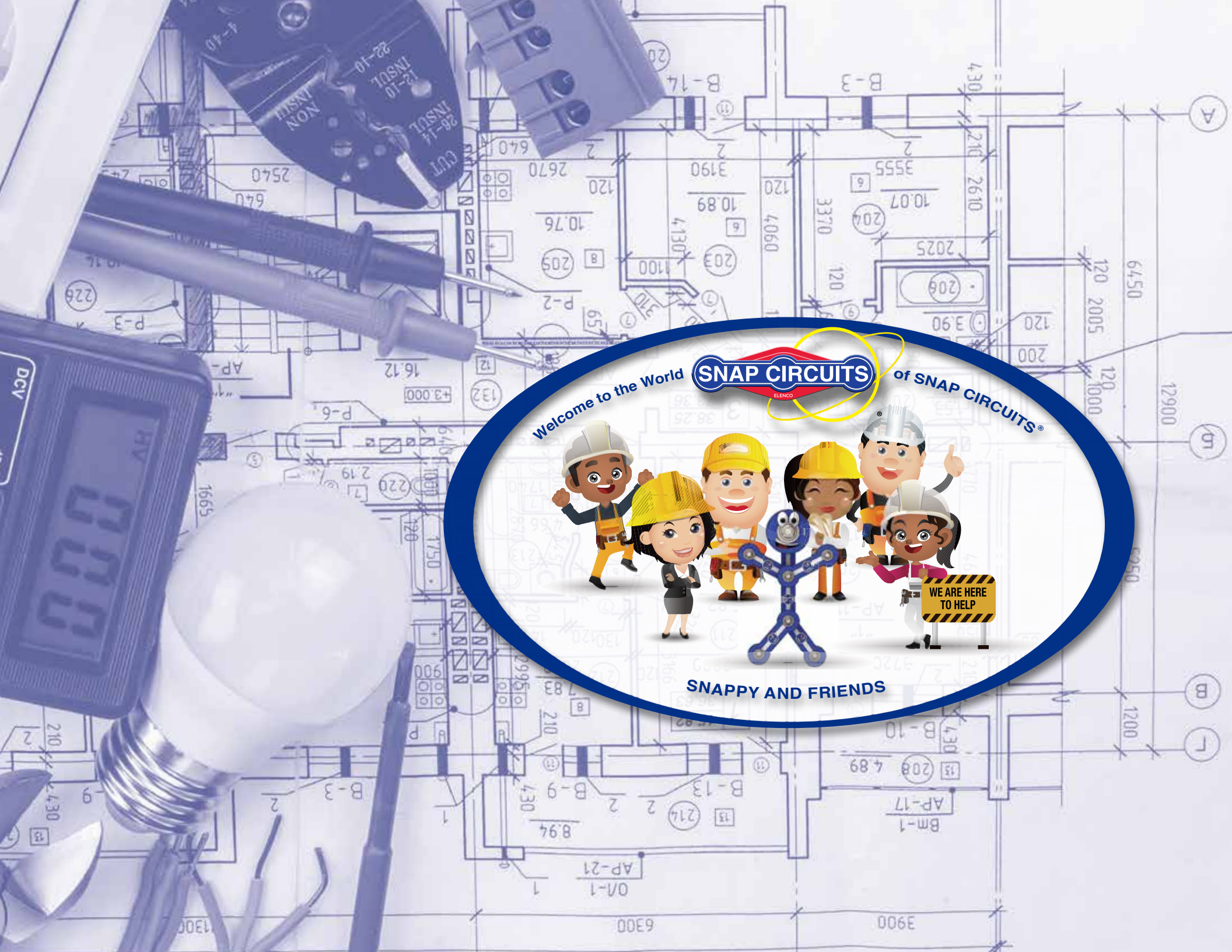
**ELENCO**  
Learn by doing.™

MADE WITH  
**CIRCUITSafe**  
fuse technology

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Welcome to the World



## SNAPPY AND FRIENDS



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**WARNING: SHOCK HAZARD** - Never connect Snap Circuits® to the electrical outlets in your home in any way!



**WARNING: CHOKING HAZARD** - Small parts. Not for children under 3 years.



**CAUTION:** The lamp (L4) has a very warm lamp enclosure.

**IMPORTANT:** Always check your wiring before turning on a circuit.  
Never leave a circuit unattended while the batteries are installed.  
Never connect additional batteries or any other power sources to your circuits.  
Discard any cracked or broken parts.

Conforms to all applicable government requirements.

Not responsible for typographical errors.

### A Note to Parents and Adults:

Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

# INTRODUCTION TO ELECTRICITY





How do you turn on your light or your television or anything else that requires power in your home<sup>1</sup>? You flip a switch, right? And if the switch doesn't work, what do you do?

*You check to see if it's plugged in.*

Anything that requires power (or charging) in your home must be 'plugged in' to the wiring inside the walls of your house or your building. The wiring inside your house is connected to the power cables on your street. And the power cables on your street are connected to the power lines that travel through your community and, eventually, back to the power plant.



**Nobody really knows what electricity is.**

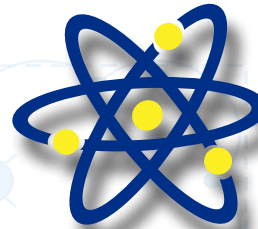
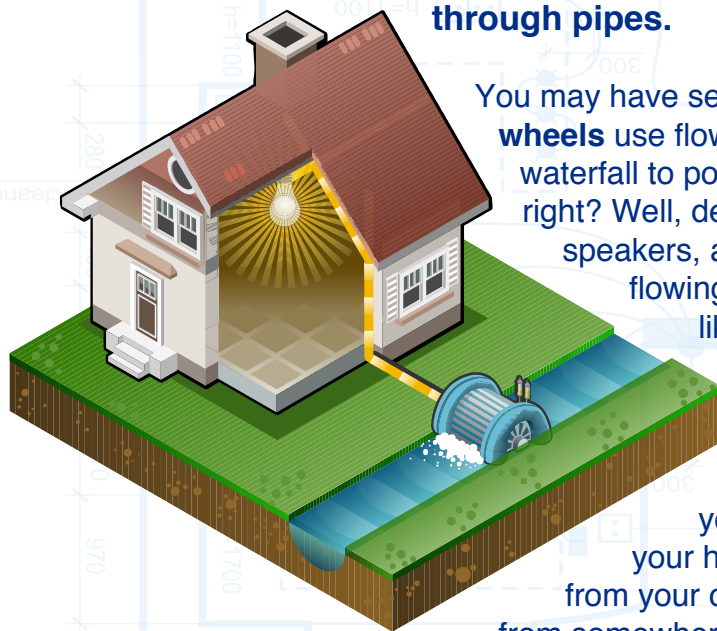
We just know that it is associated with the movement of subatomic charged particles called **electrons** . Just as water is made up of bazillions of tiny water droplets , electricity is made up of bazillions of tiny **electrons**.

**These electrons flow through metal wires the same way water flows through pipes.**

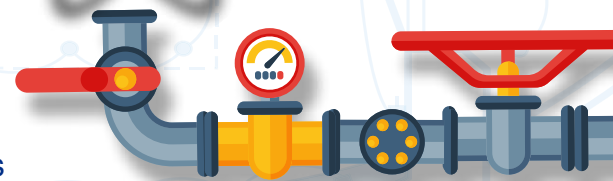
You may have seen how **water wheels** use flowing water or a waterfall to power machines, right? Well, devices like motors, speakers, and light bulbs use flowing electrons to do things

like move cars, play music,

and make light. The water that comes out of your faucets has to come from somewhere. That water is pumped through pipes from your city's water storage facilities or, if you live in the country, from your well outside. In the same way, the electricity in your house or building is pumped through wires or cables from your city's power stations. That electricity has to come from somewhere too.



**Your world is powered by electricity.**



<sup>1</sup>In this manual, sometimes we say "house" or "building" or "home". Whether you live in a city skyscraper, apartment building, townhouse, or farmhouse in the country - it doesn't matter - electricity works the same way!

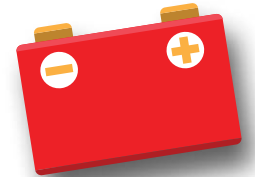


**Valves and faucets** control the flow of water throughout your home and into appliances like your **washing machine** and refrigerator. Switches and transistors control the flow of electricity throughout your home and into appliances like lamps and fans. Turning a switch off blocks the passage of electricity the way that turning a faucet off blocks the passage of water.

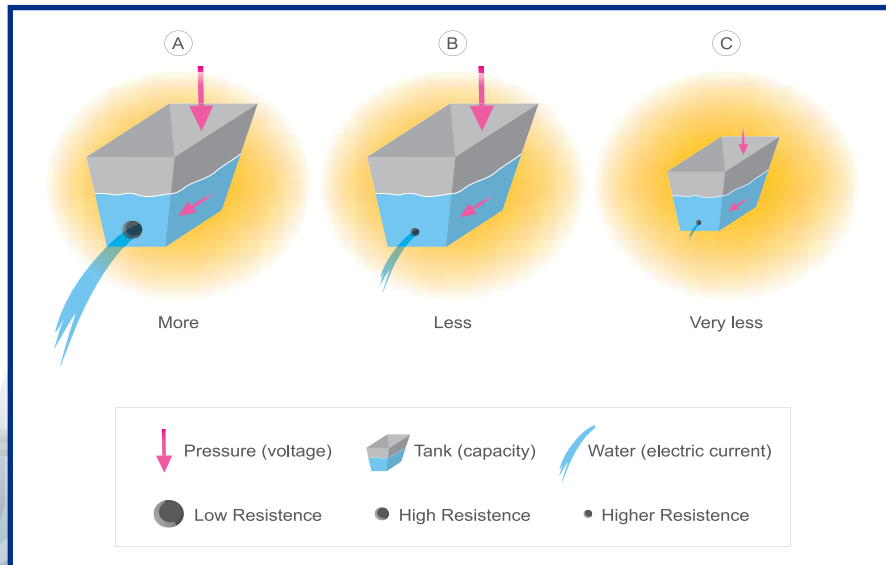


Like **water**, electricity must flow in one direction in order to do its work. It has to get from the power station to your house, and on to the next house and the buildings thereafter. The power station only pumps electricity in one direction, so you have no choice in the matter.

You just plug into a power outlet, and you're ready to go. It's not so easy with portable power sources like **batteries**. Fortunately, batteries have (+) and (-) signs to show you which direction they pump their electricity. This is why you have to put your battery in 'the right way', taking care that the (+) side of the battery is in the (+) side of the battery holder, in order for it to work.



The amount of pressure (or push) a pump puts on the water inside a pipe is measured in **PSI (pounds per square inch)**. The amount of pressure a battery (or other power source) puts on the electrons inside a wire is measured in V (volts) and is called the **voltage**.



The speed that water flows in the ocean or through a pipe is called its current. **Electrical current** (measured in amperes (A) or milliamps (mA, 1/1000 of an ampere)) is the speed that electricity flows through a wire. In either case, the faster the speed, the higher the current. Any electric current measurements you make with this set will be in milliamps.







The **power** provided by a battery (or other power source) is the amount of work that its stream of electricity can do at any given moment. **A harder stream of water will get more dirt off your car, right? This is because a hard stream of water has more power than a weak stream. Batteries that produce harder streams of electrons have more power too.** And just as the power of an ocean wave is a combination of its size and speed, the power of an electrical source is a combination of its voltage and the current it can provide. The mathematical relationship is **Power = Voltage x Current**, and power is measured in **W or watts**.

**In order to flow, electricity needs a complete circuit of conducting wire.**

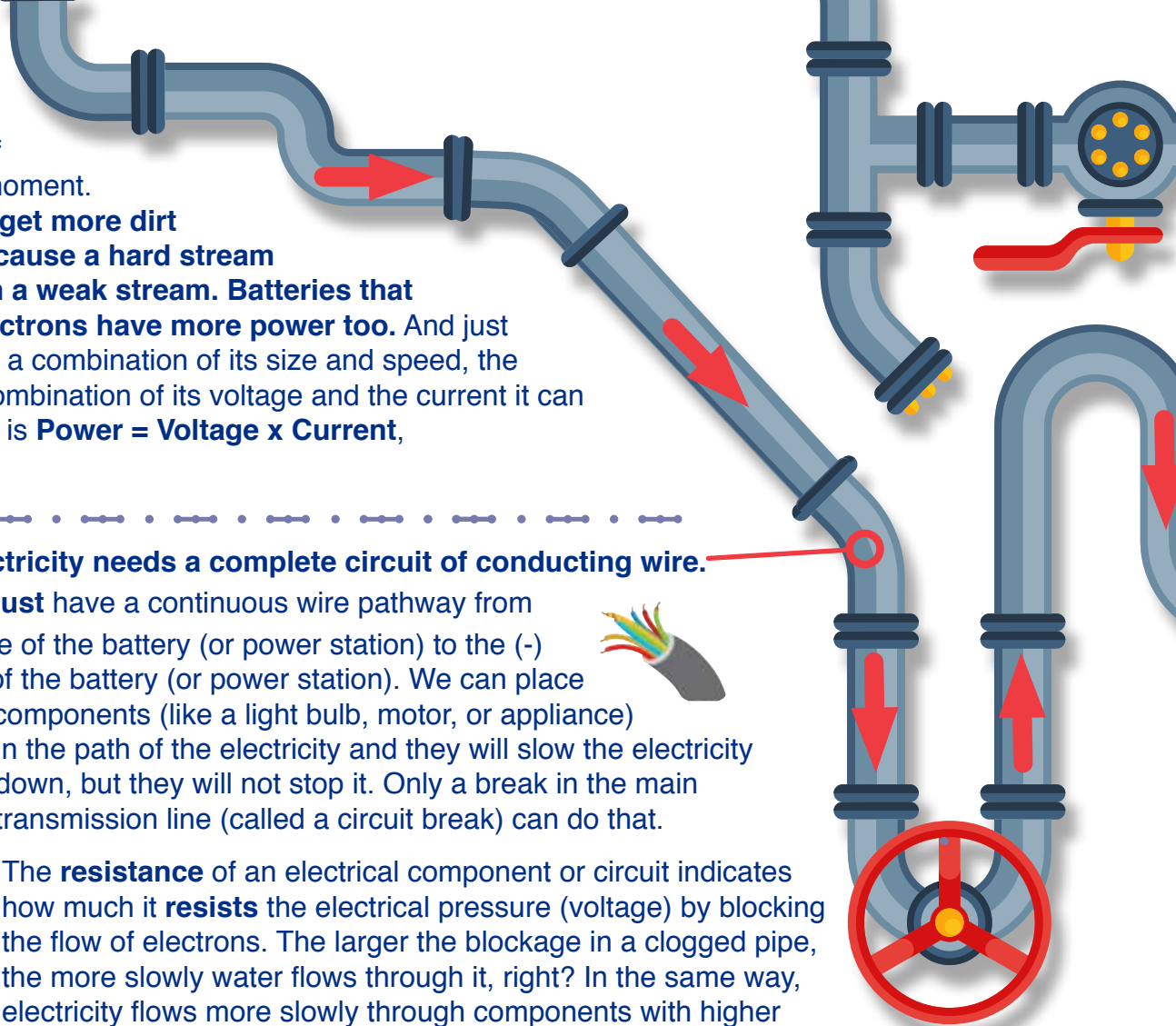
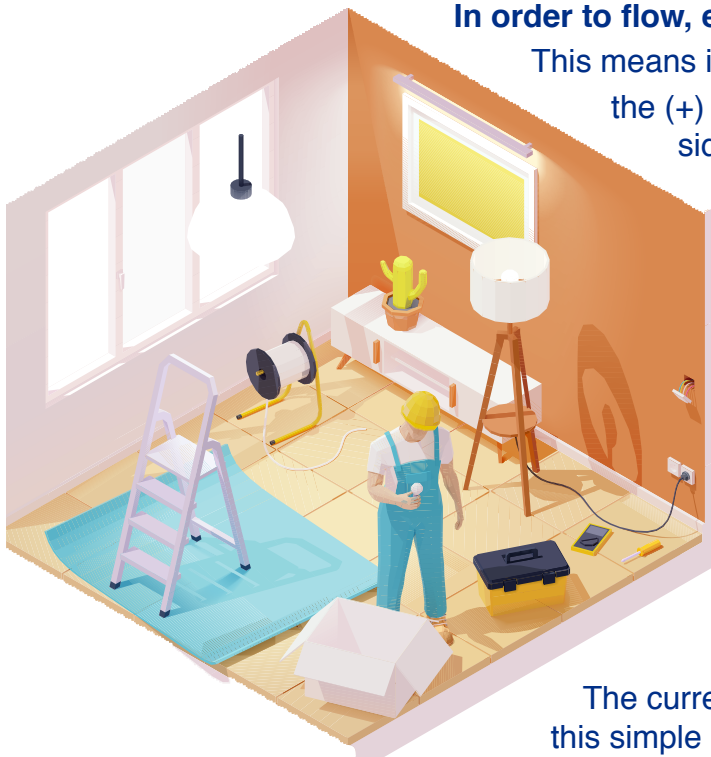
This means it **must** have a continuous wire pathway from the (+) side of the battery (or power station) to the (-) side of the battery (or power station). We can place components (like a light bulb, motor, or appliance) in the path of the electricity and they will slow the electricity down, but they will not stop it. Only a break in the main transmission line (called a circuit break) can do that.

The **resistance** of an electrical component or circuit indicates how much it **resists** the electrical pressure (voltage) by blocking the flow of electrons. The larger the blockage in a clogged pipe, the more slowly water flows through it, right? In the same way, electricity flows more slowly through components with higher resistances (measured in ohms,  $\Omega$ ). Sometimes we place special components called **resistors** in a wire pathway for the sole purpose of slowing down the electrons flowing through it.

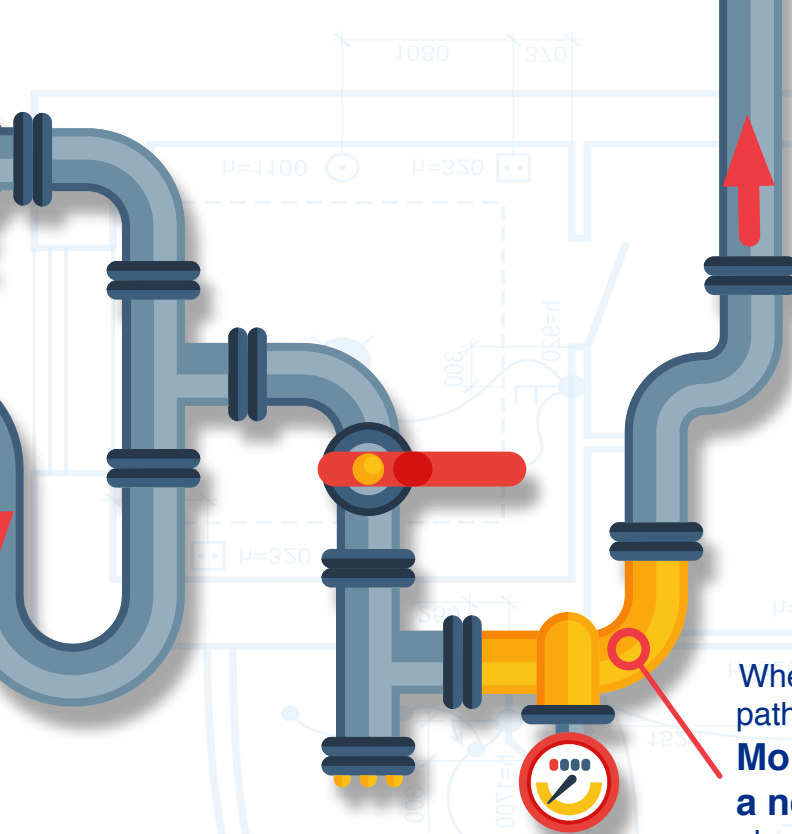
The current, voltage, and resistance of an electrical system are all related to one another through this simple mathematical equation:

$$\text{Voltage} = \text{Current} \times \text{Resistance.}$$

This equation is very important in electronics.







The voltage of the power source is a constant value - it's printed on every battery. So if the resistance goes up, the current must go down, and vice versa (if the resistance decreases, the current must increase accordingly).

As long as there are no breaks in its wire path, electricity can take side tracks along its main transmission line from the (-) to the (+) side of its power source, providing electricity to appliances, homes, and whole towns. When components are placed along these side tracks, we say they are in **parallel** to the main transmission line.

When multiple components are placed in **parallel**, the electrons are given as many paths to follow as there are parallel components.

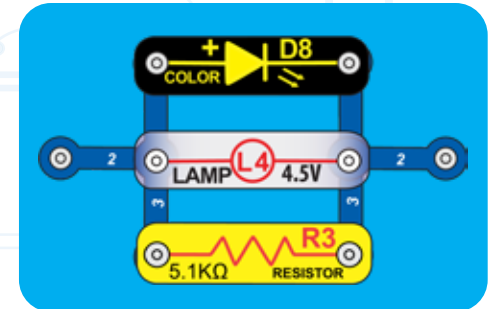
**More water flows more quickly through a partially blocked pipe than a nearly clogged one, right?** In the same way, more electrons flow more quickly along the pathway with the least resistance. For components in parallel, the lowest resistance dominates.

Components that are placed directly along the main transmission line are said to be in series. In this case, the electrons have only one pathway from the (-) to the (+) side of the power source.

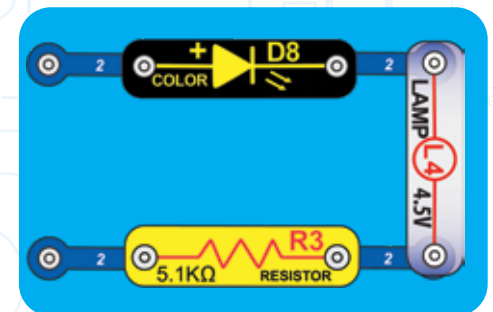
*Think about it this way: If there are three small blockages in one garden hose, the amount of water that comes out will be determined by the worst blockage, right? Same thing with electricity.*

The flow of electrons through multiple components in series will slow down the most when they travel through the component with the highest resistance. For components in **series**, the largest resistance dominates.

Components can be arranged in series in any order and still have the same combined effect on the electricity flowing through them. Same thing goes for components arranged in parallel. In this way, we combine smaller 'integrated' circuits to produce the large and complicated circuits that power our cell phones, our computers, and our entire world.



Example of a Parallel Circuit




Example of a Series Circuit

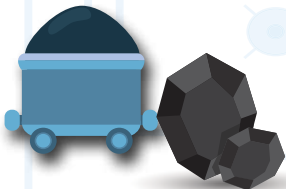




# ELECTRICITY IN OUR WORLD



A small amount of the electricity we use comes from the chemical energy in batteries (like the **AA batteries** in your B3 battery holder), but **most of the electricity used in our world is produced at enormous generators driven by steam or water pressure, or (increasingly) by wind or solar.**




**Fossil fuels (coal/oil/natural gas)** or nuclear fuels are burned/consumed to produce high-pressure steam that drives electric generators. Dams create high water pressure that drives electric generators.

**Windmills use wind to drive electric generators.**

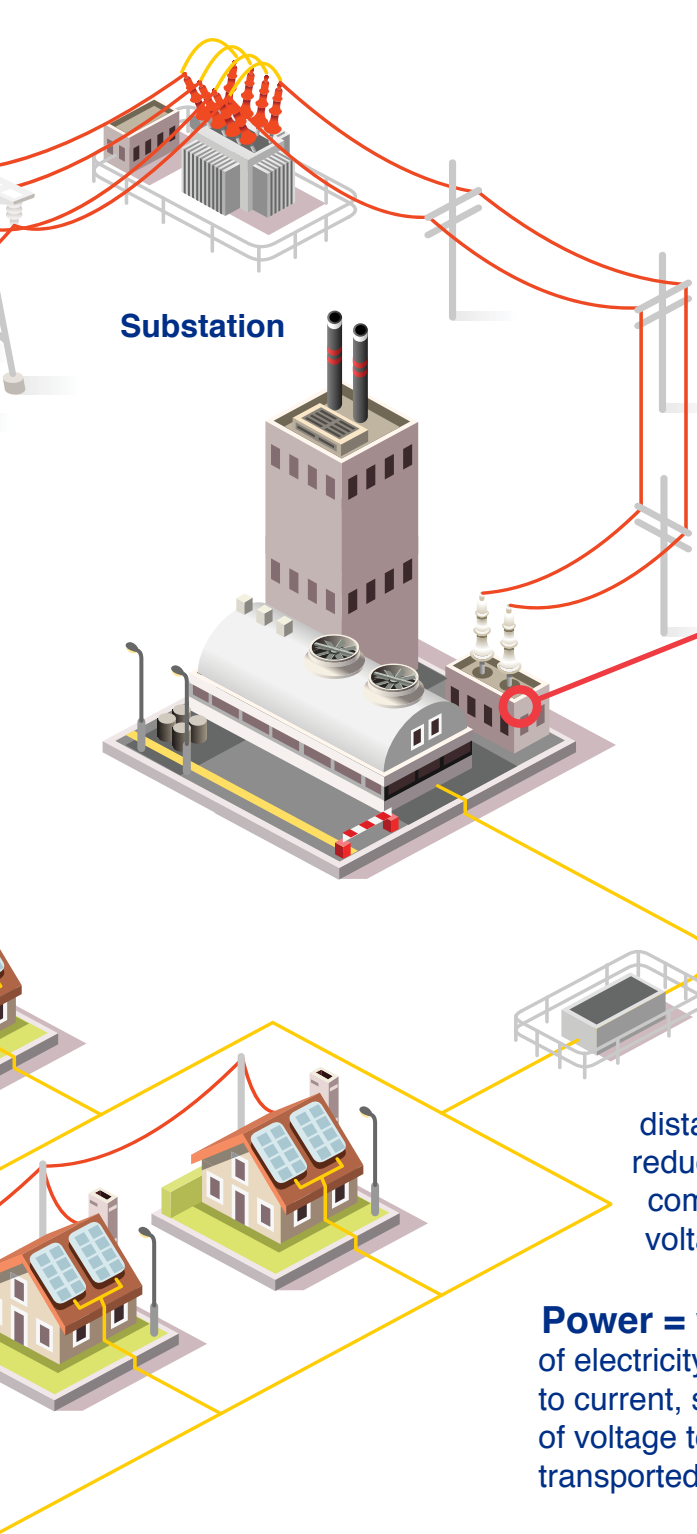


**Large arrays of solar cells produce electricity.**



**Wires are used to efficiently transport this energy to homes and businesses where it is used.** Once there, motors inside our appliances (the ones that are plugged in and turned on) turn that electricity back into the mechanical motion required to make these appliances work. The most important aspect of electricity in our society - more important than the benefits of the Internet - is that it allows energy to be easily transported over distances.

**Transformer**



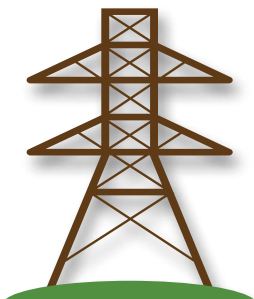
Substation

Note that “distances” includes not just large distances but also tiny distances.

Try to imagine a plumbing structure of the same complexity as the circuitry inside a portable radio - it would have to be large because we can't make water pipes so small.

Electricity allows complex designs to be made very small.

**Most electricity produced at large generating stations comes out at very high voltage (sometimes >100,000V).**



This electricity goes through high-voltage transmission line poles that stretch across the country.

When it reaches a **substation**, **transformers** reduce the voltage so it can be sent on smaller power lines. It travels through distribution lines to your neighborhood. Smaller transformers reduce the voltage again to the 120V used in our homes.

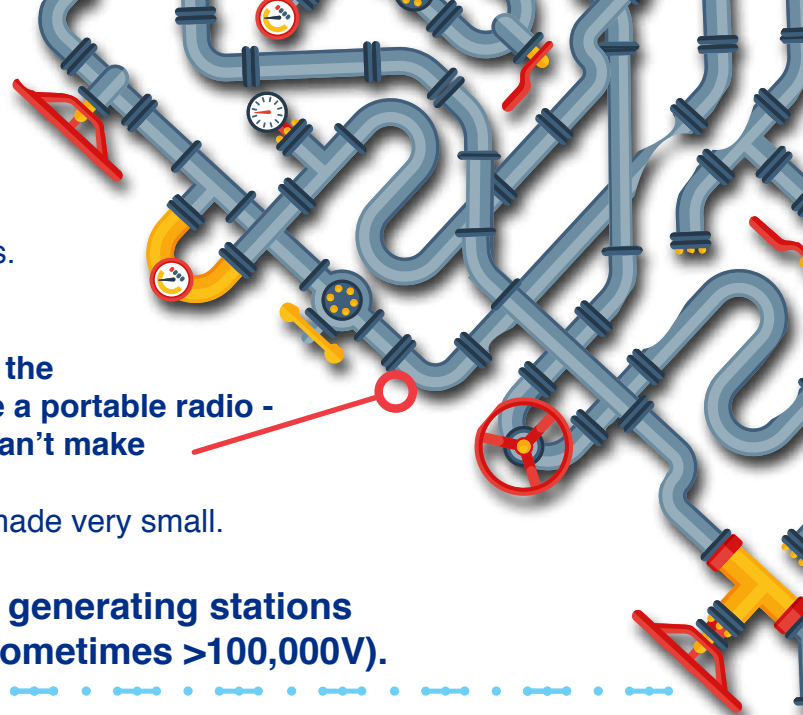
Electricity is transported over long distances at high voltage because this reduces the amount lost in transmission, compared to transporting it at lower voltage.

**Power = voltage x current**, and the amount of electricity lost in transmission is proportional to current, so transformers change the ratio of voltage to current to allow electricity to be transported more effectively over long distances.



Projects 1-2 will show how electricity can generate motion in a motor, and projects 5-6 will show how motion in a motor can be used to produce electricity.

This concept may not seem important to you but it is actually the foundation of our present society's power.





# AS ELECTRICITY ENTERS YOUR HOME

Before it goes into your house or building, the electricity produced at the power station goes through a meter and is measured by your electric company to determine how much you are using (and how much it will cost you).



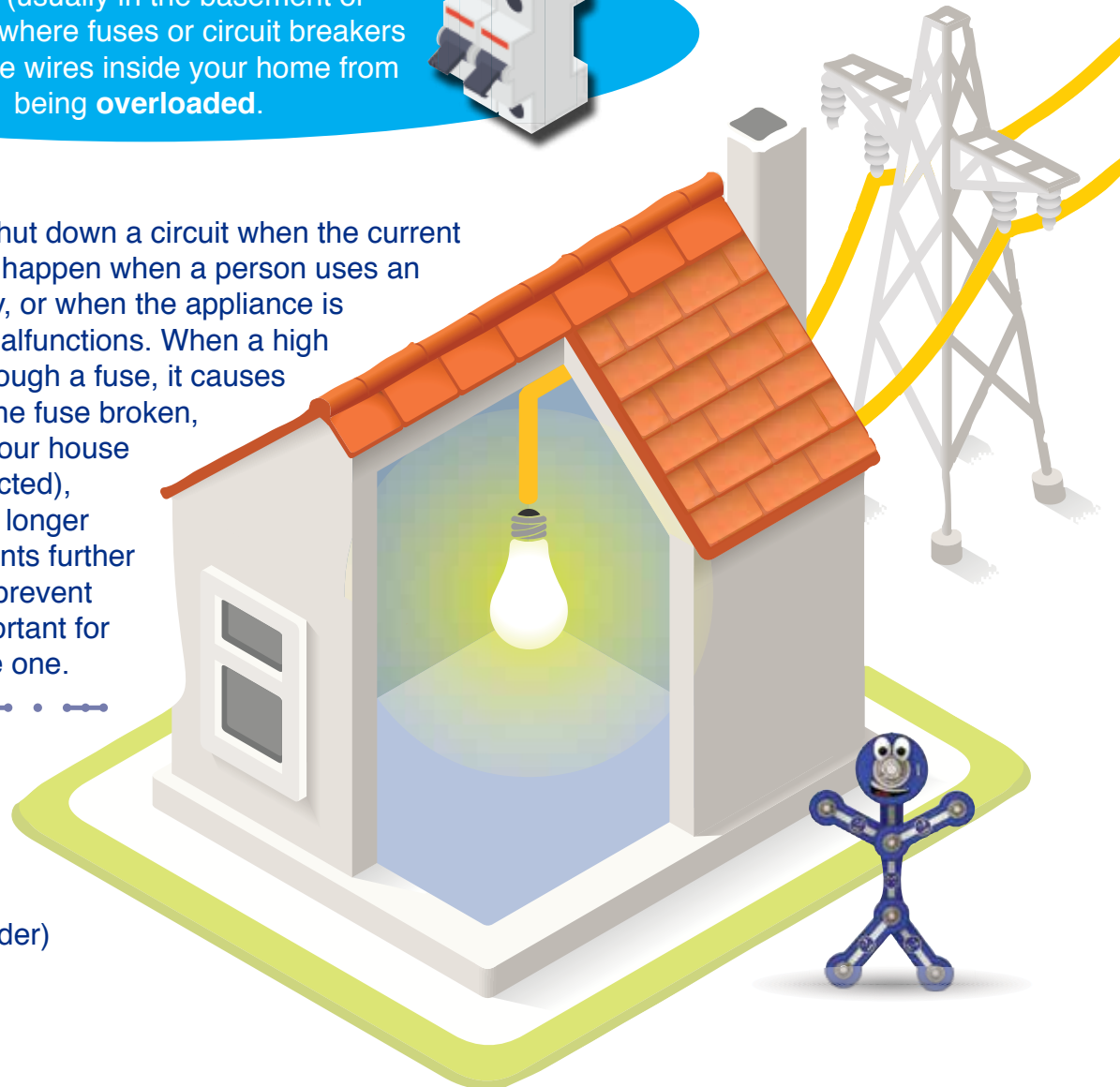
The electricity then goes through a service panel (usually in the basement or garage), where fuses or circuit breakers protect the wires inside your home from being **overloaded**.



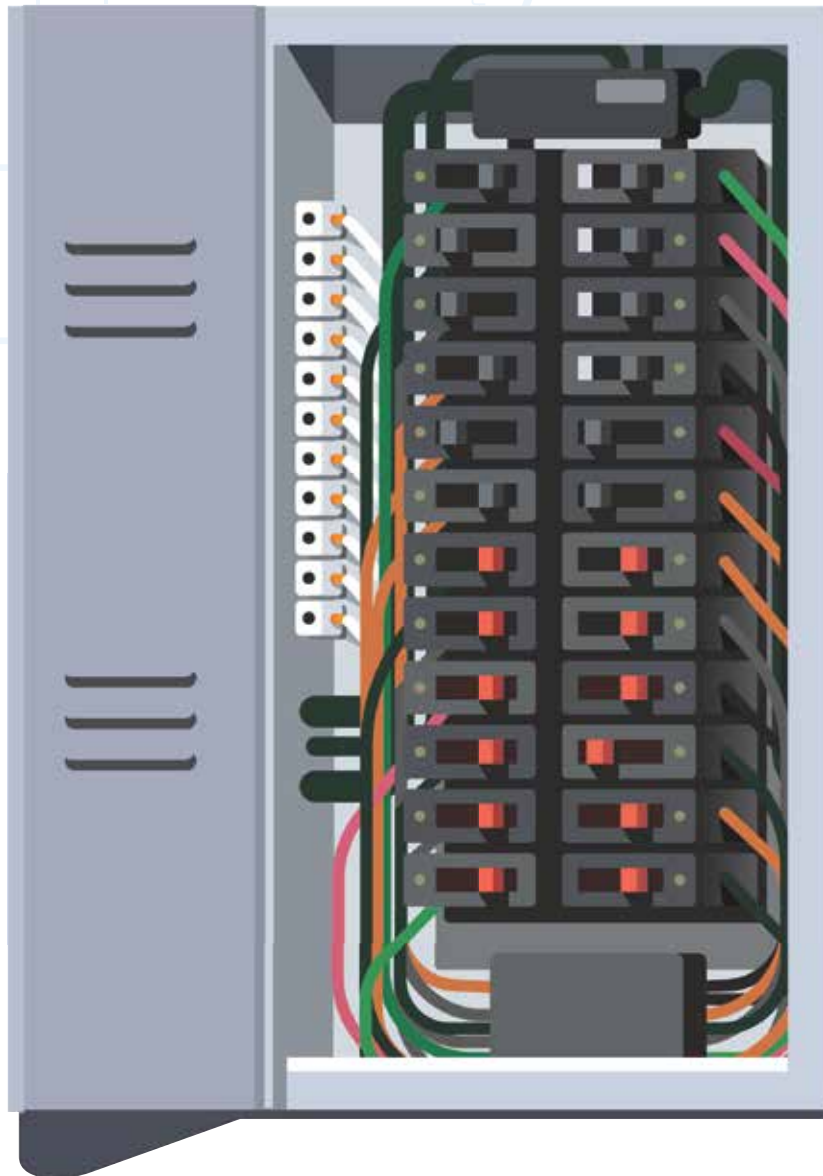
Fuses are designed to shut down a circuit when the current **gets too high**. This can happen when a person uses an appliance the wrong way, or when the appliance is designed badly or just malfunctions. When a high current spike passes through a fuse, it causes the fuse to break. With the fuse broken, the metal pathway into your house is also broken (disconnected), so that electricity can no longer flow. This shutdown prevents further damage to the circuit and can prevent explosions or fires. Fuses are important for safety and most electrical products have one.



Some fuses need to be replaced after they “blow”, but others can be reset by flipping a **switch**, and some (like the one in your B3 battery holder) can reset automatically.



**Fuses in your home's fuse box are designed to prevent a problem in part of your house from starting a fire or affecting the rest of your house.**

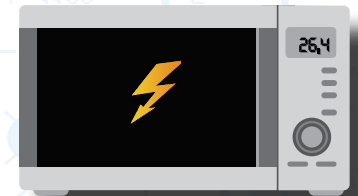


But **fuses** are not designed to protect you directly from getting hurt when you use an electrical appliance in your home because the normal operating power of some appliances is already enough to be dangerous to people.

If lightning hits a transmission line or electrical cable entering your house, it can cause a massive spike of electricity to suddenly pass through the cable and into your home.



So much electricity in such a short space of time can **overload your appliances**, burning out their components or electrical connections, which can cause a fire.



Fortunately, the wires enter your home through a **service panel**, where **fuses and circuit breakers** will block this high-powered electricity from damaging your home and your family.

(Learn more about lightning in Project 34)