First Edition

SNAP CIRCUITS©
STEM Curriculum

Teacher's Guide

Build Notes Discussion Practical Applications of Electronics

IMPORTANT:

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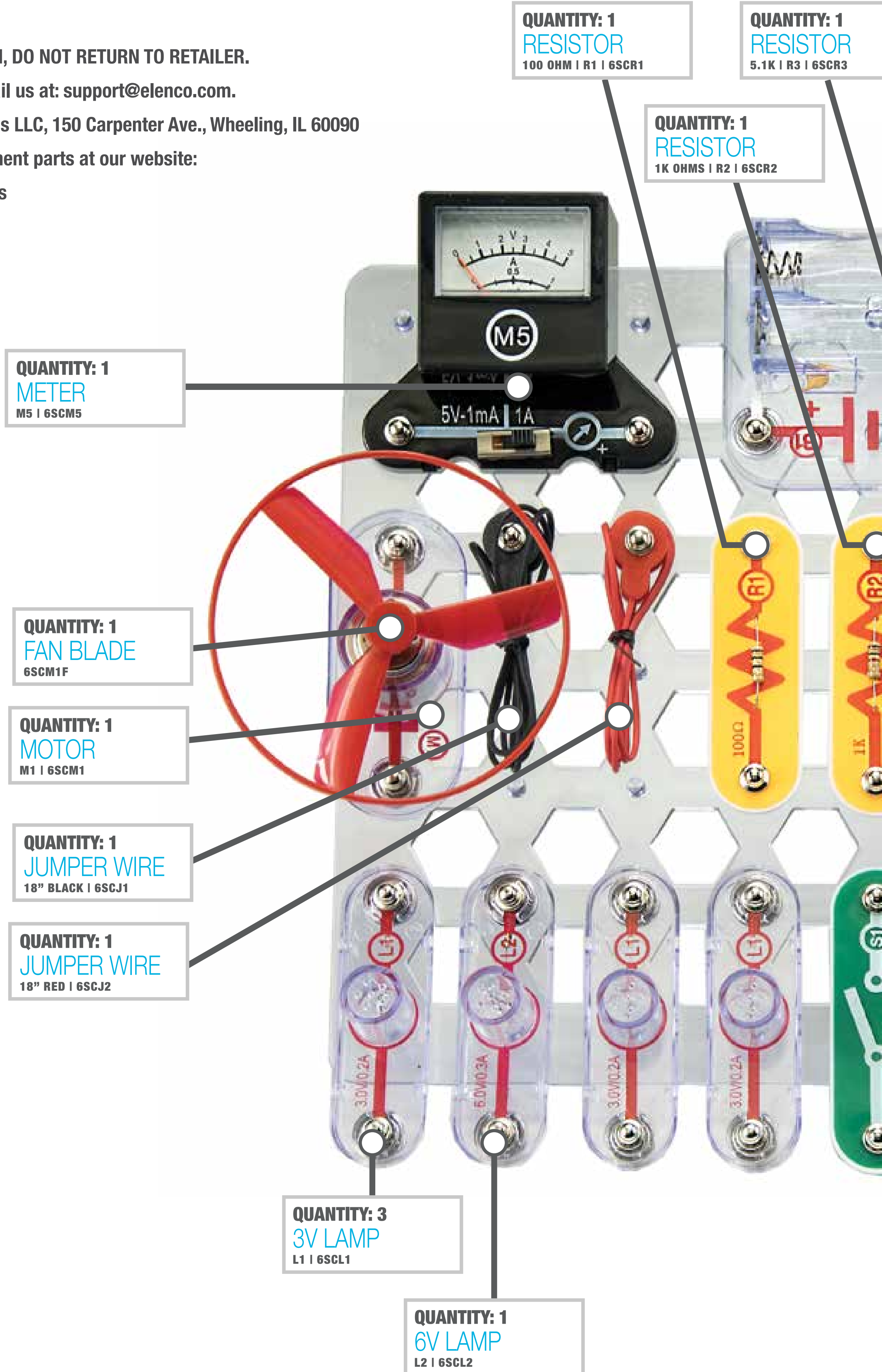


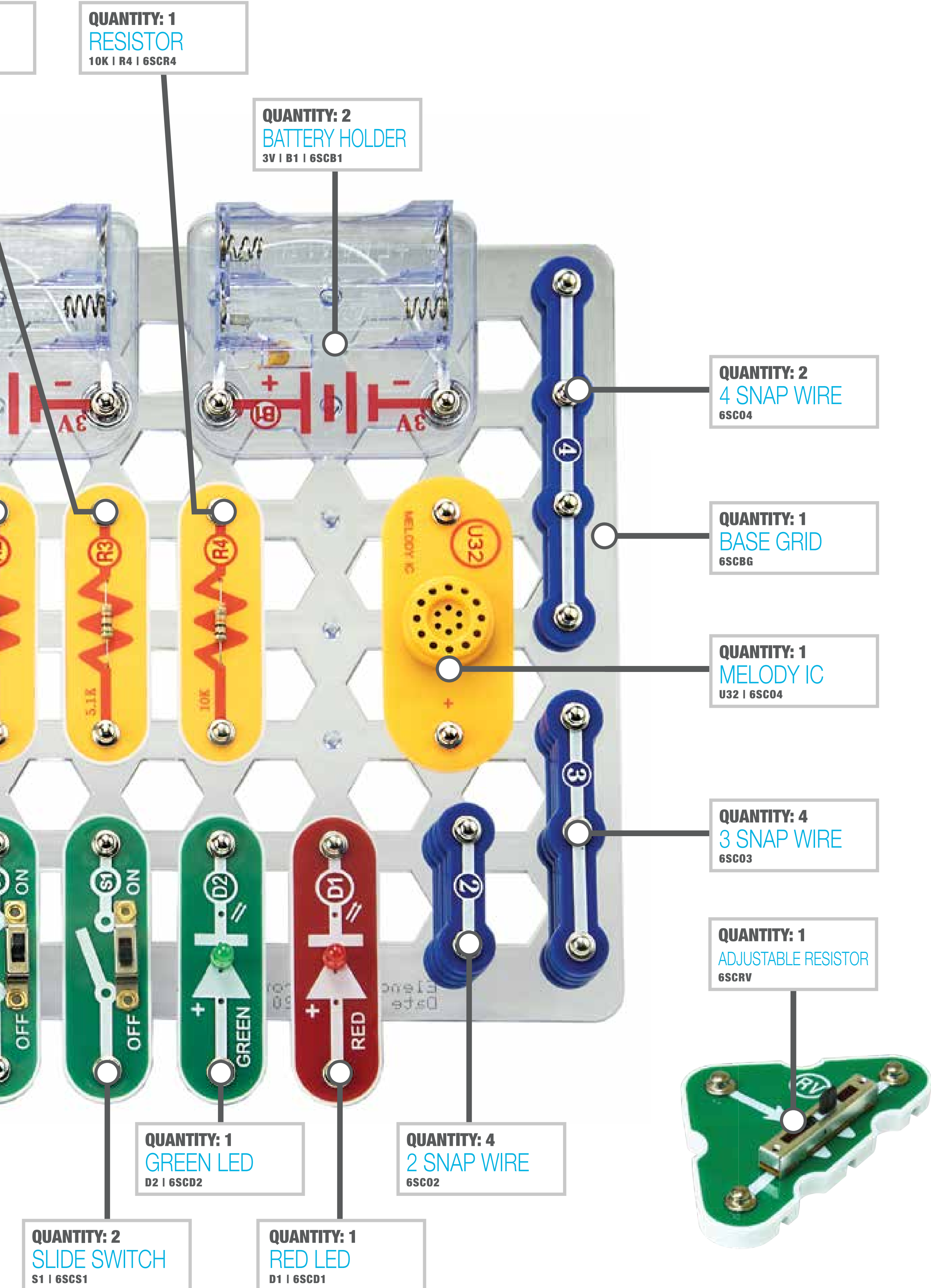

QUANTITY: 1
RESISTOR
10K | R4 | 6SCR4
QUANTITY: 2
BATTERY HOLDER
3V | B1 | 6SCB1
QUANTITY: 2
4 SNAP WIRE
6SC04
QUANTITY: 1
BASE GRID
6SCBG
QUANTITY: 1
MELODY IC
U32 | 6SC04
QUANTITY: 4
3 SNAP WIRE
6SC03
QUANTITY: 1
ADJUSTABLE RESISTOR
6SCRV
QUANTITY: 1
GREEN LED
D2 | 6SCD2
QUANTITY: 4
2 SNAP WIRE
6SC02
QUANTITY: 2
SLIDE SWITCH
S1 | 6SCS1
QUANTITY: 1
RED LED
D1 | 6SCD1

Table of Contents

Batteries:

When installing a battery in the battery holder(B1), **be sure the spring is compressed straight back, and not bent up, down or to one side**. Battery installation should be supervised by an adult.

- Use only 1.5V AA type, alkaline batteries
- Insert batteries with correct polarity.
- Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not mix old and new batteries.
- Remove batteries when they are used up.
- Do not short circuit the battery terminals.
- Never throw batteries in a fire or attempt to open its outer casing.
- Batteries are harmful if swallowed, so keep away from small children.

Introduction & Important Information

This educational version of the popular Snap Circuits® product is a tool for opening the exciting world of electronics. Following the Learn by Doing® concept, electronics will be easy for students to understand by using Snap Circuits® to build circuits as they learn about them. This course emphasizes the practical applications of electronics, without bogging down in mathematics.
This course is as much about science as about electronics.

Why should students learn about electronics? Electronics play an important and increasing role in their everyday lives, and so some basic knowledge of it is good for all of them. Learning about it teaches how to do scientific investigations and the lessons develop basic skills needed in today's world.

This product is intended for use at grades 3-5 in elementary schools.
The only prerequisite is basic reading skills.

Instructor Preparation/Organization

Determine what the learning environment will be.
Will the students be learning independently or in small groups?
How much teacher instruction will there be for each section?

Allocate time within the session as needed for:
- Teacher instruction about the topics being covered during the session.
- Getting the Snap Circuits® components into the workspace.
- Teacher instruction about the specific projects to be performed during that session.
- Building and testing the circuits.
- Performing activities (and teacher verification if desired).
- Dismantling the circuits and returning Snap Circuits® components to storage area.
- Reassembling the class for review.

Make sure the students know their objectives for the day, how much time they will need for clean-up, and where the materials are being stored.

Students must understand that there are usually many ways of making the same circuit, and that the instructor may not know all the answers. They are doing scientific investigations and many circuit projects suggest variations to experiment with.

General Activity Flow By Day

Snap Circuits® STEM Curriculum Grade 3-5
Performance Expectations Identified

The following Performance Expectations and Connections are addressed throughout the program.

- Performance Expectation 3-PS2-3- for cause and effect relationship between objects.
- ETS1.B, Engage in Argument from Evidence- for patterns and cause and effect, addressed in the formative questions in each day.
- CCSS. ELA-LITERACY.RL4.1- While there's no specific stories or text, students do take notes on the information presented which is then used as a reference of details for inferences drawn.

The following identifies each day's title of activity and any specific Performance Expectations and Connections addressed.

- Day 1: Introduction – Electricity In Our Lives
- Day 2: Explaining A Circuit (circuit vocabulary terms)
- Day 3: Creating Snap Circuit Flashlight plus Changing Loads
  Challenge Activity-Impact of Having Multiple Sources of Electrons (4-PS3-2, 4-PS3-4)
- Day 4: Conductors and Insulators (4-PS3-2, 4-PS3-4)
- Day 5-6: Loads in Series (4-PS3-2, 4-PS3-4, Math Connections of Measurement and Data with Represent and interpret data)
  Challenge Activity-Impact of Changing Loads
- Day 6-7: Loads in Parallel (4-PS3-2, 4-PS3-4, Math Connections of Measurement and Data with Represent and interpret data)
  Challenge Activity- Building a Doorbell Circuit
  Challenge Activity- Building a Doorbell With Simultaneous Light Circuit
  (4-PS3-2, 4-PS3-4, 3-5ETS1-1, 3-5ETS1-2)
- Day 8: Diodes and Resistors
  (4-PS3-2, 4-PS3-4, 3-5ETS1-3, Math Connections of Measurement and Data with Represent and interpret data, Operations and Algebraic Thinking with Write and Analyze Patterns)
- Day 9: LEDs and Variable Resistor (4-PS3-2, 4-PS3-4)
- Day 10: Resistors In Series and Resistors In Parallel: (4-PS3-2, 4-PS3-4)
- Extra Day Activity: Electric Heater (4-PS3-2)
- Extra Day Activity: Flying Saucer and Super Flying Saucer (4-PS3-2)
- Extra Day Activity 4: Electric Current

Suggested Pacing: 10 days of activities, 20-30 minutes each

Performance Expectations & Standards

Suggested Pacing: 10 days of activities, 20-30 minutes each

Unit Summary: By the end of the unit students will be able to:

- Describe how a circuit works
- Follow directions to create different kinds of circuits
- Design their own circuit
- Build, test, and troubleshoot circuits, to apply basic principles of electricity.

Stage 1 – Desired Results

Performance Expectations:
3-PS2-3. Ask questions to determine cause and effect relationships of interactions between objects not in contact with each other.
4-PS3-2. Make observations to show that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-4. Apply scientific principles of energy and motion to test and refine a device that converts kinetic energy to electrical energy or uses stored energy to cause motion or produce light or sound.
3-5 ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5 ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
- Engage in Argument from Evidence	- ETS1.B	- Patterns - Cause and Effect

ELA Standard Connections:
CCSS.ELA-LITERACY.RL.3.1
Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

CCSS.ELA-LITERACY.RL.4.1
Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

Math Connections:

Grade 3:

Measurement and Data

- Represent and interpret data.

Mathematical Practices

- Model with mathematics
- Construct viable arguments and critique reasoning
- Problem solve
- Look for and make use of structure

Grade 4:

Measurement and Data

- Solve problems involving measurement
- Represent and interpret data

Mathematical Practices

- Model with mathematics
- Construct viable arguments and critique reasoning
- Problem solve
- Look for and make use of structure

Grade 5:

Operations and Algebraic Thinking

- Write and Analyze Patterns
- Represent Data

Measurement

- Measure in a given system

Mathematical Practices

- Model with mathematics
- Construct viable arguments and critique reasoning
- Problem solve
- Look for and make use of structure

Stage 2 – Model Assessments

Pre-Assessment: May be printed or assigned digitally. **Post-Assessment:** May be printed or assigned digitally. **Summative Challenge Tasks:** Students will have challenge tasks interspersed in the 10 days.	**Formative Assessments:** Formative Assessments will be used throughout the unit to assessment and guide student instruction.

Stage 3 – Learning Plan / Road Map

Suggested Resources for Planning: Students will use Snap Circuits, a student notebook (SCAN) and have pre and post assessments.

** **The student notebook , called SCAN for Snap Circuit Activity Notebook**, is where the students can take notes, find directions for the activities, have areas to record observations and data, as well as respond to formative question prompts.

SNAP CIRCUITS©

Get to Know the Parts

Introduction

Snap Circuits® uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, lamp blocks, battery blocks, different length wire blocks, etc. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and with numbers, identifying the blocks that you will use and snap together to form a circuit.

How to Use It

For Example:

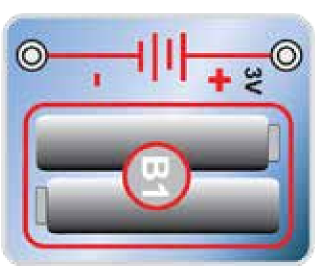
This is the **switch block** which is green and has the marking S1 on it as shown in the drawings.

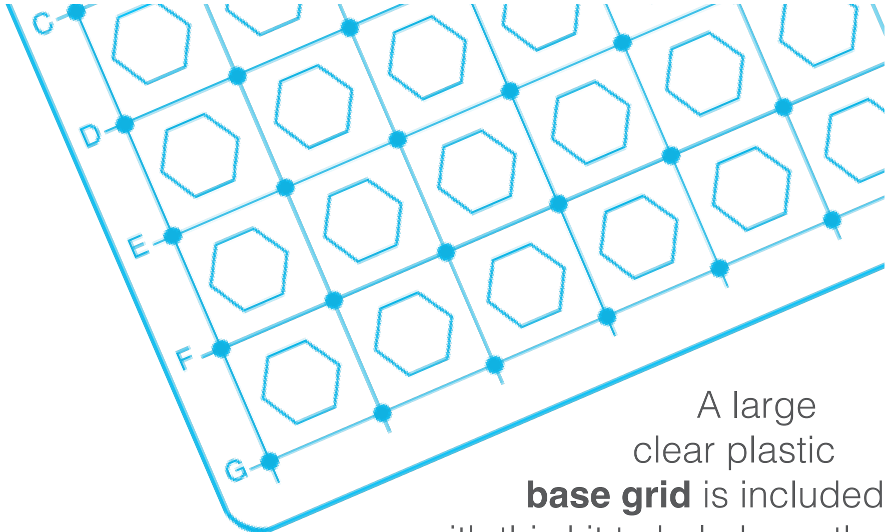
Please note that the drawing doesn't reflect the real switch block exactly (it is missing the ON and OFF markings), but gives you the general idea of which part is being used in the circuit.

This is a **wire block** which is blue and comes in different wire lengths.

This one has the number 2 , 3 , or 4 on it depending on the length of the wire connection required.

To build each circuit, you have a **power source block** number B1 that needs two (2) "AA" batteries (not included with the Snap Circuits® kit). When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side. Battery installation should be supervised by an adult.





A large clear plastic **base grid** is included with this kit to help keep the circuit blocks properly spaced. You will see evenly spaced posts that the different blocks snap into. You do not need this base to build your circuits, but it does help in keeping your circuit together neatly. The base has rows labeled A-G and columns labeled 1-10.

Next to each part in every circuit drawing is a **small number** in orange. This tells you which level the component is placed at. Place all parts on level **1** first, then all of the parts on level **2**, then all of the parts on level **3**, etc.

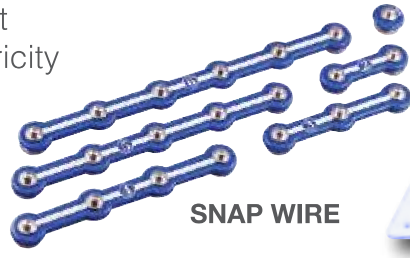
Place the fan on the motor M1 whenever that part is used, unless the project you are building says not to use it.

Some circuits use the **jumper wires** to make unusual connections. Just clip them to the metal snaps or as indicated.

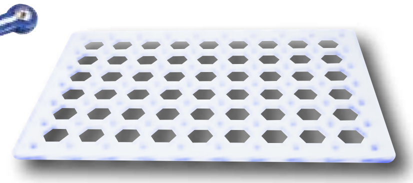
Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

About Your Snap Circuits® Parts

The blue snap wires are wires used to connect components. They are used to transport electricity and do not affect circuit performance. They come in different lengths to allow orderly arrangement of connections on the base grid.



SNAP WIRE



BASE GRID

The red and black jumper wires make flexible connections for times when using the snap wires would be difficult. They also are used to make connections off the base grid.

JUMPER WIRE

Wires transport electricity just like pipes are used to transport water. The colorful plastic coating protects them and prevents electricity from getting in or out.

The base grid is a platform for mounting parts and wires. It functions like the printed circuit boards used in most electronic products, or like how the walls are used for mounting the electrical wiring in your home.

SNAP WIRES & JUMPER WIRES

BASE GRID

The motor (M1) converts electricity into mechanical motion. An electric current in the motor will turn the shaft and the motor blades, and the fan blade if it is on the motor.

Fan

Motor (M1)

MOTOR & FAN

The meter (M5) measures voltage when connected in parallel to a circuit and measures current when connected in series in a circuit. The activities in this book only use it to measure voltage.

This meter has one voltage scale (5V) and two current scales (1mA and 1A). These use the same meter but with internal components that scale the measurement into the desired range. Note: Your M5 meter is a simple meter. Don't expect it to be as accurate as normal electronic test instruments.

Meter (M5)

METER

The battery holder (B1 or B1B) produce an electrical voltage using a chemical reaction. This "voltage" can be thought of as electrical pressure, pushing electrical "current" through a circuit. This voltage is much lower and much safer than that used in your house wiring. Using more batteries increases the "pressure" and so more electricity flows.

Battery Holder (B1)

BATTERY HOLDER

(Part designs are subject to change without notice).

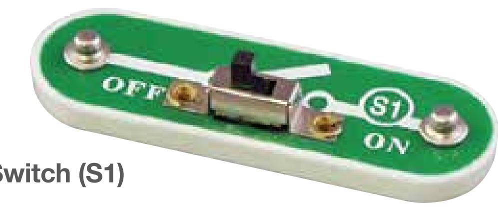
About Your Snap Circuits® Parts

A light bulb, such as in the 3V lamp (L1) or 6V lamp (L2), contains a special thin high-resistance wire. When a lot of electricity flows through, this wire gets so hot it glows bright. Voltages above the bulb's rating can burn out the wire.

Lamps (L1 & L2)

LAMPS

The slide switch (S1) connect ("ON") or disconnect ("OFF") the wires in a circuit. When ON they have no effect on circuit performance. Switches turn on electricity just like a faucet turns on water from a pipe.



Slide Switch (S1)

SWITCHES

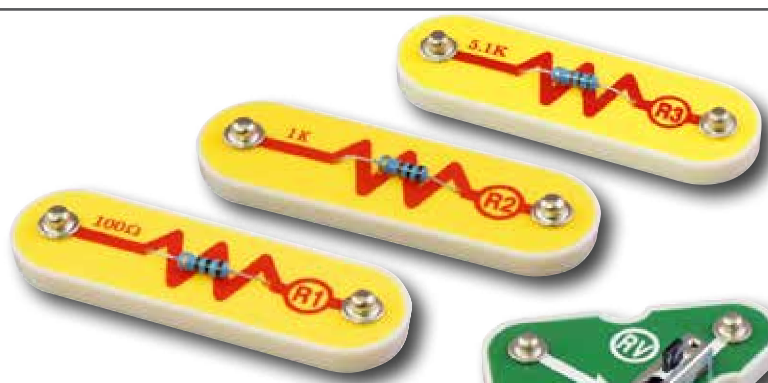
The red LED (D1) and green LED (D2) are light emitting diodes, and may be thought of as a special one-way light bulbs. In the "forward" direction, (indicated by the "arrow" in the symbol) electricity flows if the voltage exceeds a turn-on threshold (about 1.5V for red and about 2.0V for green); brightness then increases. A high current will burn out an LED, so normally the current must be limited by other components in the circuit, however your Snap Circuits® LEDs have internal resistors (usually 330Ω) to protect against incorrect wiring. LEDs block electricity in the "reverse" direction.

LED (D1 & D2)

LEDs

Resistors "resist" the flow of electricity and are used to control or limit the current in a circuit. This set includes 100Ω (R1), 1kΩ (R2), 5.1kΩ (R3), & 10kΩ (R4) resistors ("k" symbolizes 1,000, so R4 is really 10,000Ω). Materials like metal have very low resistance (<1Ω), while materials like paper, plastic, and air have near-infinite resistance. Increasing circuit resistance reduces the flow of electricity.

The variable resistor (RV) is a 50kΩ resistor but with a center tap that can be adjusted between 200Ω and 50kΩ.



Resistors (R1, R2, & R3)

Variable Resistor (RV)

RESISTORS

(Part designs are subject to change without notice).

What is Electricity?

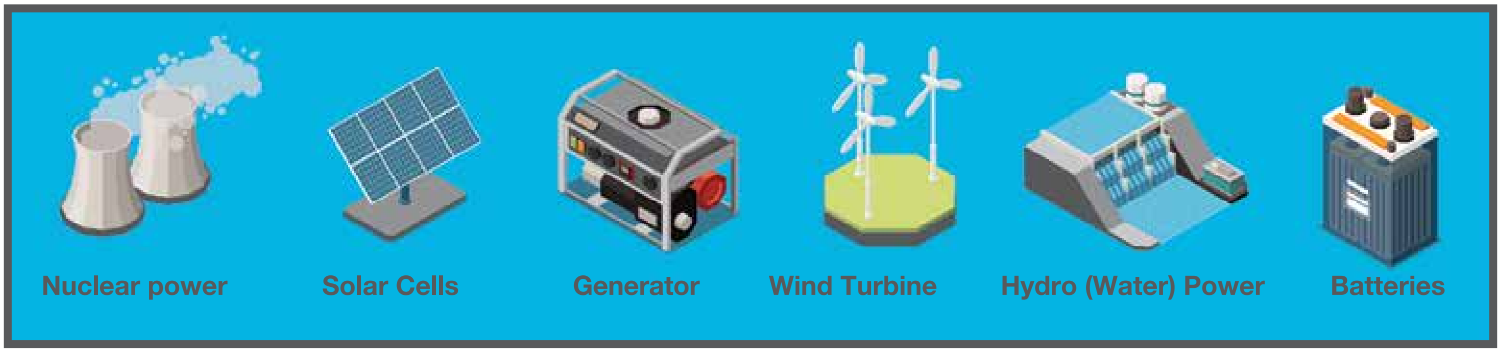
Discussion

In this section, you will learn about basic electrical components and circuits. By building circuits using Snap Circuits®, you will begin to understand the electrical world.

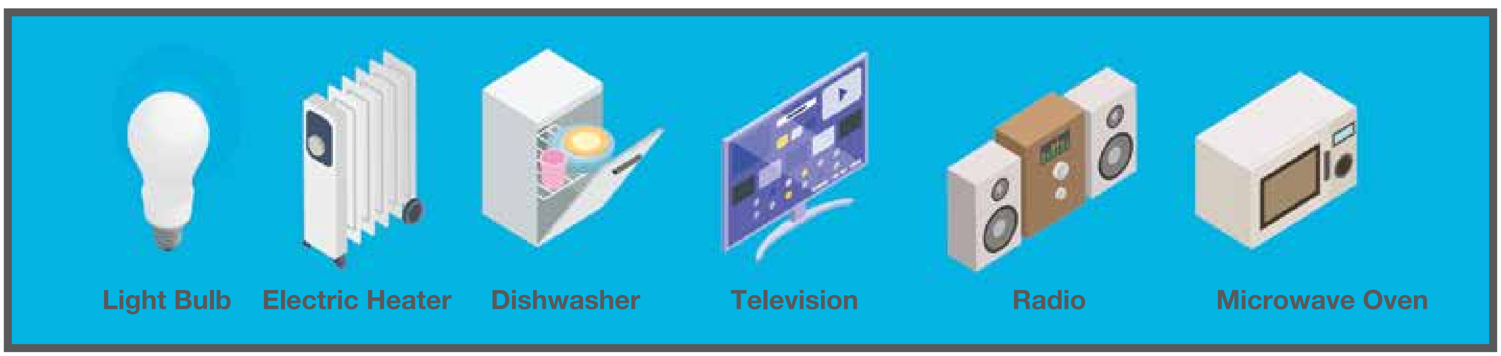
Introduction to Electricity

What is electricity?
Nobody really knows. We only know how to produce it, understand its properties, and how to control it.

It can be created by **chemistry** (batteries), **magnetism** (generators), **light** (solar cells), **friction** (rubbing 2 balloons), and **pressure** (piezoelectric crystals).



Electricity is energy that can be used to save us effort (electric toothbrushes and dishwashers), **heat things** (electric heaters and microwave ovens), **make light** (light bulbs), **and send information** (radio and television).



But electricity can also be dangerous if abused **(electric shock)**.

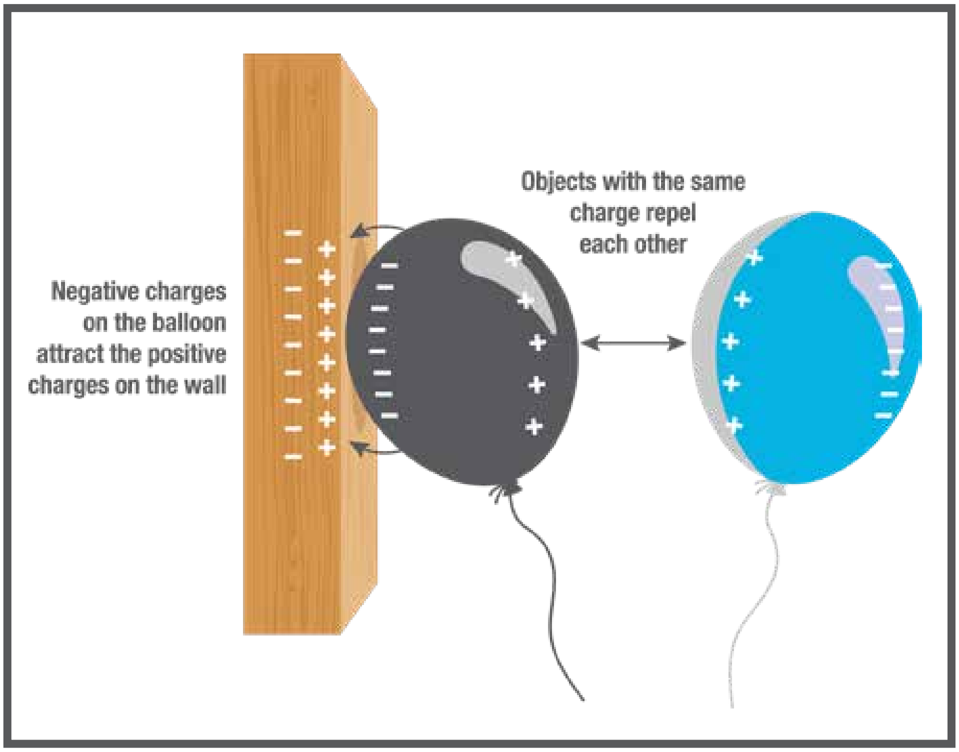
Electricity

The name electricity came from the Greek name **"elektron"** which means amber, the material in which electrical effects were first observed.

What do you think of electricity as being?

Electricity is one of the fundamental forces of nature. At its most basic level, it is an attraction and repulsion between sub-atomic (very, very, very, very tiny) particles within a material. This attraction/repulsion is referred to as an electrical charge; it is similar to and closely related to **magnetism.** These attractions/repulsions are extremely powerful but are so well balanced out at the sub-atomic level that they have almost no effect on our lives.

Gravity is actually the attraction between objects due to their weight (or technically, their mass). This effect is extremely small and can be ignored unless one of the objects is as big as a planet (like the earth). Gravity attraction never goes away and is seen every time you drop something. Electrical charge, though usually balanced out perfectly, can move around and change quickly.

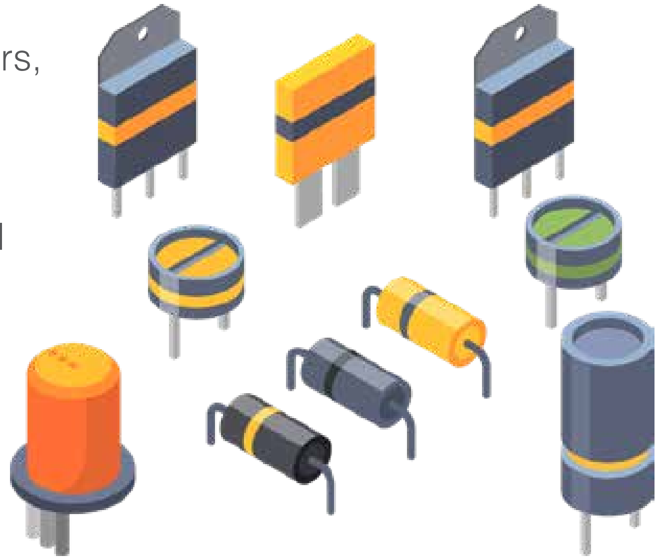


For example, think about how **two balloons** that cling to each other when you rub them together. This is due to an electric charge that has built up between them. There is also a gravity attraction between the balloons, but it is always extremely small.

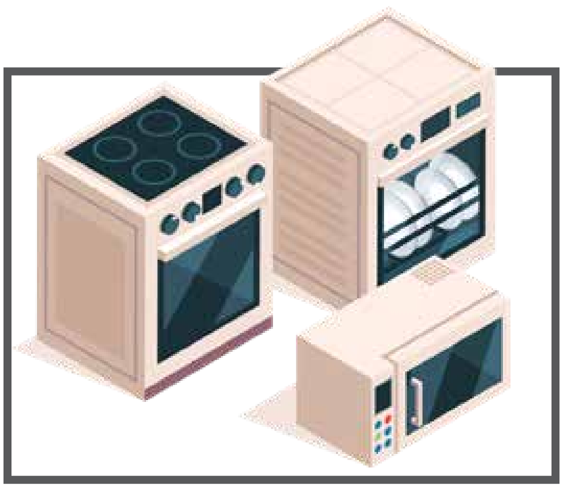
Electricity

Electronics is the science of working with and controlling electricity.

Many work-saving appliances like dishwashers, hairdryers, and drills are electrical but not electronic.

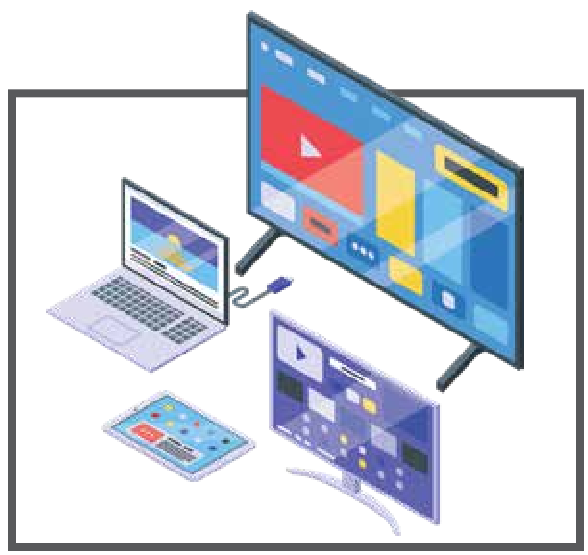


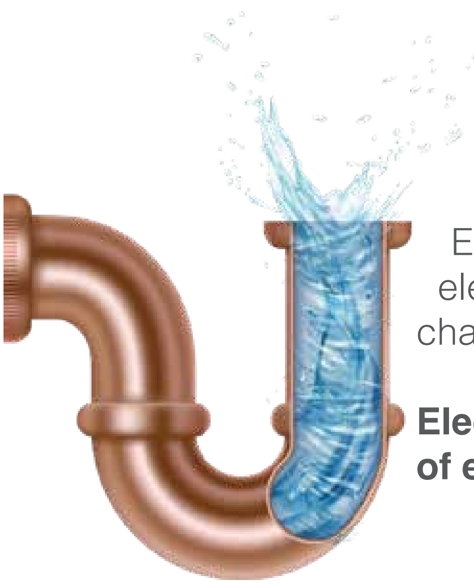
Electronic products use electricity to control themselves, using parts like **resistors, capacitors, and transistors**.
Electrical appliances are only controlled mechanically.



A good way to think of the difference between **electrical and electronic products** is to think about moving into a new house. Most products in the empty house are electrical (such as all the wiring and switches in the walls, dishwashers, electric ovens, air conditioners, most types of thermostats).

Most products you bring from your old house to your new house are **electronic** (Such as **TVs, computers**, touch-tone phones, radios, most battery operated products), but not all (such as hairdryers, electric power tools).

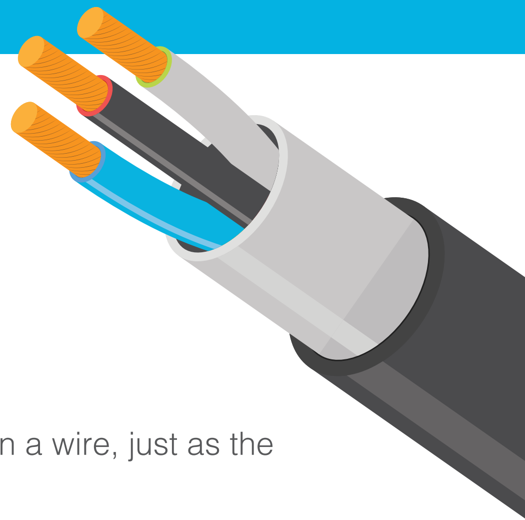




Electricity is the movement of sub-atomic particles (with their electrical charges) through a material due to an electrical charge outside the material.

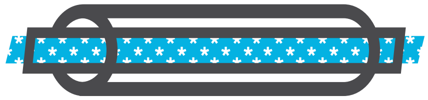
Electricity will be easier to understand if you think of the flow of electricity through circuits as water flowing through pipes.

WIRES



Wires can be thought of as large, smooth pipes that allow water to pass through easily. Wires are made of metals, usually copper, that offer very low resistance to the flow of electricity.

Water in a Pipe



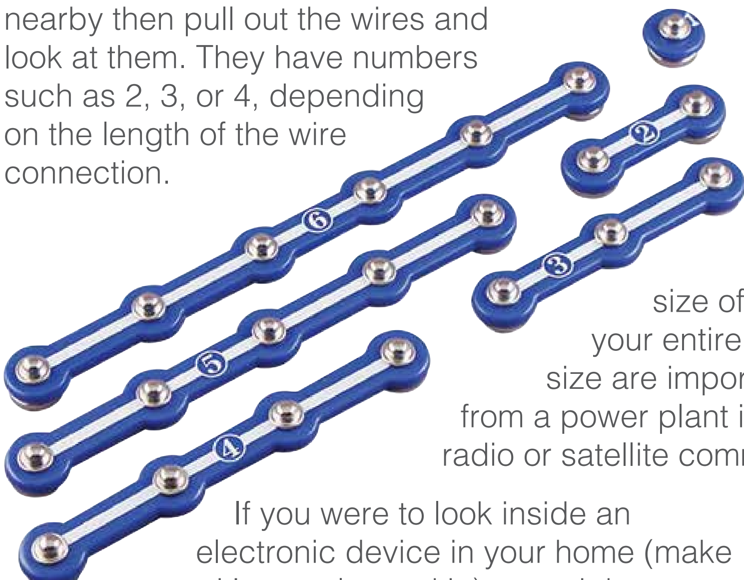
Electricity in a Wire

The electric current is a measure of how fast electricity is flowing in a wire, just as the **water** current describes how fast water is flowing in a pipe.

It is expressed in **amperes** (**A**, named after **Andre Ampere** (1775-1836) who studied the relationship between electricity and magnetism) or milliamp (mA, 1/1000 of an ampere).

With **Snap Circuits®** the wires you will use have been shaped into snap wire strips, to make interconnection easy. ***These work the same as any other wires you might find in your house, since they are made of metal.***

If you have the **Snap Circuits®** parts nearby then pull out the wires and look at them. They have numbers such as 2, 3, or 4, depending on the length of the wire connection.



Wires can generally be as long as desired without affecting circuit performance, just as using garden hoses of different lengths has little effect on the water pressure as you water your garden.

However, there are cases where the length and size of a pipe does matter, such as in the water lines for your entire city or in an oil refinery. Similarly, wire length and size are important for electric power lines transporting electricity from a power plant in a remote area to a city, and in circuits used in radio or satellite communication.

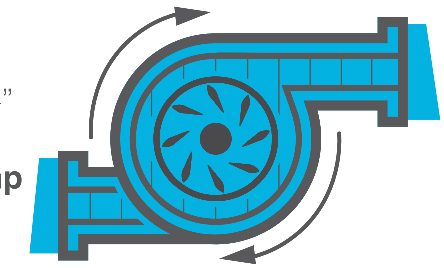
If you were to look inside an electronic device in your home (make sure it's not plugged in) you might see a lot of wires of different colors. The actual wires are all the same color of metal, but they have a protective covering over them. The colors are used to easily identify which wire is which during assembly and repair of the circuit.
The covering is also used to prevent different parts of a circuit from connecting accidentally.

Try to imagine the total length of wire used in all the products in your home!

Batteries

To make water flow through a pipe we need a pump. To make electricity flow through wires we use a **battery**. A battery creates an electrical charge across wires. It does this by using a chemical reaction and has the advantage of being simple, small, and portable.

Voltage is a measure of how strong the electric charge from your battery is, and is similar to the water pressure. Notice the "+" and "–" signs on the battery. These indicate which direction the battery will "pump" the electricity, **similar to how a water pump can only pump water in one direction.**



Water Pump

AA Battery

It is expressed in **volts** (**V**, and named after **Alessandro Volta** (1745-1827)who invented the battery in 1800)..

The 0V (zero volt) or "–" side of the battery is often referred to as "ground", since in house or building wiring it is connected to a rod in the ground as protection against lightning.

Battery power is much easier to use in electronics than the electricity that powers your home. This is because most electronic circuits only need a low voltage source to operate; all the electricity produced by your electric company comes at a higher voltage, which must be converted down.

If a circuit is given too much voltage, then its components will be damaged. It is like having the water in your faucet come out at higher pressure than you need, and it splashes all over the room. If water in a pipe is at too high of pressure, then the pipe may burst. Batteries are selected to give your circuit just the voltage it needs.

Your **Snap Circuits®** uses two 1.5V batteries in a holder (snap part **B1**, actual batteries are not included). Notice that just to the right of the battery holder pictured is a symbol, the same symbol you see on the battery holder. Engineers are not very good at drawing pictures of their parts, so when engineers draw pictures of their circuits they use symbols like this to represent them.

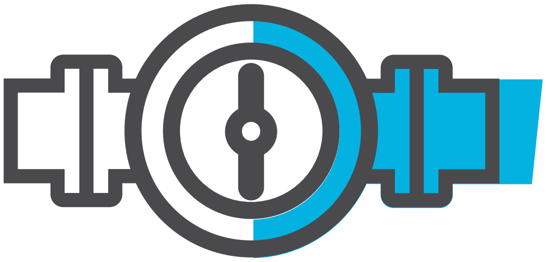
Battery Symbol

Batteries are made from materials like zinc and magnesium dioxide, electricity flows as these react with each other. As more material is used up by the reaction, the battery voltage is slowly reduced until eventually the circuit no longer functions and you have to replace the batteries. Some batteries, called rechargeable batteries (such as the batteries in your cell phone), allow you to reverse the chemical reaction using another electric source. That way the batteries can last through years of use.

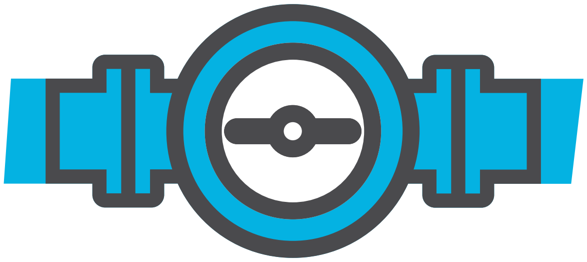
Challenge for students: Try to count how many batteries are in your home, your count will probably be low. Many products that use your house power also have batteries to retain clock or programmed information during brief power outages (such as computers and VCRs).

Switches

Since you don't want to waste water when you are not using it, you have a faucet or valve to turn the water on and off.



Off Position



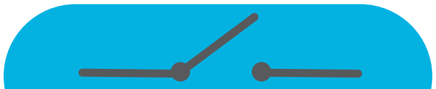
On Position

Similarly,
you use a switch to turn the electricity on and off in your circuit.

A **switch** connects (the "closed" or "on" position) or disconnects (the "open" or "off" position) the wires in your circuit.

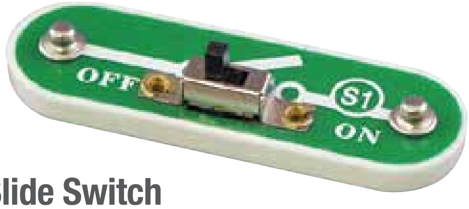
Just as the plumbing industry has a wide range of valves for different situations, there are many types of switches used in electronics.

The type shown below is called a **slide switch**, because you slide it back and forth to turn it on and off. Snap Circuits® includes one of these (**part S1**), shown here.



Switch Symbol

As with the battery, the slide switch is represented by a symbol, shown to the right. If you have the Snap Circuits® parts nearby, take out the switch and look at it.

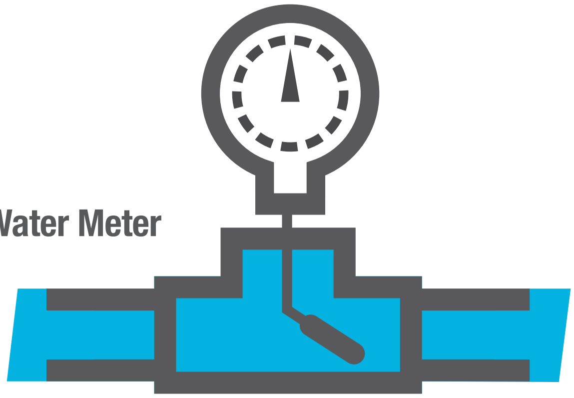


Slide Switch

You can think of slide and press switches like the water faucet in your kitchen (which pours out water until you turn it off) and a water fountain in a school or movie theater (which only squirts out water as long as you are pressing the button).

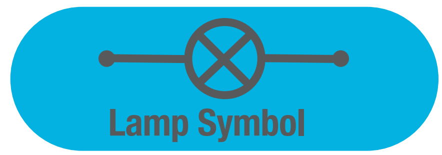
Switches in modern electronics come in many diverse forms.
Challenge: Try to count how many are in your home or car; you will be amazed. There are slide, press, membrane, rotary, push-button, and other switches controlling nearly everything.

Lamp



In a **lamp**, electricity is converted into light, the brightness of the lamp increases as more electric current flows through it. **You can think of a lamp as a water meter**, since it is showing us how much current is flowing in a circuit just as a water meter shows how much water is flowing in a pipe.

Snap Circuits® includes lamps (**part L1** (shown here) and L2). If you have the parts with you, take it out and look at it.



Lamp

Just as there are different types of water meters to work with different pressures and volumes of water, there are also different lamps. Lamp L1 is a low pressure meter, and works with voltages (electrical pressures) of up to 3V. Higher voltages than that will damage the bulb.

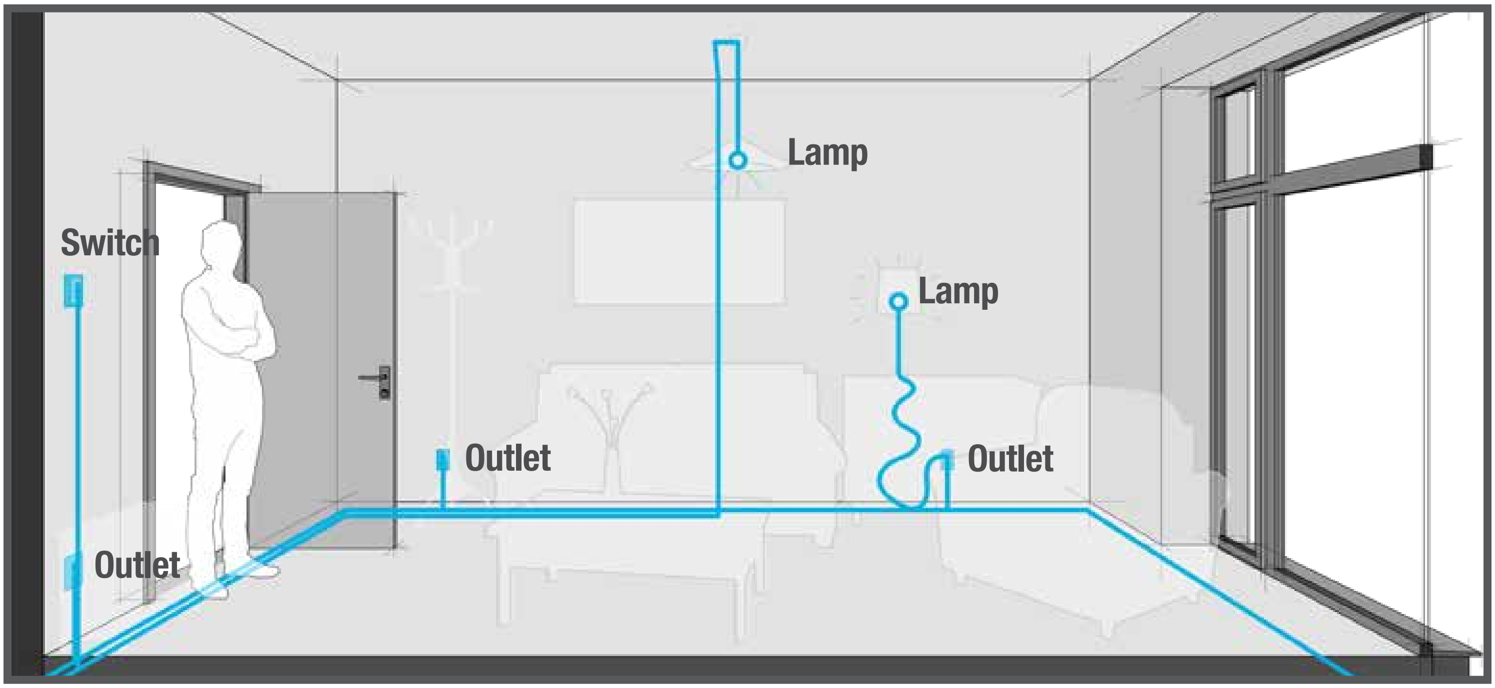
While occasionally lamps are used to indicate how much electricity is flowing in a circuit, they are mostly used to light our homes, businesses, and streets.

Although scientists had been experimenting with electricity for years, the first practical use of electricity occurred when inventor **Thomas Edison** used it to light a bulb similar to these. For many years electricity was used almost exclusively for lighting. That has since changed. Now only a small percentage of the electricity produced in the United States is used for lighting with the rest going to a vast range of uses in everyday life that Edison would never have imagined.

Thomas Alva Edison (1847-1931) Developed many devices. These inventions included early versions of the electric light bulb.

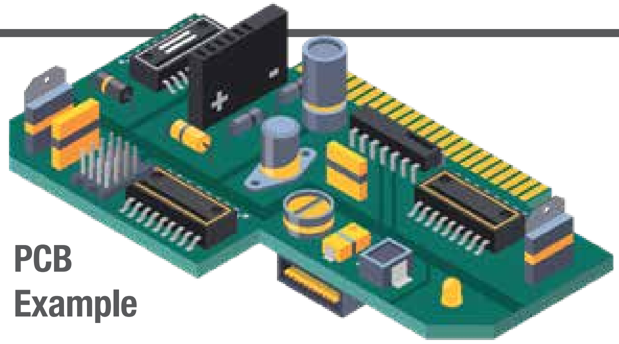
Base Grid

The water in your home flows through pipes mounted in the walls and floors of your home, and similarly the **electricity in your house** flows through wires mounted in the walls and ceilings of your home. But the wires in your walls take a lot of hard work to install and then can't be moved.

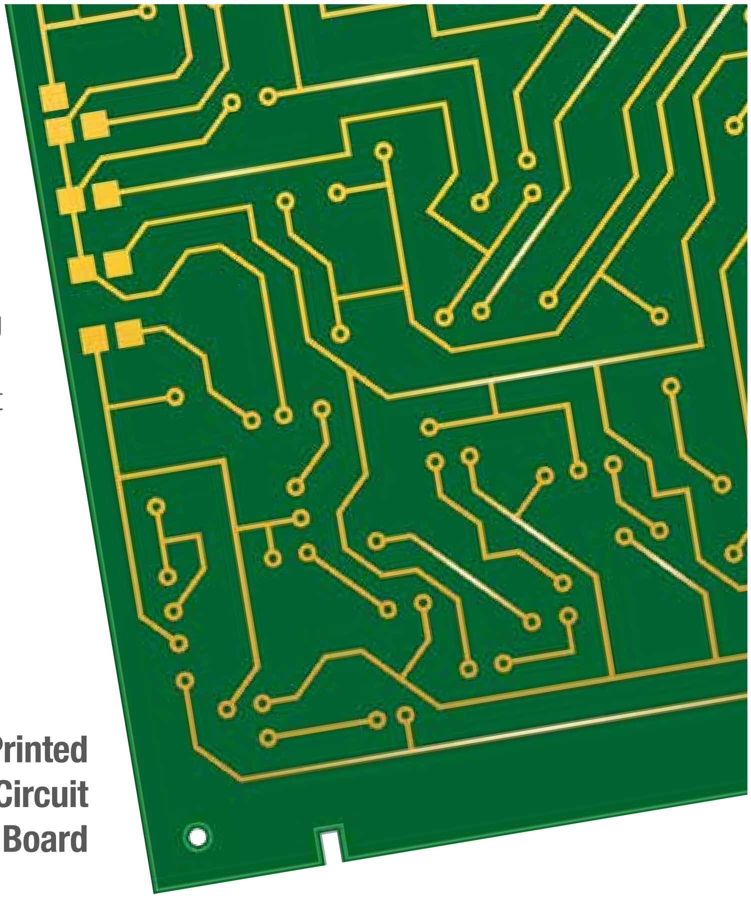


Most products that use electricity are small, easy to move, and easy to build. That is because they have almost all of their components and wires mounted on "circuit boards" such as these:

Boards like these are used in almost all electronic products, look inside any radio or computer and you will find them. Note that the "wires" connecting parts mounted on the circuit board are literally "printed" on the surface of the board; hence circuit boards all are called "**printed circuit boards**" or **PCBs**.



PCB Example



Printed Circuit Board

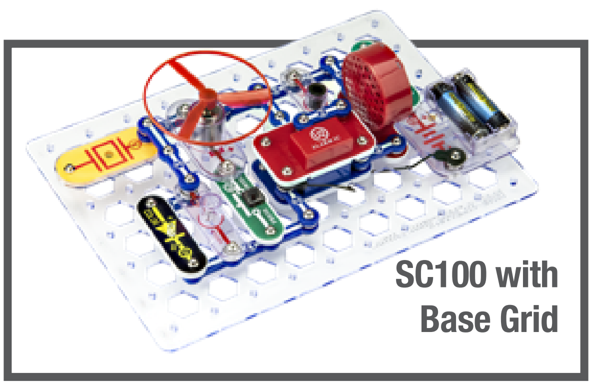
Base Grid

In the same manner Snap Circuits® uses a **clear plastic base grid** with evenly spaced posts to mount the snap parts and wires and to keep them together neatly.

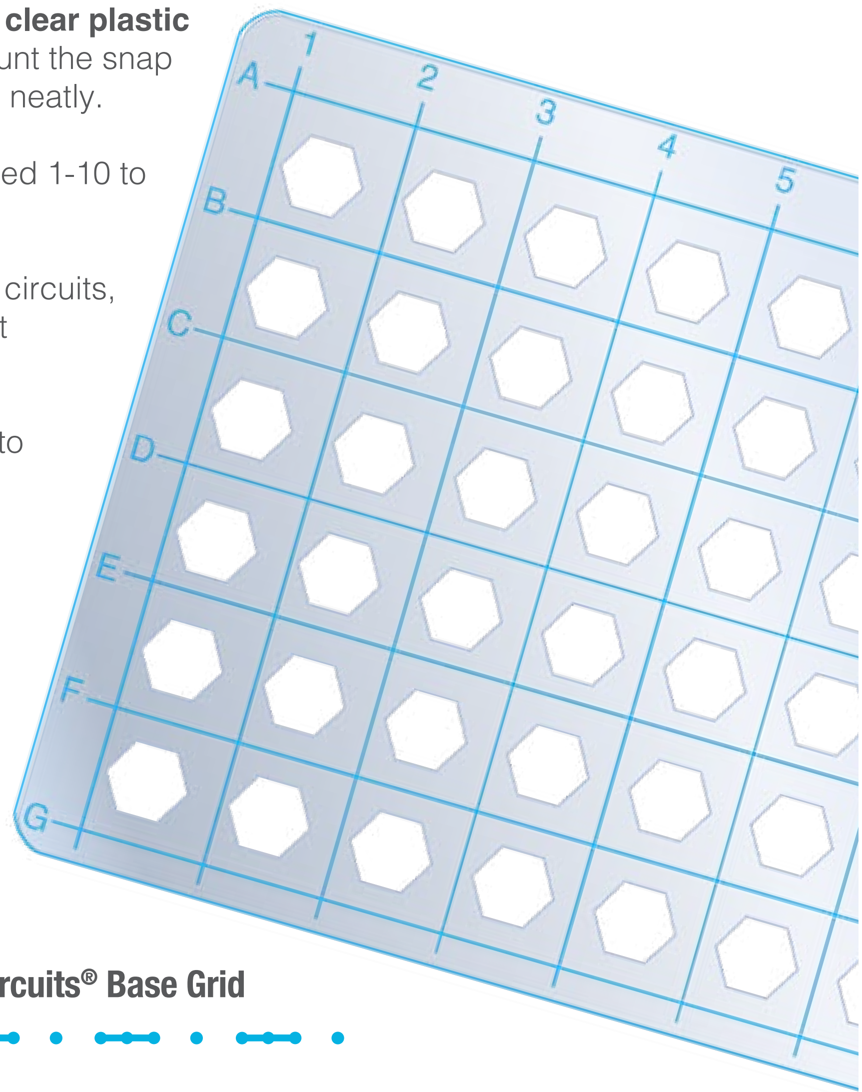
It has rows labeled A-G and columns labeled 1-10 to easily identify points in your circuit.

You don't need the base grid to build your circuits, but building larger curcuits, can be difficult without one!

The base grid is shown here, compared to a picture of a typical circuit industry board before parts are mounted.

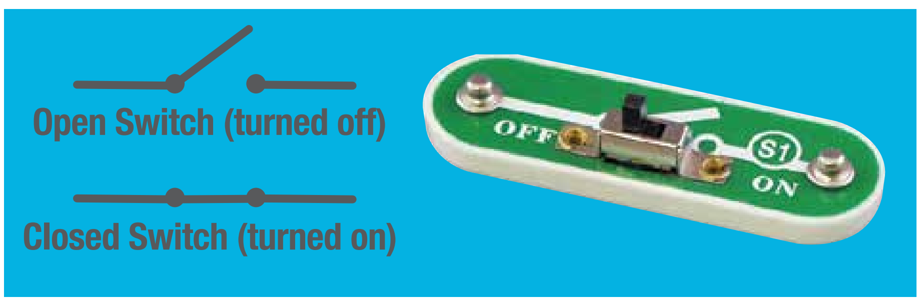


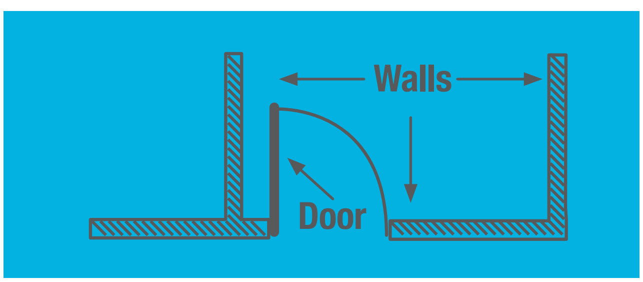
SC100 with Base Grid



Snap Circuits® Base Grid

In electronics, the "**on**" position of a switch is also called the "**closed**" position. Similarly, the "**off**" position is also called the "**open**" position. This is because the symbol for a slide switch is similar to the symbol for a door in an architect's drawing of a room:





The electronics symbol for a slide switch should be thought of as a **door to a circuit**, which swings open when the switch is off. The "door" to the circuit is closed when the switch is on. **This is shown here in drawings using the part symbols:**

INTRODUCTION
Electricity In Our Lives

Day 1

Note to teachers:
The suggested responses to observations and formative questions are highlighted in **bold**.

Use this code to access the slides presentation.
Or go to https://www.elenco.com/scsc3cp/

Introduction: Electricity In Our Lives

Brainstorm how electricity impacts our lives.

What are some uses of electricity? Students in table groups will make a list of 10-15 uses. After 5 minutes, tables will share their ideas with the whole class.

• How does electricity work?

This will also be discussed in table groups. After about 4 minutes, the table groups will share their ideas with the whole class.

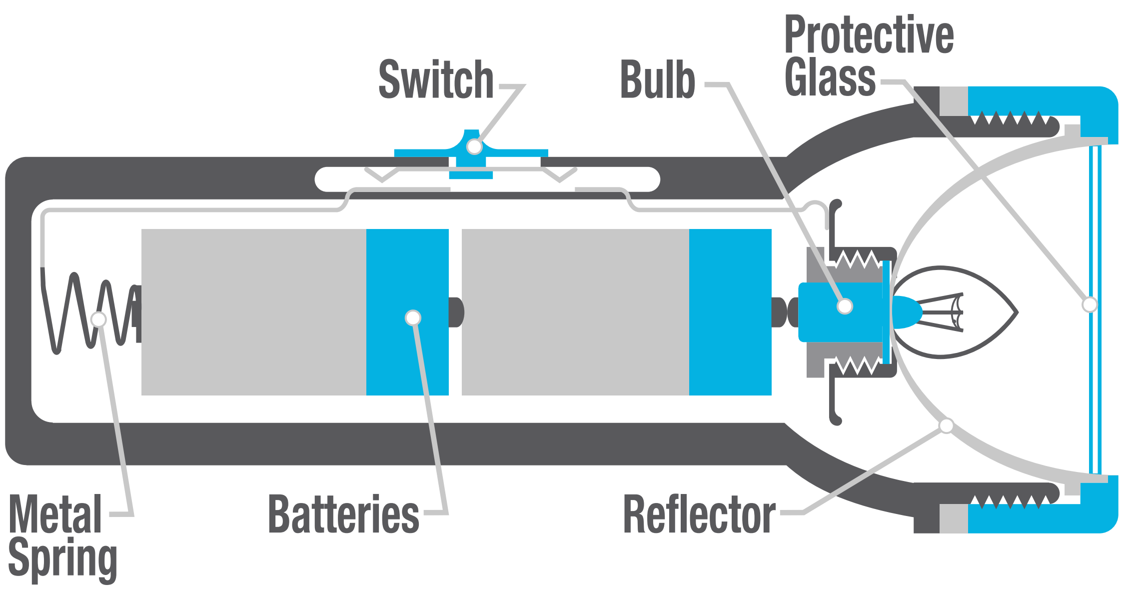
• Students can work in their table groups to define the following terms. Information can be added to their **S**nap **C**ircuit **A**ctivity **N**otebook (**SCAN**)

- Circuit
- Voltage
- Current
- Resistance
- Load

Flashlight Function:

• Discuss how a flashlight works. If one is available in the classroom, then demonstrate it to the students.

• In the SCAN students are to identify as many parts as they can and try to explain how the parts work together to create light.



INTRODUCTION
Explaining a Circuit

Day 2

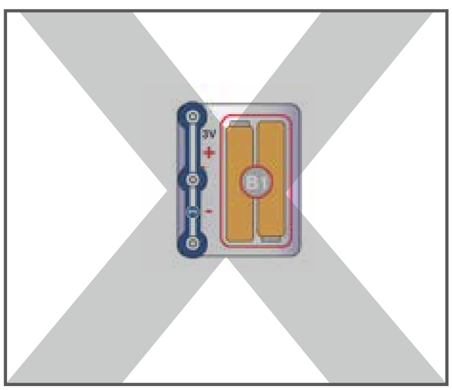
Students remember how a flashlight works and are now provided with some information about terms that will be used to describe circuits and electricity.

The terms to be discussed include a circuit (including parts, closed, open, and short), load, voltage, current, and resistance.

Explaining a Circuit

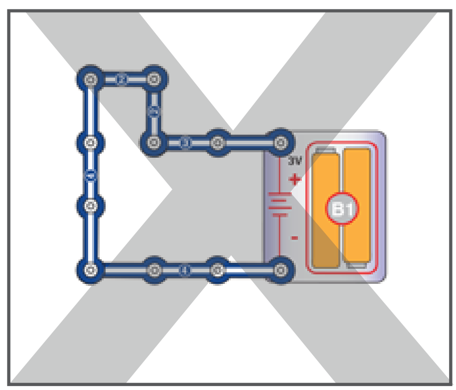
Narration: A Circuit: (Definition, parts, closed, open, and short)

- The term circuit can have its origins traced back to the 14th century and means to go around in a circle.
- Contains 3 essential parts> a source of electrons (maybe called a power source), a path for the electrons, and a load which is what the electrons work on. Students will go back to the parts of the flashlight, from Day 1, and label them (batteries>source of electrons, path for the electrons >the metal contacts and wires, though these might not all be visible, and the load> the light bulb).
- For a circuit to work there must a continuous path, no breaks, from the source of electrons, along the path, through the load (or loads), and back to the source. In this case the circuit is said to be closed.
- If there is a break then there it is called an open circuit and the load won't operate.
- This path of electrons starts at the negative side of the source and ends at the positive side.
- Ask the students what is the role of the switch in the flashlight. Make it clear that a switch is not a required part of a circuit. It is a convenience. If the students didn't identify what the role of a switch is then inform them that a switch allows the user to control when the circuit is closed or open.
- There is also another name used for describing some circuits and that is a short circuit. If there is only a source of electrons and a path, without a load, this is called a short circuit. You DON'T want a short circuit. This prevents the circuit from working and may damage and/or quickly drain your batteries.



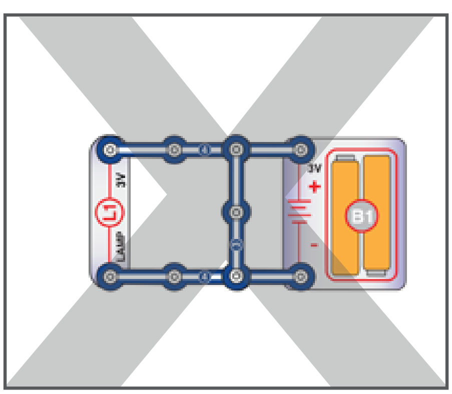
SHORT CIRCUIT!

Short Circuit - the two terminals of the battery are connected.



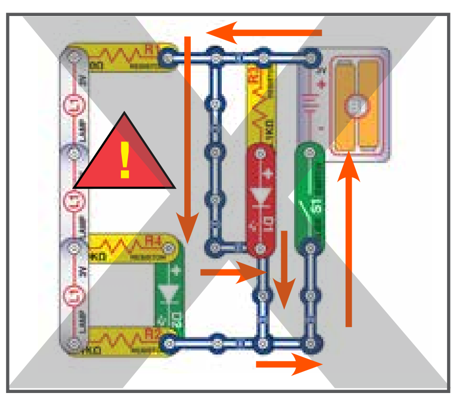
SHORT CIRCUIT!

Short Circuit - there is no load in the wiring path to create resistance.



SHORT CIRCUIT!

Short Circuit - the circuit has a load (the lamp) but there is another path the electricity can go that has no load.

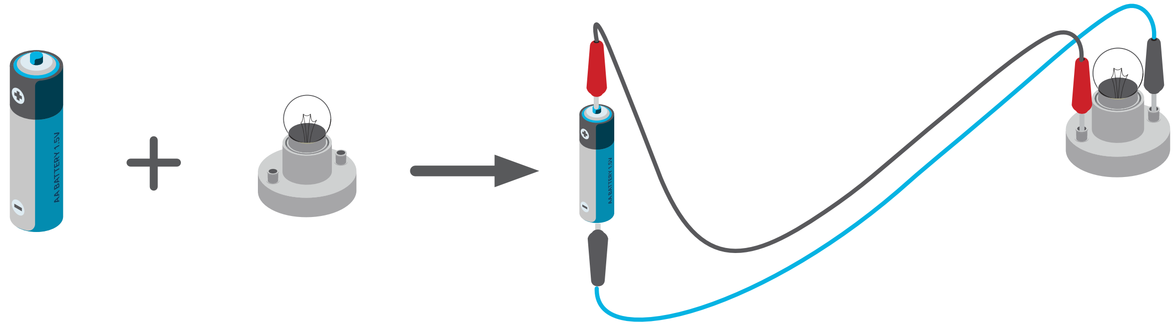


SHORT CIRCUIT!

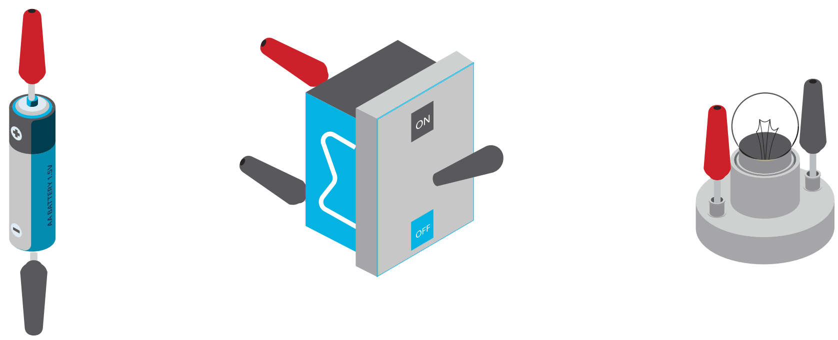
When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.

Explaining a Circuit

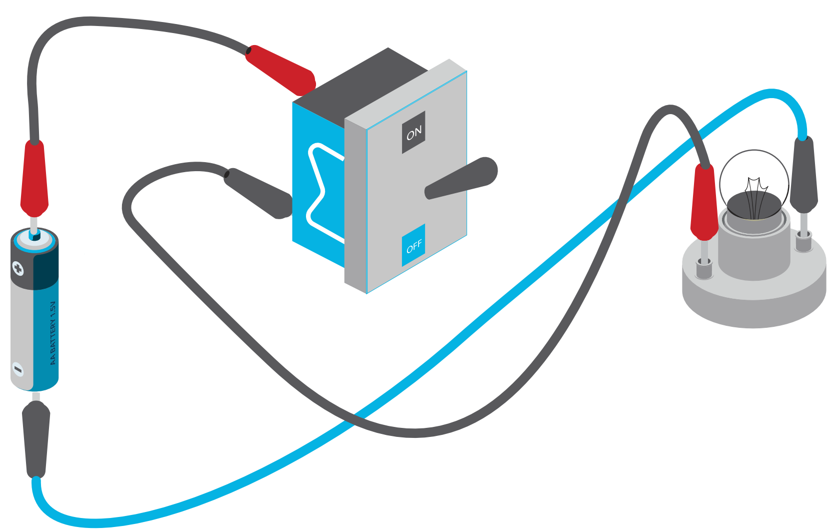
The class will practice these concepts with the pictures on the slide show presentation .



How can these be connected?



Here's an answer

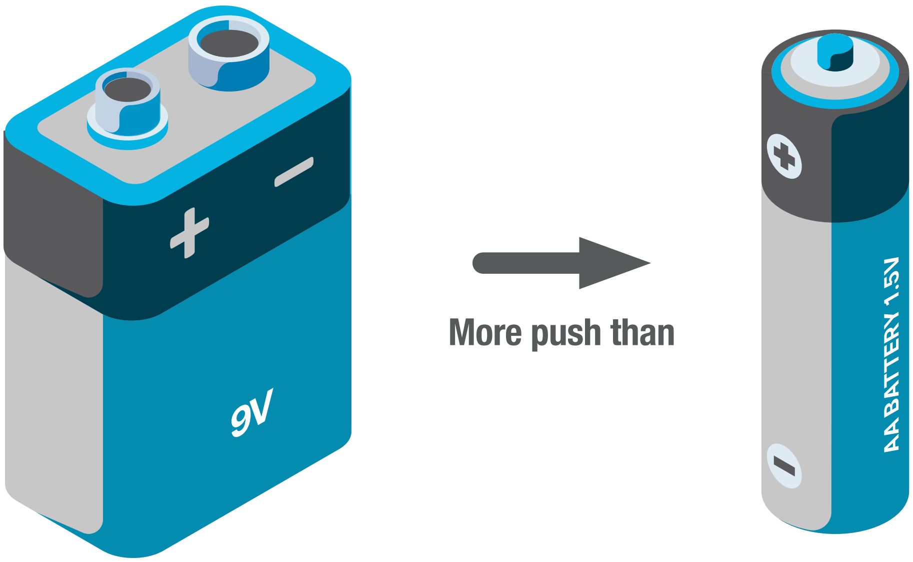


Explaining a Circuit

Defining Other Circuit Terms: (These were mentioned on Day 1)

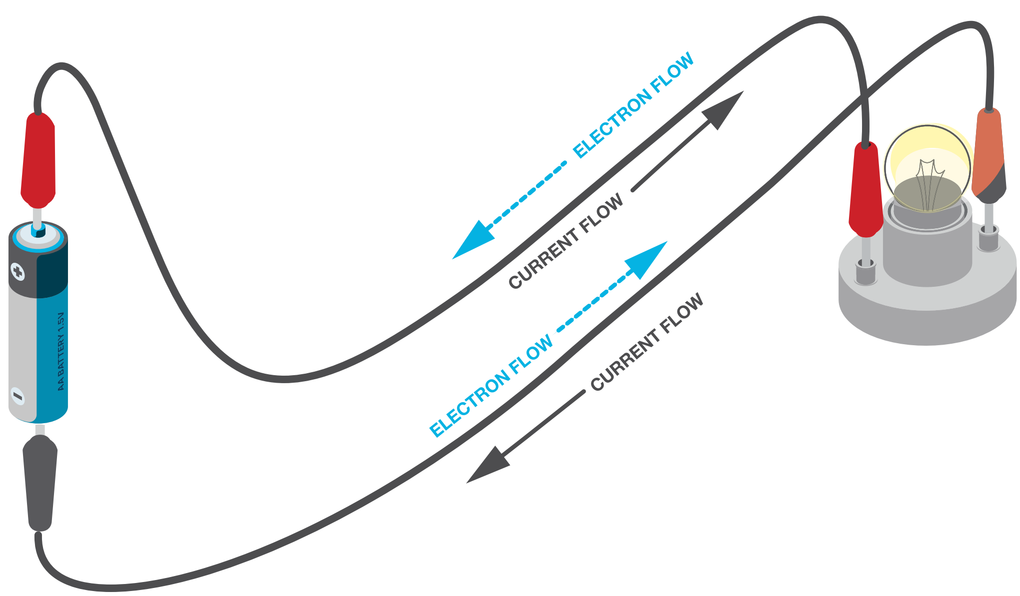
• **Voltage**: This is considered the push of the electrons, think of it as electrical pressure. It has units of volts and the higher the voltage the more push there is.

For example, a **9-volt battery** has more "push" than a **1.5-volt battery**.



• It is important to note that voltages can be added together when batteries are properly connected end to end.

• **Current**: This is how fast the electrons are flowing and has units of amps. There are actually a couple of ways to look at the direction of the flow of current. One is from an electron standpoint and flows out of the negative terminal toward the positive (this is based on nuclear physics). The other is called the conventional or current flow and it goes in the opposite direction (this was used since electricity was first discovered).



Current and Resistance

Let's look at current in situations you might be more familiar with.

Think of the term current as it relates to the flow of water through a system. Imagine the difference in current for a lazy river ride versus a rapids ride. The current is much faster for the rapids ride.

- Students might be familiar with the term **current** as it relates to the flow of water through a system. Students should imagine the difference in current for a **lazy river** ride versus a **rapids ride**. The current is much faster for the rapids ride.

Slow current in a lazy river.

Resistance: This term means a restricting or blocking of something. In a circuit, this refers to restricting the flow of electrons and has units called ohms.

1. In our **lazy river** scenario, you could create resistance or restrict the flow by dragging your feet. This will result in you moving slower down the river because there is resistance to the movement.

2. A rock in the rapids will restrict the flow of water there too.
3. It should be noted that electrons try to avoid resistance and considering that virtually all materials have some resistance, electrons will choose the path of least resistance.

Faster current in rapids river ride.

Formative questions in the SCAN:

These all are related to the flashlight the students worked on.

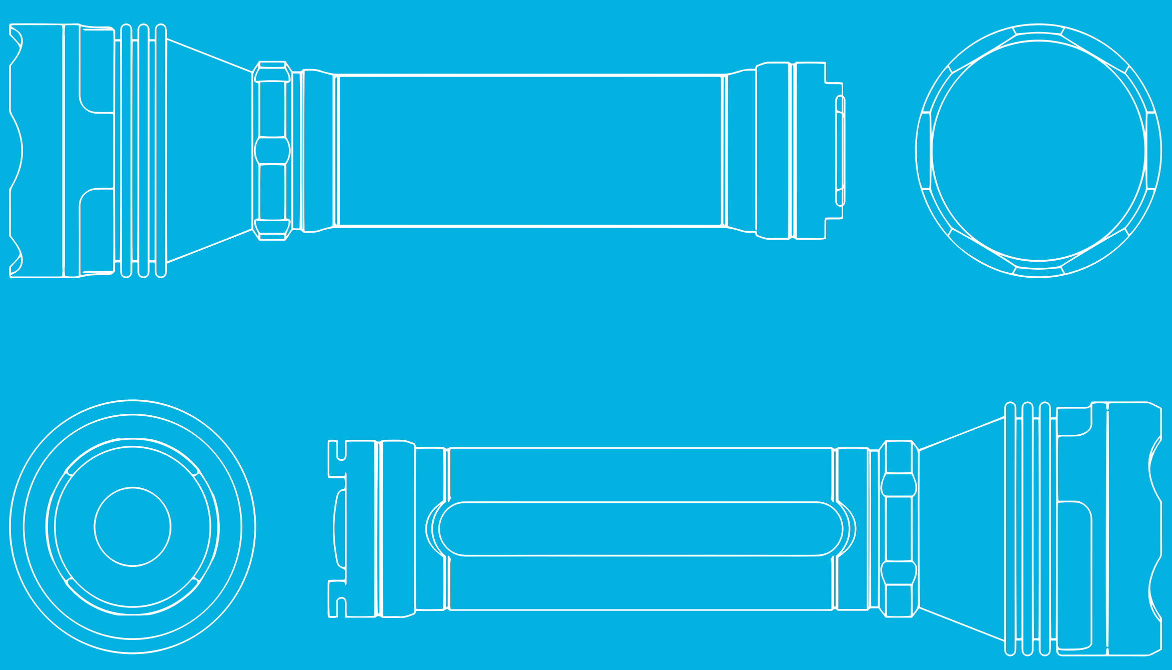
1. What is the source of electrons? (**Batteries**)
2. What is the load? (**The light bulb**)
3. How much voltage does your flashlight have? (**This depends on the flashlight used.**)
4. What is the job of the switch? (**Open and close the circuit**)
5. If everything in the flashlight is connected properly and the bulb won't light, give an explanation as to why? (**There are 3 options: batteries are "dead" (no longer can be used as a source), circuit is open at the switch, or the bulb is burnt out/not working**.)

SNAP CIRCUITS

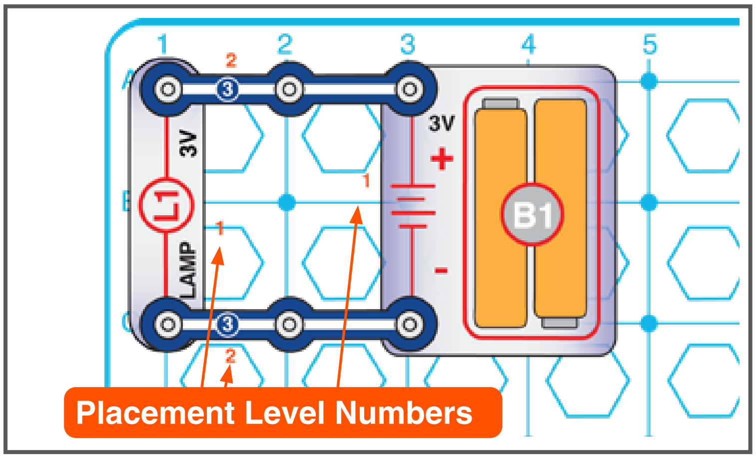
CREATING WITH SNAP CIRCUITS®

Build a "Flashlight"

Day 3



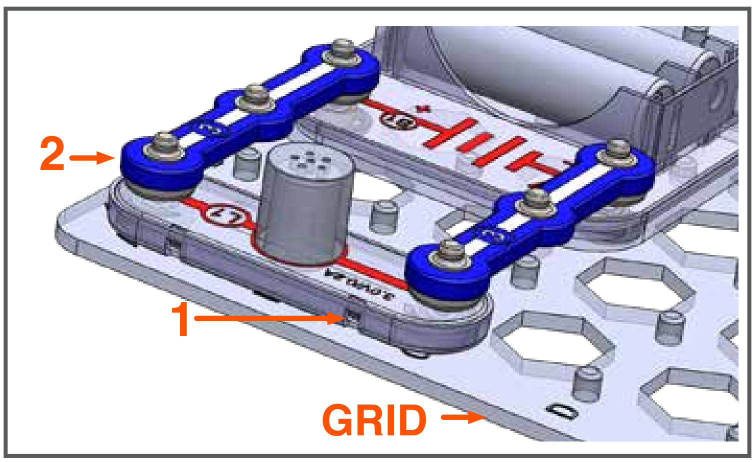
Creating a Snap Circuits® flashlight plus changing loads



Build the circuit as shown in the picture.
First place the parts with Placement Level Number "**1**", then the parts with Placement Level "**2**".

Parts used:
2 3-snap wire
1 Battery holder (B1)
1 Base grid
1 3V Lamp (L1)

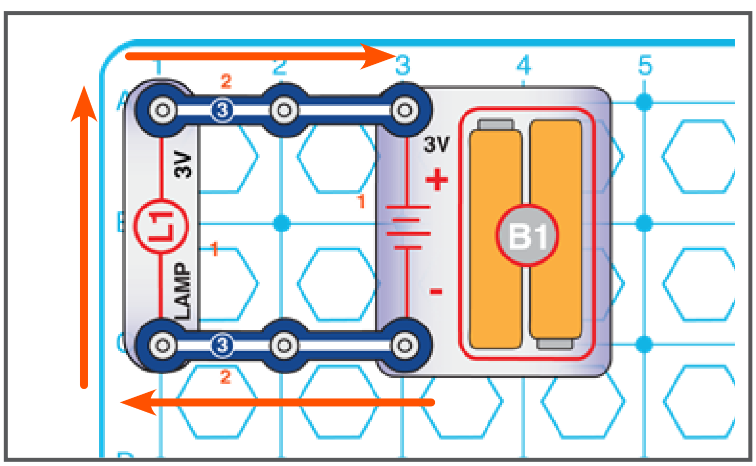
Note: if you are using AC-SNAP (The optional Snap Circuits® AC adapter) then connect the 3V side of the B6 module in place of the battery holder. For additional information turn to page 74



Placement Numbers

Numbers signify the placement level of the placed parts.

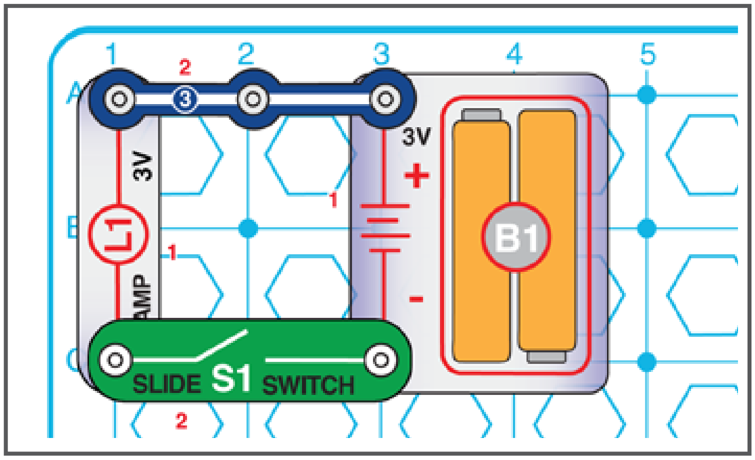
EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
LIGHT (L1)	Light turns on	Bright



This is the simplest circuit, it has 1 of each of a circuit's requirements - a source of electrons, a path for the electrons, and a load.

Let's trace the path of the electrons.

Creating a Snap Circuits® flashlight plus changing loads



Now, there's a component missing in our simple Snap Circuit flashlight when compared to our original flashlight.
What is it? **A SWITCH**. Let's add it
.

Replace one of the 3-snap wires with a slide switch (labeled S1).

EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
LIGHT (L1)	Light turns on	Bright

Directions, Observations, and Formative questions in the SCAN:

1. With the slide switch in the off position will the bulb light? Yes or **No** (circle one)
2. Is the circuit open or closed? **Open** or Closed (circle one)

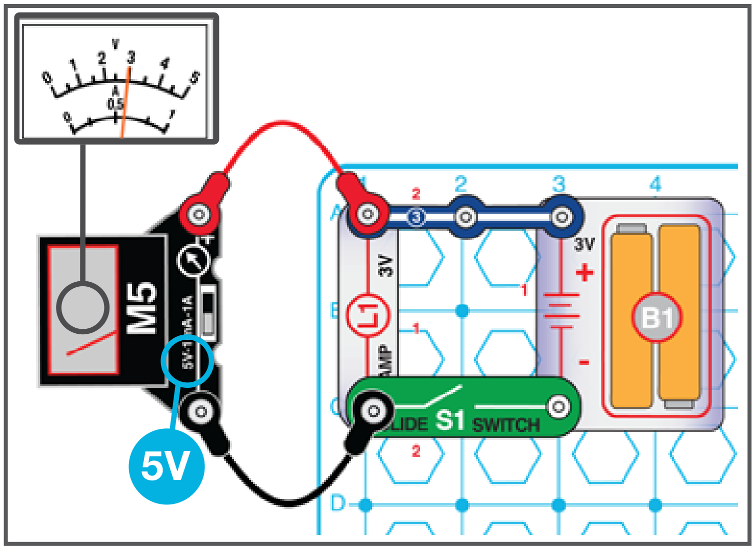
Now set the switch to the on position.

1. What happened to the circuit? Describe this. **With the slide on the switch now pointing to on, the circuit is closed and the light will turn on.**
2. In either situation, if the electrons could travel, have we changed the path of electrons? Yes or **No** (circle one)

Let's look at voltage

Build the circuit shown below.

Set the meter (M5) to the 5V setting. Use the meter to measure voltage, reading the measurement shown on the 5V scale.



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
METER (M5)	Needle Moves	3V
LIGHT (L1)	Light turns on	Bright

Parts used:

1	**3-snap wire**	**1**	**Meter (M5)**
1	**Battery holder (B1)**	**1**	**Slide switch (S1)**
1	**Base grid**	**1**	**Red jumper wire**
1	**3V Lamp (L1)**	**1**	**Black jumper wire**

Note for all circuits using meter (M5): Your actual results may vary. M5 is a simple meter; don't expect it to be as accurate as normal electronic test instruments. Results can also vary depending on the strength of your batteries.

Creating a Snap Circuits® flashlight plus changing loads

Directions, Observations, and Formative questions in the SCAN:

1.Turn the switch on. What is the voltage? **Over 3V with new batteries**

2.Where does the voltage come from? **Explain The voltage is coming from the batteries.**

3.Does the value of the voltage make sense? Explain. **The response should touch on something related to what the meter shows for the voltage across the light compared to the voltage supplied from the batteries**

Loads can be changed

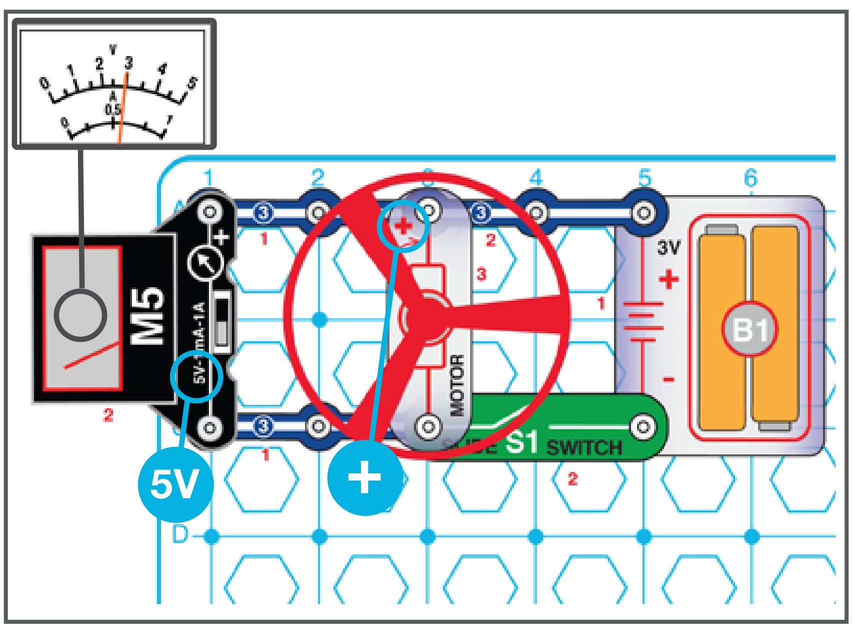
Build the circuit shown in the picture below, with a motor instead of a lamp.
Set the meter (M5) to the 5V setting. M1 has the + sign on the same side with B1 + sign.

Directions and Observations:

1.Turn the switch on.

a. What happens to the fan? **It spins**

b. What does the meter read? **Over 3V with new batteries**



EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	3V
FAN	Switch on	Spinning

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Parts used:
- 3 3-snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 1 Motor (M1)
- 1 Fan
- 1 Meter (M5)
- 1 Slide switch (S1)

Challenge Opportunities for students [addresses 4-PS3-2, 4-PS3-4]
Directions, Observations, and Formative questions for the SCAN:

What do you think would happen if you replaced the 3-snap wire at upper right with a second B1 battery holder (so 4 batteries instead of 2)?

1. Any changes to the fan? Explain **The fan would spin faster.**
2. Any change on the meter? Explain **The voltage would be higher.**

INTRODUCTION TO
Conductors and Insulators

Day 4

Narration: This day will start with a little chemistry background.

In circuits, we have talked about sources of electrons and pathways for the electrons. Let's discuss some more information about electrons. This will be about chemistry. An atom, the fundamental component of everything is made of a center nucleus and an outer area called the electron cloud. Electrons are part of the outer area. In the nucleus, are little particles called protons and, in nearly every atom, also neutrons.

For electricity to flow, for there to be current, electrons must be able to easily move from atom to atom.

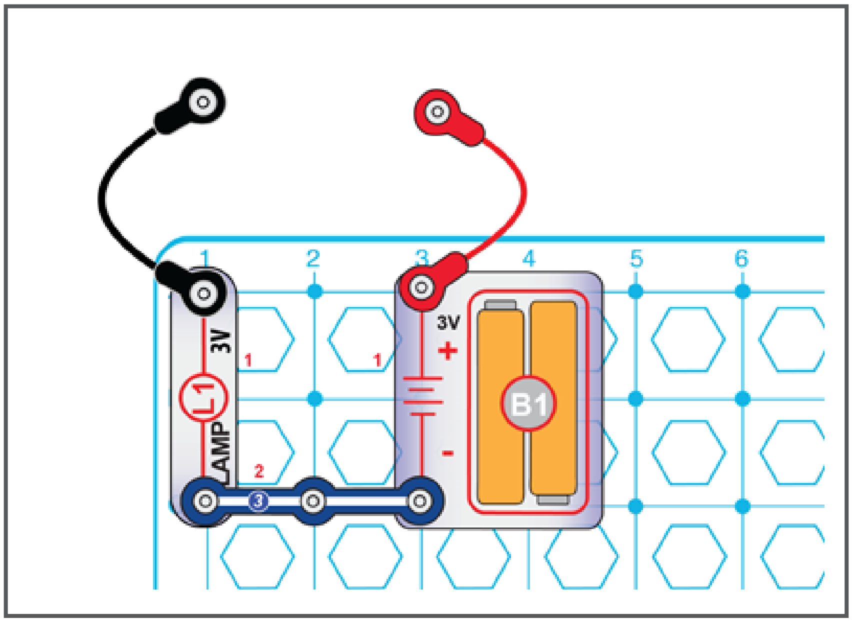
Conductors and Insulators

[addresses 4-PS3-2, 4-PS3-4]

• Materials that allow this movement between atoms to easily occur are called conductors. The best conductors are usually pure metals and include options like copper, gold, and silver. Wires are most often made of copper because it is abundant and we can mine it in high purity.

• Materials that can't easily allow for the movement of electrons are called insulators. While most things labeled on the Periodic Table are metals, the other materials would be considered insulators, though they are rarely used for one reason or another. Insulators used in circuits are generally a compound or a combination of materials. Common insulators are often made of plastic or rubber.

Create the circuit shown here:



Parts used:
3 3-snap wire
1 Battery holder (B1)
1 Base grid
1 Black jumper wire
1 Red jumper wire
1 3V Lamp (L1)
Various household materials (not included)

Directions and Observations for the SCAN:

• Students should find materials around the classroom, place the loose ends of the jumper wires on the material (but not touching each other), and observe if the light turns on or stays off. The material will be classified as either a conductor (if the light turns on) or an insulator (if the light stays off). Students put their observations in the table below.

Materials (use items you have)	Lamp ON or OFF	Conductor or Insulator?
Paper clip		
Metal spring		
Pen		
Coin		
Paper		
Shirt		

INTRODUCTION TO
Loads in Series

Day 5 & 6

Narration:

- Let's consider where the loads are in a special arrangement called in series.

- When the loads connect with each other such that there is only 1 pathway that starts at the source of electrons, connects through each load on order, and then ends at the source of electrons, this is known as a series circuit.

- Let's first revisit a simple circuit, remembering that for this circuit there is only 1 load. After that we will add more loads in series and find out what happens to the loads both visually and by looking at the voltage across the loads.

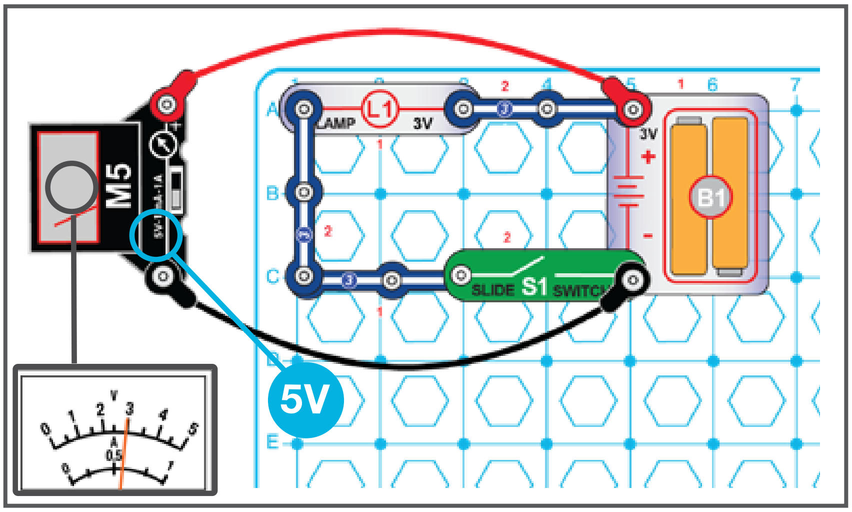
Loads in Series

[addresses 4-PS3-2, 4-PS3-4 Math Connections of Measurement and Data with Represent and interpret data]

Pictures of circuits used: (shown in progression of activities)

Build the circuit shown below: Simple Circuit revisited.

- Begin with the meter connected across B1, as shown below.



Meter directly across batteries:

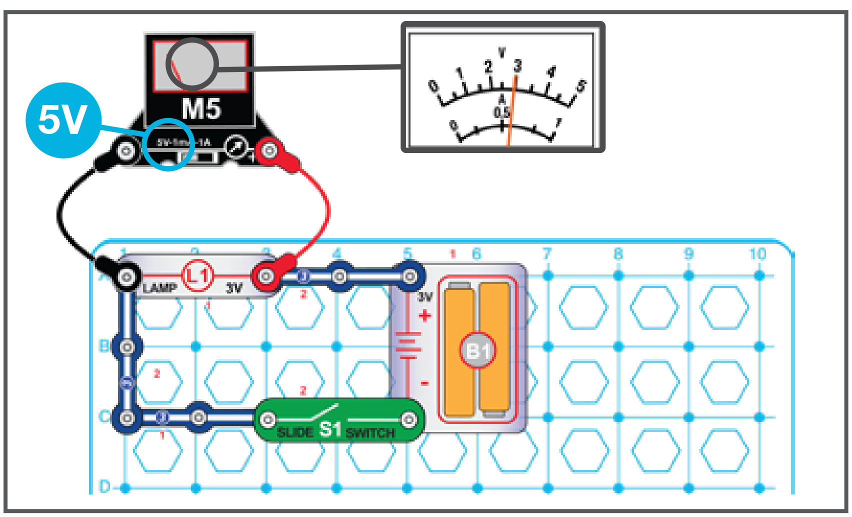
EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	3V
LIGHT (L1)	Light turns on	Bright

Parts used:

3	3-snap wire	1	Meter (M5)
1	Battery holder (B1)	1	Slide switch (S1)
1	Base grid	1	Red jumper wire
1	3V Lamp (L1)	1	Black jumper wire

Directions, Observations, and Formative questions in the SCAN:

1. When the switch on S1 is turned on:
   a. What happens to the light? **On** or Off
   b. Does the light appear **bright** or dim?
   c. What does the meter show for voltage? **Over 3V with new batteries**
2. Students should turn off the switch.



Meter across one lamp:

EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	3V
LIGHT (L1)	Light turns on	Bright

Parts used:

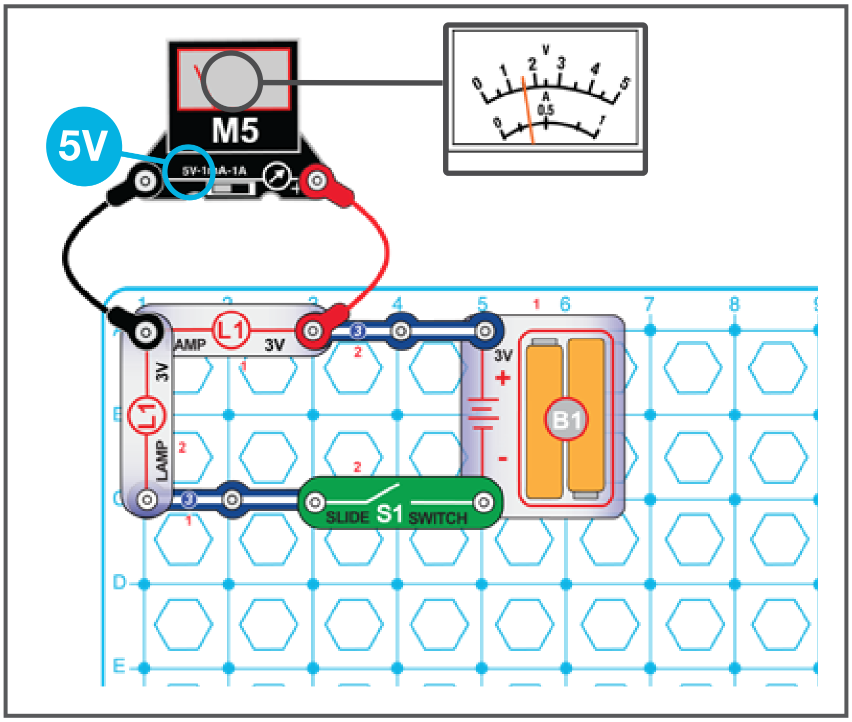
3	3-snap wire	1	Meter (M5)
1	Battery holder (B1)	1	Slide switch (S1)
1	Base grid	1	Red jumper wire
1	3V Lamp (L1)	1	Black jumper wire

3. Now let's move the meter to be snapped across the lamp (L1), as shown above.
4. When the slide switch (S1) is turned on:
   a. What happens to the light? **On** or Off?
   b. Does the light appear **bright** or **dim**?
   c. What does the meter show for voltage? **Over 3V with new batteries**
5. Students should turn off the switch.

Loads in Series

Let's make a Series Circuit with 2 Loads:
Make the series circuit below using two L1 lamps connected in series. That means if you trace the pathway of the electrons that you will make one continuous loop from the source of electrons (starting at the negative terminal), through each of the 2 lights, and back to the source (finishing at the positive terminal).

Directions, Observations, and Formative questions in the SCAN:

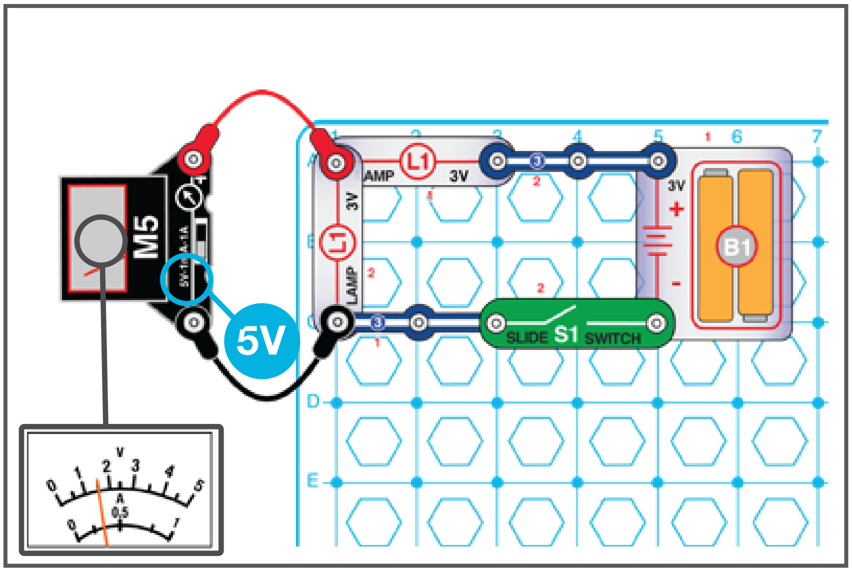


1. When the meter is snapped across the first light and the switch (S1) is turned on:
    a. What happens to the light? Is it On or Off? **On**
    b. What does the meter show for voltage over the first light? **1.5V**
    c. When comparing the brightness of the 2 lights to the brightness of the light in simple circuit, which circuit produced the brighter lights? **Simple Circuit** or Series circuit?

EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
METER (M5)	Needle Moves	1.5V
TOP LIGHT (L1)	Light turns on	Med Bright
LEFT LIGHT (L1)	Light turns on	Med Bright

d. Describe how the brightness of the lights in the series circuit compares with the brightness of the light in the simple circuit. **The lights in the series circuit are dimmer than the light in the simple circuit.**

2. Students should turn off the switch.



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
METER (M5)	Needle Moves	1.5V
TOP LIGHT (L1)	Light turns on	Med Bright
LEFT LIGHT (L1)	Light turns on	Med Bright

3. When the meter is moved and is snapped across the second light and the switch (S1) is turned on:
    a. What does the meter show for voltage across the 2nd light in the series? **1.5V**
    b. Are the meter readings for the series circuit **higher**, lower, or the same for the reading for the simple circuit?
    c. Describe how you think the meter readings might impact the brightness of the light(s).
    The lower the meter reading, the dimmer the light.
4. Students should turn off the switch.

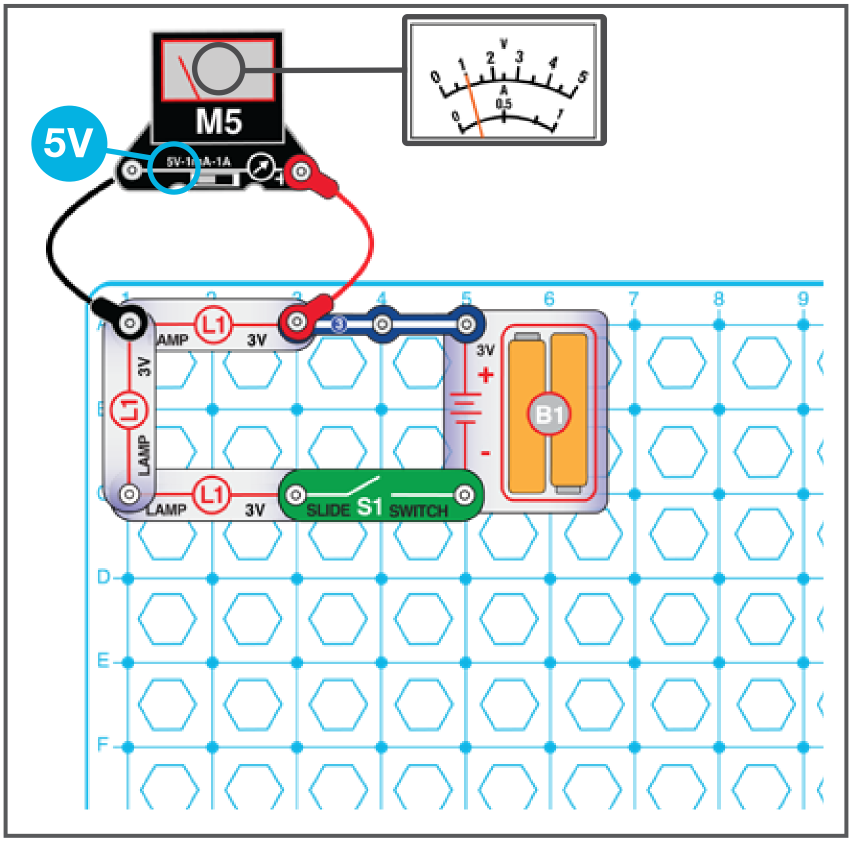
Skip this section if time is limited

Let's try a series circuit with 3 lights instead of just 2:

• Make the series circuit below using three L1 lamps connected in series. That means if you trace the pathway of the electrons that you will make one continuous loop from the source of electrons (starting at the negative terminal), through each of the 3 lights, and back to the source (finishing at the positive terminal).
• Students will sequentially move the meter along the loop to determine the voltage at each position.

Directions, Observations, and Formative questions in the SCAN:

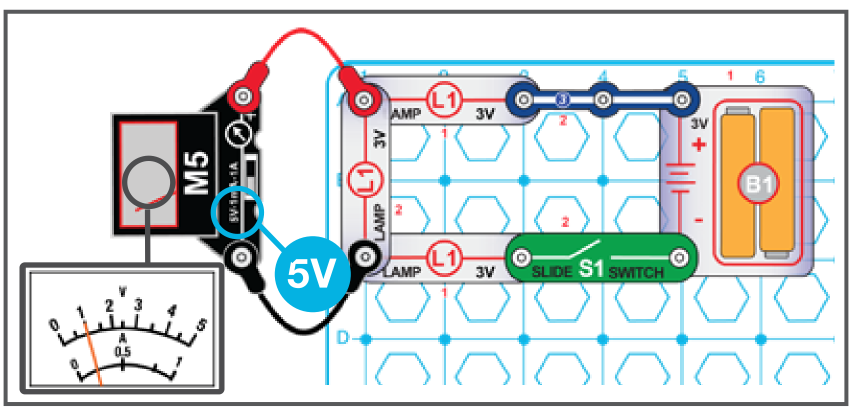
1. When the meter is snapped across the first light and the switch (S1) is turned on:



a. What happens to the light? Is it On or Off? **On**
b. What does the meter show for voltage over the first light? **1V**
c. When comparing the brightness of the 2 lights to the brightness of the light in simple circuit, which circuit produced the brighter lights? **Simple Circuit** or Series circuit
d. Describe how the brightness of the lights in the series circuit compares with the brightness of the light in the simple circuit. **The lights in the series circuit are dimmer than the light in the simple circuit.**
e. When comparing the brightness of the 3 lights to the brightness when there were only 2 lights, in which series circuit were lights brighter? **2 light series circuit** OR 3 light series circuit

2. Students should turn off the switch.

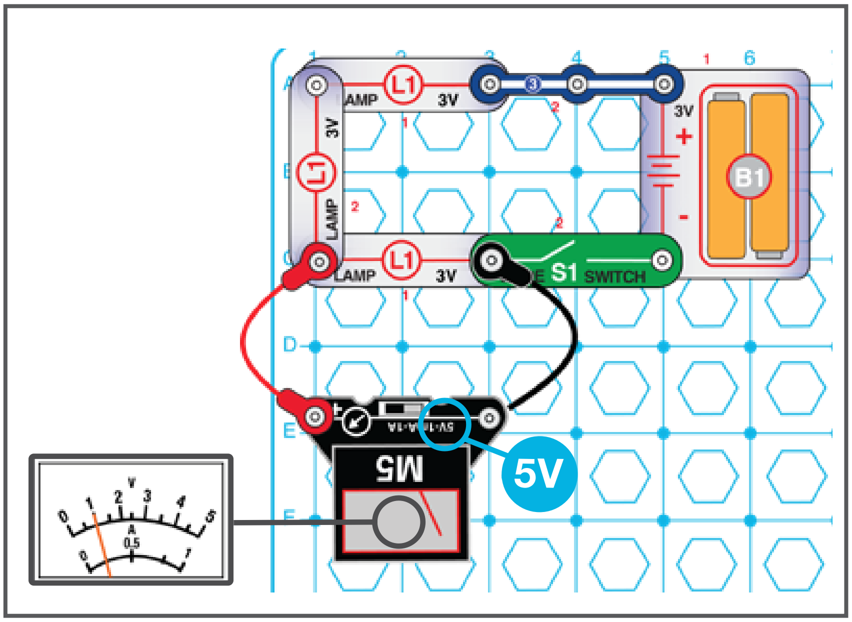
EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	1V
TOP LIGHT (L1)	Light turns on	Dim
LEFT LIGHT (L1)	Light turns on	Dim
BOTTOM LIGHT (L1)	Light turns on	Dim



EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	1V
TOP LIGHT (L1)	Light turns on	Dim
LEFT LIGHT (L1)	Light turns on	Dim
BOTTOM LIGHT (L1)	Light turns on	Dim

3. When the meter is moved and is connected across the second light and the switch (S1) is turned on:
   a. What does the meter show for voltage over the 2nd light in the series? **1V**
   b. Are the meter readings for the 3 light series circuit higher, **lower**, or the same for the reading for the simple circuit?
   c. Describe how you think the meter readings might impact the brightness of the light(s).
   The lower the meter reading, the dimmer the light.
4. Students should turn off the switch.

Skip this section if time is limited



EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	1V
UPPER LIGHT (L1)	Light turns on	Dim
LEFT LIGHT (L1)	Light turns on	Dim
LOWER LIGHT (L1)	Light turns on	Dim

5. When the meter is moved and connected across the third light and the switch (S1) is turned on:
   a. What does the meter show for voltage across the 3rd light in the series? **1V**
   b. Describe how you think the meter readings might impact the brightness of the light(s). **The lower the meter reading, the dimmer the light.**

6. The students should turn off the switch.

7. Students should disconnect the meter.

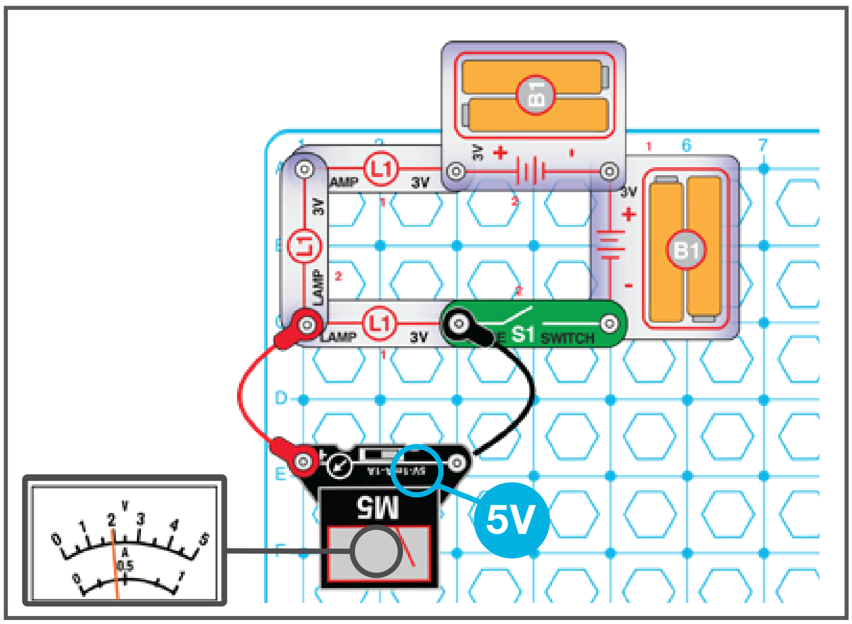
8. Students should remove the middle lamp. Students should not put anything in its place.

9. Students should turn on the switch.
   a. Do the other 2 lights still work? Yes or **No**
   b. Explain what you think just happened. **Because all of the lights are part of the same path, when one light is removed, it didn't matter which one, then all of the lights will go out. The removal of one part of the path creates an open circuit. No electricity flows through an open circuit.**

Skip this section if time is limited:

NOTE: This circuit is for class discussion, but is not shown in the SCAN.

Narration: It is not just loads, like lights, that can be arranged in series in a circuit. All sorts of circuit components can be connected. This includes sources of electrons like batteries. As there are two sides or terminals to a battery it is very important to connect them properly. You might be familiar that there is a flat side to a battery, the negative terminal, and a side with a little knob on the end, that is the positive terminal. You connect the positive terminal of one battery to the negative terminal of the next battery. When connecting sources in series, the result will be that the voltages add together. Different components have different voltage needs, so a circuit with more voltage can run more loads. A picture of how this will look for Snap Circuits® is found below.



Note: if you are using AC-SNAP (The optional Snap Circuits® AC adapter) then connect the 6V side of the B6 module in place of one battery holder and use a 3 snap wire in place of the other battery holder..
For additional information turn to page 74

Series Circuit with 3 Loads and 2 battery holders:

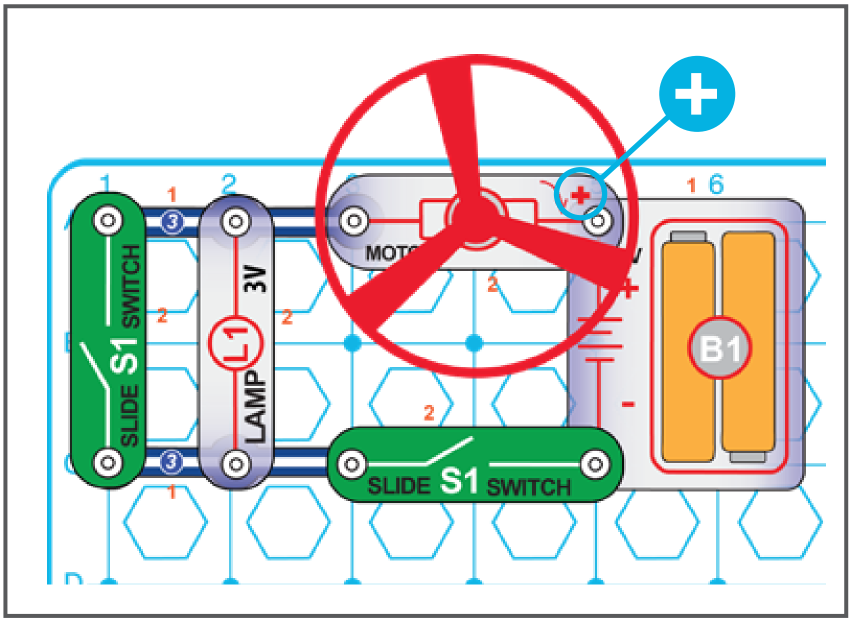
EXPECTED RESULTS: With S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	2V
UPPER LIGHT (L1)	Light turns on	Med Bright
LEFT LIGHT (L1)	Light turns on	Med Bright
LOWER LIGHT (L1)	Light turns on	Med Bright

Parts used:
- 2 Battery holder (B1)
- 1 Base grid
- 3 3V Lamp (L1)
- 1 Meter (M5)
- 1 Slide switch (S1)
- 1 Red jumper wire
- 1 Black jumper wire

Challenge Activity: Changing Loads -Skip this section if time is limited.

Narration: Many of us have ceiling fans in our homes. Often these ceiling fans also have a light. With one flick of a switch on the wall both the fan and the light turns on. But what if you only want the fan to work? Can you construct a circuit that uses both a motor/fan and a light where you can have the fan work with or without the light?

Some things to consider: Students will construct a series circuit with 2 loads, one is a light and the other is a motor/fan combination. The students already have experience with constructing simple circuits with just the motor/fan blade combination and with just a light, they should be able to understand how each of the loads work by themselves.



Answers for P.23 in the Student Notebook

EXPECTED RESULTS: Left S1 On, Right S1 On		
PART	**ACTION**	**RESULT**
LIGHT (L1)		Off
FAN	Motor turns fan	Fan spins

Parts used:
- 2 3-snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 1 3V Lamp (L1)
- 1 Motor (M1)
- 1 Fan
- 2 Slide switch (S1)

DISCUSSION

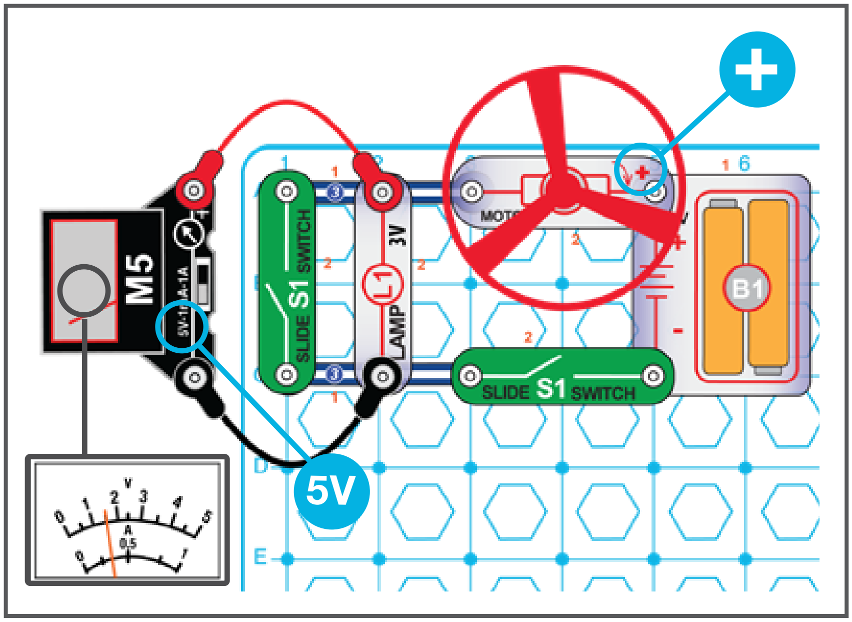
1. A little added twist is present here, the addition of a second switch. Students will explore "the path of least resistance" by using this second switch, the one that is physically parallel to lamp L1. More on this in the explanation portion, in **bold**, in the formative questions section below.
    a. How many loads will you need? **2 (Motor and Lamp)**
    b. How many switches will you need? **2 S1 Switches**

Challenge Activity: Changing Loads -Skip this section if time is limited.

2. Observations and Formative questions for the SCAN:

a. With both switches turned off, explain how you think this series circuit functions. Your response should include a description of the pathway through this circuit and what you think will happen to the L1 lamp and the fan. **Students might identify that when the switches are turned on that both the light and the fan will work. Students should be describing that the pathway starts at the negative terminal, travels through the switch to the light {they may say something about the second switch}, through the motor to make the fan spin, and then end at the positive terminal.**

b. Connect the meter across the lamp and discuss how the meter readings differ from the loads when used in simple circuits and if the performance (brightness of the light or fan speed) changes as a result of being in the series circuit. (**Below are some sample directions, observations with meter readings, and formative responses that teacher might wish to pose to the students.**)



Circuit with meter added across lamp:

EXPECTED RESULTS: Left S1 Off, Right S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	1V
FAN	Motor turns fan	Fan spins
LIGHT (L1)	Turns on	Dim

Parts used:

2	3-snap wire	1	Fan
1	Battery holder (B1)	1	Meter (M5)
1	Base grid	2	Slide switch (S1)
1	3V Lamp (L1)	1	Red jumper wire
1	Motor (M1)	1	Black jumper wire

c. With the switch closest to the batteries turned on, and the other one off:

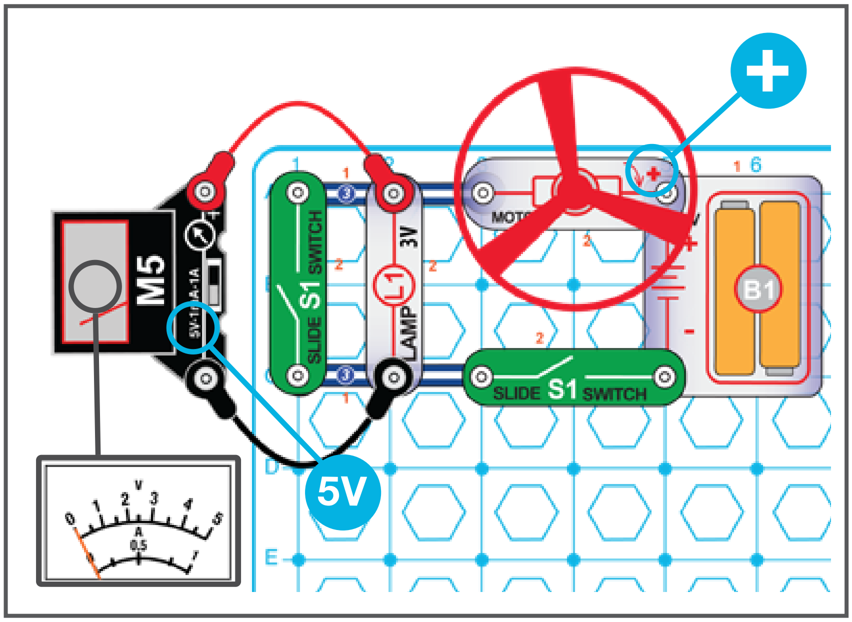
1) Does the light turn on? **Yes** or No

2) Does the fan spin? **Yes** or No

3) What is the voltage reading on the light? (**1V**)

d. With the switch closest to the batteries still turned on, turn on the other switch as well:

Challenge Activity: Changing Loads -Skip this section if time is limited.



EXPECTED RESULTS: Left S1 On, Right S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	0V
FAN	Motor turns fan	Spins Fast
LIGHT (L1)	-------	Off

Parts used:

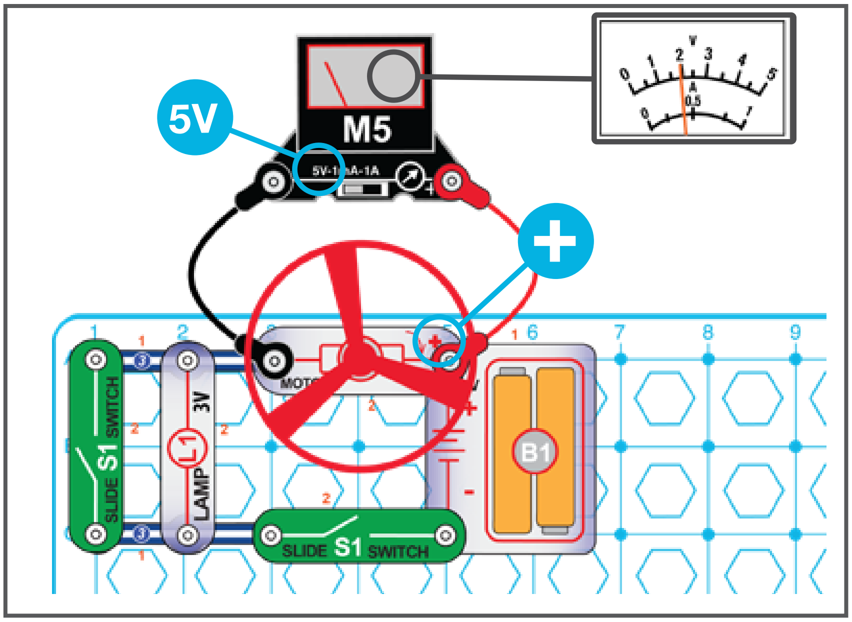
- **2 3-snap wire**
- **1 Battery holder (B1)**
- **1 Base grid**
- **1 3V Lamp (L1)**
- **1 Motor (M1)**
- **1 Fan**
- **1 Meter (M5)**
- **2 Slide switch (S1)**
- **1 Red jumper wire**
- **1 Black jumper wire**

1) Does the light turn on? Yes or **No**
2) Does the fan spin? **Yes** or No
3) If your response above is yes, does the speed of the fan change at all? **Spins Faster** or Spins Slower
4) What is the voltage reading on the light? (**0V**)
5) Explain what you think is happening when the second switch is turned on and why this is occurring. (**Responses can vary widely. Below teachers will find out how to discuss "path of least resistance".**)

e. Turn off both switches.

f. Move the meter over to snap across the motor. Our switching sequence from above will be repeated now.

g. With the switch closest to the batteries turned on, and the other one off:



EXPECTED RESULTS: Left S1 Off, Right S1 On		
PART	**ACTION**	**RESULT**
METER (M5)	Needle Moves	2V
FAN	Motor turns fan	Fan spins
LIGHT (L1)	Turns on	Dim

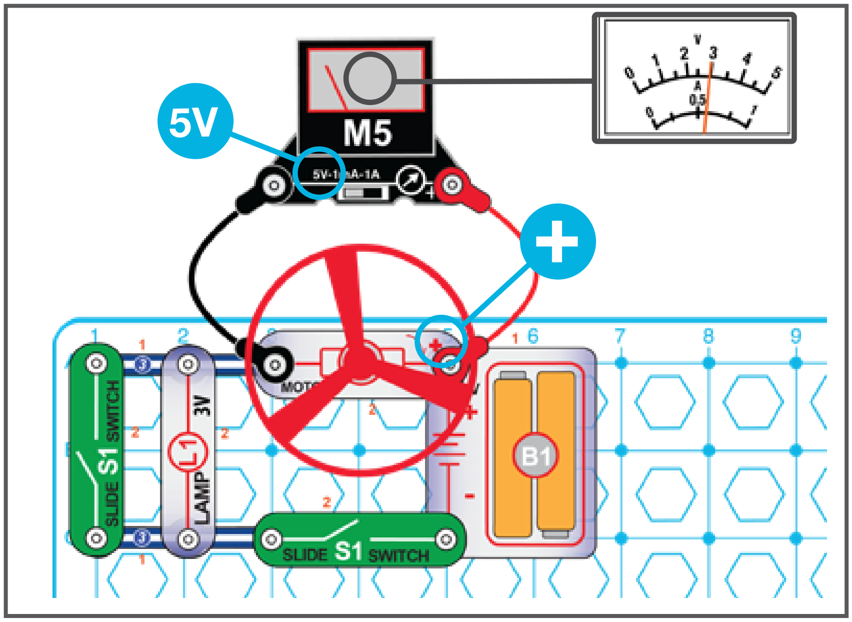
Parts used:

- **2 3-snap wire**
- **1 Battery holder (B1)**
- **1 Base grid**
- **1 3V Lamp (L1)**
- **1 Motor (M1)**
- **1 Fan**
- **1 Meter (M5)**
- **2 Slide switch (S1)**
- **1 Red jumper wire**
- **1 Black jumper wire**

1) Does the light turn on? **Yes** or No
2) Does the fan spin? **Yes** or No
3) What is the voltage reading on the motor? **2V**

h. With the switch closest to the batteries still turned on, turn on the other switch as well:

Challenge Activity: Changing Loads -Skip this section if time is limited.



EXPECTED RESULTS: Both S1s On		
PART	ACTION	RESULT
METER (M5)	Needle Moves	3V
FAN	Motor turns fan	Spins fast
LIGHT (L1)	Turns on	Off

Parts used:

2	3-snap wire	1	Fan
1	Battery holder (B1)	1	Meter (M5)
1	Base grid	2	Slide switch (S1)
1	3V Lamp (L1)	1	Red jumper wire
1	Motor (M1)	1	Black jumper wire

1) Does the light turn on? Yes or **No**
2) Does the fan spin? **Yes** or No
3) If your response is yes, does the speed of the fan change at all? **Spins Faster** or Spins Slower
4) What is the voltage reading on the motor? **3V**

i. Turn both switches off.

Narration

Here's a discussion of "path of least resistance". On Day 2 students were given a brief introduction to what resistance is. Electricity will choose to flow along the path where the components have lower resistance compared to a different path. In general, a load has more resistance than just a wire. Thus, when the second switch is also turned on, the path of the electricity flows from the batteries, through the first switch, bypasses the light because the path can go through the lower resistance of the wire instead, and then on to the motor, ending back at the batteries. Some of the evidence for this includes:

a. That the light doesn't turn on.
b. That the voltage across the light goes drops to 0V.
c. That the motor spins faster.
d. That the voltage on motor increases to 3V.

INTRODUCTION TO
Loads in Parallel

Day 6 & 7

Narration:

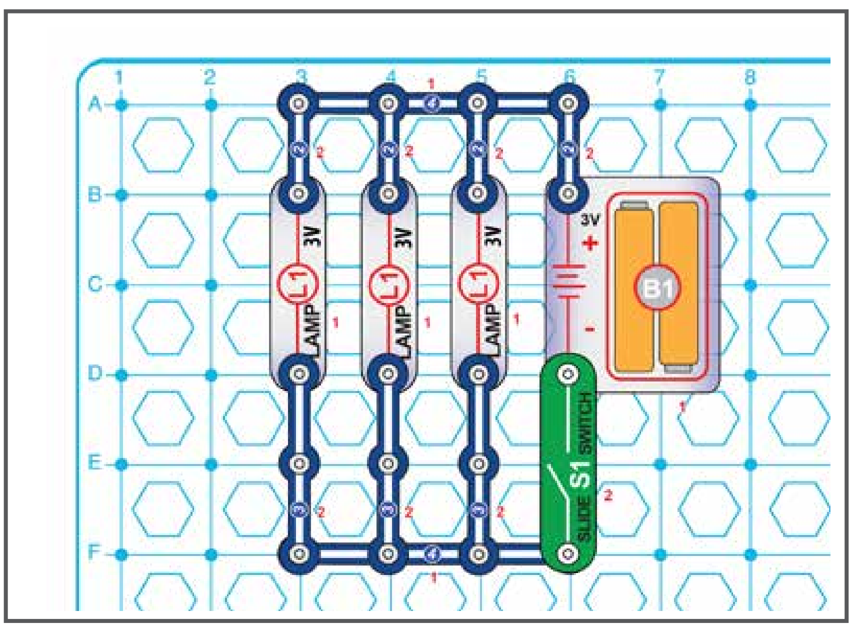
(Review of series circuit) With electricity, for a series circuit, the electrical path can be traced showing that the electricity flows to each load in order, one after the other. There is another type of circuit, that has multiple loads, and that is called parallel. In a parallel circuit, electricity flows in multiple pathways, independent of the other paths.

Loads in Parallel

[addresses 4-PS3-2, 4-PS3-4, Math Connections of Measurement and Data with Represent and interpret data]

Directions, Observations and Formative questions for the SCAN:
Students build the circuits shown on pages 49-50.

1. Students should connect the meter across the batteries.
2. Students should turn on the switch.
    a. What is the voltage shown on the meter? **2.5V - 3V**
    b. Are the lights on? **Yes** or No
    c. In remembering how the 2 or 3 lights in series looked, in terms of brightness, how would you consider the lights connected in parallel to be? **Brighter than the series lights**, dimmer than the series lighters, or the same brightness as the series lights
3. Students should reconnect the meter to be across the light closest to the batteries. It is not necessary to turn off the switch while reconnecting the meter.
    a. What is the voltage? **2.5V - 3V**
4. Students should reconnect the meter to be across the light in the middle.
    a. What is the voltage? **2.5V - 3V**
5. Students should reconnect the meter to be across the light farthest from the batteries.
    a. What is the voltage? **2.5V - 3V**
6. Students should turn off the switch and disconnect the meter.
    a. Why do you think each of the lights had the same high voltage?
    Students should respond something along the lines of that each light has an independent pathway from the batteries, through the switch, through the light, and back to the batteries.
7. Students should disconnect, remove from the circuit any one light. **They can choose which light they remove.**
8. Students should turn on the switch.
    a. What happened to the other lights? **All remaining lights lighted** or only one of the remaining lights lighted or none of the lights lighted
    b. Explain why you think that occurred. **If the students found that the remaining lights lighted, then the reason was because each of the lights has its own unique pathway for the electricity.**



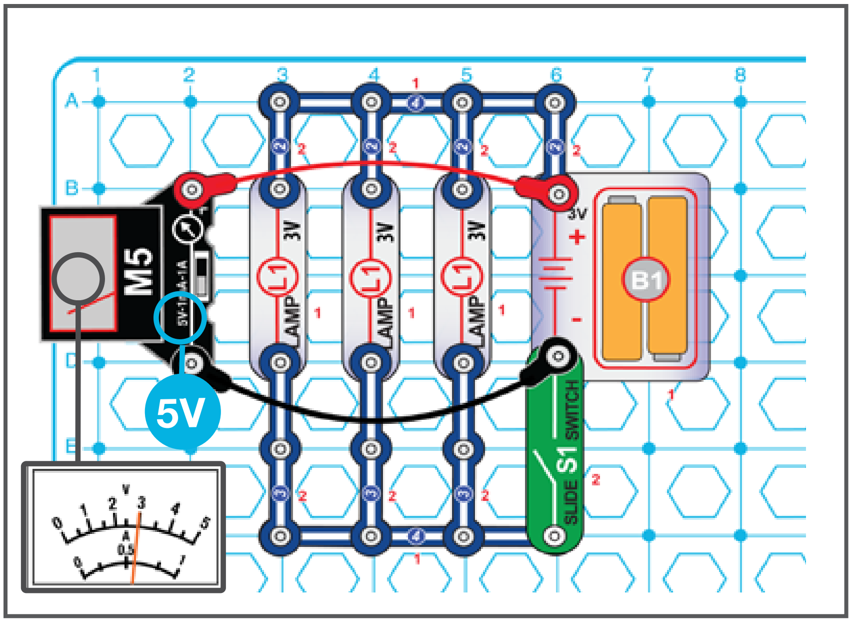
3 lamps, no meter yet:

EXPECTED RESULTS: With S1 on		
PART	ACTION	RESULT
LEFT LIGHT (L1)	Turns on	Bright
CENTER LIGHT (L1)	Turns on	Bright
RIGHT LIGHT (L1)	Turns on	Bright

Parts used:

4	2-Snap wire	1	Black jumper wire
3	3-snap wire	3	3V Lamp (L1)
2	4-Snap wire	1	Motor (M1)
1	Battery holder (B1)	1	Fan
1	Base grid	1	Meter (M5)
1	Red jumper wire	1	Slide switch (S1)

Loads in Parallel

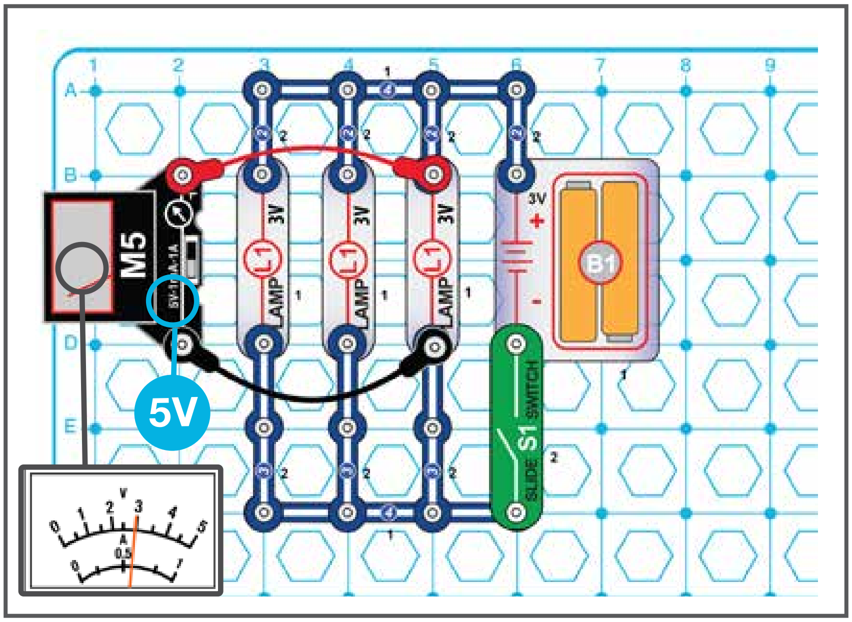


3 lamps, meter position 1 (Refer to Step 1):

EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
LEFT LIGHT (L1)	Turns on	Bright
CENTER LIGHT (L1)	Turns on	Bright
RIGHT LIGHT (L1)	Turns on	Bright
METER (M5)	Needle moves	2.5V-3V

Parts used:

- 4 2-Snap wire
- 3 3-snap wire
- 2 4-Snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 1 Red jumper wire
- 1 Black jumper wire
- 3 3V Lamp (L1)
- 1 Meter (M5)
- 1 Slide switch (S1)

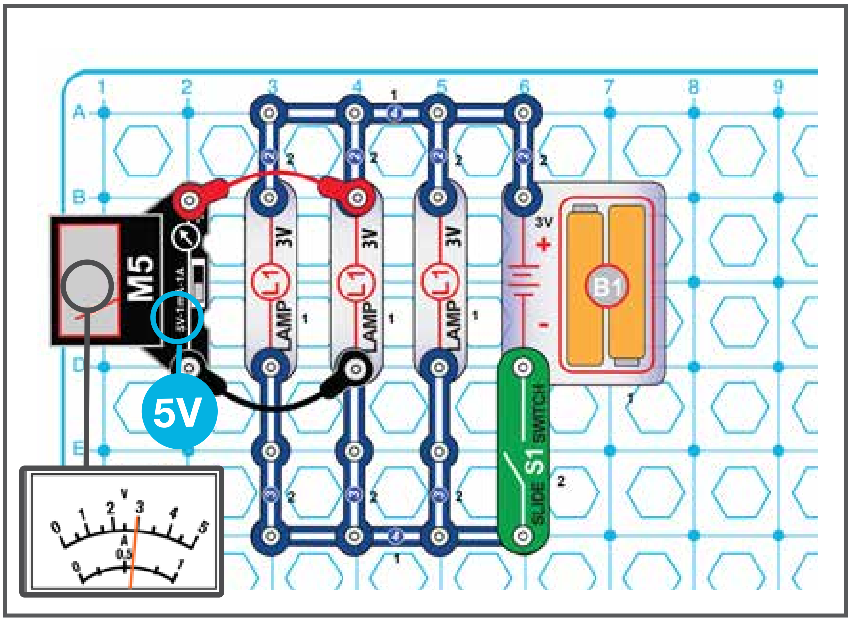


3 lamps, meter position 2 (Refer to Step 3):

EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
LEFT LIGHT (L1)	Turns on	Bright
CENTER LIGHT (L1)	Turns on	Bright
RIGHT LIGHT (L1)	Turns on	Bright
METER (M5)	Needle moves	2.5V-3V

Parts used:

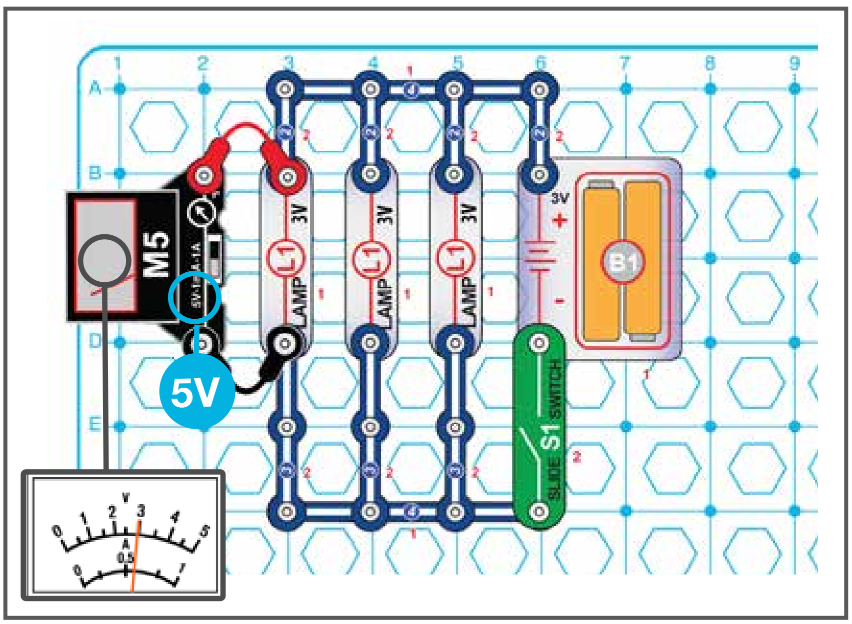
- 4 2-Snap wire
- 3 3-snap wire
- 2 4-Snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 1 Red jumper wire
- 1 Black jumper wire
- 3 3V Lamp (L1)
- 1 Meter (M5)
- 1 Slide switch (S1)



3 lamps, meter position 3 (Refer to Step 4):

EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
LEFT LIGHT (L1)	Turns on	Bright
CENTER LIGHT (L1)	Turns on	Bright
RIGHT LIGHT (L1)	Turns on	Bright
METER (M5)	Needle moves	2.5V-3V

Parts used:
- **4 2-Snap wire**
- **3 3-snap wire**
- **2 4-Snap wire**
- **1 Battery holder (B1)**
- **1 Base grid**
- **1 Red jumper wire**
- **1 Black jumper wire**
- **3 3V Lamp (L1)**
- **1 Meter (M5)**
- **1 Slide switch (S1)**



3 lamps, meter position 4 (Refer to Step 5):

EXPECTED RESULTS: With S1 on		
PART	ACTION	RESULT
LEFT LIGHT (L1)	Turns on	Bright
CENTER LIGHT (L1)	Turns on	Bright
RIGHT LIGHT (L1)	Turns on	Bright
METER (M5)	Needle moves	2.5V-3V

Parts used:
- **4 2-Snap wire**
- **3 3-snap wire**
- **2 4-Snap wire**
- **1 Battery holder (B1)**
- **1 Base grid**
- **1 Red jumper wire**
- **1 Black jumper wire**
- **3 3V Lamp (L1)**
- **1 Meter (M5)**
- **1 Slide switch (S1)**

Changing Loads -Door Bell

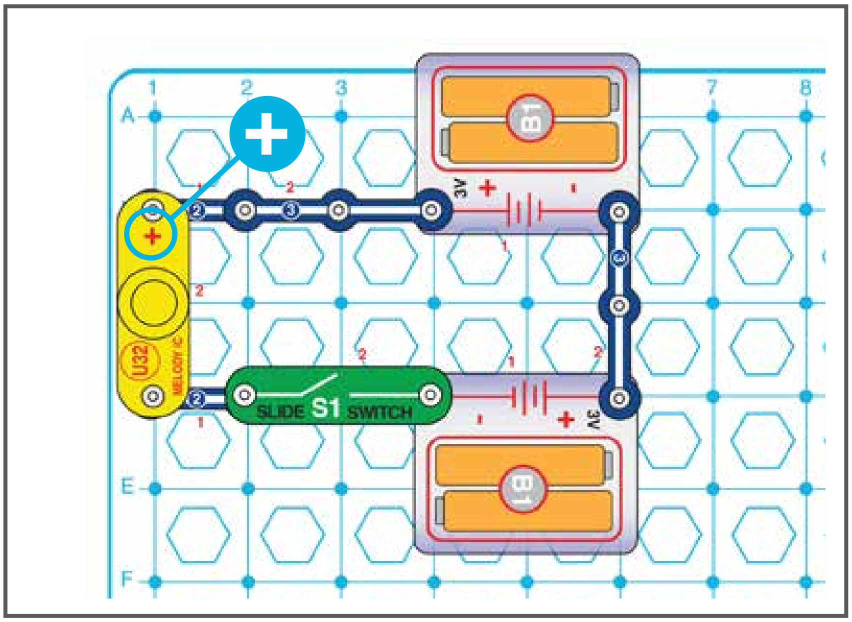
[addresses 4-PS3-2, 4-PS3-4, 3-5ETS1-2]

Challenge Activity
Students Create the circuit shown below.

Directions, Observations and Formative questions in the SCAN:

Door Bell:

1. When the switch is turned on, describe what happened. **Music played**



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
MELODY IC (U32)	Switch on	Music

Possible parts needed:

2	2-snap wire
2	3-snap wire
2	Battery holder (B1)
1	Base grid
1	Slide switch (S1)
1	Melody IC (U32)

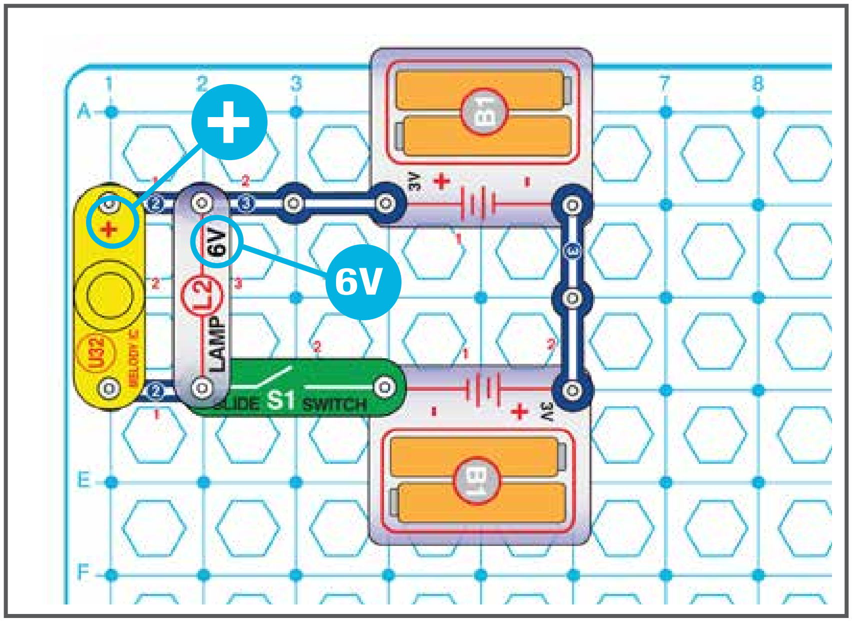
Changing Loads -Door Bell

[addresses 4-PS3-2, 4-PS3-4, 3-5ETS1-2]

Doorbell with Light:

Students, let's see if you can solve a common problem.
The scenario is that there is a person who has a hearing loss and can't easily hear the doorbell.

2.Can you create a circuit that, when it is turned on (when the switch is turned on) that both the doorbell rings AND a light turns on?



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
MELODY IC (U32)	Switch on	Music
LIGHT (L2)	Switch on	Bright

Possible parts needed:
- 2 2-snap wire
- 2 3-snap wire
- 2 Battery holder (B1)
- 1 Base grid
- 1 6V Lamp (L2)
- 1 Slide switch (S1)
- 1 Melody IC (U32)

a. Describe the circuit that you created and what the results were when you tested it? **Students should create a circuit where the doorbell and light are arranged in parallel with each other.**

b. When the switch is turned on, describe what happened.
When the switch is turned on both the doorbell rings and the light turns on.

SNAP CIRCUITS

INTRODUCTION TO
LEDs and Resistors

Day 8

Note:

Days 8-10 can be skipped to save time, at the discretion of the teacher. Teacher may still include some of the Extra Day Activities, depending on which activities you feel would be most beneficial to the students.

LEDs and Resistors

[addresses 4-PS3-2, 4-PS3-4, 3-5ETS1-3, Math Connections of Measurement and Data with Represent and interpret data, Operations and Algebraic Thinking with Write and Analyze Patterns]

Narration:

We are adding in 2 new components: resistors and a LED (Light Emitting Diode).
Let's revisit Day 2 and our discussion on resistors. A function of a resistor is to restrict or to make more difficult the passage of electricity through an area of a circuit. All materials have some resistance to them, but adding a resistor, of a certain level, can be a way to specifically decrease the passage of electricity. Resistors have many applications including reducing the flow of electricity to limit power consumption or protect sensitive components, and to reduce voltage to a desired level. Resistors can be made in a wide range of levels and their ratings are in units of ohms. The higher the number of ohms, the greater the amount of their resistance to the flow of electricity.

A new component of our discussion is the Light Emitting Diode (LED). An LED is a semiconductor device that emits light when activated. An LED acts as a one-way valve that allows electricity to flow in only ONE direction. You will see on our LED parts that its symbol has a vertical line touching the tip of a triangle, also includes a + sign. When the LED is positioned in the circuit so that the + sideis facing the + terminal of the source, then electricity will flow through it. But when the + side is facing the – terminal of the source, then the LED stops all flow of electricity.

The LED symbol also has 2 arrows coming away from the vertical line, because it emits light when properly positioned and activated by voltage. LEDs are commonly used as indicator lights and often for home lighting because they are more energy efficient than incandescent light bulbs.

Directions, Observations and Formative questions for the SCAN:

Students build the circuits shown on page 56.(Page 32 in the SCAN)

1. When the switch is turned on what happens to the LED? The light turns on OR **The light stays off**
    a. If your light stayed off, why do you think this happened? Have you checked your LED?

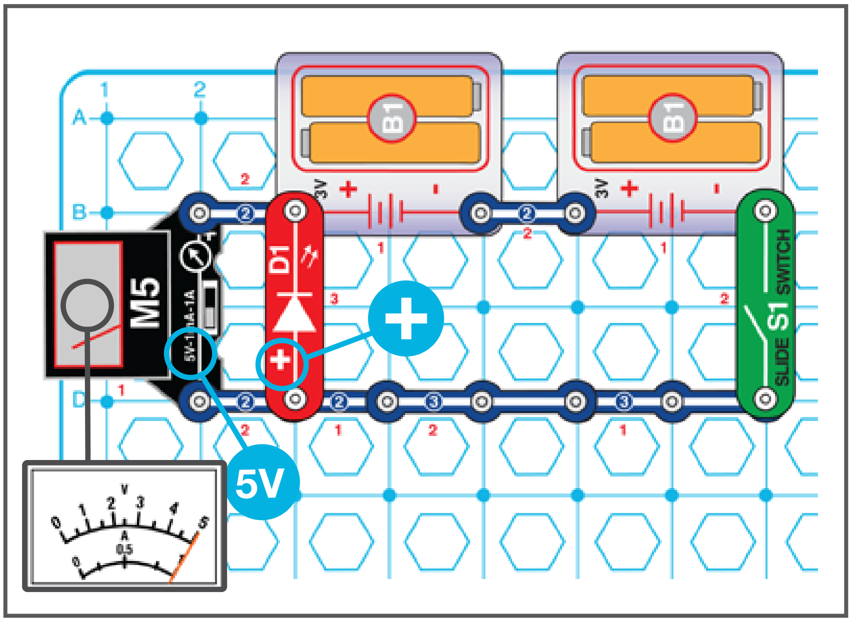
Students should point out that the + side of the LED wasn't facing the + terminal of the batteries. So, the diode part wasn't allowing any electricity to flow.

2. Turn the switch off.
3. If your light stayed off in part 1 flip your LED around.
    a. Turn the switch on. What happens to the LED? The light turns on OR **The light turns off**
    b. Would you consider the light to be **bright** or dim?
    c. What is the voltage showing on the meter? **More than 5V**
4. Turn the switch off.
5. Replace the 3-snap wire with the R1 resistor that has 100 Ohms of resistance. This part is marked as 100Ω. Unlike with the LED, there is no specific direction or way the resistor has to be put in the circuit.
    a. Turn on the switch.
    b. Does the light turn on? **Yes** or No
    c. Would you consider the light to be **bright** or dim?
    d. What is the voltage showing on the meter? **About 5V**

6. Replace the R1 resistor with the R2 resistor (1KΩ, 1000 ohms of resistance), then the R3 resistor (5.1KΩ, 5100 ohms of resistance), and then the R4 resistor (10KΩ,10,000 ohms of resistance). it is not necessary to turn off the switch while replacing the resistor. Record the LED brightness and the voltage on the meter in the table below.

Resistance Level (Ohms)	Voltage on Meter (V)	Brightness of Light
0	more than 5V	Very bright
100	about 5V	Very bright
1000 (1K)	about 3V	Bright
5100 (5.1K)	about 2V	Dim
10,000 (10K)	less than 2V	Very dim

7. Can you describe the trend of what happens to the brightness of the light in LED as the resistance in the circuit changes and why?
As the resistance in the circuit increases, the brightness of the light in the LED decreases. This is because as resistance goes up the amount of electricity that flows through the circuit decreases. This lower amount of electricity is shown because when the resistance goes up, the voltage shown on the meter goes down, indicating that there is less electricity flowing through the LED. Thus, voltage and resistance are inversely related.



Circuit for step 1, LED backwards:

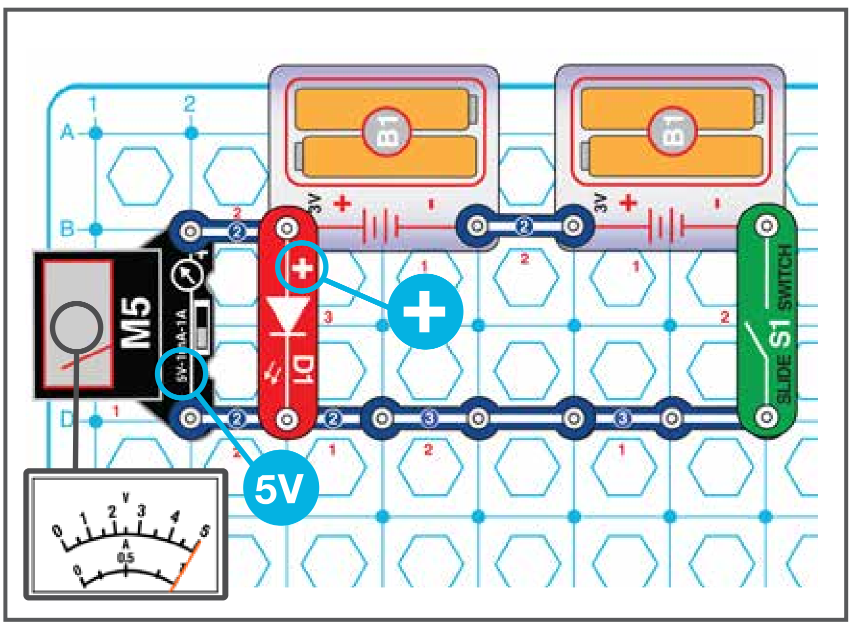
EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
METER (M5)	Needle Moves	>5V
RED LED (D1)	Switch on	Off

Parts used:

- 4 2-snap wire
- 2 3-snap wire
- 2 Battery holder (B1)
- 1 Base grid
- 1 Red LED (D1)
- 1 Meter (M5)
- 1 Slide switch (S1)

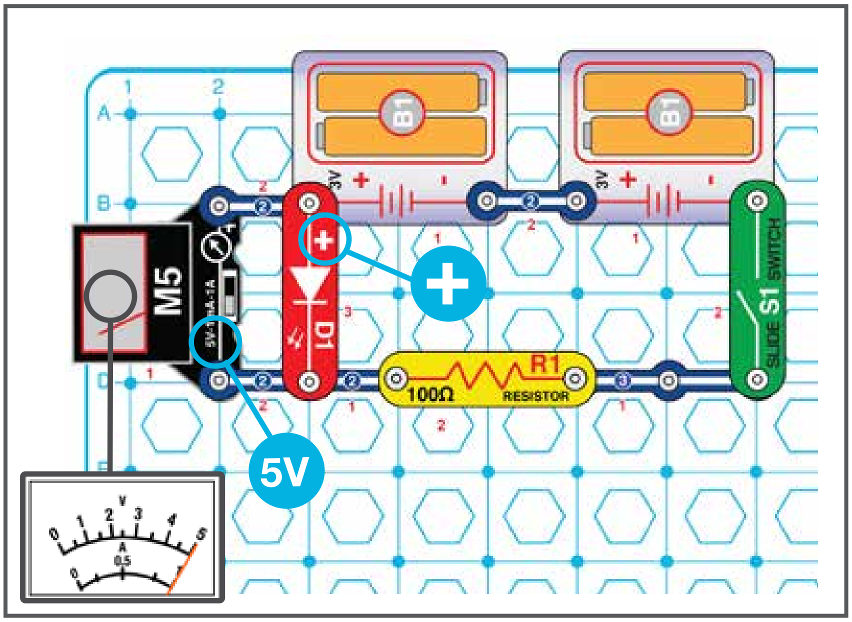
used later:

- 1 100Ω resistor (R1)
- 1 1kΩ resistor (R2)
- 1 5.1kΩ resistor (R3)
- 1 10kΩ resistor (R4)



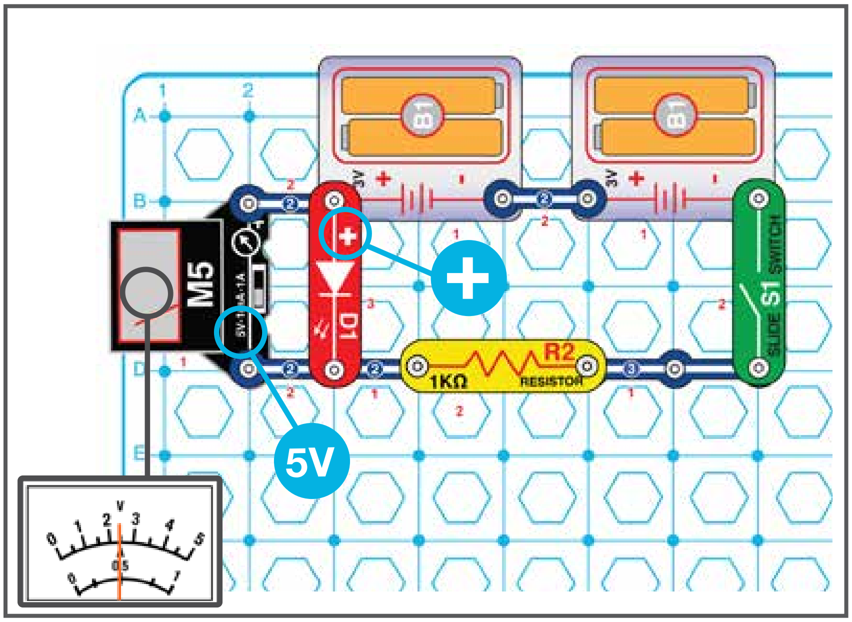
Circuit for step 3, LED with no resistor:

EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
METER (M5)	Needle Moves	5V
RED LED (D1)	Switch on	Very Bright



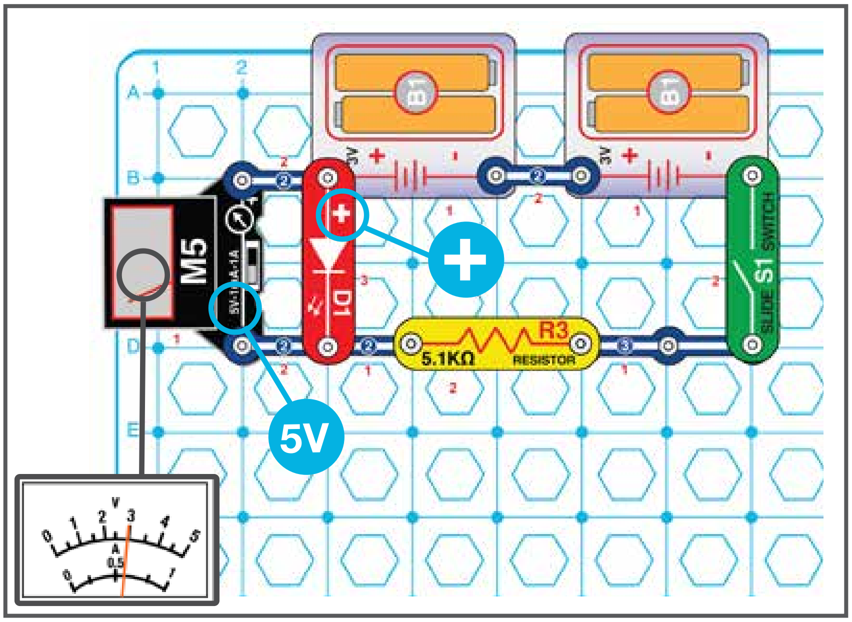
Circuit for step 5, LED with 100Ω:

EXPECTED RESULTS: With S1 on		
PART	ACTION	RESULT
METER (M5)	Needle Moves	5V
RED LED (D1)	Switch on	Very Bright



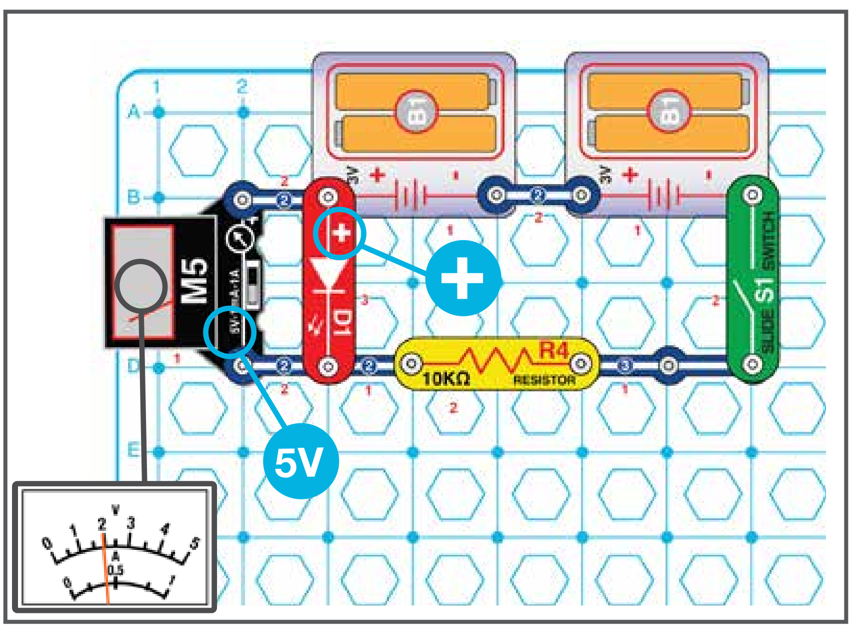
Circuit for step 6, LED with 1KΩ:

EXPECTED RESULTS: With S1 on		
PART	ACTION	RESULT
METER (M5)	Needle Moves	3V
RED LED (D1)	Switch on	Bright



Circuit for step 6, LED with 5.1KΩ:

EXPECTED RESULTS: With S1 on		
PART	ACTION	RESULT
METER (M5)	Needle Moves	2V
RED LED (D1)	Switch on	Dim



Circuit for step 6, LED with 10KΩ:

EXPECTED RESULTS: With S1 on		
PART	ACTION	RESULT
METER (M5)	Needle Moves	<2V
RED LED (D1)	Switch on	Very dim

INTRODUCTION TO
LEDs and Variable Resistor

Day 9

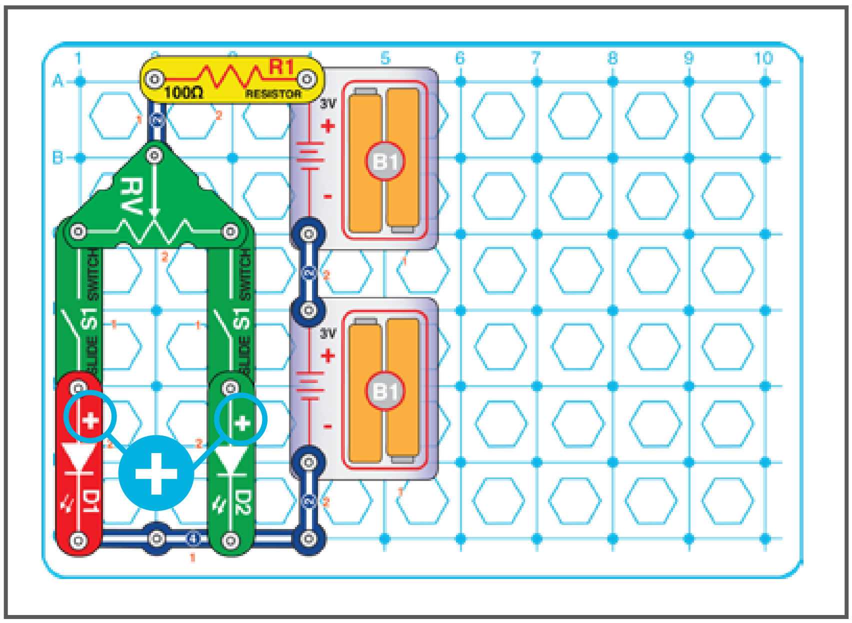
Narration:

It is common to control the brightness of a light, either in a room or on an iPad, with a dimmer switch. The dimmer switch is actually a variable resistor with can change the resistance just by moving a slide from one side to the other. To show the application of changing resistance with a single device let's take a look at combining a variable resistor with diodes in this fun set up. Students should be able to find the different pathways through this circuit.

[addresses 4-PS3-2, 4-PS3-4]

Directions, Observations and Formative questions for the SCAN:

1. Students build the circuit below. Students need to start with the variable resistor slide in the center position.
2. Students should make sure that their LEDs are properly positioned to allow electricity to flow.



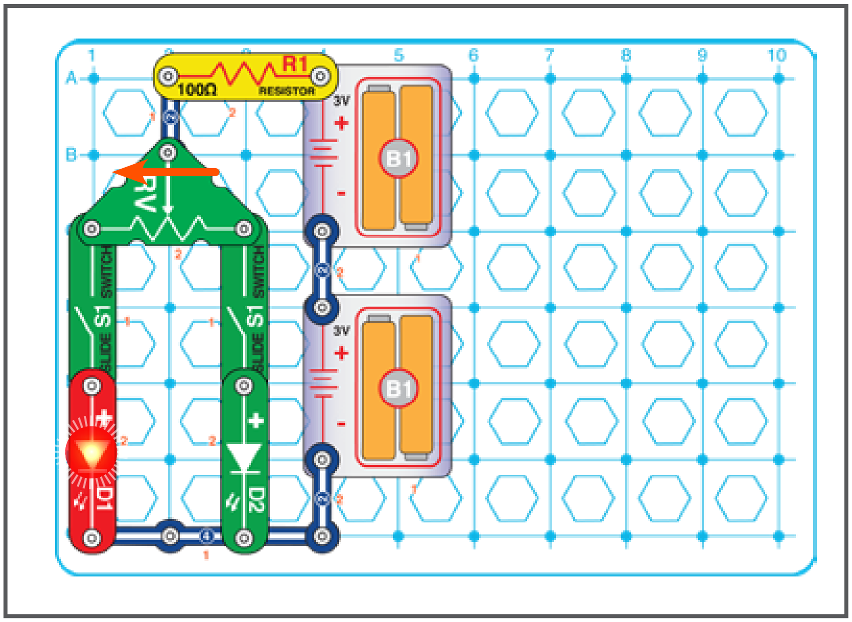
EXPECTED RESULTS: Left S1 on, Right S1 on		
PART	ACTION	RESULT
RESISTER SLIDE (RV)	Moves Center	----
RED LED (D1)	Switch on	Dim
GREEN LED (D2)	Switch on	Dim

Parts used:

3	2-snap wire
1	4-snap wire
1	Battery holder (B1)
1	Base grid
1	Red LED (D1)
1	Green LED (D2)
1	100Ω resistor (R1)
1	Variable resistor (RV)
2	Slide switch (S1)

3. Students move the variable resistor slide to the left.
4. Describe what happened to the lights in the LEDs and why? **Students should discuss that when they moved the slide to the left that the left LED turned on. This must mean that when the variable resistor is positioned on the left that a lower resistance pathway has been created on the left allowing the left LED to turn on.**
5. Students move the slide on the variable resistor to the right.
6. Describe what happened to the lights in the LEDs and why? **Students should discuss that when they moved the slide to the right that the right LED turned on. This must mean that when the variable resistor is positioned on the right that a lower resistance pathway has been created on the right allowing the right LED to turn on.**

LEDs and Variable Resistors

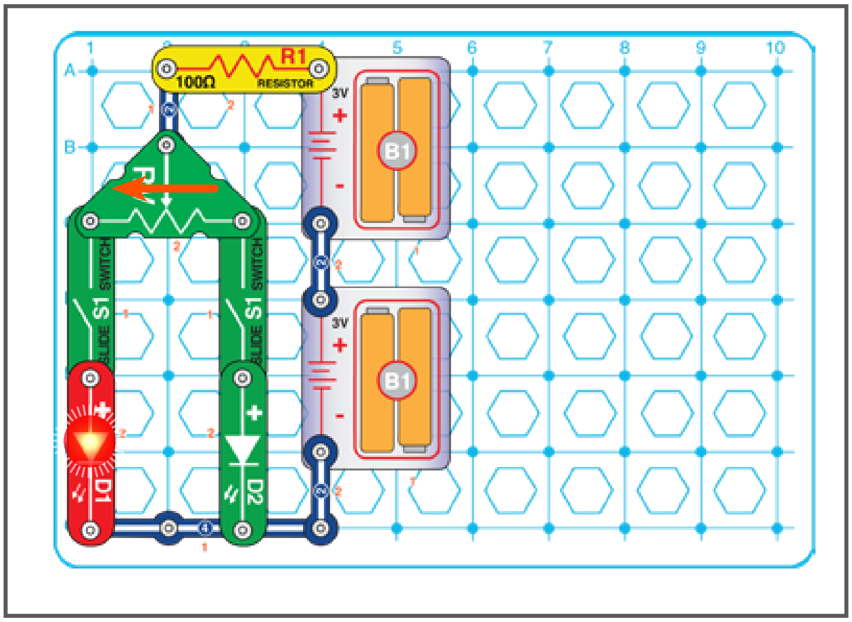


Circuits for step 3:

EXPECTED RESULTS: Left S1 On, Right S1 Off, RV to Left		
PART	**ACTION**	**RESULT**
VARIABLE RESISTOR (RV)	Move Left	----
RED LED (D1)	Switch on	Bright
GREEN LED (D2)	Switch on	Off

Parts used:

3	2-snap wire	1	Red LED (D1)
1	4-snap wire	1	Green LED (D2)
1	Battery holder (B1)	1	100Ω resistor (R1)
1	Base grid	1	V4ariable resistor (RV)
		2	Slide switch (S1)



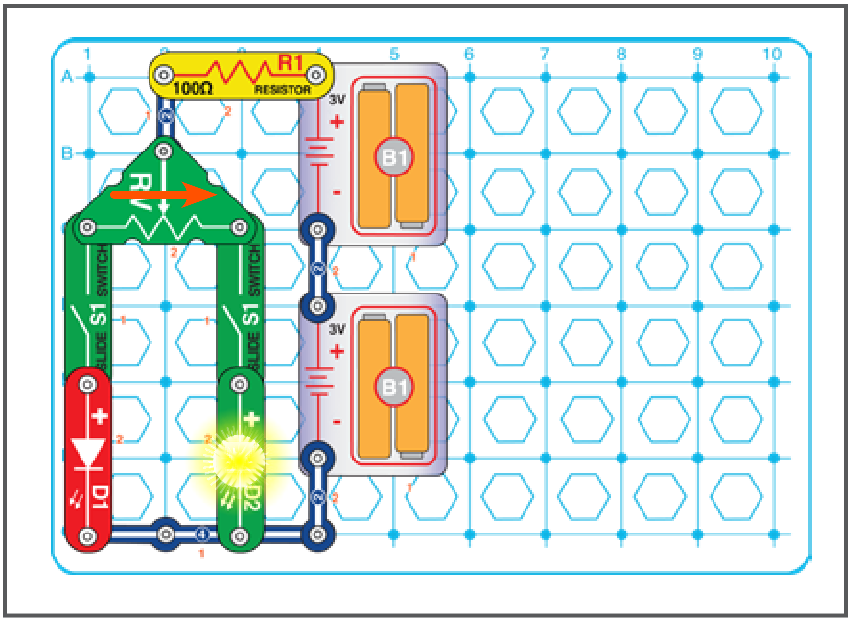
Circuits for step 3:

EXPECTED RESULTS: Left S1 On, Right S1 On, RV to Left		
PART	**ACTION**	**RESULT**
VARIABLE RESISTOR (RV)	Move Left	----
RED LED (D1)	Switch on	Bright
GREEN LED (D2)	Switch on	Very Dim

Parts used:

3	2-snap wire	1	Red LED (D1)
1	4-snap wire	1	Green LED (D2)
1	Battery holder (B1)	1	100Ω resistor (R1)
1	Base grid	1	Variable resistor (RV)
		2	Slide switch (S1)

LEDs and Variable Resistors

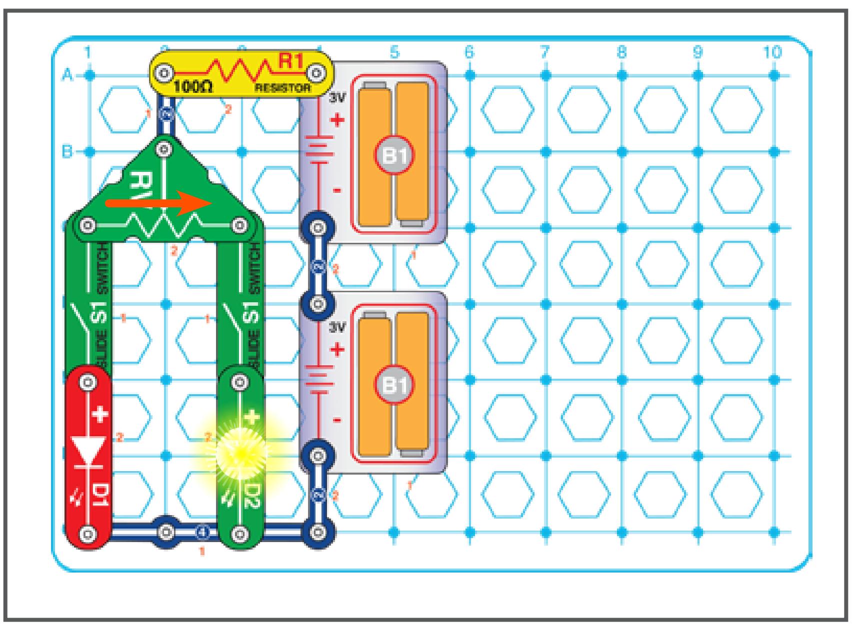


Circuits for step 5:

EXPECTED RESULTS: Left S1 Off, Right S1 Off, RV to Right		
PART	**ACTION**	**RESULT**
VARIABLE RESISTOR (RV)	Move Right	----
RED LED (D1)	Switch on	Off
GREEN LED (D2)	Switch on	Bright

Parts used:

- 3 2-snap wire
- 1 4-snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 1 Red LED (D1)
- 1 Green LED (D2)
- 1 100Ω resistor (R1)
- 1 Variable resistor (RV)
- 2 Slide switch (S1)



Circuits for step 5:

EXPECTED RESULTS: Left S1 On, Right S1 Off, RV to Right		
PART	**ACTION**	**RESULT**
VARIABLE RESISTOR (RV)	Move Right	----
RED LED (D1)	Switch on	Very Dim
GREEN LED (D2)	Switch on	Bright

Parts used:

- 3 2-snap wire
- 1 4-snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 1 Red LED (D1)
- 1 Green LED (D2)
- 1 100Ω resistor (R1)
- 1 Variable resistor (RV)
- 2 Slide switch (S1)

INTRODUCTION TO

Resistors in Series and Resistors in Parallel

Day 10

Narration:

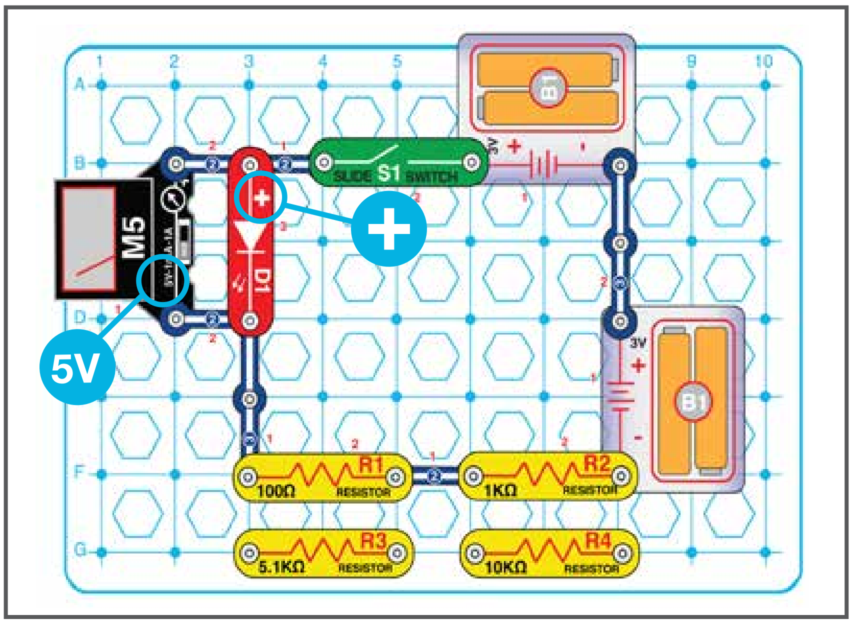
Students have been introduced to a number of different circuit components including, a source of electrons (batteries), conductors (wires), switches, resistors, LEDs, and different types of loads (lights, motors, and doorbells). They have also been introduced to different types of circuits including simple, series, and parallel. All circuit components can perform differently depending on how they arranged. An example of this is batteries in series or in parallel don't perform the same way as resistors in series or in parallel. In today's activities, we are going to look at how a simple circuit's performance can change when resistors are use either arranged in series or in parallel.

Resistors in Series

[addresses 4-PS3-2, 4-PS3-4]

Directions and Observations for the SCAN.

1. Students build the circuit pictured below, making sure that the LED is positioned properly.
2. Turn the switch on.
   a. What is the voltage measured across the LED? **(3V)**
3. Replace R1 with R3. It is not necessary to turn off the switch while doing this.
   a. What is the voltage measured across the LED. **(2V)**
4. Replace R2 with R4.
   a. What is the voltage measured across the LED? **(1.5V)**
5. Turn the switch off.



EXPECTED RESULTS: With R1 & R2		
PART	ACTION	RESULT
METER (M5)	Needle Moves	3V
RESISTOR 100Ω (R1)	Install	----
RESISTOR 1kΩ (R2)	Install	----

Parts used:

4	2-snap wire	1	Meter (M5)
2	3-snap wire	1	100Ω resistor (R1)
2	Battery holder (B1)	1	1kΩ resistor (R2)
1	Base grid	1	5.1kΩ resistor (R3)
1	Red LED (D1)	1	10kΩ resistor (R4)
		1	Slide switch (S1)

Replace R1 with R3:

EXPECTED RESULTS: With R3 & R2		
PART	ACTION	RESULT
METER (M5)	Needle Moves	2V
RESISTOR 5.1kΩ (R3)	Install	----
RESISTOR 1kΩ (R2)	Install	----

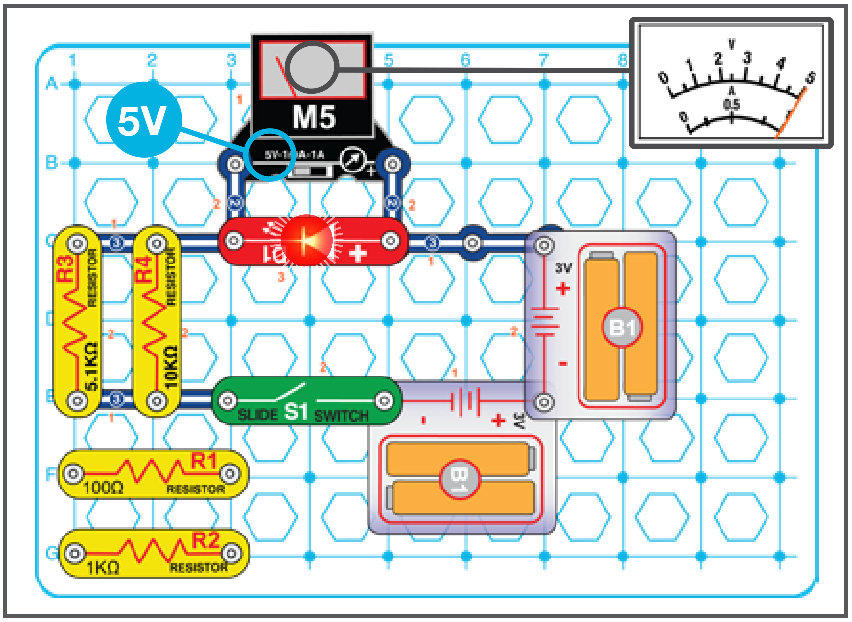
Replace R2 with R4:

EXPECTED RESULTS: With R3 & R4		
PART	ACTION	RESULT
METER (M5)	Needle Moves	1.5V
RESISTOR 5.1kΩ (R3)	Install	----
RESISTOR 10kΩ (R4)	Install	----

Resistors in Parallel

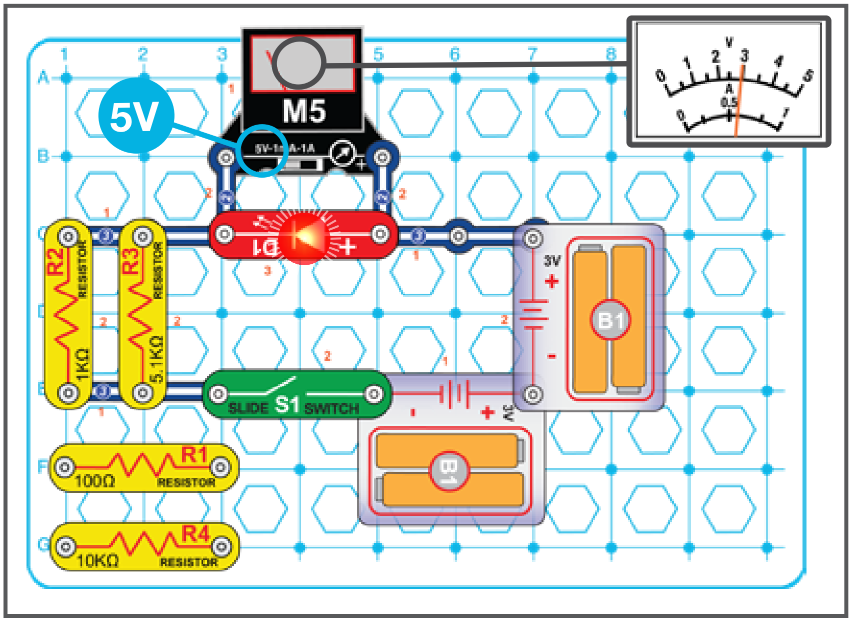
Directions and Observations for the SCAN.

1. Students build the circuit pictured below, making sure that the LED is positioned properly.
2. Turn the switch on.
    a. What is the voltage measured across the LED? (**4.5V-5V**)
3. Replace R1 with R3. It is not necessary to turn off the switch while doing this.
    a. What is the voltage measured across the LED? (**Around 3V-3.5V**)
4. Replace R2 with R4.
    a. What is the voltage measured across the LED? (**Around 2V-2.5V**)



EXPECTED RESULTS: With S1 On, R1 & R2		
PART	ACTION	RESULT
METER (M5)	Needle Moves	4.5V-5V
RED LED (D1)	Switch on	Bright

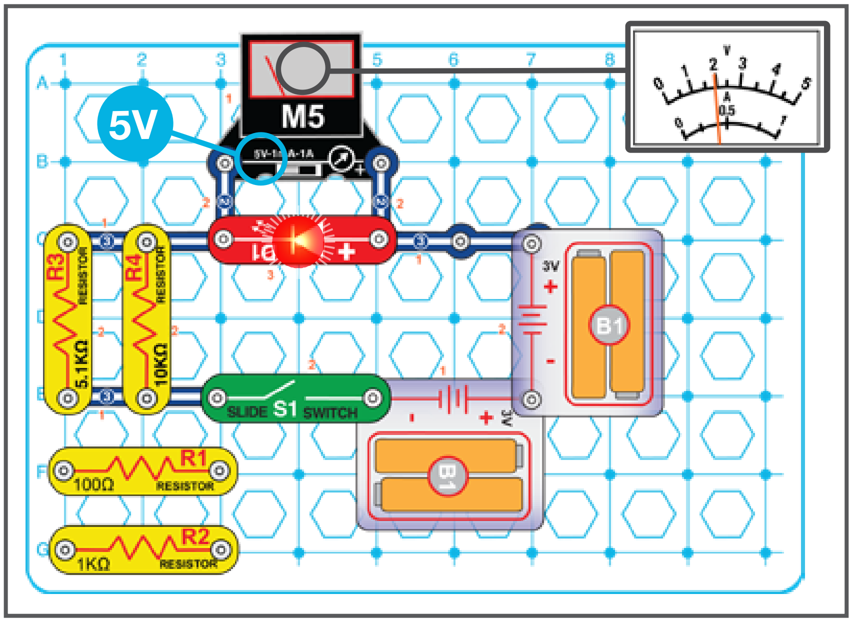
Parts used:			
		1	Meter (M5)
2	2-snap wire	1	100Ω resistor (R1)
3	3-snap wire	1	1kΩ resistor (R2)
2	Battery holder (B1)	1	5.1kΩ resistor (R3)
1	Base grid	1	10kΩ resistor (R4)
1	Red LED (D1)	1	Slide switch (S1)



EXPECTED RESULTS: With S1 On, R2 & R3		
PART	ACTION	RESULT
METER (M5)	Needle Moves	3V-3.5V
RED LED (D1)	Switch on	Bright

Parts used:			
		1	Meter (M5)
2	2-snap wire	1	100Ω resistor (R1)
3	3-snap wire	1	1kΩ resistor (R2)
2	Battery holder (B1)	1	5.1kΩ resistor (R3)
1	Base grid	1	10kΩ resistor (R4)
1	Red LED (D1)	1	Slide switch (S1)

Resistors in Parallel



EXPECTED RESULTS: With S1 On, R3 & R4		
PART	ACTION	RESULT
METER (M5)	Needle Moves	2V-2.5V
RED LED (D1)	Switch on	Dim

Parts used:			
2	2-snap wire	1	Meter (M5)
3	3-snap wire	1	100Ω resistor (R1)
2	Battery holder (B1)	1	1kΩ resistor (R2)
1	Base grid	1	5.1kΩ resistor (R3)
1	Red LED (D1)	1	10kΩ resistor (R4)
		1	Slide switch (S1)

5. Which situation, resistors in series or resistors in parallel created the higher level of resistance in the circuits? Explain your response.

The resistors in *series* produces the higher level of resistance. The evidence is the voltage is lower in the resistors in series circuit, with R1 and R2 of 3V compared to 5V. In actuality, when resistors are in series their resistance levels add together. So, in the resistors in series the effective resistance is 100 Ohms + 1000 Ohms= 1,100 Ohms.

When resistors are in *parallel* their levels add the inverse of their original values. So, the effective resistance is 1/100 Ohms + 1/1000 Ohms= 1/.011= 90.9 Ohms. So, when the resistors are in parallel, they provide only a small amount of resistance. This same type of comparison can be made with the combination, in both series and parallel circuits, of R2 and R3. Now it is 2V for resistors in series and 3V for resistors in parallel.

We could go through the math again finding that resistors in series add their resistance values together, while the resistors in parallel add the inverse of their resistance values. The pattern holds for the final combination of R3 and R4. For comparison, students could create the simple circuit with the LED, no resistors at all, and measure the voltage across the LED.

Bonus

Extra Day Activities

1 - 4 Circuits

Narration:

You may have heard the famous phrase by Albert Einstein of "Energy cannot be created or destroyed; it can only be changed from one form to another."

In earlier activities, we have seen electrical energy converted into light, into motion, and into sound. We are now going to show two types of conversion. One conversion is changing the chemical energy within the batteries into electrical energy. And then electrical energy can be converted into both light and heat.

Students will build this simple circuit, only 1 load, with 2 battery packs in series. Immediately after turning the switch on students will see the light on. Within about a minute or 2 of turning the switch on students, holding a finger on top of the light, we will notice a change in the heat of the material.

Extra Day Activity 1: Electric Heater

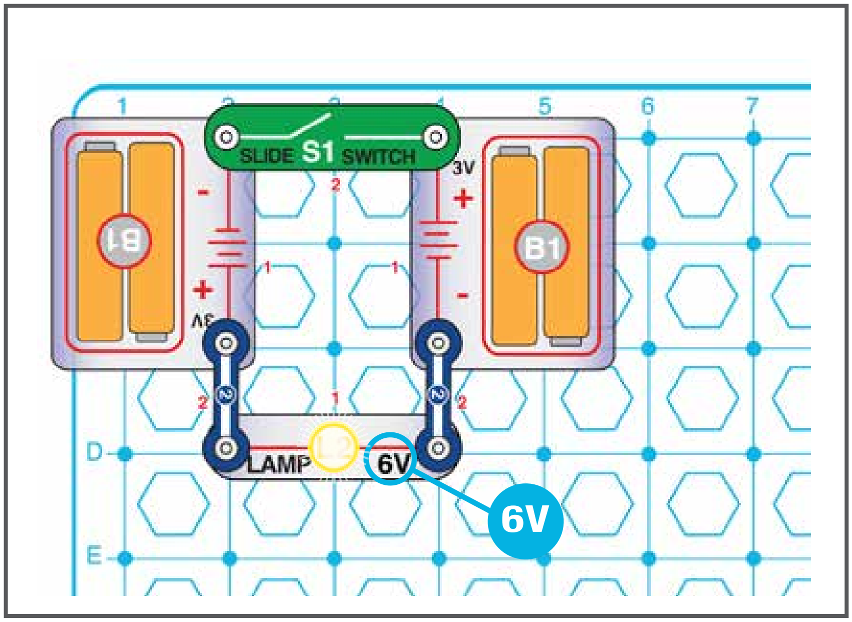
[addresses 4-PS3-2]

Directions and Observations for the SCAN.

1. Students build the circuit shown below.
2. Turn the switch on.
3. Describe what you see immediately after turning the switch on. **The light turns on.**
4. Describe any changes you feel after a few minutes of having the switch on.

Initially the L2 feels at a normal, room temperature. But after a couple of minutes of being on, the lamp begins to heat up.

5. Was there evidence of energy conversion? If yes, describe this. **Yes, there is conversion. The chemicals in the batteries are converted to electrical energy. That electrical energy is converted into both light and heat.**
6. Turn the switch off.



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
LAMP (L2)	Switch on	Bright

Parts used:
- 2 2-snap wire
- 2 battery holder (B1)
- 1 Base grid
- 1 6V Lamp (L2)
- 1 Slide switch (S1)

Extra Day Activity 2: Flying Saucer

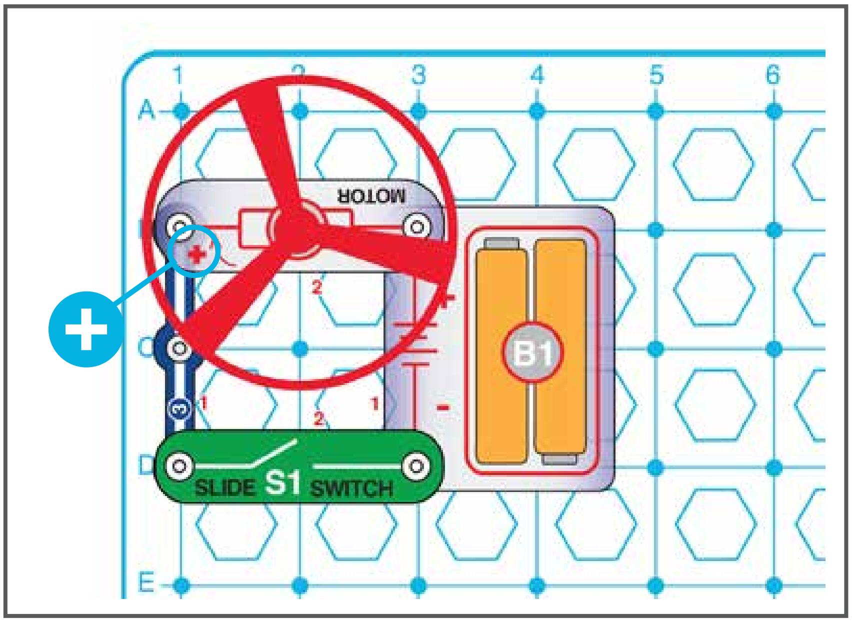
[addresses 4-PS3-2]

Narration:

On Day 3 and Day 5/6 activities, the students had a chance to look at a circuit with the load being a motor with a set of fan blades. Students should take particular attention at the direction of the motor's positive side. Due to this orientation, as the fan blades spin, they are locking the fan on the shaft of the motor. When the motor stops the blade can unlock and fly off the shaft.

Directions and Observations for the SCAN.

1.Students create the circuit below.
2.Turn the switch to on.
3.Describe what you see after turning the switch on. **The fan blade spins.**
4.Turn the switch off.
5.Describe what you see after turning the switch off. **When the motor stops the fan blade flies off.**



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
FAN	Switch on	Spins Fast

Parts used:

1	3-snap wire
1	Battery holder (B1)
1	Base grid
1	Motor (M1)
1	Fan
1	Slide switch (S1)

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Extra Day Activity 3: Super Flying Saucer

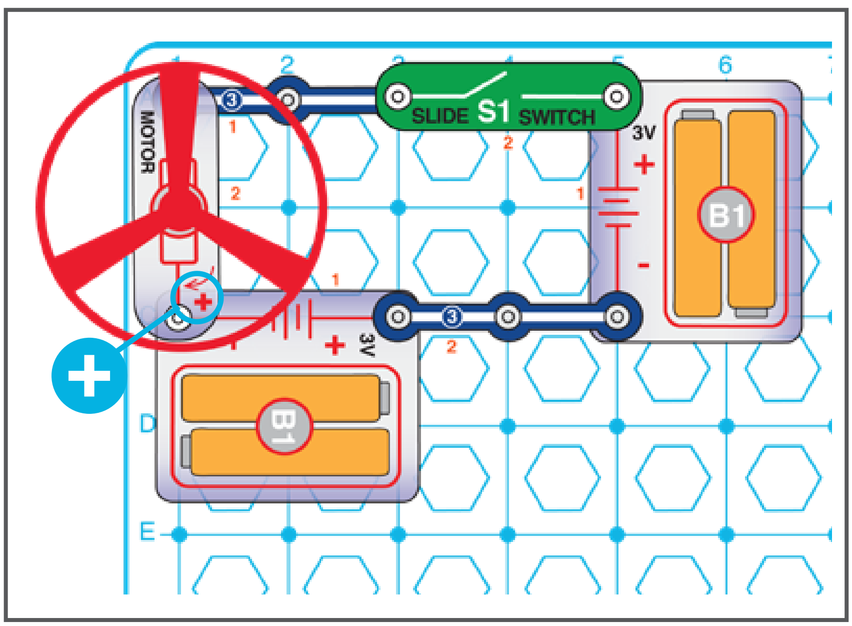
[addresses 4-PS3-2]

Narration:

The easiest way to make a super fan involves doubling the batteries in the circuit. Once again, the students should take particular attention at the direction of the motor's positive side. Due to this orientation, as the fan blades spin, they are locking the fan on the shaft of the motor. When the motor stops the blade can unlock and fly off the shaft. Having the ability to spin a shaft very fast is valuable in equipment like drills and rotating brushes.

Directions and Observations for the SCAN.

1. Students create the circuit below.
2. Turn the switch to on.
3. Describe what you see after turning the switch on. **The fan blade spins.**
4. Turn the switch off.
5. Describe what you see after turning the switch off. **When the motor stops the fan blade flies off.**



EXPECTED RESULTS: With S1 On		
PART	ACTION	RESULT
FAN	Switch on	Spins Very Fast

Parts used:

2	3-snap wire
2	Battery holder (B1)
1	Base grid
1	Motor (M1)
1	Fan
1	Slide switch (S1)

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Extra Day Activity 4: Electric Current

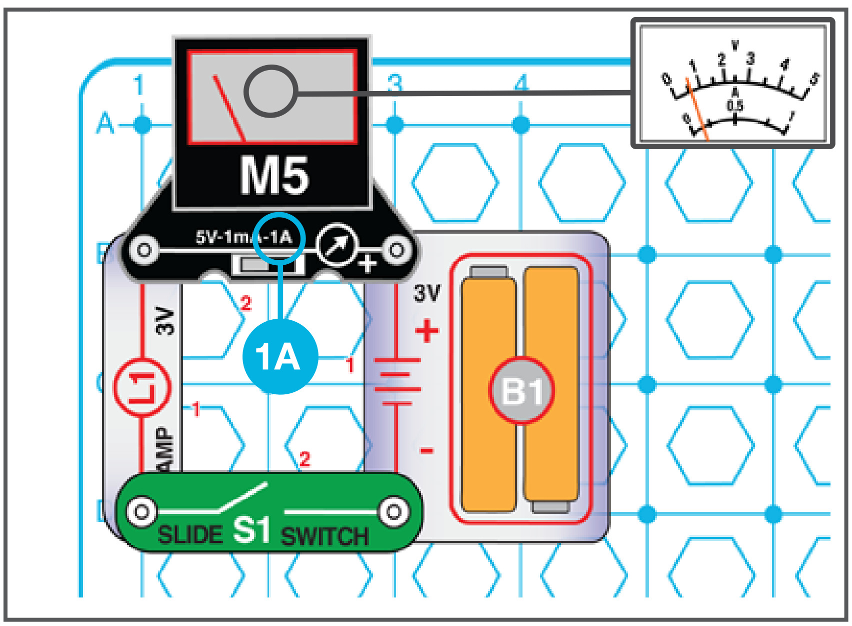
[addresses 4-PS3-2]

Narration:

Voltage is a measure of electrical pressure across a circuit or component. Electric current is a measure of how fast electricity is flowing through a circuit or component. Increasing the voltage (pressure) across a component will increase the current through it. Electric current is measured in Amps.

Directions and Observations for the SCAN.

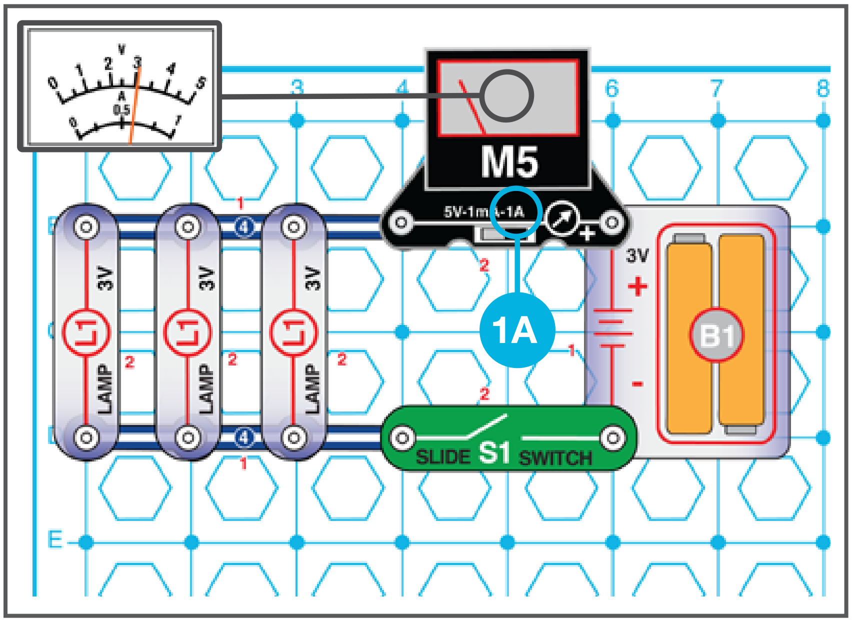
1. Students build the simple circuit below. Students set the meter to the 1A setting, and will measure the current using the 0-1 scale on the meter (measuring Amps).
   a. Turn on the switch.
   b. What is the current measured on the meter? **About 0.2A**
   c. Turn off the switch.



EXPECTED RESULTS: With S1 On, R1 & R2		
PART	ACTION	RESULT
METER (M5)	Needle Moves	0.2A
RED LED (D1)	Switch on	Bright

Parts used:

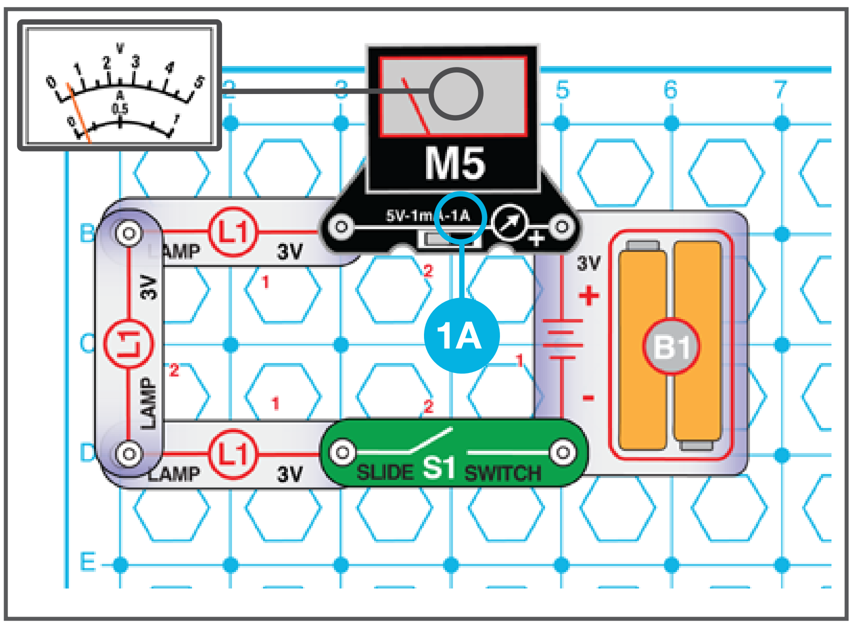
1	Battery holder (B1)
1	Base grid
1	3V Lamp (L1)
1	Meter (M5)
1	Slide switch (S1)



EXPECTED RESULTS: With S1 On, R1 & R2		
PART	ACTION	RESULT
METER (M5)	Needle Moves	0.6A
LAMP (L1) LEFT	Switch on	Bright
LAMP (L1) MIDDLE	Switch on	Bright
LAMP (L1) RIGHT	Switch on	Bright

Parts used:
- 2 4-snap wire
- 1 Battery holder (B1)
- 1 Base grid
- 3 3V Lamp (L1)
- 1 Meter (M5)
- 1 Slide switch (S1)

2. Students create the lamps in parallel circuit above.
    a. Turn on the switch.
    b. What is the current measured on the meter? **About 0.6A**
    c. Turn off the switch.



EXPECTED RESULTS: With S1 On, R1 & R2		
PART	ACTION	RESULT
METER (M5)	Needle Moves	0.1A
LAMP (L1) LEFT	Switch on	Dim
LAMP (L1) MIDDLE	Switch on	Dim
LAMP (L1) RIGHT	Switch on	Dim

Parts used:
- 1 Battery holder (B1)
- 1 Base grid
- 3 3V Lamp (L1)
- 1 Meter (M5)
- 1 Slide switch (S1)

3. Students create the lamps in series circuit above.
    a. Turn on the switch.
    b. What is the current measured on the meter? **About 0.1A**
    c. Turn off the switch.

4. **Questions for students:**
    a. Which circuit used the most current? Simple circuit, **lamps in parallel circuit,** or lamps in series circuit
    b. Which circuit used the least current? Simple circuit, lamps in parallel circuit, or **lamps in series circuit**
    c. Which circuit do you think will drain your batteries the fastest? Simple circuit, **lamps in parallel circuit**, or lamps in series circuit

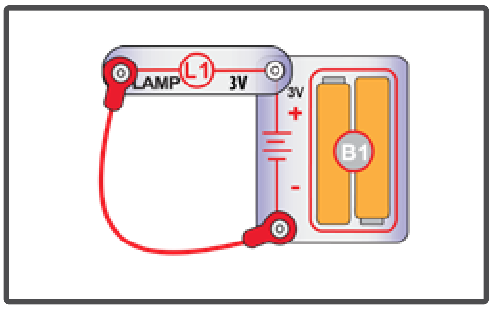
Troubleshooting

1. **Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.**
2. **Be sure that parts with positive/negative markings are positioned as per the drawing.**
3. **Be sure that all connections are securely snapped.**
4. **Try replacing the batteries.**

If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

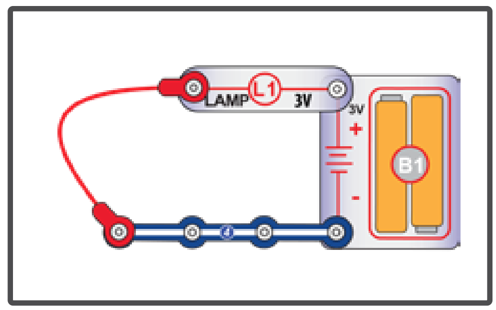
1. **3V lamp (L1), 6V lamp (L2), red LED (D1), green LED (D2), melody IC (U32), motor (M1), meter (M5), and battery holder (B1)**: Place batteries in holder. Place each lamp directly across the battery holder, it should light. Place each LED and the melody IC directly across the battery holder ("+" to battery "+"), the LED should light and the melody IC should play a tune. Do the same with the motor (motor + to battery +), it should spin to the right at high speed. Set the meter to the 5V scale and place directly across the battery holder (meter "+" to battery "+"), it should measure about 3V. If none work then replace your batteries and repeat, if still bad then the battery holder is damaged.

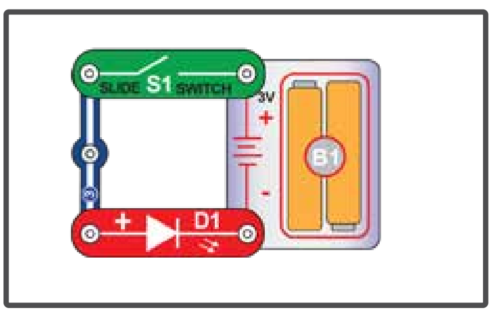
   If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. If any of the three prongs are broken then request a replacement motor top (part # 6SCM1T) from Elenco®.



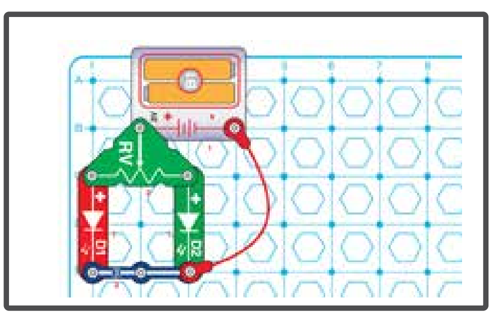
2. **Jumper wires:** Use this mini-circuit to test each jumper wire, the lamp should light.

3. **Snap wires:** Use this mini-circuit to test each of the snap wires, one at a time. The lamp should light.





4. **Slide switch (S1) and 100Ω (R1), 1kΩ (R2), 5.1kΩ (R3), and 10kΩ (R4) resistors:** Use this mini-circuit to test each switch, if the LED (D1) doesn't light then the slide switch is bad. Replace the slide switch with R1, the LED should still be bright. Replace R1 with R2, then R3, then R4; the LED should get progressively dimmer.



5. **Variable resistor (RV):** Use this mini-circuit to test RV. Move RV's lever to the left should light the red LED, moving RV's lever to the right should light the green LED.

You may order additional / replacement parts at: www.elenco.com/replacement-parts

ELENCO® ELECTRONICS LLC 150 Carpenter Avenue Wheeling, IL 60090 U.S.A.
Phone: (847) 541-3800 | Fax: (847) 520-0085 E-mail: support@elenco.com

ELENCO® is not responsible for parts damaged due to incorrect wiring.

Pre-Test and Post-Test Answers:

1. True 2. True 3. True 4. False 5. True 6. False 7. True 8. True 9. False 10. True 11. False 12. True

Note: If you are using **AC-SNAP** (The optional Snap Circuits® AC adapter) then connect the 3V side of the B6 module in place of the battery holder.

To purchase AC-SNAP, go to **Elenco.com**

WARNING: 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.

Adult Supervision: 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.

WARNING: SHOCK HAZARD -
Never connect Snap Circuits© to the electrical outlets.
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

CAUTION: Very warm motor (M1) enclosure.

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

CAUTION: The lamp (L1&L2) has a very warm lamp enclosure.

WARNING: This product produces flashes that may trigger epilepsy in sensitive individuals

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SNAP CIRCUITS