Teaching Electricity

Ohio Energy Project

7th and 9th grade

Professional Development

Goals of Session

- Build a series, parallel and short circuit.
- Understand the basic components of an electric circuit.
- Build a circuit to complete a given task.
- Use electronic symbols to describe and write out a circuit.
- Use a meter to measure volts, current, and resistance in a circuit.
- Demonstrate ways energy can be transferred in an electric circuit (sound, light, heat, mechanical energy).

Pre-test

What do you know?

What is Electricity?

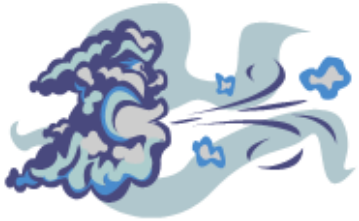
- https://www.studentenergy.org/topics/electricity
- This is a 3:10 video from www.studentenergy.org

Coal Sequence Activity

Place cards in proper sequence of events.

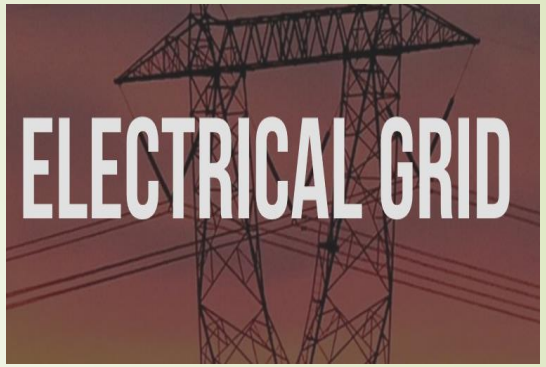
Coal Mining

Steam



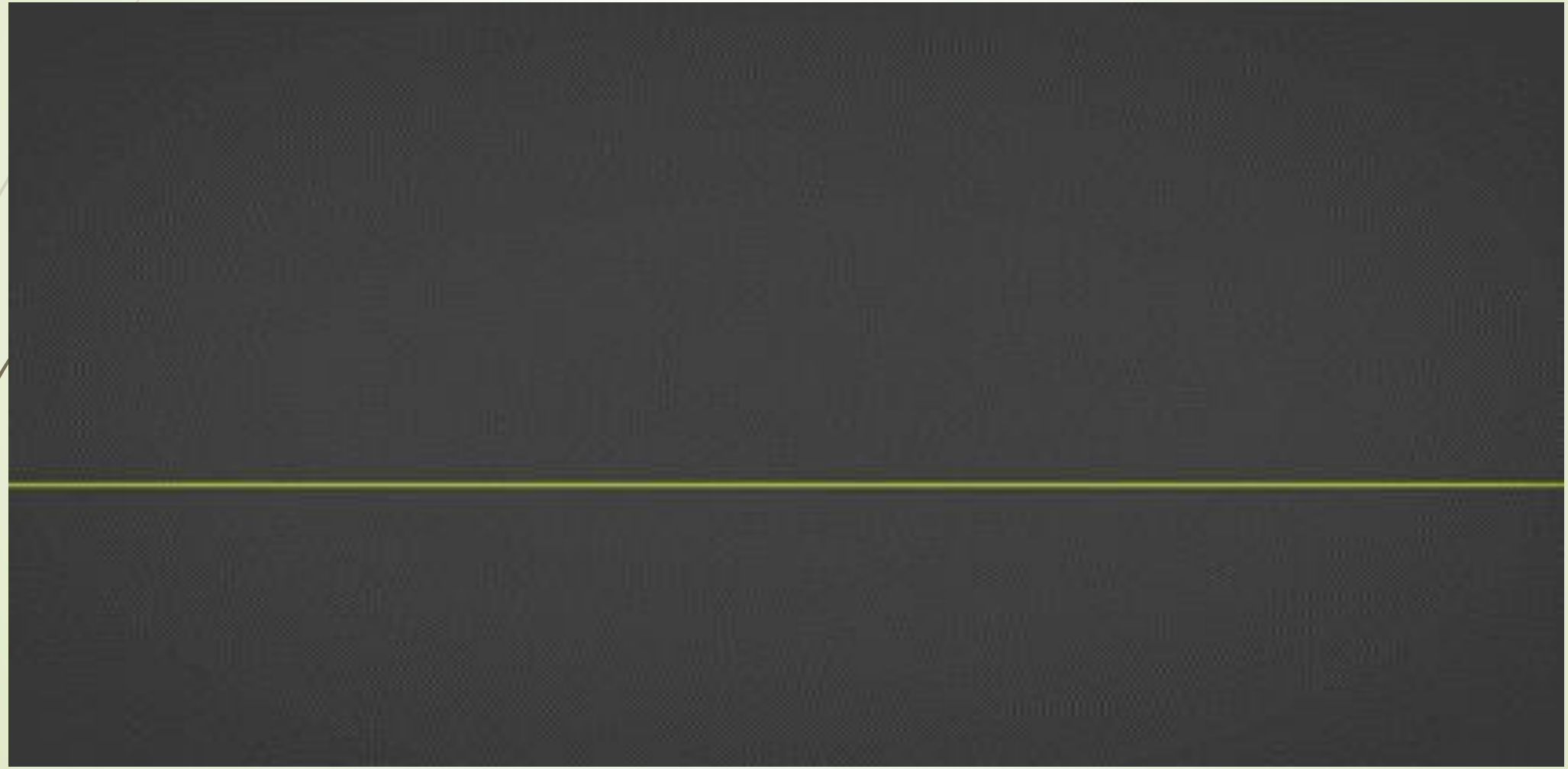
Coal Sequence

Where Does your Electricity Come From?



For more detailed information, follow up with the student energy 3:11 video

https://www.studentenergy.org/topics/electrical-grid



Circuits are Everywhere
Understanding the Mechanics of Solar Technology

This lesson was written for Ohio Sea Grant by Lyndsey Manzo. It was developed for a Solar Education Workshop presented at OSU's Stone Lab in June 2106. All lessons are available at:

go.osu.edu/teachers

Copies are also can be found at the OEP website:

www.ohioenergy.org

Circuits Exploration – Background Information

- Electricity is a ***secondary*** energy source. A primary source must be transformed to electrical energy.

- Electricity produced at power plants is alternating current using a generator.
  Advantage: AC can travel long distances with minimal loss of energy
  Transformers are used to increase or decrease the voltage (electrical pressure).

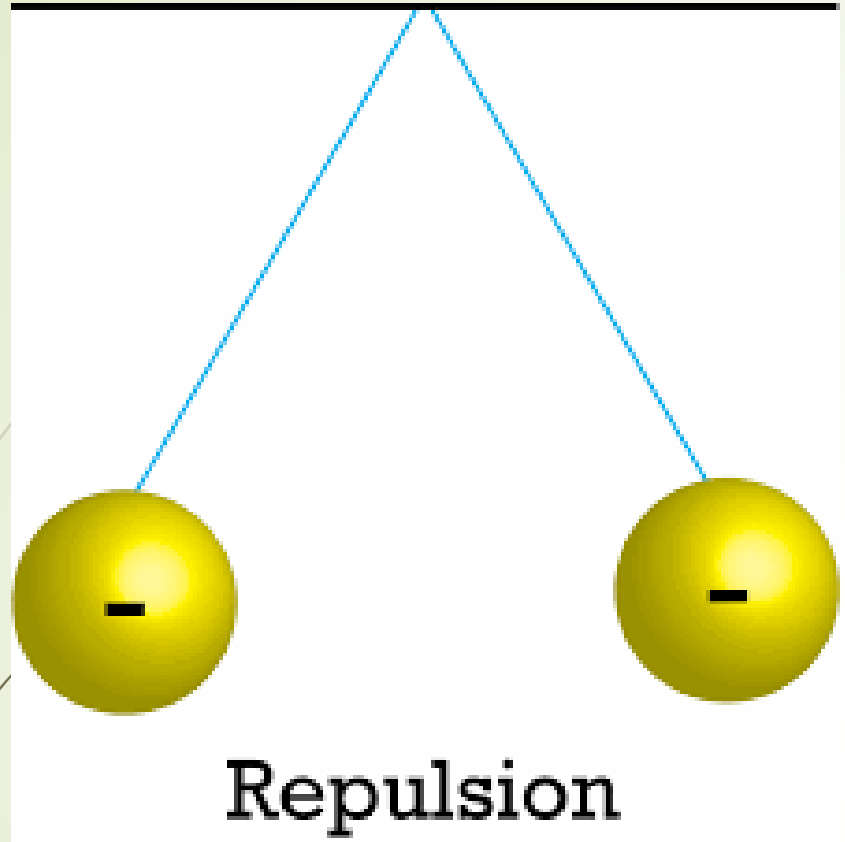
- Chemical energy is be transformed to electrical energy in a battery – Direct Current.
  - Two different metals are used in a chemical solution.
  - The reaction at the anode end gives up electrons and the reaction at the cathode end absorbs them.
  - This is a direct current since the electrons only flow in one direction.

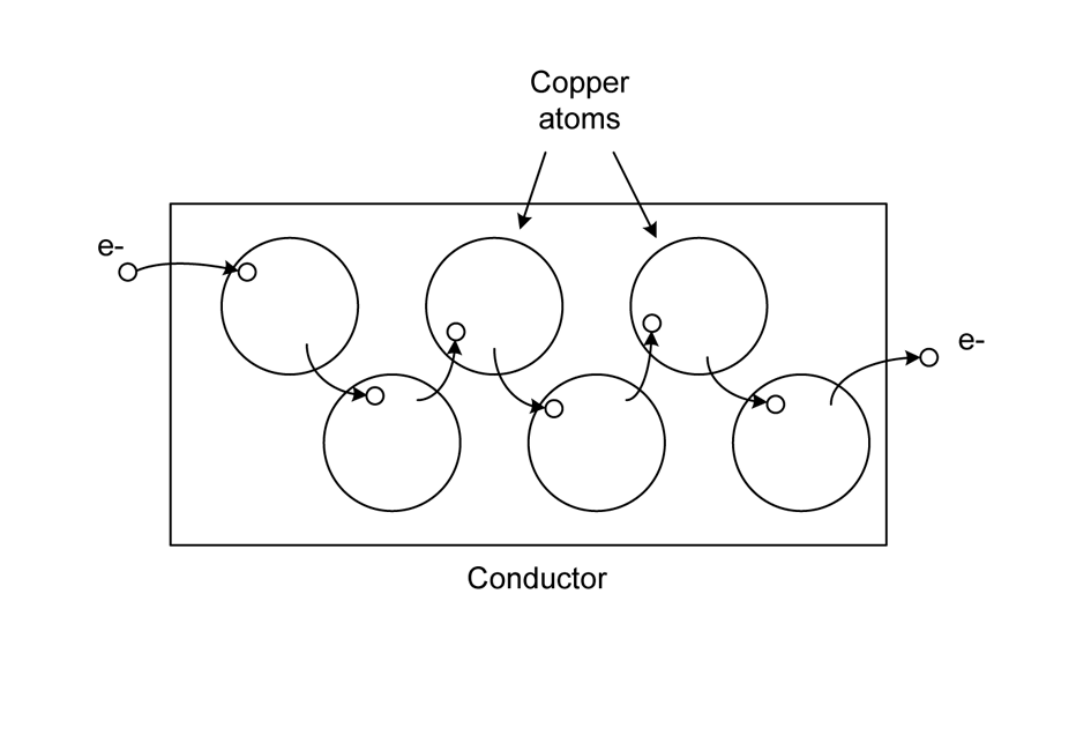
  Advantage: Portable

Why do electrons flow in a circuit?

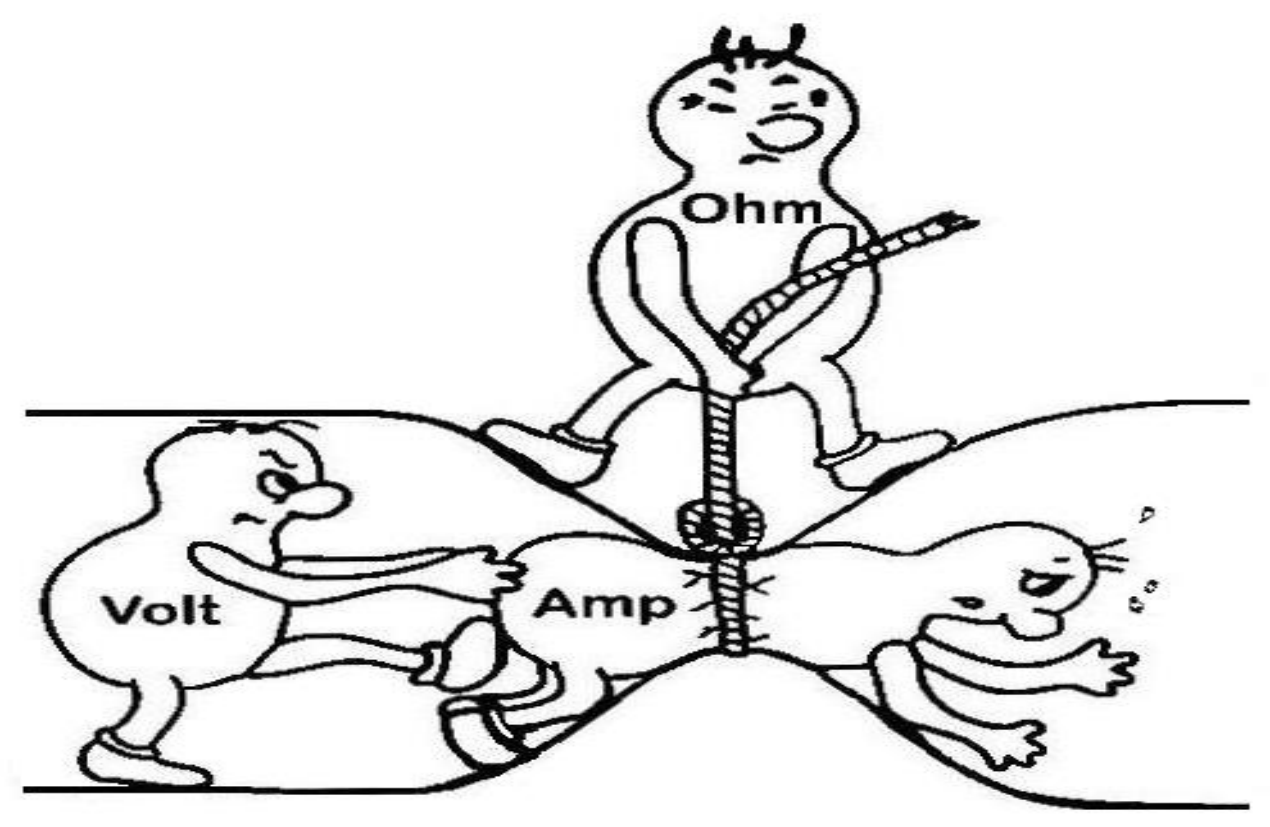
Electrical potential energy

- Potential energy is stored energy that an object has due to its position or shape.
- An electric charge has potential energy because of its position in an electric field.
- For example, when two negative charges are close together, they have potential energy because they repel each other and have the potential to push apart.
- If the charges move apart, their potential energy decreases.
- Electric charges always move spontaneously from a position where they have higher potential energy to a position where their potential energy is lower.


Repulsion


Copper atoms
e-
e-
Conductor

Electrical Relationships

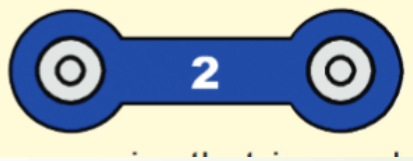


I x R = V

Amperage X Resistance = Voltage

Building Tips for Snap Circuits

1. The "wires" are embedded in the blue wire blocks of different lengths.



2. Each block has a different function and label. For example, the green slide switch is marked on the diagram.

3. A clear plastic grid, labeled 1 - 10 and A - G, is to help space components are wires. It functions as a printed circuit board.

Building Tips for Snap Circuits, continued

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

5. Some components have a **+** and a **–** side or terminal. The motor is an example.

Each lesson was designed to:

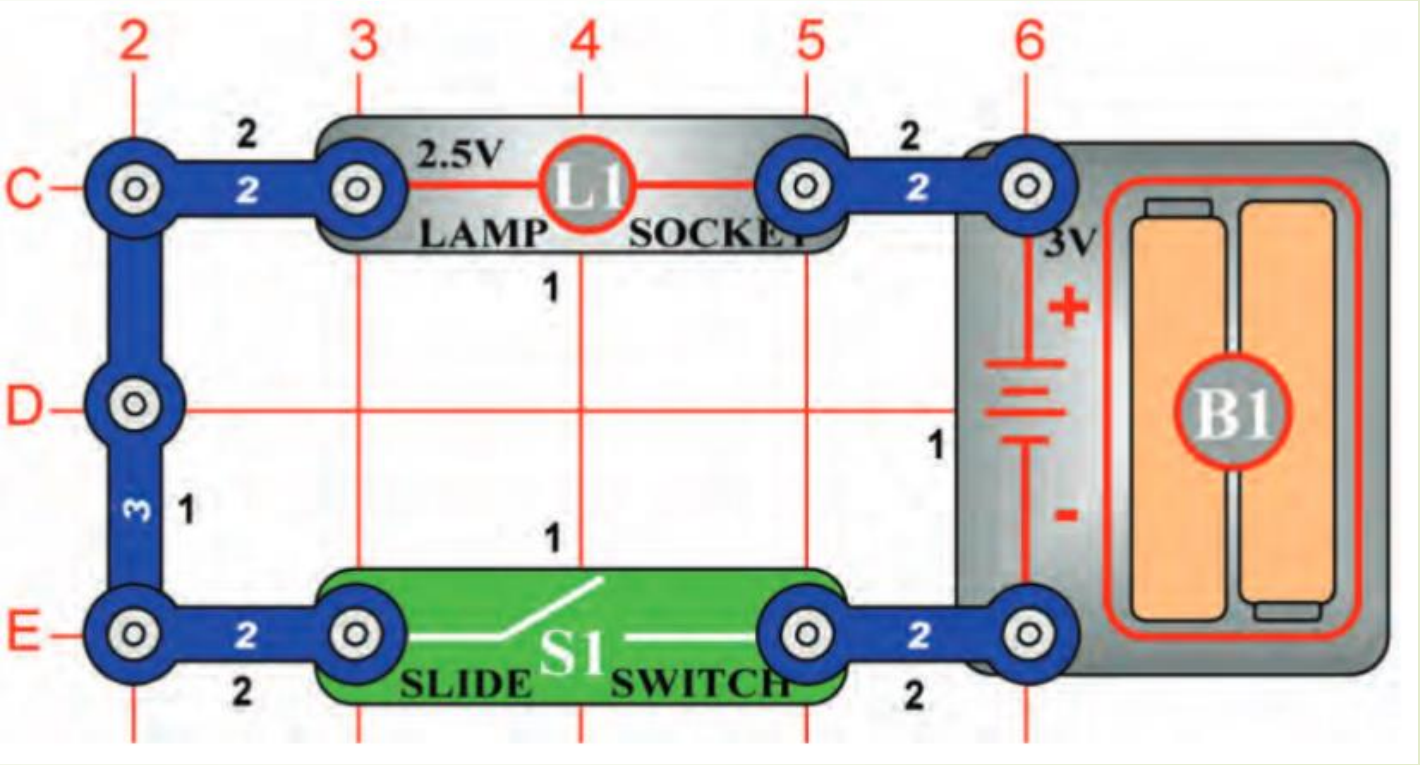
- have students build the circuit.
- understand what is happening within the circuit.
- hypothesize and test changes in a circuit.
- troubleshoot as to why it does or doesn’t work.

Lesson 1
Circuits Exploration

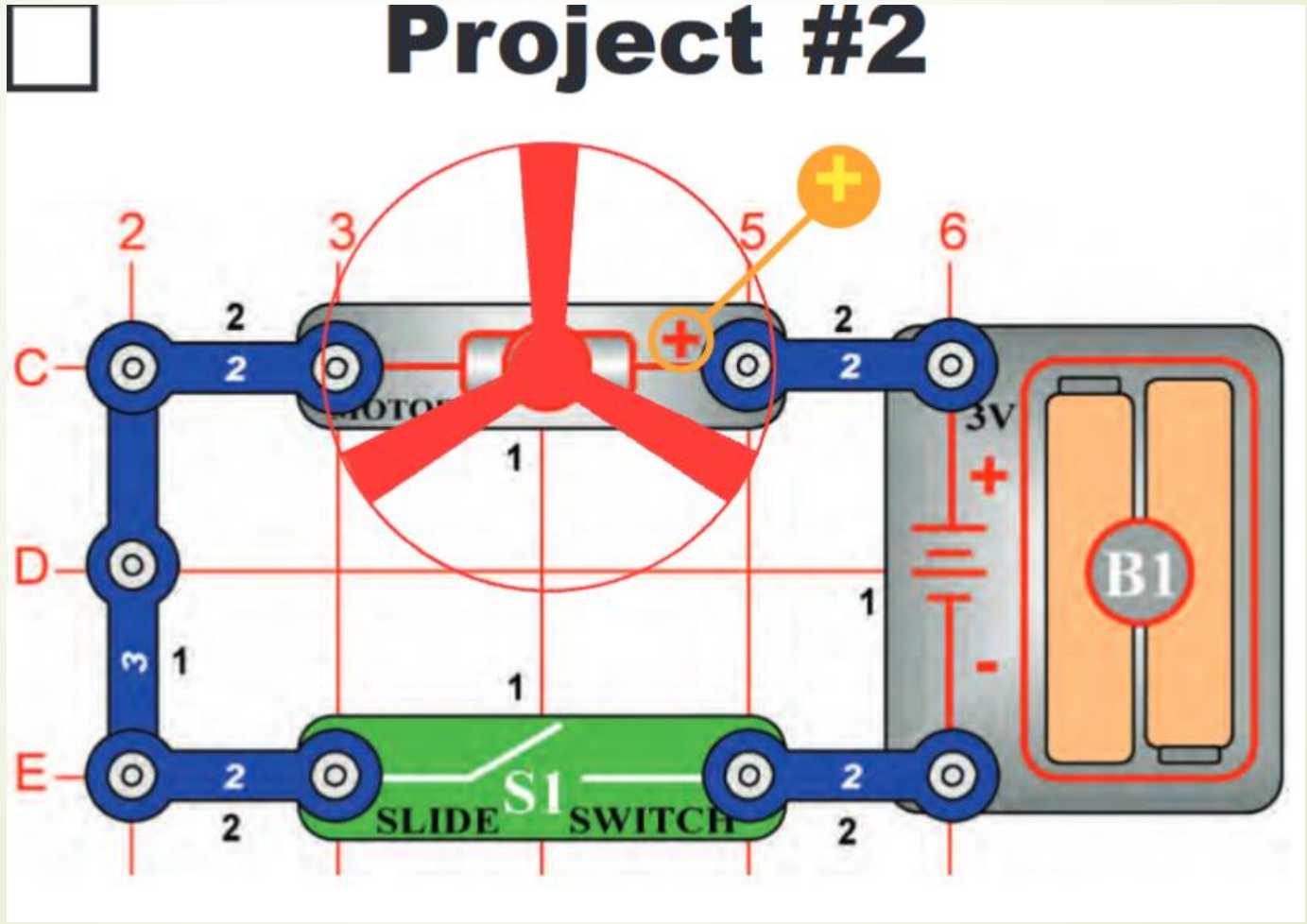
- Students will build series circuits. Parts include a switch, light, motor and battery.
- Students will build parallel circuits.
- Series and Parallel circuits can be combined.

Complete questions after building Project 1

Build Project 1



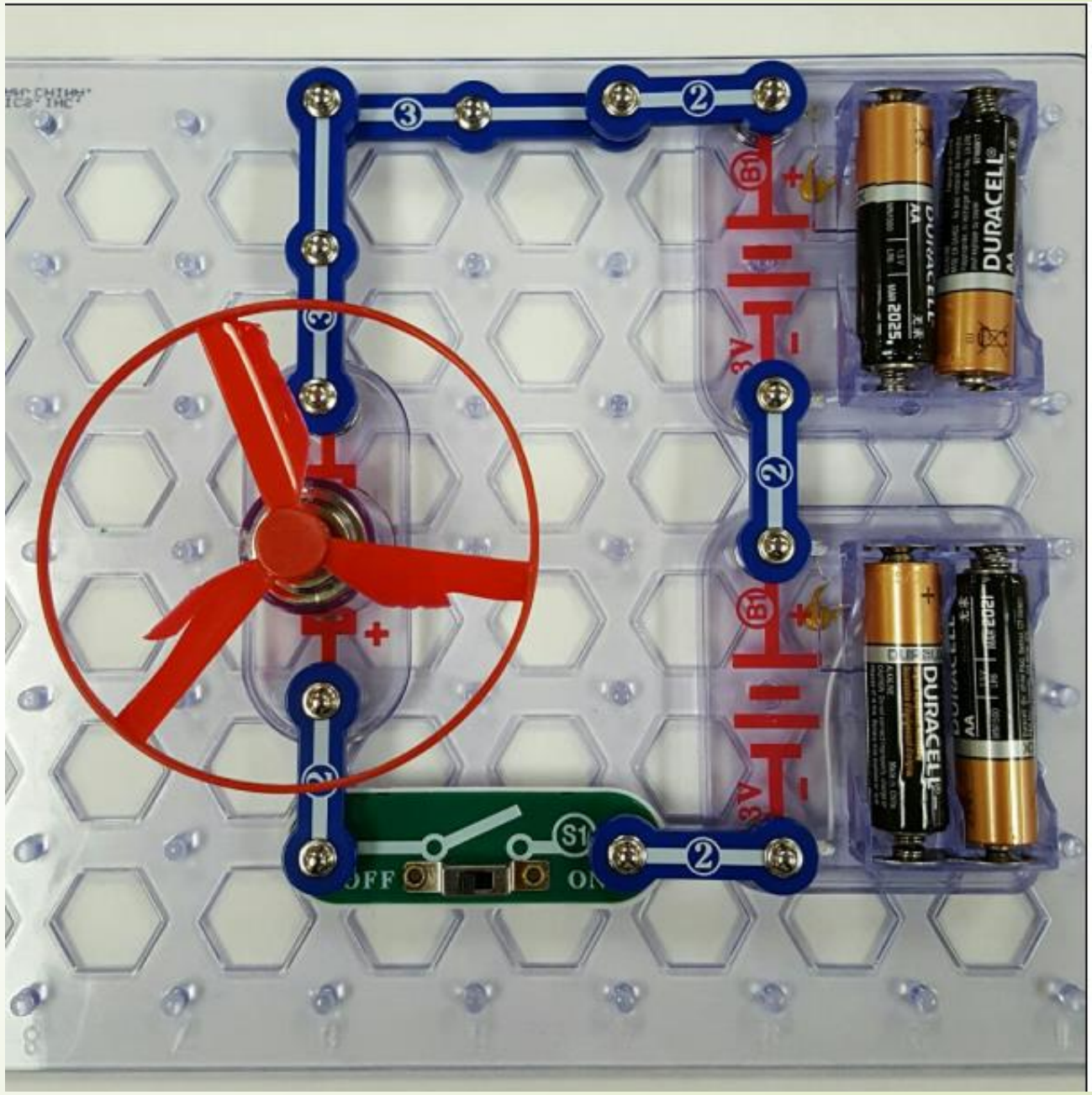
Build projects answering the questions before continuing

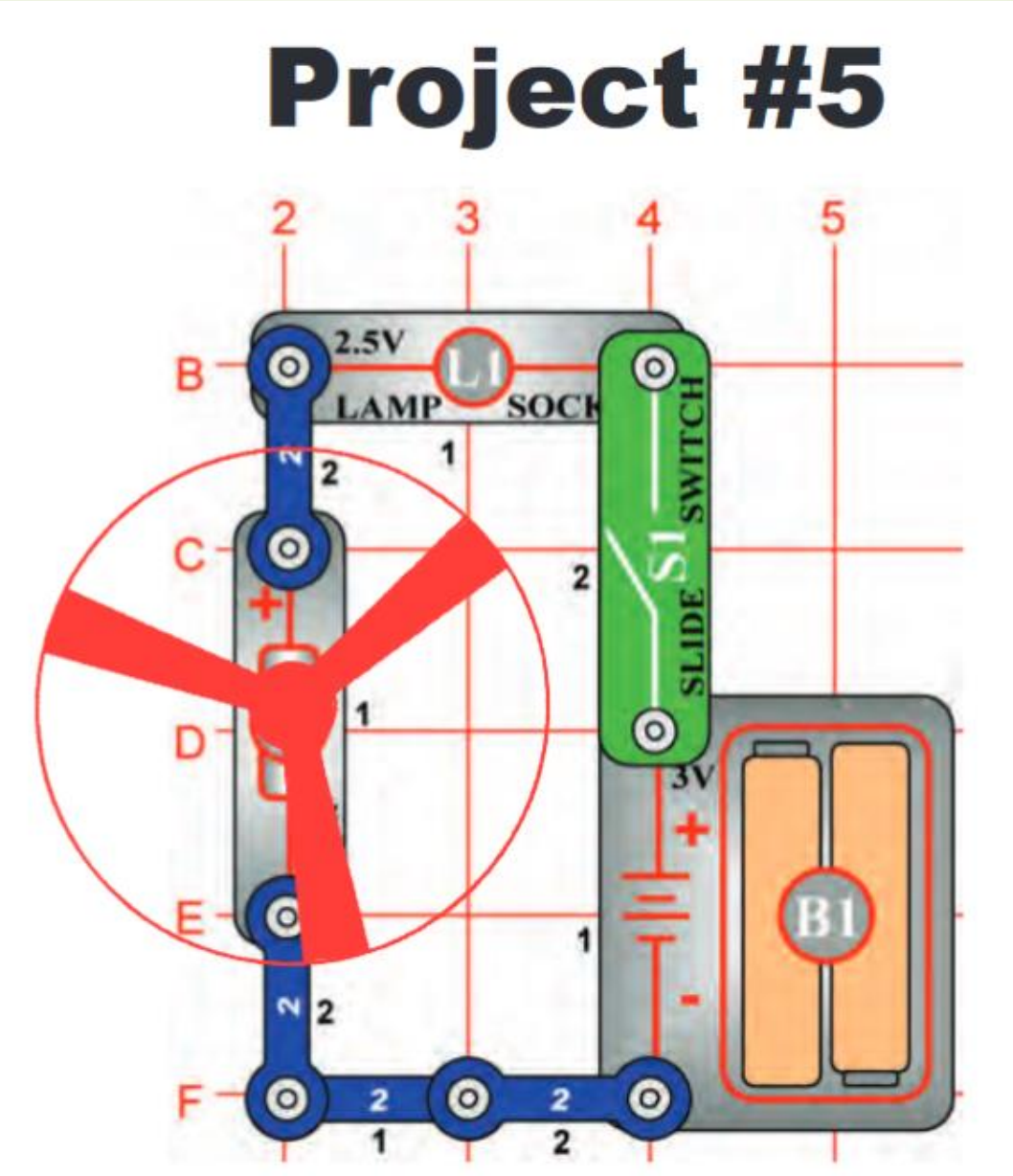


Project 11 & extension:
Add another battery pack in series

BE SURE

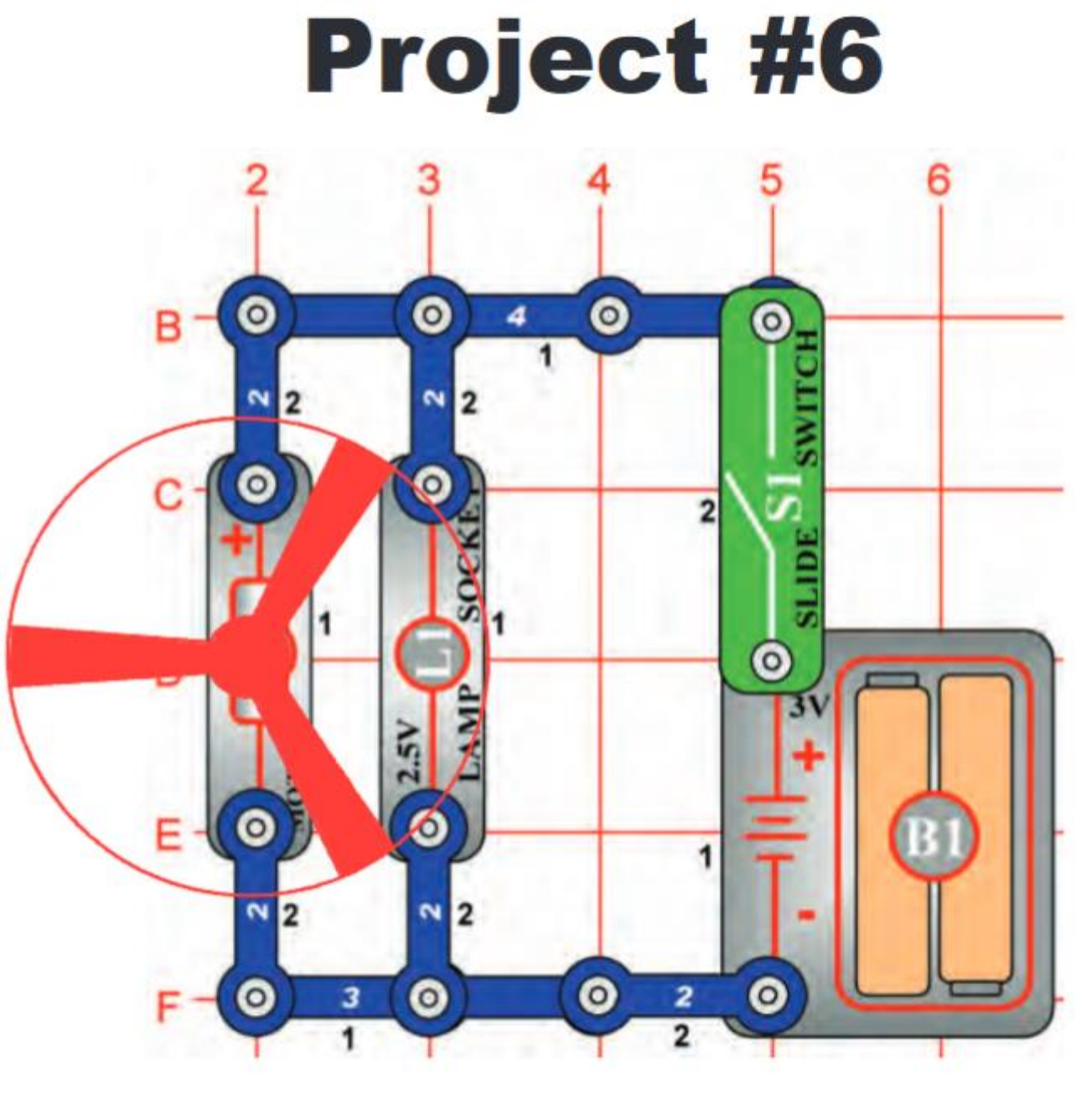
The "+" sign on the motor is closest to the "–" (negative terminal) of the battery.



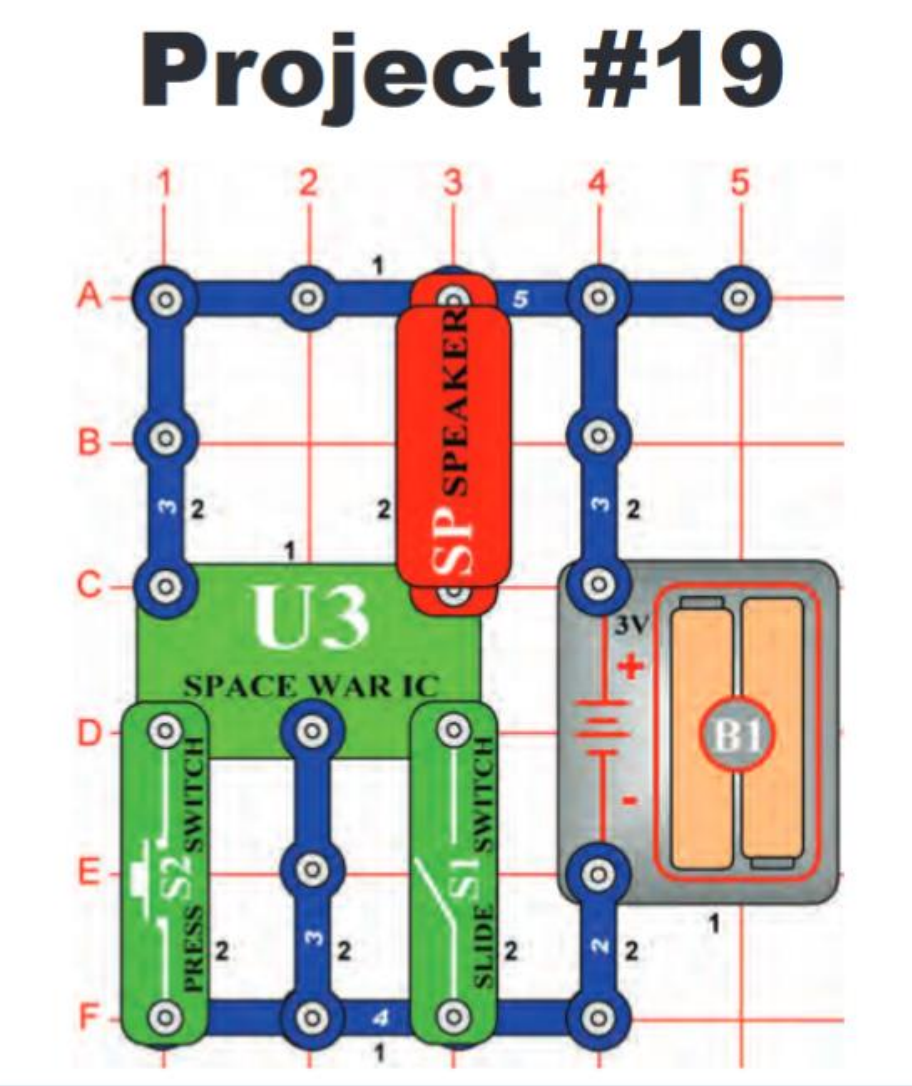


Fan and Lamp Wired in Series

Fan and Lamp In Parallel



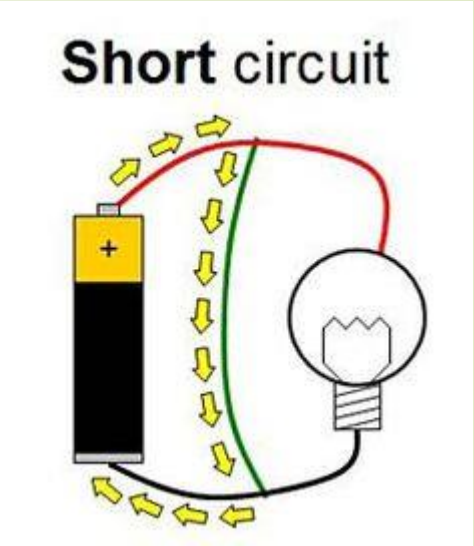
Activity 19 uses a combination of parallel and series circuits with two switches and the introduction of an integrated circuit.



Space War

Short Circuits

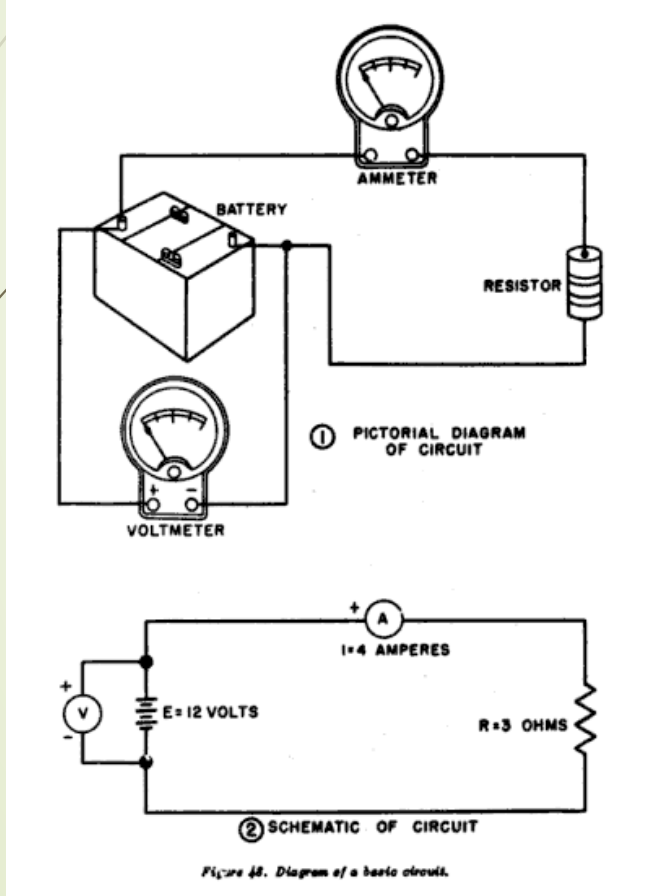
A short circuit occurs when there is a no resistance path across the batteries.



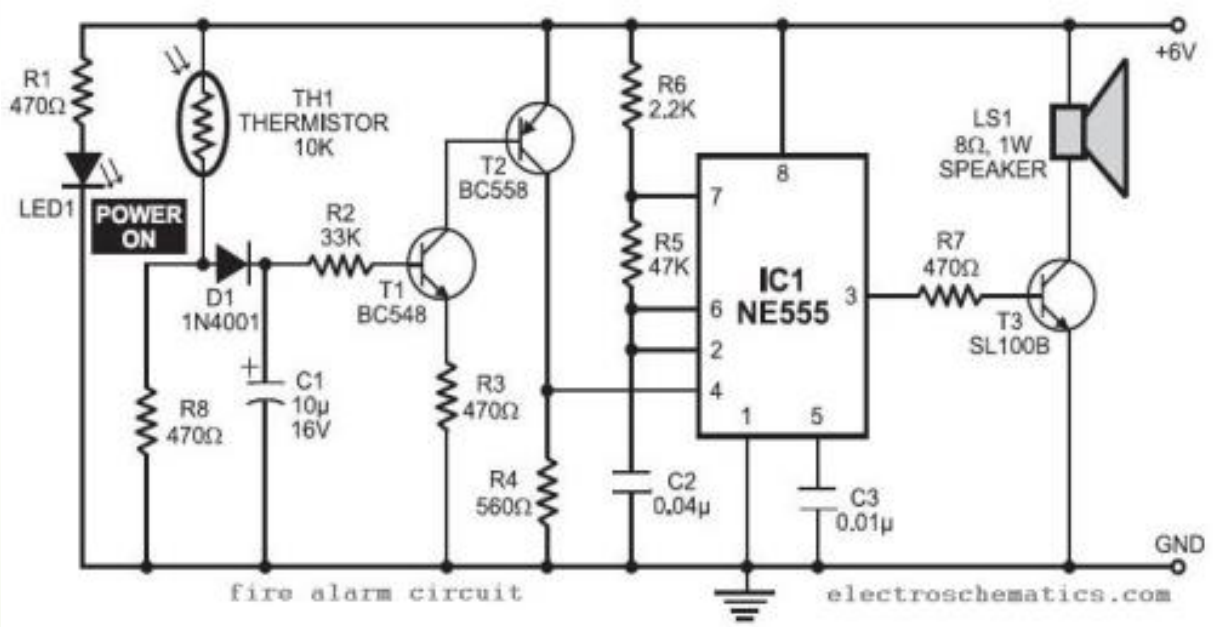
In electrical devices unintentional short circuits are usually caused when a wire's insulation breaks down, allowing charge to flow along a different path than the one intended.

Design Challenge Schematics

Simple



More Complex



Lesson 2
Introduction to Resistance

Resistance refers to electrical friction or resistance to flow between the electric current and the material it is flowing through.

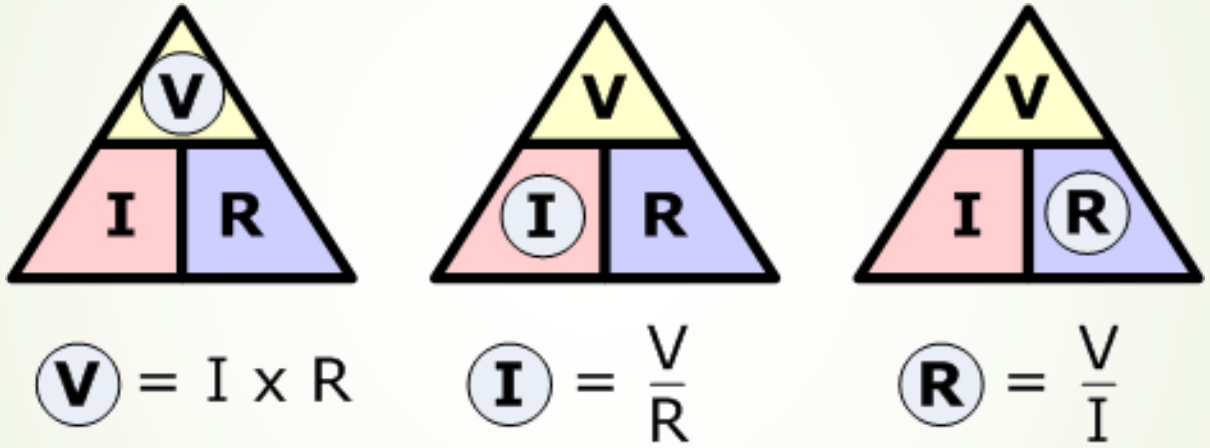
Resistance limits and controls the flow of electricity.

Resistance in a circuit can vary with:

- the length of the wire
- the thickness of the wire
- the metal used to make the wire.

Resistors are devices that are also known as loads and have a set or variable resistance.

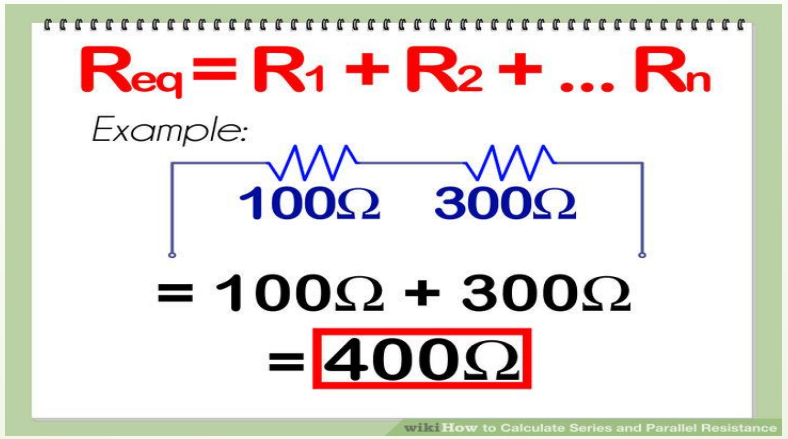
Ohm's Law



Resistance is measured in Ohms - Ω

Multiple resistors can be included in a circuit in series or parallel.

If a circuit has several resistors in **series**, find the total resistance by adding the resistance for each resistor.



Multiple resistors in a series circuit.

$$I = \frac{V}{R}$$

- The resistors serves as a "**voltage** dividing network" because the current stays the same across the circuit.
- The voltage is divided by the resistors.
- Each resistor increases the total resistance in the circuit.

Multiple resistors in a parallel circuit

In a parallel circuit, the **voltage** across each resistor (and each branch of the circuit) is the same value, but the current (amperage) is divided.

- When resistors are used in parallel, they become a "**current** dividing network." Each path reduces resistance. Think multiple lanes in a highway.

- The current flowing through each resistor is only part of the total current in the circuit.

Multiple resistors can be included in a circuit in parallel.

$$V = I \times R$$

- To find total resistance R_T across the circuit

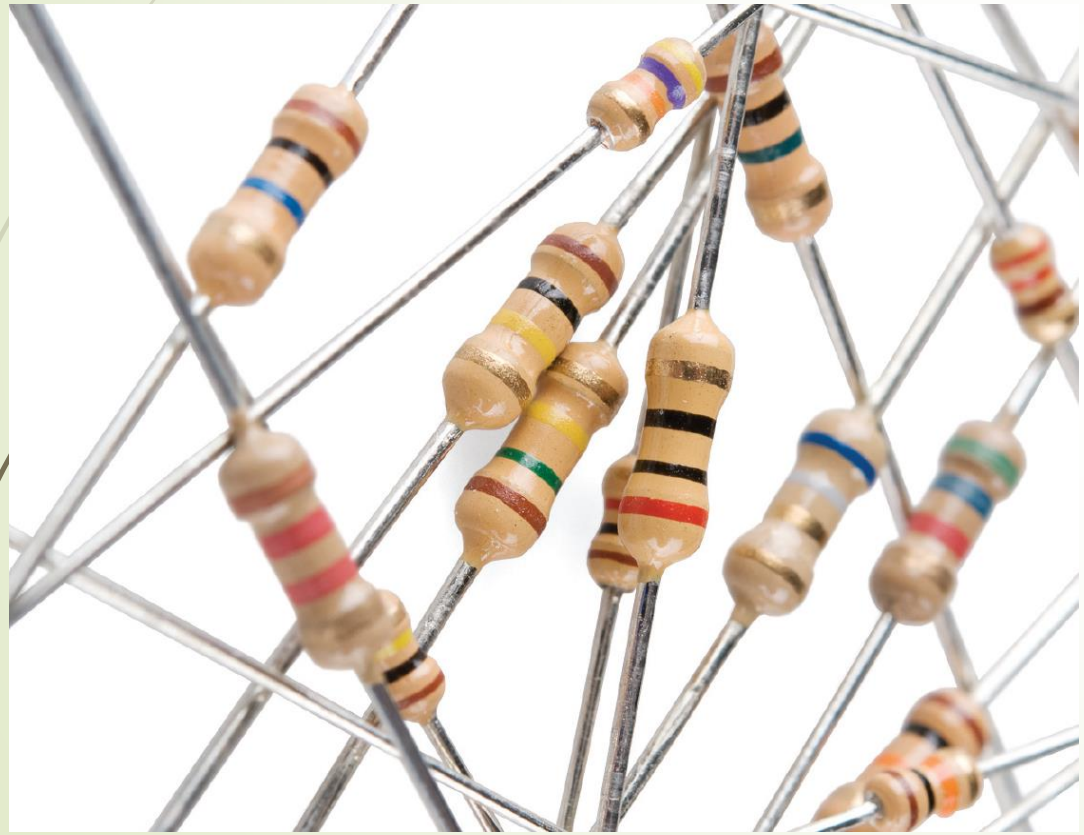
$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$$

- For example, a circuit has two resistors in parallel, each with 4Ω resistance.

$$1/R_T = 1/4\Omega + 1/4\Omega \rightarrow 1/R_T = 1/2\Omega \rightarrow R_T = 2\Omega.$$

- In other words, two branches of equal resistance are exactly twice as easy to get through as one branch alone.

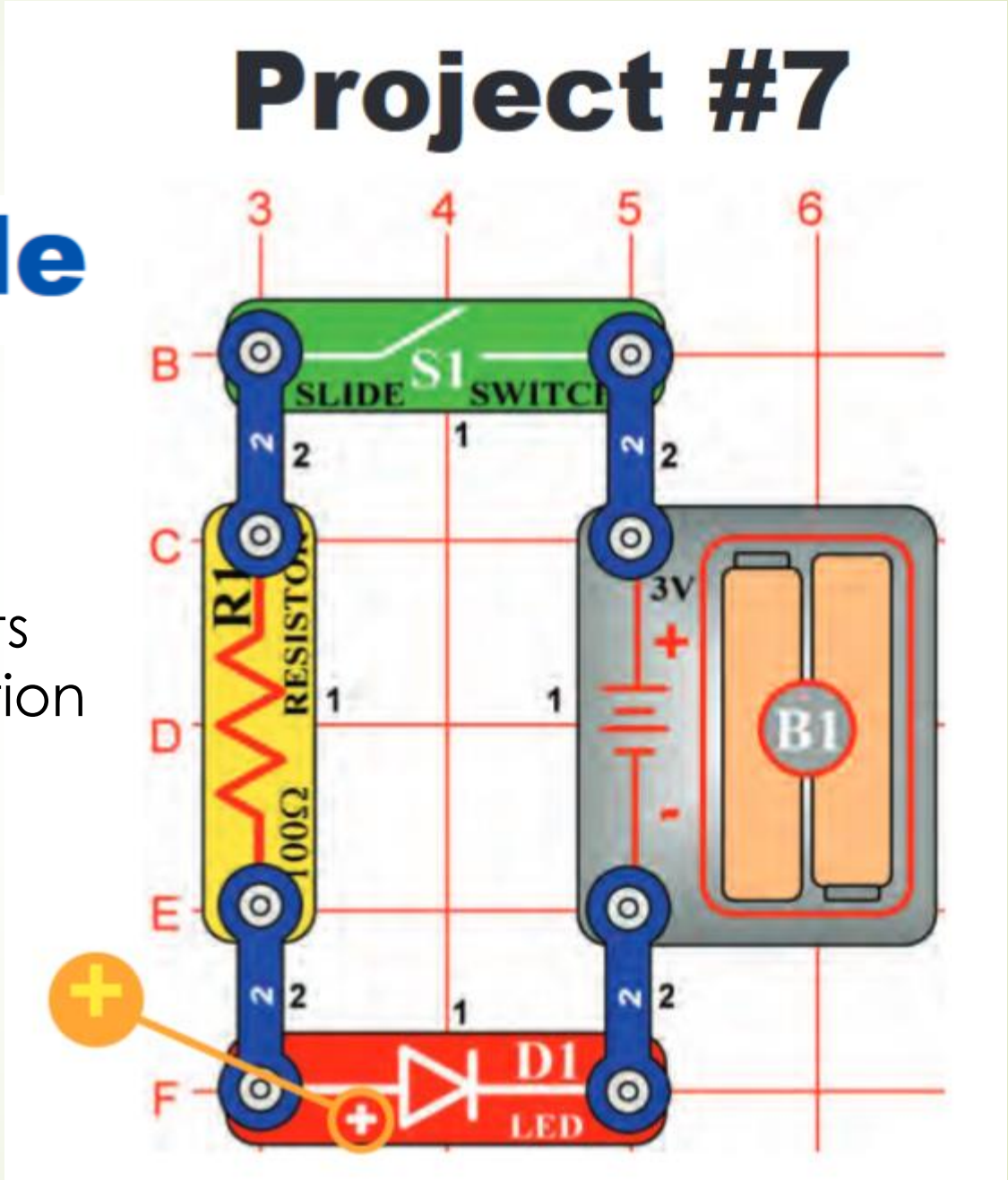
Lesson 2
Introduction to Resistance



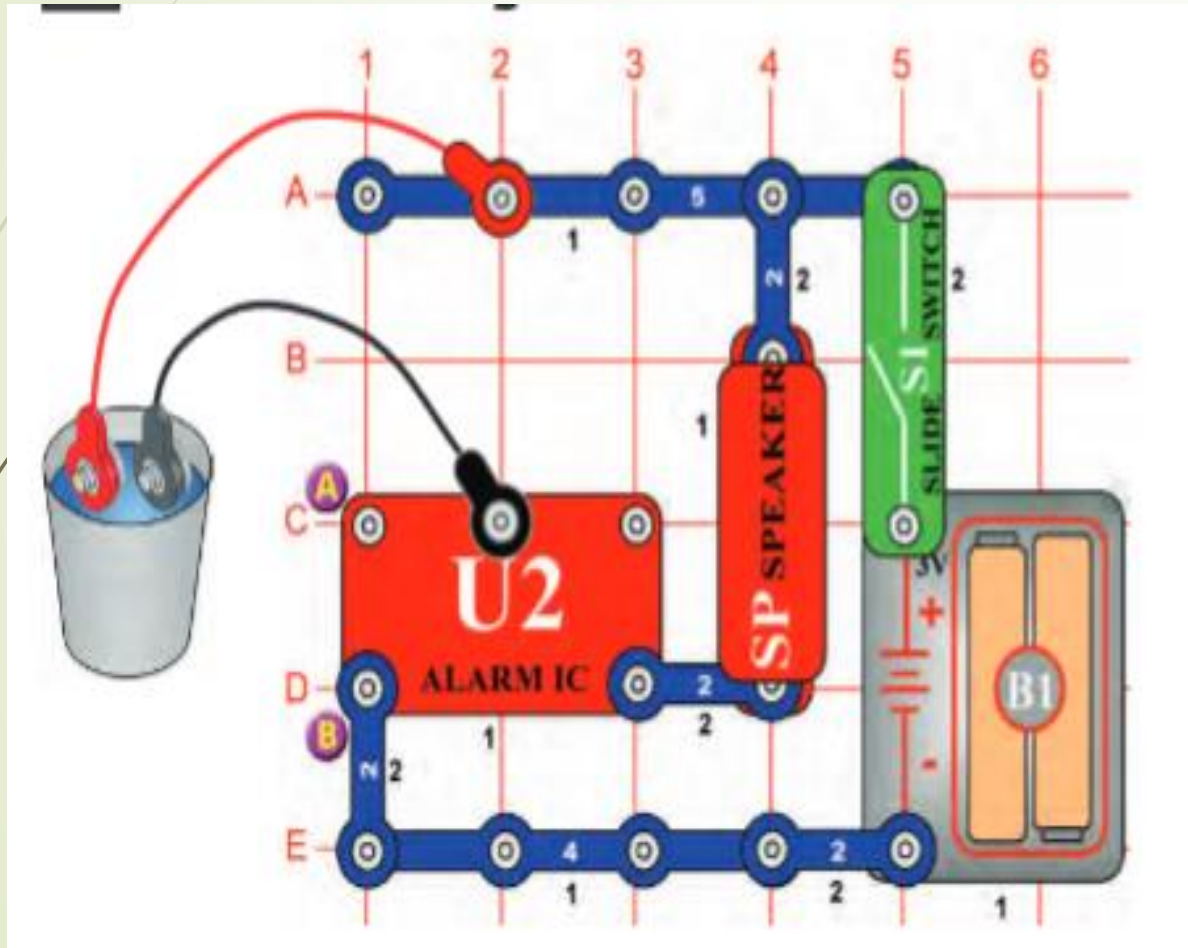
- *Types of resistors in Snap Circuits*
- 1 KΩ Resistor
- 5.1 KΩ Resistor
- 10 KΩ Resistor
- 100 KΩ Resistor
- 1 100 Ω Resistor
- Variable Resistor
- Photoresistor

Light Emitting Diode

Note: In order to answer all the Questions about this project, students must first read background information and terms.



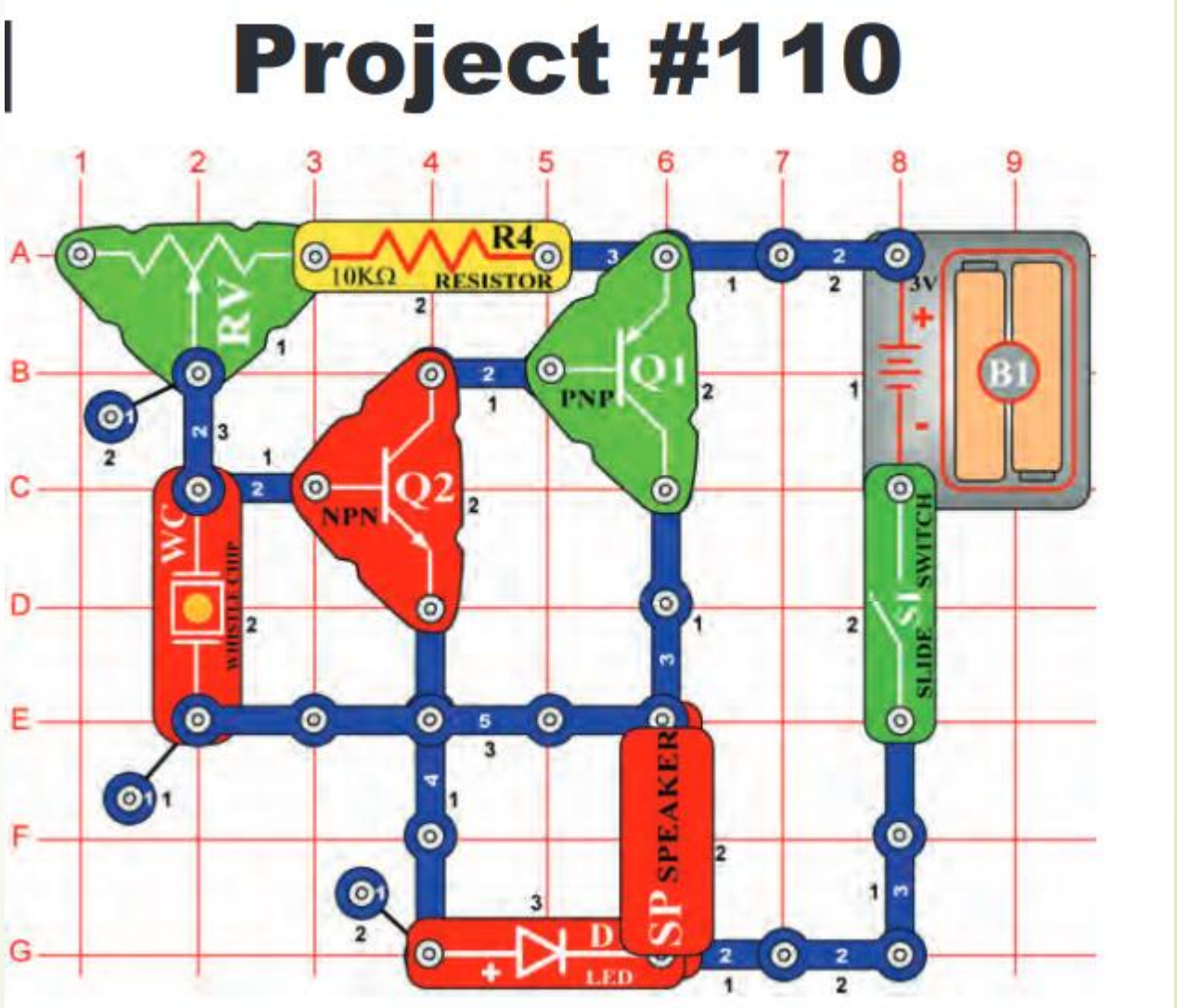
Complete
Projects 98 - Water Alarms



For Project 99
Add salt to water

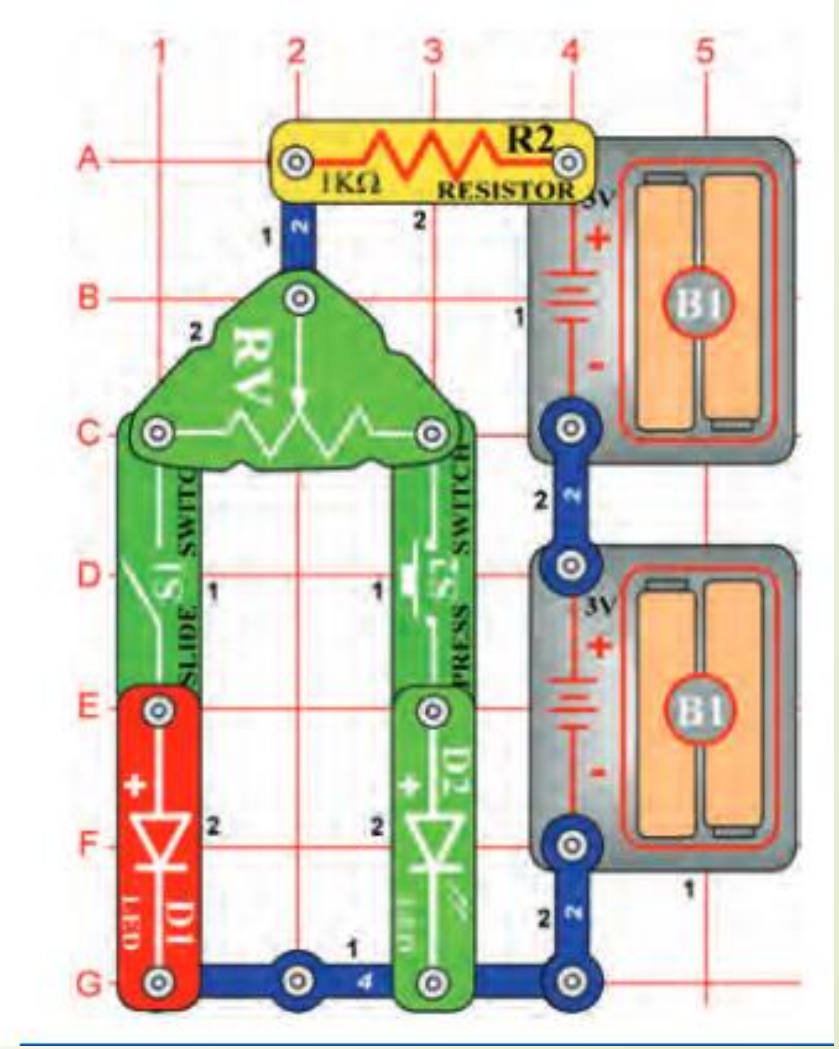
Adjustable Tone Generator

Just as a faucet controls the Amount of water that comes out of your pipe, a variable or adjustable resistor controls the flow of electrons in a circuit.



Project 172 –
Red and Green Control

More variable resistors



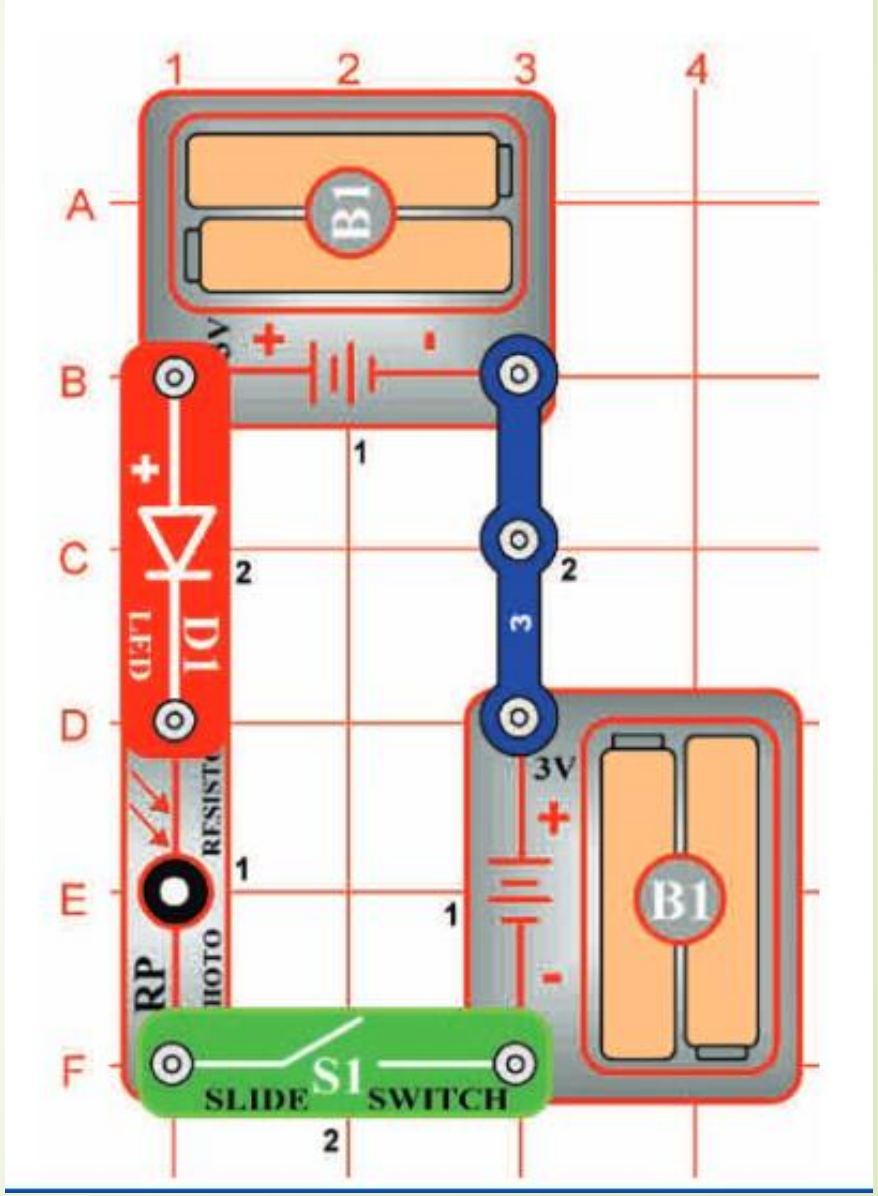
Photoresistor Control

Project #272

Some materials change their resistance when light shines on them.

These light sensitive materials, such as Cadmium Sulfide are classified as ***photoresistors.***

Resistance increases as the light becomes brighter.

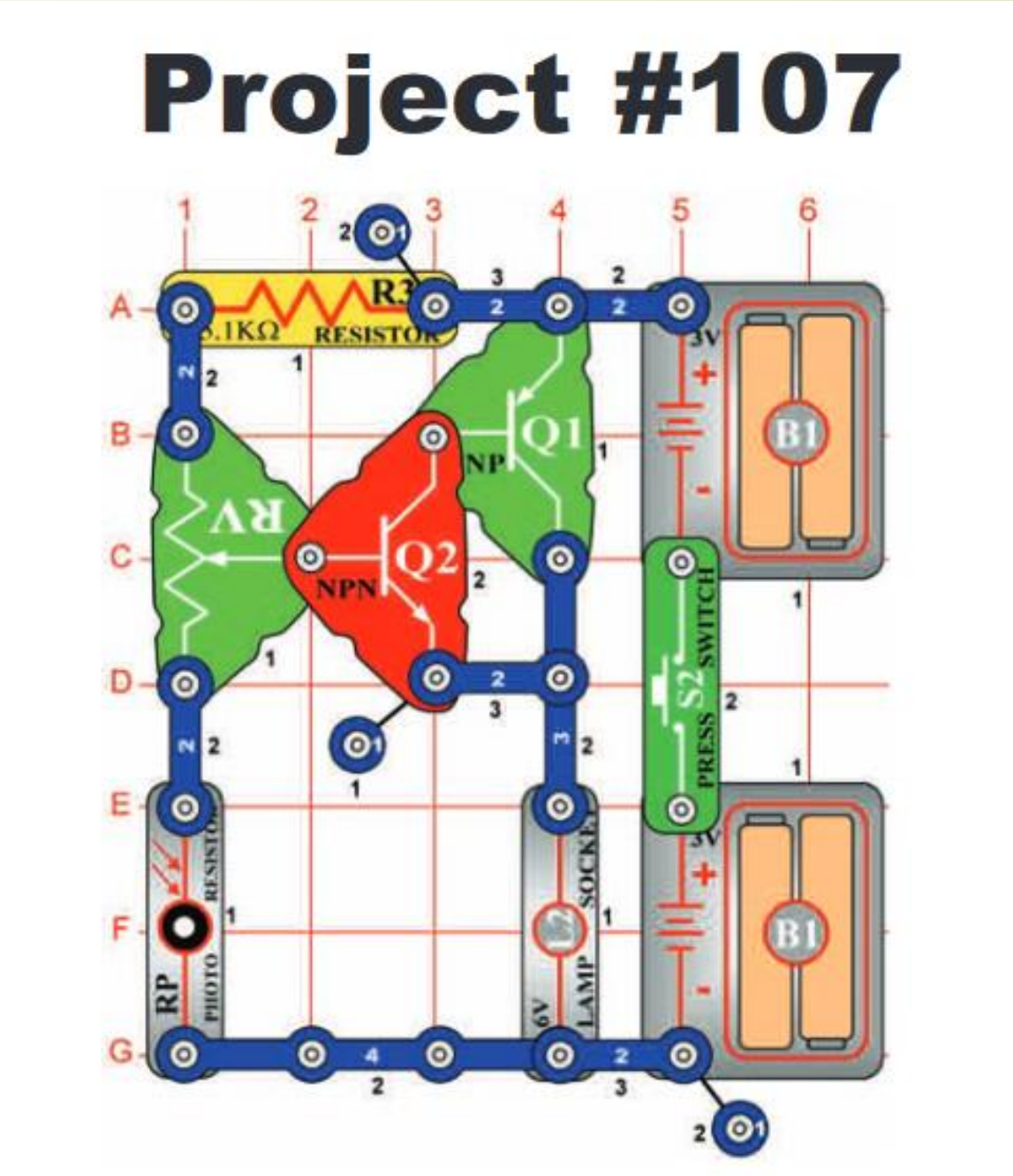


Automatic Street Lamp

This project has multiple resistors including:

- 5.1K Ω
- Variable resistor
- Photoresistor

It also uses a transistor. These can be considered a current amplifiers.



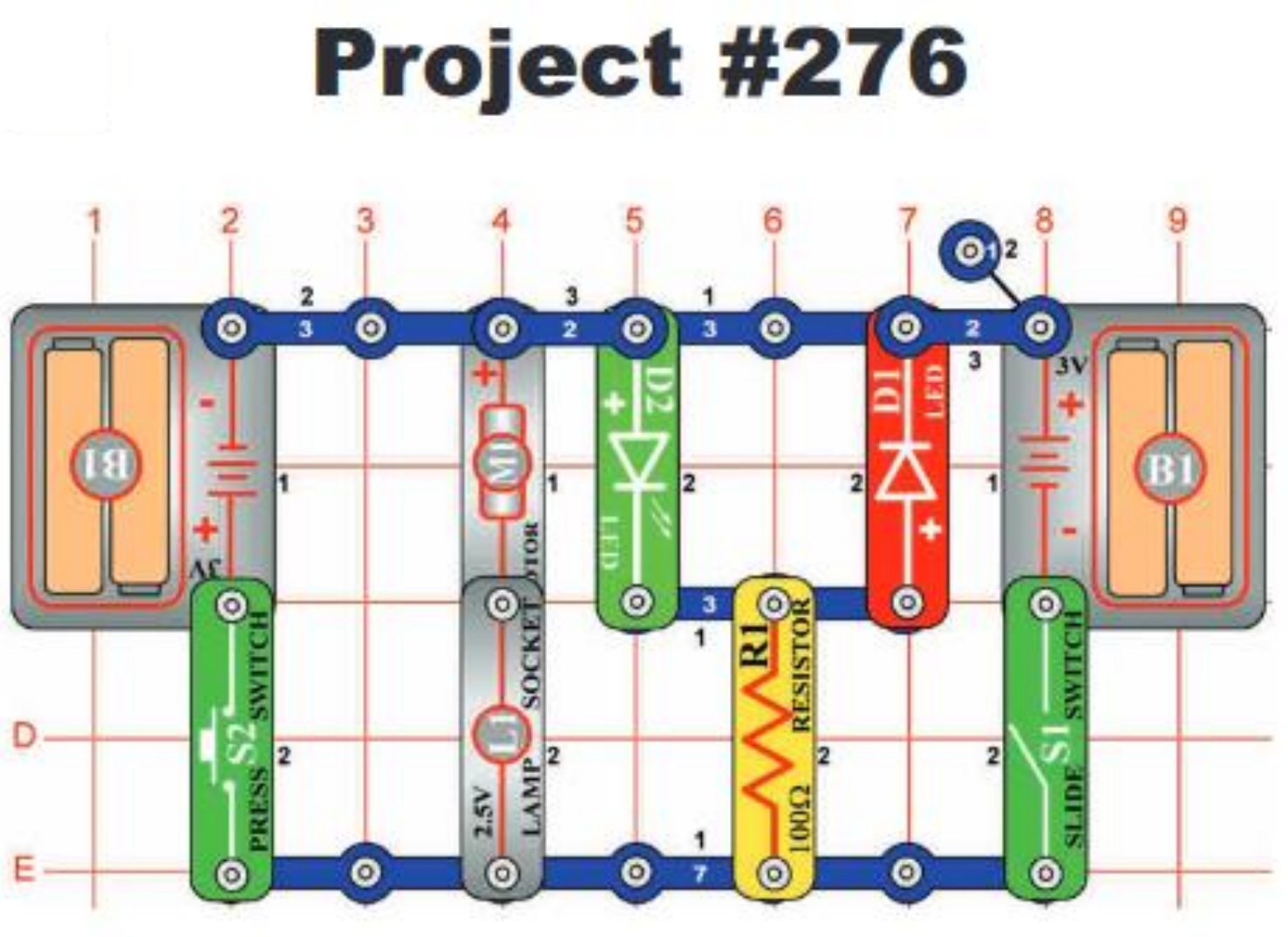
Optional Projects with Resistance

LED Fan Rotation Indicator

Two sets of batteries will drive the fan in opposite directions.

The lit LED indicates the direction.

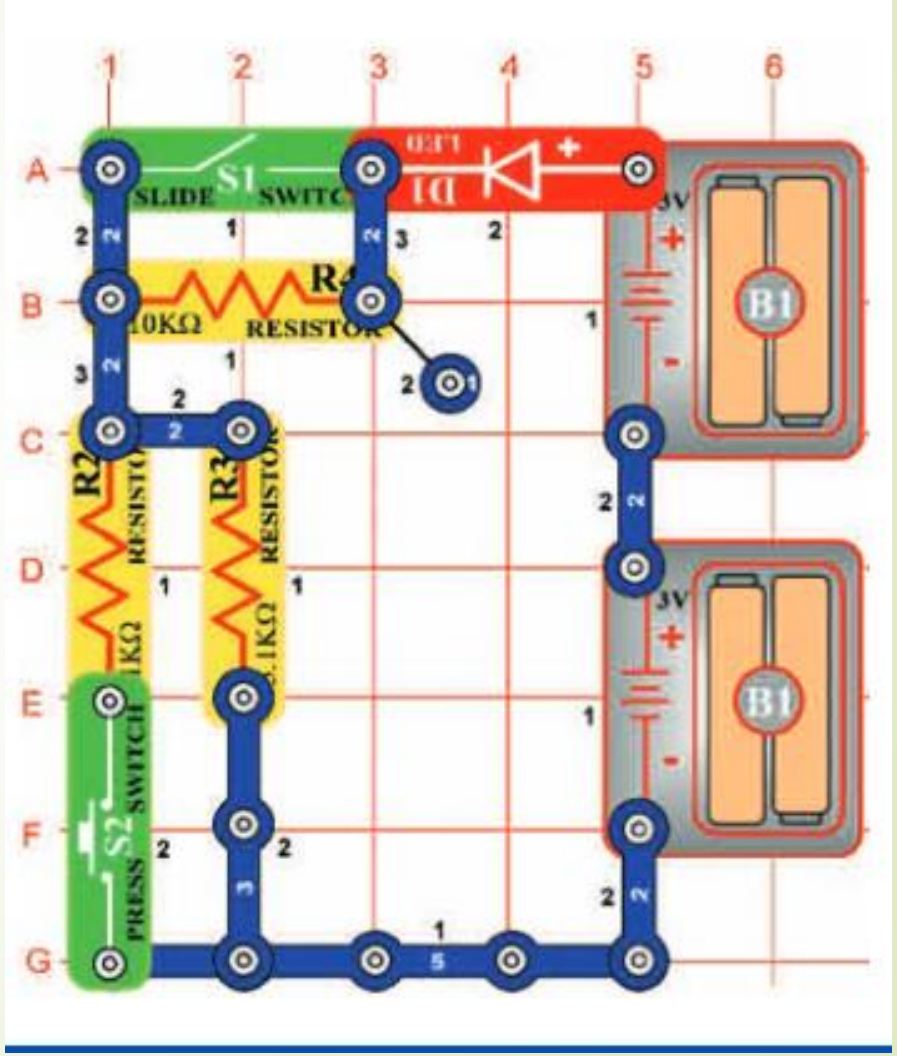
Turning on both switches Causes a short circuit.



Projects 173 – Current controllers

Resistors in parallel and series circuits.

Changing the switch, changes the path for the electrons.

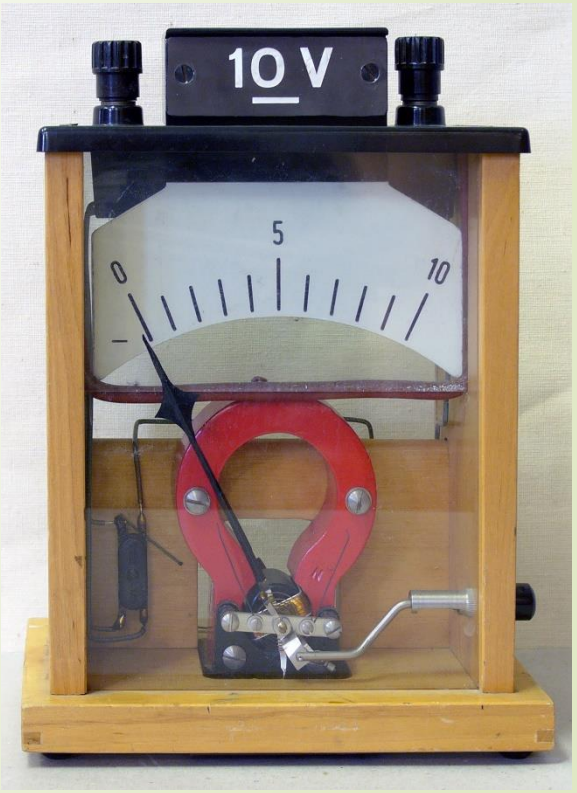


Lesson 3 Meters

Inside a meter is a fixed magnet within a movable coil.

As current flows through the coil, it creates a magnetic field.

The interaction between the two magnetic fields causes the pointer on the meter to move.



Remember the relationship

As current increased, resistance decreases.

As current decreases, resistance increases.

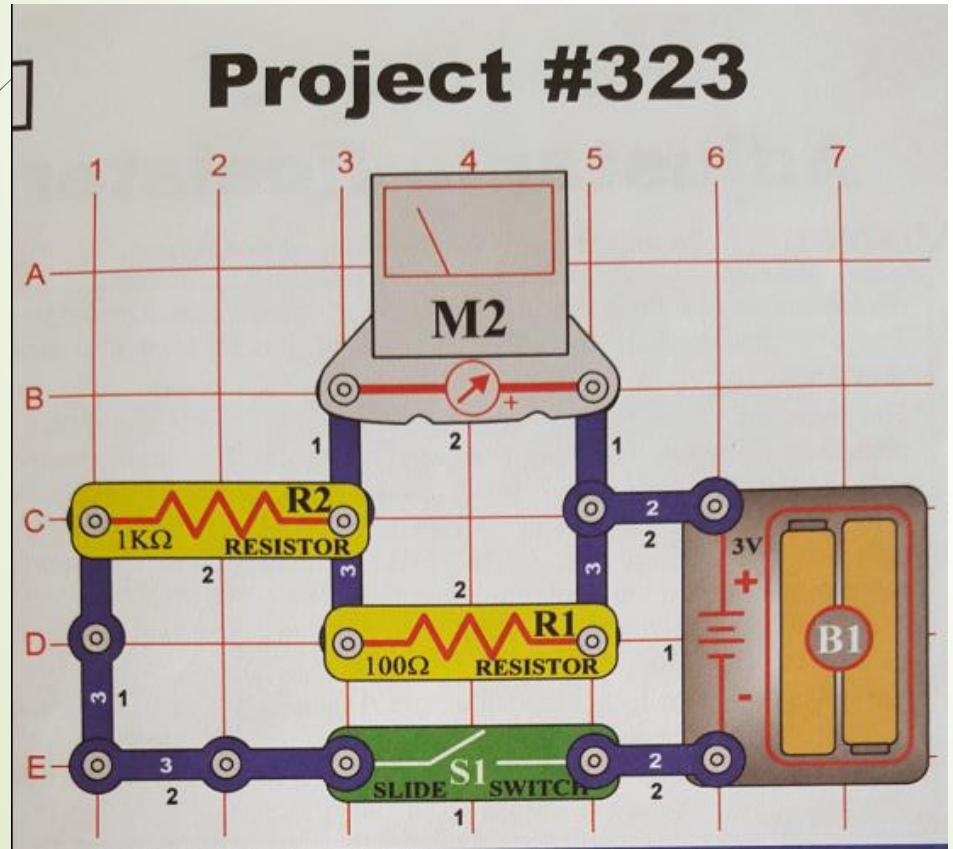
Inverse relationship.

The snap circuit meter measures current in a series circuit and voltage in parallel.

Lesson 3 Meters

Activity 1

Project 323 – 3mA (milliamp) Meter

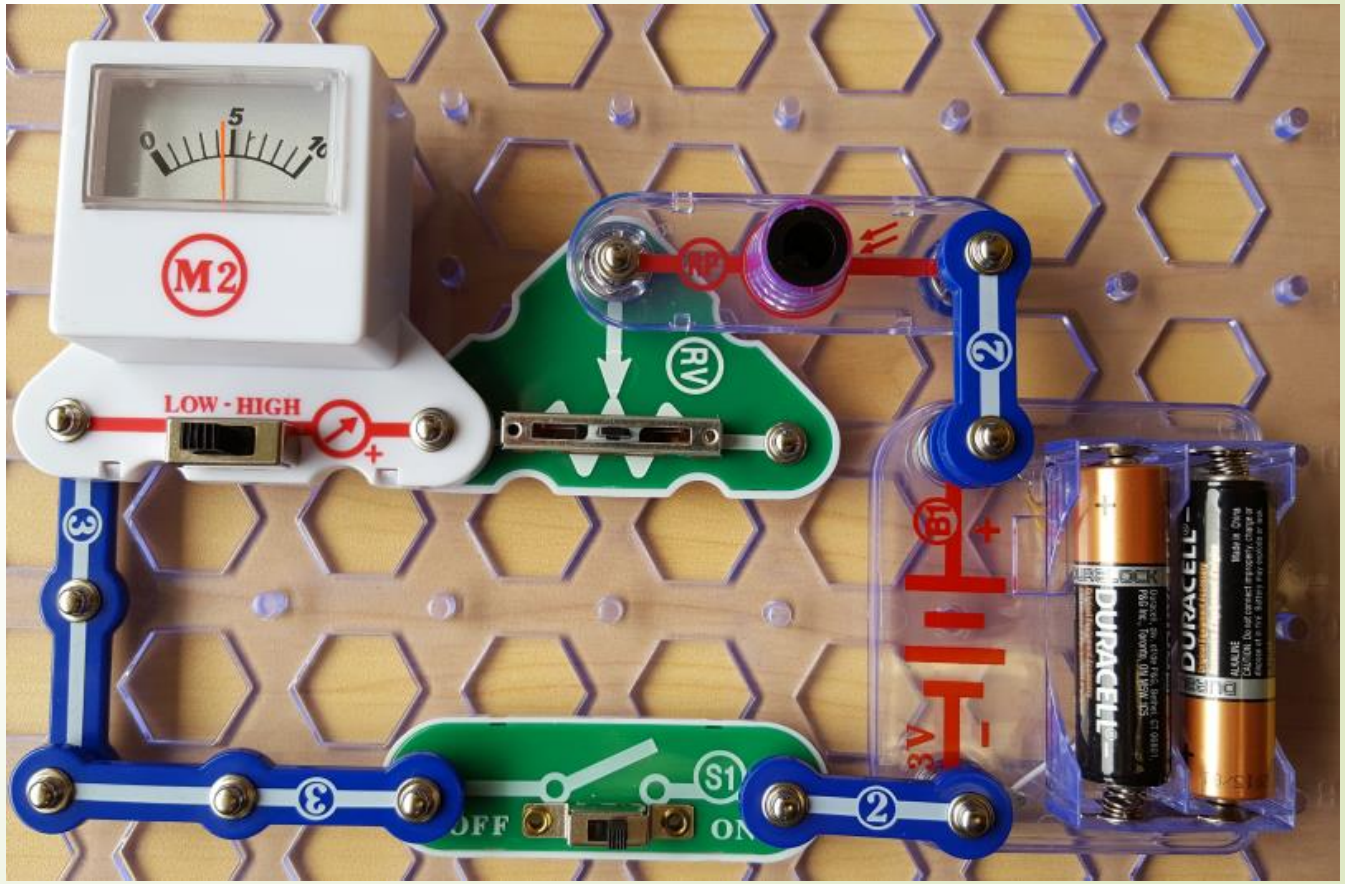


Project 324 0-3 Voltmeter

Activity 2:

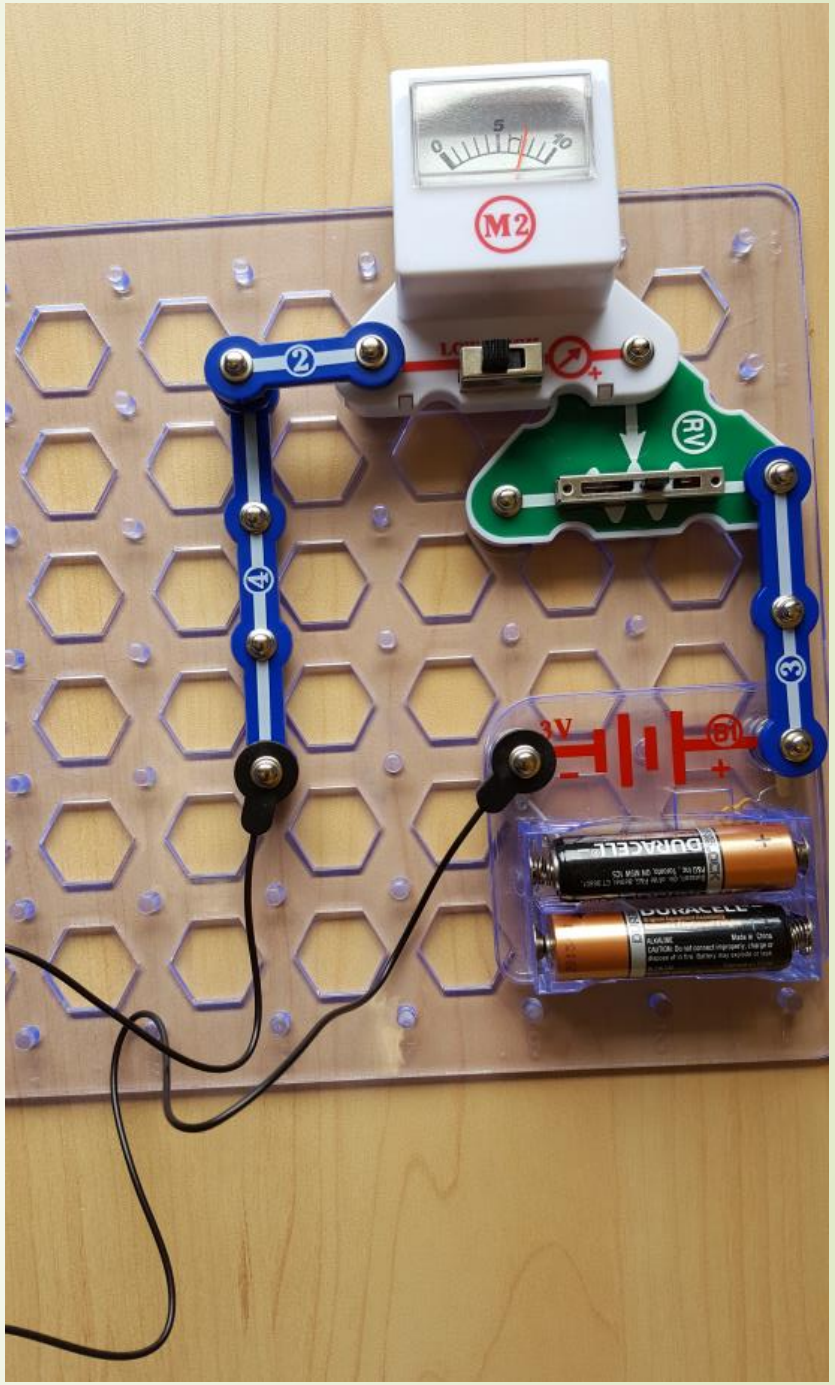
Project 325
Function of Adjustable Resistor

Project 486
Simple Illumination Meter



Activity 3:

Project 494 –
Measuring the Resistance of Different Loads



Extension Activities

Continued electricity topics that may be explored with Snap Circuits include:

- Capacitors
- Transistors
- Generators
- More Integrated Circuits
- Activity 242 builds an AM radio