BrainStorm STEM EDUCATION

STEM KIT

EDUCATOR GUIDE

CIRCUITRY

CREATED FOR BOTH HOME AND SCHOOL

PERFECT FOR THE CLASSROOM

DESIGNED BY TEACHERS FOR TEACHERS

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LESSON OVERVIEW

Class Information

In this lesson, students will learn about circuits. We will focus on the overall concept of electricity; how it flows and what causes it. The class will learn the difference between static and current electricity. Students will learn how to differentiate the two types of circuits, series and parallel. As well as learning the basic components of a circuit and how to identify them in a circuit diagram.

CONCEPTS

- **Circuitry**
- **Types of Circuits**
- **Types of Electricity**
- **Electric Currents**
- **Power Sources**
- **Switches & Buttons**

LESSON OBJECTIVES

- Describe the difference between static and circuit electricity.
- Identify the basic components of a circuit.
- Understand how the Circuit sword lights up
- Be able to conceptualize a basic circuit diagram.
- Describe the difference between series and parallel circuits.

EDUCATIONAL STANDARDS

NGSS - Next Generation Science Standards

K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem

3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4-PS3.B.3 Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

INTRODUCTION

In this lesson we will be learning about the basics of circuitry. We will break down the different components of circuits, electrical charge and how we can build our own circuits. As well as learning about how to understand and draw an electrical circuit diagram.

VOCABULARY

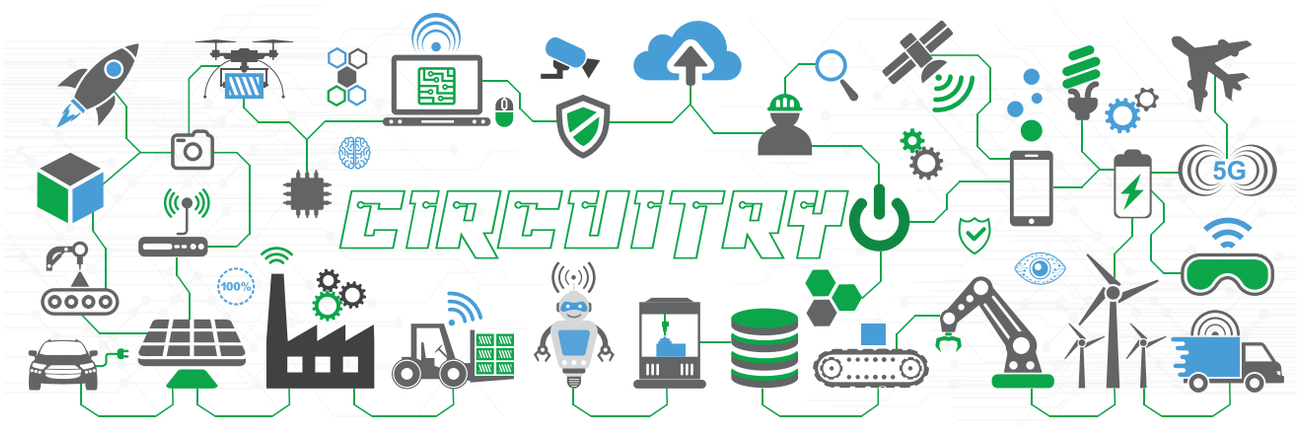
Electric current - any movement of electric charge carriers.

Circuit - Anything that starts and ends in the same place.

Battery - Device used to store electrical charge in a portable container.

LED - type of semiconductor that stands for Light Emitting Diode

Switch - Part of an electric circuit that controls the flow of the electric current through the circuit.



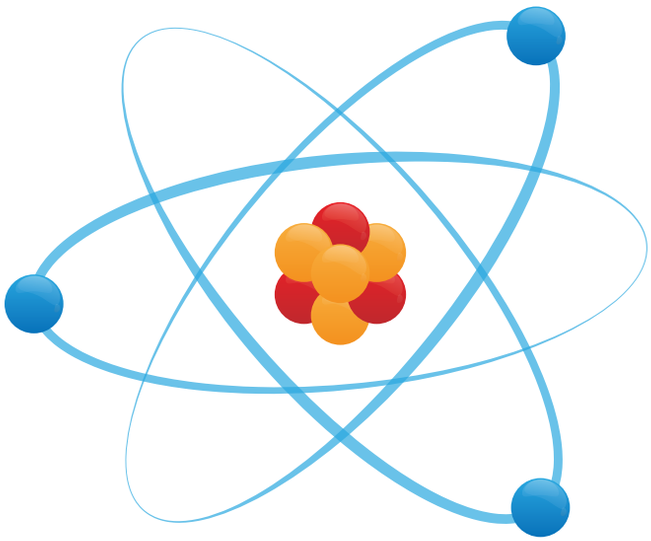
WHAT IS ELECTRICITY?

Electricity is the follow of an electrical charge. The charge of an atom is a property of its matter. We can measure the charge of the atom by the breakdown of protons and electrons in the atom. Atoms are broken down into 3 components; Electrons, Protons and Neutrons. Neutrons are Neutral meaning they carry no charge. Protons are positively charged an they are found in the nucleus of the atom with the neutrons. Electrons are negative and can act as charge carriers between atoms. The electrons float in the space around the nucleus in varying distances from the nucleus. The electrons that are the furthest from the nucleus require the least amount of force to be pulled away from the atom. If we are able to pull the electron away from the atom and cause it to move, this will form an electric current.

Electron
Negatively charged particles
Atomic mass 0

Neutron
Particles that contain no charge
Atomic mass 1

Proton
Positively charged particles
Atomic mass 1



ELECTROSTATIC FORCE

When 2 charges get close together, there is a force that operates between them. This is explained by Coulomb's Law which states that charges of opposite types are attracted together and charges of the same type repel each other. OPPOSITES ATTRACT, SAME REPELS.

As the charges interact with each other and pull and push on the free electrons, it will cause the electrons to be pulled to the next atom in a chain reaction. This movement of the free atoms is the electric current.

STATIC VS CURRENT ELECTRICITY

Depending upon where you see electricity, you could see it take form in 2 different ways: static or current. While the circuit sword experiment is a form of current electricity, it is important to understand the difference between static and current electricity.

Static Electricity

Static electricity exists when there is a buildup of charges on or within an object. The charge will stay at rest or in static electricity until the 2 groups of the opposite charges can find a path between each other to balance out the electric system. When the charges do find a path between to equalize the system, there is a resulting static discharge that can result in a release of energy in the form of light.

Depending upon the level of attraction with the charges and what is insulating the space between them, you can have small discharges as little shocks or very large ones in the form of lightning.

Current Electricity

Current Electricity is the form of electricity that allows us to use electricity in electronics. This only exists if the charges are able to constantly flow. Current electricity is dynamic meaning that the charges are always moving, as opposed to static electricity which is at rest until it has a reaction to the opposing charges. We can harness the energy of current electricity by controlling it in a circuit.

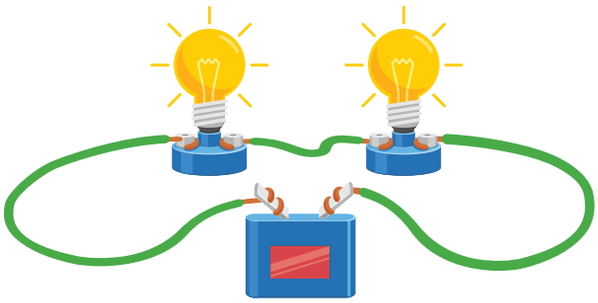
Circuits

A Circuit is something that starts and ends in the same place. In order for a circuit to conduct electricity, the circuit must be a closed, never ending loop. If a circuit does not fully connect in the loop, the circuit is considered open and will not send the electric current through. If the circuit is closed, it is fully connected and the electric current is able to travel through the circuit and power the circuit components.

SERIES VS PARALLEL CIRCUITS

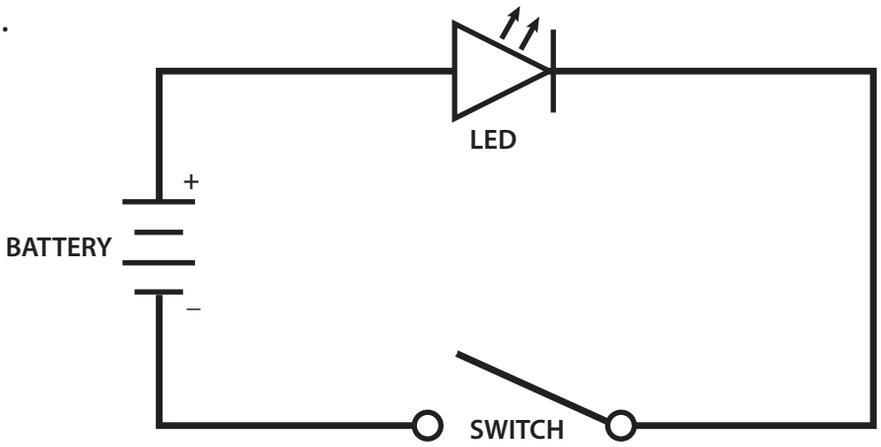
Circuits can be built with different paths for the current to flow through. In a series circuit, all of the components are connected end-to-end meaning that the circuit forms a single path.If one component in a series circuit stops working, it will make the circuit open and not able to conduct electricity. In a parallel circuit, all the components are divided into separate paths meaning that if one component stops working, the circuit can still conduct electricity. The amount of voltage from the power source is divided across all of the circuit components, meaning that a 2 volt battery would provide 1 volt to each light bulb in a 2 bulb series circuit. Whereas in a parallel circuit, the voltage is the same across all of the components.

SERIES CIRCUIT



PARALLEL CIRCUIT

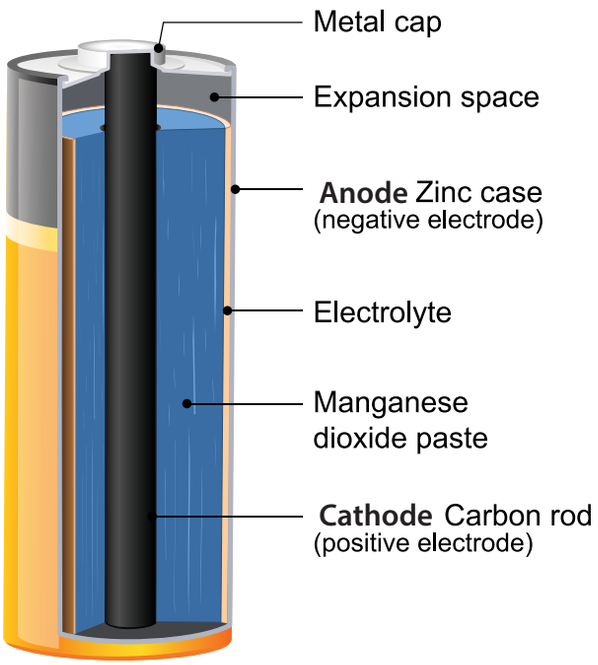
Circuits can be drawn out to show the connections and electron flow in an electron drawing as seen below. Each of the components in the circuit are shown with symbols to map out their connection in the circuit. This is how scientists can design a circuit before building it to plan and try to find any issues early on.



COMPONENTS OF A CIRCUIT

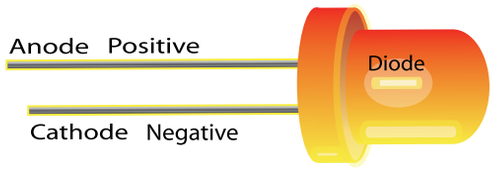
BATTERIES & POWER SOURCES

All electric circuits need to have a power source to provide the electricity. In small devices, the power source is provided from a battery. In circuits on a larger scale such as a building, the power will come from a public power plant. A Battery is a container for chemicals that store energy to change into electric energy while being used. The battery has a positive side and a negative side. The positive side is called the cathode and the negative side is the anode which are separated by an electrolyte. When the 2 sides of the battery are connected by an outside wire, the electrolyte causes electrons to flow from one side of the battery to the other and out through the circuit.



LEDs

LEDs or Light Emitting Diodes are semiconductors that when the electrons flow through a circuit is creates light. LEDs work by forming a p-n junction which is a connection between a p-type semiconductor and an n-type semiconductor. The P-type contains positively charged carriers and the n-type contains electrons. When the electrons flow through a closed circuit the from the n to p, the junction is formed and the LED emits light. The P-type corresponds to the anode side and the N-Type corresponds to the Cathode side. The electricity can only travel from positive to negative, so it is important for the LED to be positioned correctly in order to light up.



COMPONENTS OF A CIRCUIT(Cont.)

SWITCHES

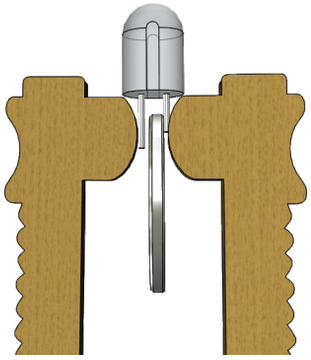
A Switch is put into an electric circuit to allow us to control the flow of an electric current. A switch will allow the user to make the circuit go from open to closed. If you flip a light switch from off to on, it closes the circuit to allow the electricity to flow through and turn the light on. The symbol in a circuit drawing that denotes a switch is seen below.

OPEN SWITCH

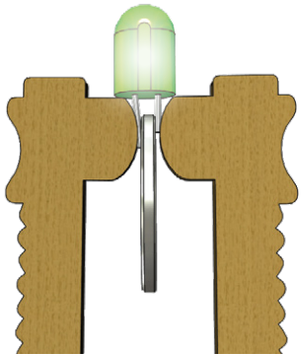
CLOSED SWITCH

THE CIRCUIT SWORD SWITCH

The Circuit Swords are a very basic circuit that works in order to make an LED light up and give the illusion of a sword made out of light. This Circuit is composed of a Battery, and LED and a Switch. When you build your circuit sword, you are putting the LED so that the anode is in contact with the battery, while the cathode is elevated. Since the cathode is not connected to the battery, it is an open circuit meaning electricity is not flowing through the LED. The wooden sides of the circuit sword act as a switch for our circuit. When the sides are squeezed together, it pushed the extended cathode of the LED to make contact with the battery closing the circuit and turning the LED on!



OPEN



CLOSED

PROJECT OVERVIEW

Learn about circuitry, the basic components and how to differentiate between the different types of circuits. This lesson will focus on the overall concept of electricity; how it flows and what causes it. What is the difference between static and current electricity?

SAFTEY WARNINGS:

Please read all saftey warnings before use:

Choking Hazard: Small parts not for children under 6 years or any individual who have a tendency to place inedible objects in their mouths.

Eye protection should be worn at all times.

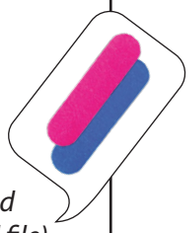
Adult supervision required.

MATERIALS

Durable wooden construction pieces
LEDs
Colored Tubes
Batteries
Key Rings

Colors may vary.

1



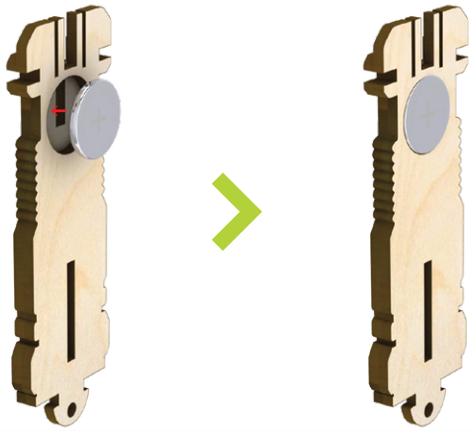
NOTE: *If any wooden pieces are hard to remove, use a blunt tool to carefully punch them out, and ask an adult for help if needed. Use the sanding stick included in your kit (it looks like a small nail file) to smooth out any rough edges or spots where pieces don't fit together easily. Just find the tight spot and gently sand the edge until it fits just right.*

2

3

Positive Side of Battery

Negative Side of Battery



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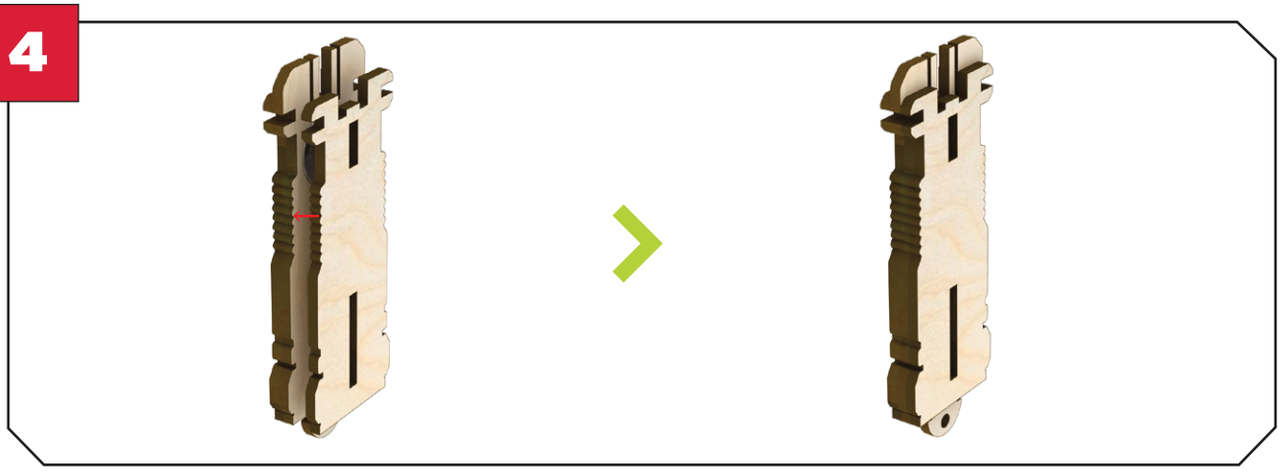

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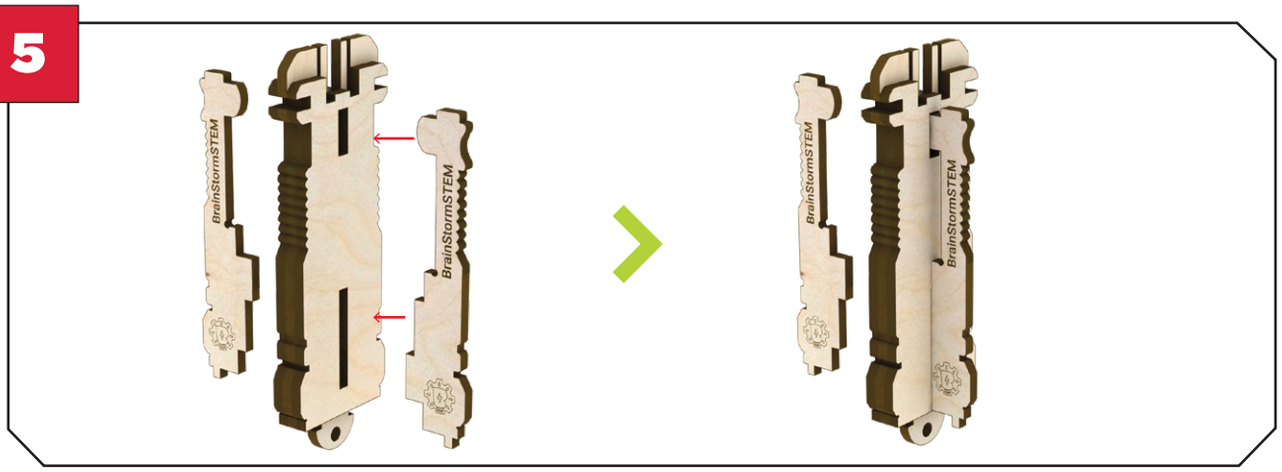
BrainStormSTEM
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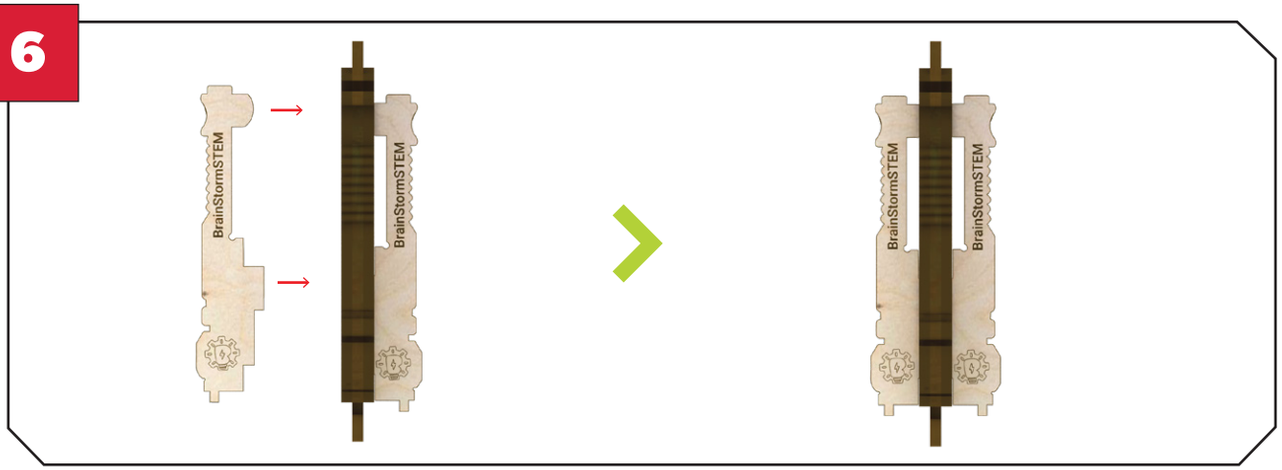
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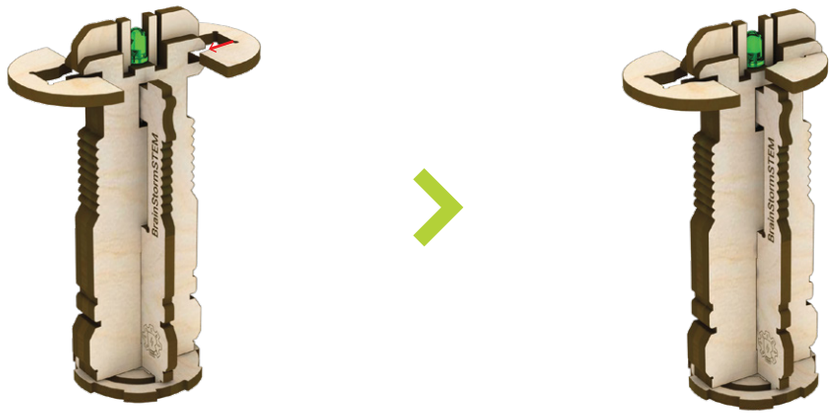
9

NOTE: The Anode should be inserted to make contact with the Positive side of the Battery

10


BrainStormSTEM
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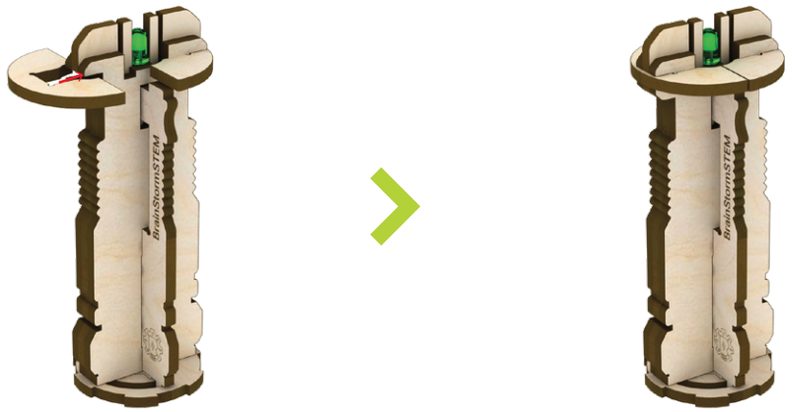
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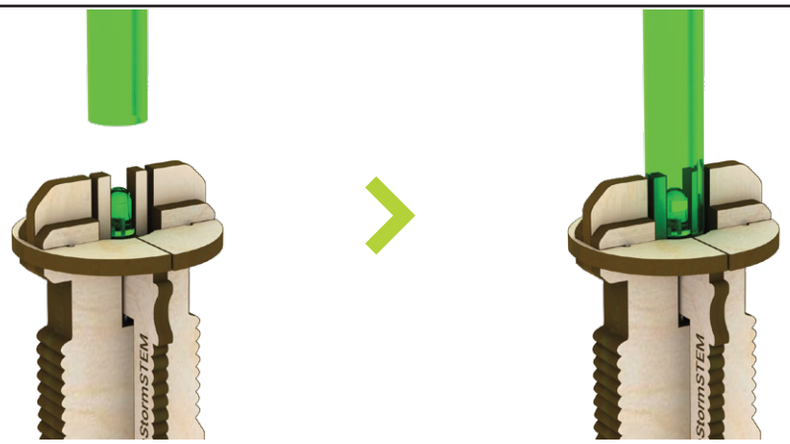
12


StormSTEM
StormSTEM

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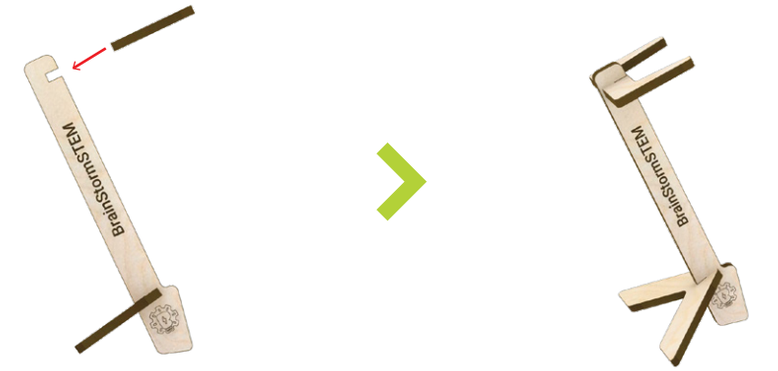
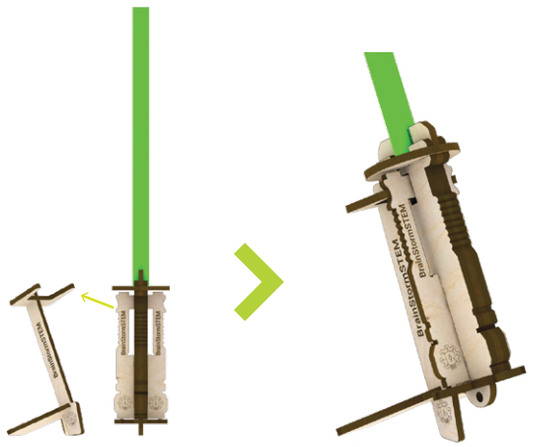
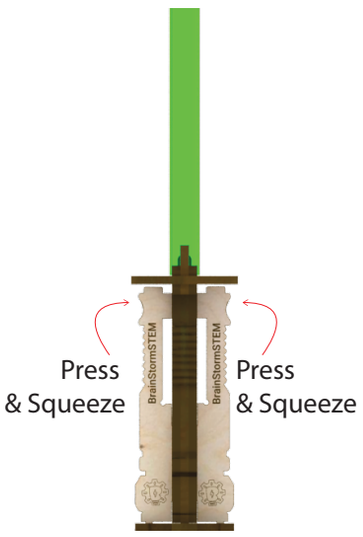


HOW TO USE



Place on to Stand

OR

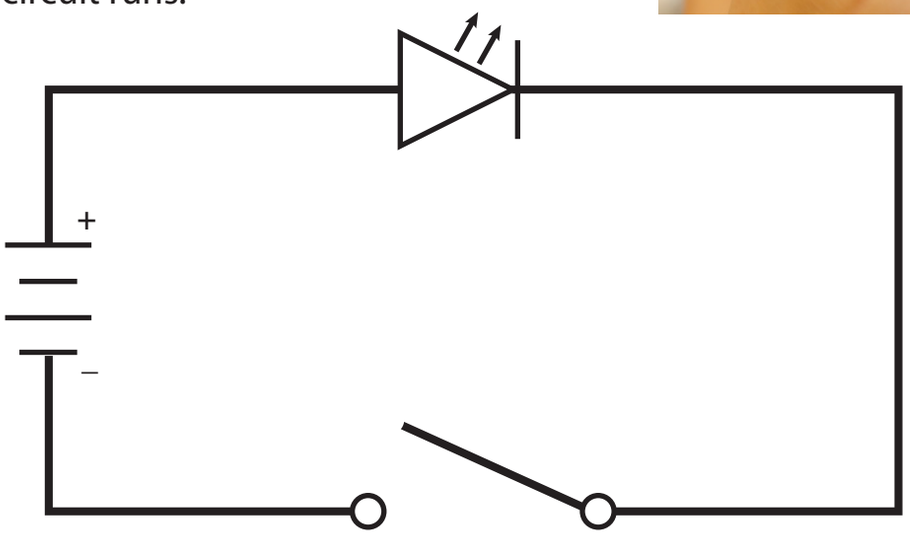


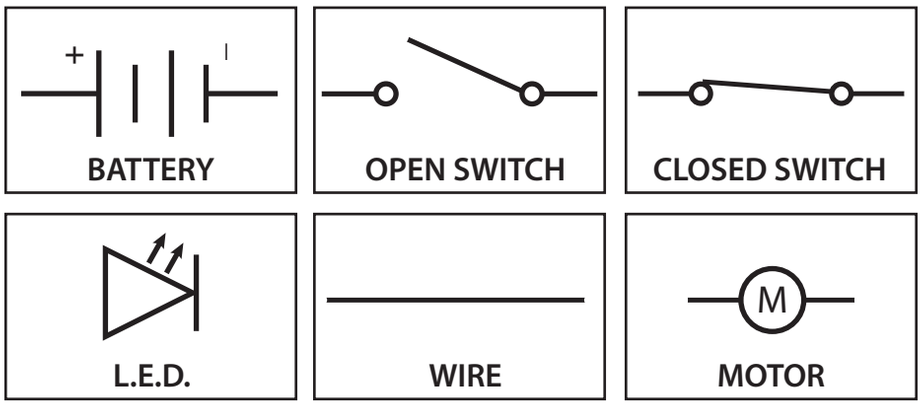
Press & Squeeze

ACTIVITY FOR PROJECT

The Circuit Sword kit can be used to just build and design your own circuit sword. But in order to make the circuit sword into a more engaging classroom activity, we can learn how to draw out a circuit diagram to help us understand circuits on a deeper level.

Drawing circuit diagrams is useful in the working world in industries such as electronic technicians, electrical engineers and more! The students will be able to practice drawing the symbols and putting them in a circuit diagram to design how a circuit runs.





WORKSHEET (BEGINNER)

Name(s): _____

Date: _____

As circuits get more complex it is helpful to create a plan to know how to build your circuit. Today we are going to practice drawing the circuit components and drawing a circuit diagram!

First Trace the circuit symbols and then try drawing them in the blank space.

BATTERY

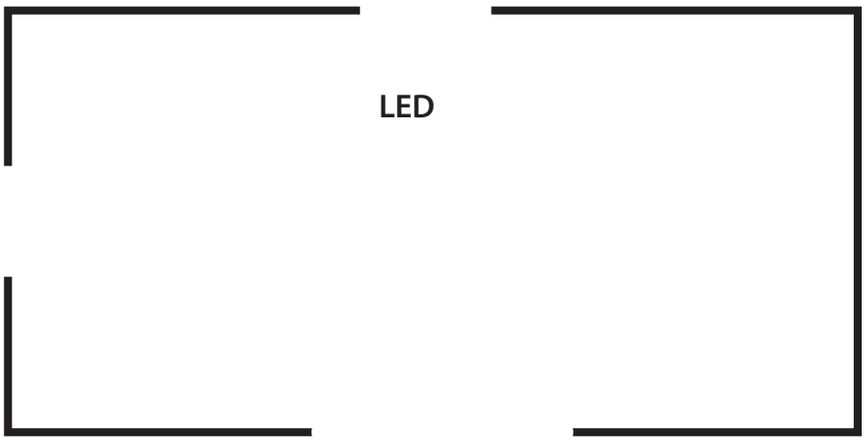
WIRE

L.E.D.

CLOSED SWITCH

OPEN SWITCH

MOTOR



CLOSE CIRCUIT

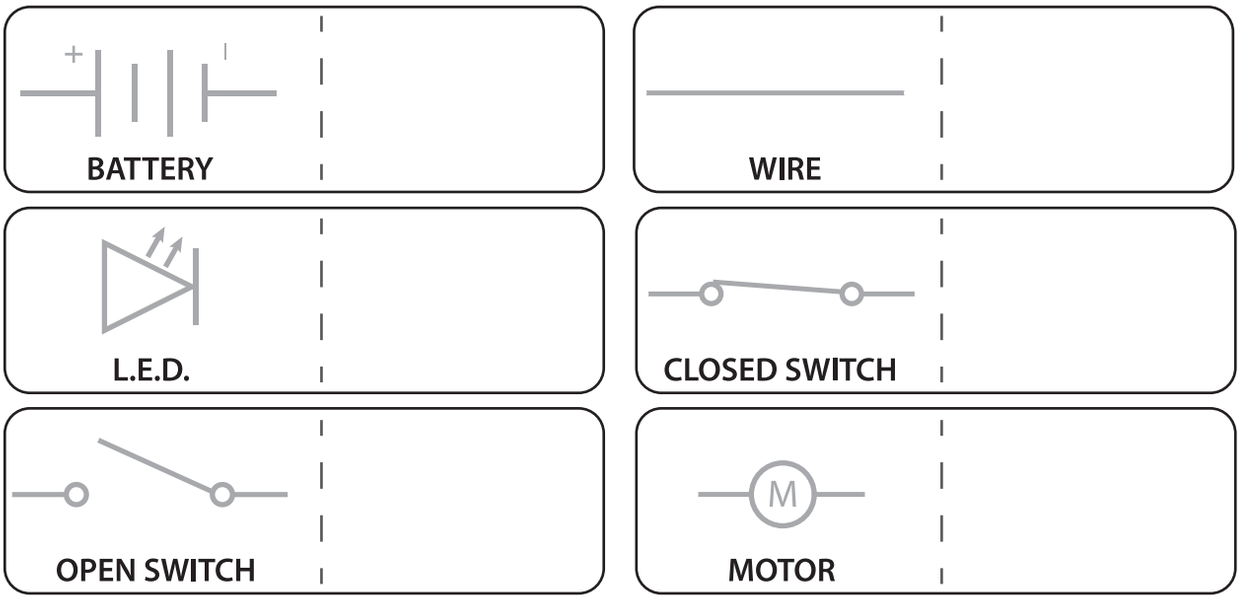
WORKSHEET (ADVANCED)

Name(s): _____

Date: _____

As circuits get more complex it is helpful to create a plan to know how to build your circuit. Today we are going to practice drawing the circuit components and drawing a circuit diagram!

First Trace the circuit symbols and then try drawing them in the blank space.



In the space below, draw your own circuit using the circuit symbols.

Describe what your circuit does _____

_____