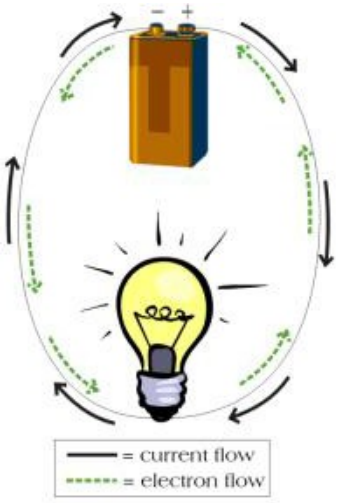
# Activity 1: Simple Circuit

Overview:

A circuit is a path that electricity flows along. It starts at a power source, like a battery, and flows through a wire to a light bulb or other object and back to other side of the power source. You can build your own circuit and see how it works with this project!




## Learning Outcomes

1. Understand the basic workings of a simple circuit connection.

2. Understand battery polarity and its effects.

## Materials

- Small light bulb
- 2 AA batteries (or correct voltage for your light bulb)
- Bulb holder
- Battery holders

# The Activity

## Steps:

1. Slightly unscrew the two small screws at each end of the bulb holder's base; make sure you don't completely unscrew the small screws.

2. Grab the end of the ground/negative (black) wire from the battery holder and place the metal part in the gap between the top of the screw and the bulb holder's base; make sure that the screw is making contact with the metal part of the wire, if the wire needs to be stripped ask an expert to assist you).

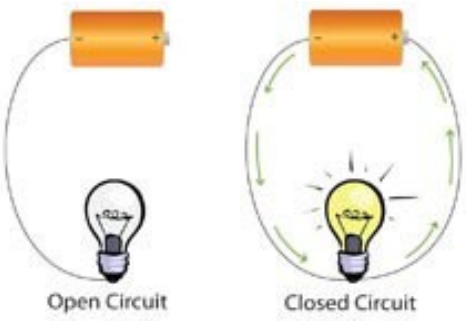
3. Grab the end of the power/positive (red) wire from the battery holder and place the metal part in the gap between the top of the unused screw and the bulb holder's base; make sure that the screw is making contact with the metal part of the wire, if the wire needs to be stripped ask an expert to assist you).

4. Screw in the light bulb on to the bulb holder; make sure it is sturdily screwed in place.

5. Place the two batteries into the battery holder making sure the negative (-) makes contact with the string and the positive (+) makes contact with the flat metal.

** If the bulb is not lit, it could be possible reasons; the bulb is out, the metal part of the wire is not making contact with the screws, the batteries are connected incorrectly, and/or the batteries are out**

## What happened?




In the first part, you made a simple circuit that used a battery to light up a light bulb. Batteries supply electricity. When they're connected properly, they can "power" things, like a flashlight, an alarm clock, a radio, or a timer. Why didn't the light bulb light up when you connected it to one end of the

battery with a wire? Electricity from a battery has to flow out one end (the negative or "-" end) and back in through the positive ("+") end in order to work. What you built with the battery, wire, and bulb in step 3 is called an open circuit. In order for electricity to start flowing, you need a closed circuit. Electricity is caused by tiny particles with negative charges, called electrons. When a circuit is complete, or closed, electrons can flow from one end of a battery all the way around, through the wires, to the other end of the battery. Along its way, it will carry electrons to electrical objects that are connected to it - like the light bulb - and make them work!

In the second part, you added another battery. That should have made the light bulb burn more brightly, because two batteries together can supply more electricity than just one! The paper clip across the bottom of the battery pack allowed electricity to flow between the batteries, making the flow of electrons stronger

## Assessment

1. What conclusions can you make about the flow of electricity in a closed circuit?

2. If a circuit is not working properly, like a light bulb not lighting up, what may be some possible causes?

3. What are ways of increasing the voltage of a circuit?

# Activity 2: Insulators and Conductors

Overview:

Materials that electricity can flow through are call conductors. Materials that stop electricity from flowing are called insulators. You can find out which things around your house are conductors and which are insulators using the circuit you made in the last project to test them!

## Learning Outcomes

1. Understand the difference between a conductor and Insulators.

2. Be able to identify which test material are inductors and which are conductors.

# Materials

- Circuit with light bulb & 2 batteries
- Extra alligator clip wire (or aluminum foil wire*)
- Objects to test (penny, paper clip, LED light, aluminum foil, popsicle stick, nail, etc.)

# The Activity

## Steps:

1. Screw in the light bulb on to the bulb holder; make sure it is sturdily screwed in place.

2. Using the end of one of the power/positive (red) alligator clips, connect the clip to the top of one of the screws; make sure the meatal part of the clip is making contact with the screw. Repeat the same step for one of the ground/negative (black) alligator clips.

3. Using another power/positive (red) alligator clip connect one end to the positive(+) of the battery. Repeat the same step for the end of anther ground/negative (black) alligator clip.

4. You have made an open circuit and the bulb should not light up. Next you will test objects to see if they are conductors or insulators. If the object is a conductor, the light bulb will light up. It is an insulator, it will not light. For each object, guess whether you think each object will complete the circuit and light up the light bulb or not.

5. Connect the ends of the free wires to an object and see what happens. Some objects you could test are a paper clip, a pair of scissors (try the blades and the handles separately), a glass, a plastic dish, a wooden block, your favorite toy, or anything else you can think of.

## What happened?

Before you test each object, guess whether it will make the light bulb light up or not. If it does, the object you're touching the wires to is a conductor. The light bulb lights up because the conductor completes, or closes, the circuit and electricity can flow from the battery to the light bulb and back to the battery! If it doesn't light up, the object is an insulator and it stops the flow of electricity, just like an open circuit does.

When you set up the circuit in step 1, it was an open circuit. Electrons could not flow all the way around because two of the wires were not touching. The electrons were interrupted. When you placed an object made of metal between the two wires, the metal closed or completed the circuit - the electrons could flow across the metal object to get from one wire to the next! Objects that completed the circuit made the light bulb light up. Those objects are conductors. They conduct electricity. Most other materials, like plastic, wood, and glass are insulators. An insulator in an open circuit does not complete the circuit, because electrons cannot flow through it! The light bulb did not light up when you put an insulator in between the wires.

If you're using wires or alligator clips, take a good look at them. Inside they are made of metal, but they have plastic around the outside. Metal is a good conductor. Plastic is a good insulator. The plastic wrapped around the wire helps keep electrons flowing along the metal wire by blocking them from transferring to other object outside of the wires.

| **Object** | **Prediction** (Insulator/Conductor) | **Insulator or Conductor** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

## Assessment

1. What types of material did you identify as inductors and which did you identify as conductors?

2. Do you think an inductive material can be transform into a conductive material? Hint: think of distil water and salt water.

3. Explain the benefits of inductors and conductors and how they are useful on current devices.

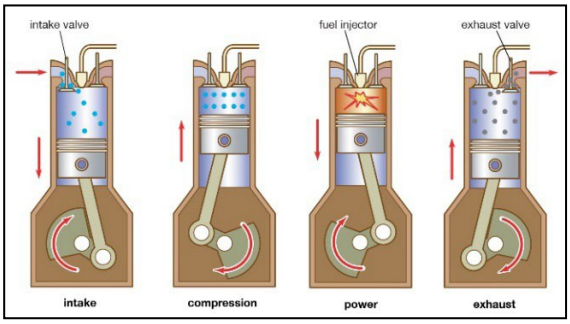
## Activity 3: Electric Vehicle

Overview:

The big difference between electric vehicles and traditional combustion vehicles is what is used to more the vehicle. Traditional combustion vehicles use combustion reactions; which use the process of taking a carbon and hydrogen base compound, or in the case of vehicles, gasoline, and reacting it with

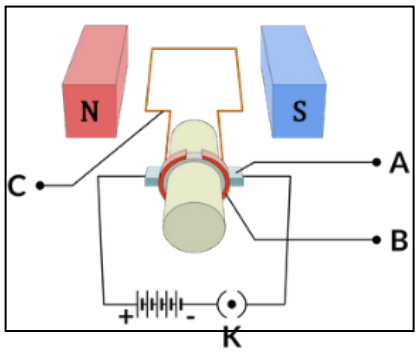
oxygen. As the gasoline and air mix a spark plug creates a small electrical spark which starts of the reaction, the reaction creates huge amount of energy which then pushes a piston down; this process is done multiple time a minute – from 1000 to 8000 times/rotations? a minute. One huge consequence of traditional combustion vehicles is the result of these combustion reactions, because when gasoline and oxygen react, the resulting compounds are water and carbon dioxide. Carbon dioxide is the leading compound for global pollution and global climate change.

**Figure 1. Combustion Cycles:**




Due to the carbon dioxide output, research was done to create the modern electric vehicles. Currently, Tesla is the leading manufacturer of electric cars. Electric vehicles work similar to how remote control (RC) toy cars work; there are three critical components - the induction motor, the battery, and the control unit. An induction motor is composed of two large permanent magnets, coils, and a rod. As current passes through a rod it creates an electric field which then reacts with the magnetic field created by the magnets and cause the coils to spin. As the coils spin the rod spins as well, causing anything connected to the rod to spin. The control unit is critical to how an electric vehicle operates; it works very similar to how a gas pedal works in a traditional combustion vehicle. The control unit controls the amount of voltage applied to the motor, causing the electrical field to either weaken (causing the motor spin slower) or strength (causing the motor to spin faster).

**Figure 2. Induction Motor:**

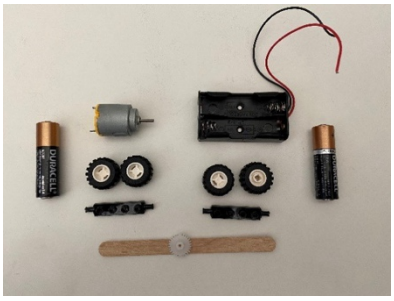


## Learning Outcomes

1. Understand how induction motors work and are used to drive a wheel.
2. Understand the difference between a combustion and electric vehicle.
3. Be able to use the knowledge learn from activity one and implement that knowledge in this activity.

## Materials

1. One popsicle stick
2. Two Lego axels
3. Four Lego wheels
4. One Induction motor
5. One gear
6. One battery holder
7. Two AA batteries
8. One roll of tape



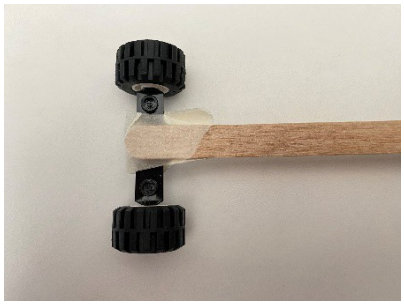
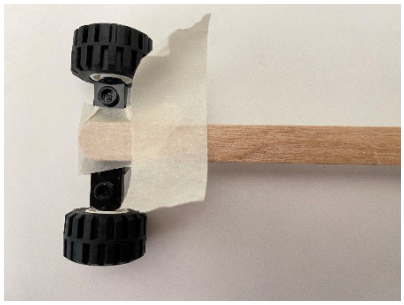
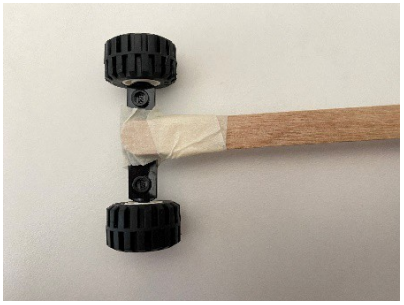
## The Activity

This activity will focus on creating a simple electric vehicle out of craft materials and a small motor. Please follow the steps carefully to have a full functional vehicle. You will be using previous materials learned in activity one to complete this activity. Furthermore, while performing the activity think of the material and determine which one is a conductor and which one is an inductor.

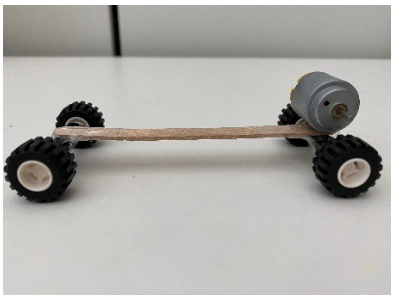
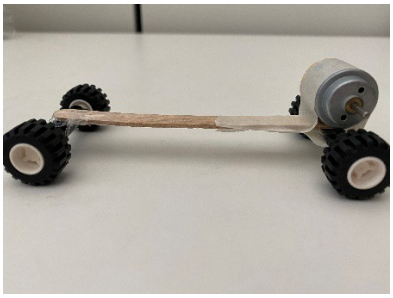
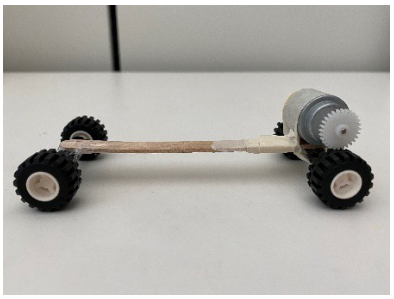
## Steps:

1.Place the Lego wheels to each ends of the axels, you will hear a click sound if they are placed correctly.

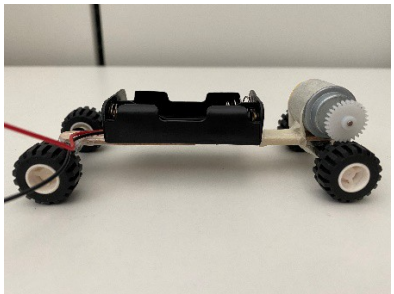
2. Tape both Lego axels using the cross method to each end of the popsicle stick. Assure that the axes are held sturdy by the tape

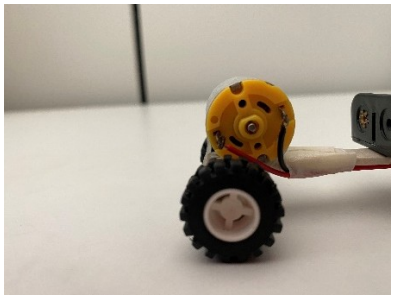
3. Place the motor on top of one end of the popsicle stick and use the cross method to tape the motor; connect the gear to the motor making sure the gear makes full contact with the tire below it. Assure that the motor is held sturdy by the tape.

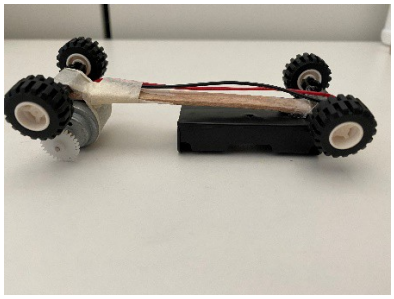
4. Placed the battery holder on the same side as where the motor is placed; place it as close to the center as possible. Assure that the side of the battery holder with the wires is facing the opposite direction from where the motor is placed.



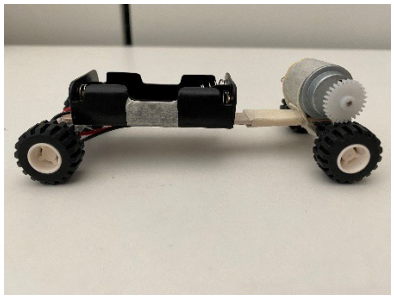
5. Connect the motor to the wires.



6. Run the wired down the bottom of the build until the ends of the wire are by the motor and use tape to both hold the wires and the battery holder. Assure wires are away from the tires, as it could prevent the build to move.



7. Connect the battery and watch the build run!
Note* that if your build is not moving in the direction you intended it go, go back to step 6 and swap the connected wire; this should change the direction of the motor spin.



# Assessment

1. How was knowledge learned in activity one used for this activity? What closed circuit was created.

2. Why does swapping the power and ground cable change the direction of the motor?

3. What are ways that we can increase the speed of the vehicle?



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