Lesson 2:
Electrical Engineering and Balloon vs. Wind Powered Cars

(Instruct/Play/Investigate/Test)

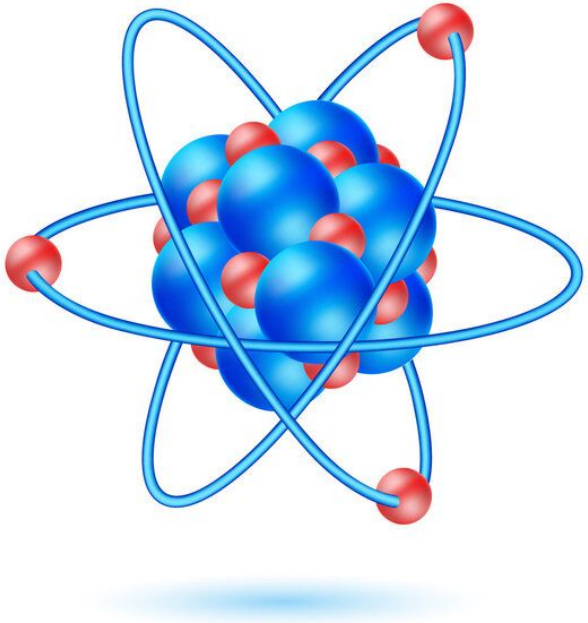
Vocabulary

- ★ **Constraint:** restrictions or limits for a solution
- ★ **Electrical conversion:** the changing of direct current to alternating current
- ★ **Electrical energy:** energy from the movement of tiny particles
- ★ **Force:** a push or pull
- ★ **Kinetic energy:** the energy from moving objects
- ★ **Potential energy:** energy stored in an object based on its position

Electrical Energy

The world is made of atoms. Atoms are made of tiny particles called protons, neutrons, and electrons.

- Protons have a positive charge
- Neutrons do not have a charge
- Electrons have a negative charge



These tiny, charged particles have electrical **forces** between them as they attract or repel each other. This makes them move. The movement of these particles results in a form of energy called **electrical energy**. The faster that the electrons move, the more energy they have.

Electricity

Through years of research and discovery, engineers have learned how to “make” and control electrical energy. Machines, like electric generators, convert energy from different sources into electrical energy. Energy sources include natural gas, coal, wind, and water.

Places like power plants use electrical energy to generate electricity. This electricity is then transported to homes and businesses.

Uses of Electricity

There are many uses of electricity. It is used for everyday activities.

lighting

appliances

entertainment

Challenge: You have one minute to locate as many things around you that uses electrical energy. How many items can you find?

Currents for Power

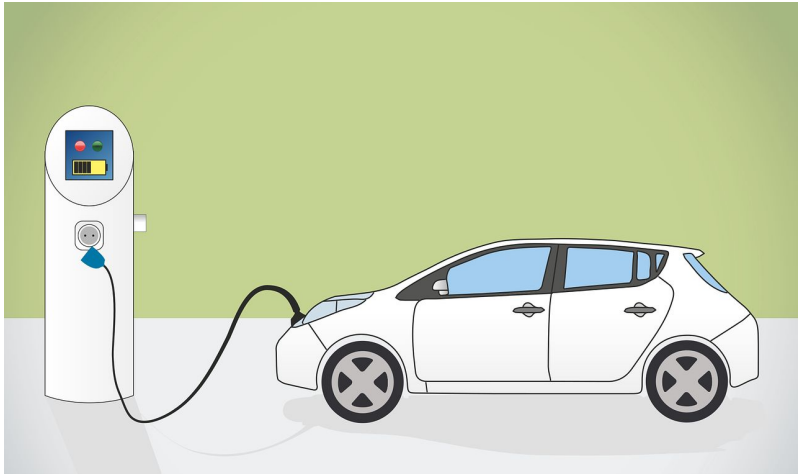
Some items use a direct current, or DC, for power. Other items use a current called called alternating current, or AC. This means that an **electrical conversion** is needed to change DC to AC for the items to work.

DC runs in only one direction. It is good for low power items and storing power, like in batteries.

AC allows the charge to run back and forth. It is good for high power items and moving power long distances, like in a power line.

Electrical Engineers

Engineers that study, make, and work with devices and systems that use electricity are called electrical engineers. These engineers must be problem solvers to find solutions for many different types of problems. An electrical engineer may be asked to find a solution for:

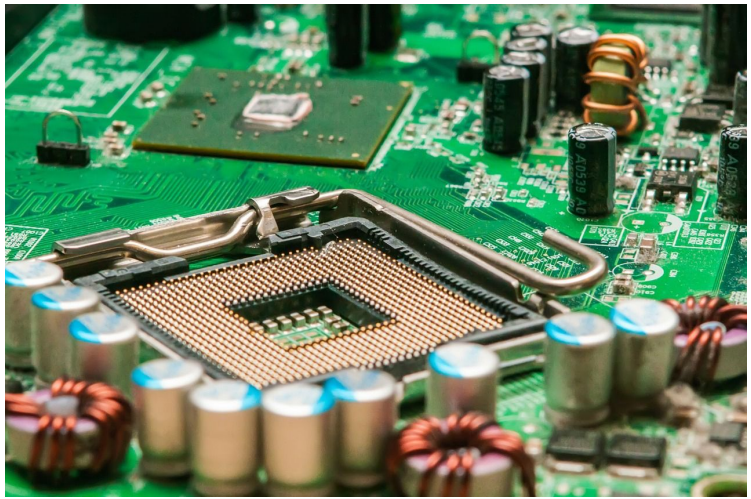


- getting power to a specific location
- getting power from a different source
- powering vehicles and machines
- increasing battery power and efficiency
- making machines to help patients move and communicate
- increasing digital signal processes

kids in tech
EXCITE. EDUCATE. EMPOWER

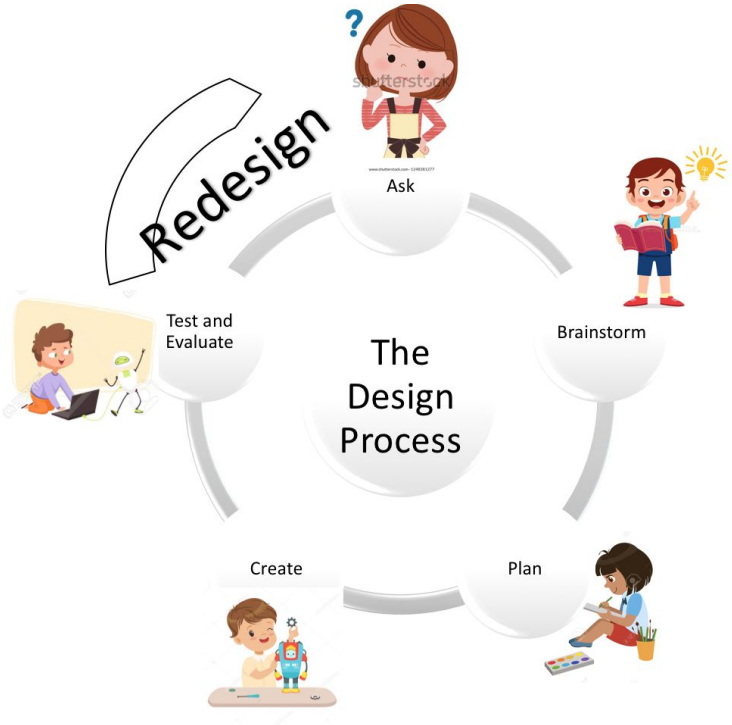
Industries that Need Electrical Engineers

Electrical engineers can work in many different places. They help a variety of different industries to operate, expand, and change over time. Just to name a few, these engineers can work with:



- power systems and electricity
- computers and electronics
- gaming and robotics
- navigation systems and appliances
- telecommunication and media
- automotives and transportation
- systems and engineering
- signals and transmission for tv, phones, radios, Wi-Fi, and more

Engineering Design Process



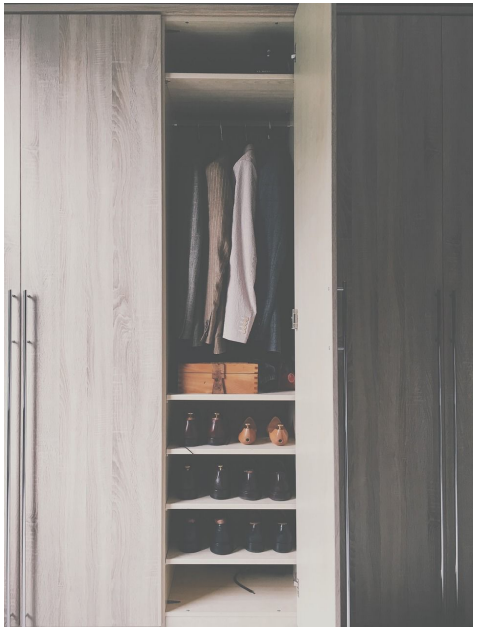
Electrical engineers use the Engineering Design Process to solve problems. The steps include:

1. Ask: figure out the problem, constraints, and criteria
2. Brainstorm: potential solutions
3. Plan: using the best solution
4. Create: a prototype of the solution
5. Test and Evaluate: what works and does not work
6. Redesign: improve the solution

kids in tech
EXCITE. EDUCATE. EMPOWER

Electrical Engineering in Action

You are trying to clean your closet. The problem is that it is too dark to see in there. You do not have a plug near or in your closet. You do not have a light switch either.



Step 1: Ask

The Problem	You need light in your closet so that you can see inside.
The Constraints	You need to only use items that you have around the house.
The Criteria	It needs to portable, reliable, handheld, and bright.

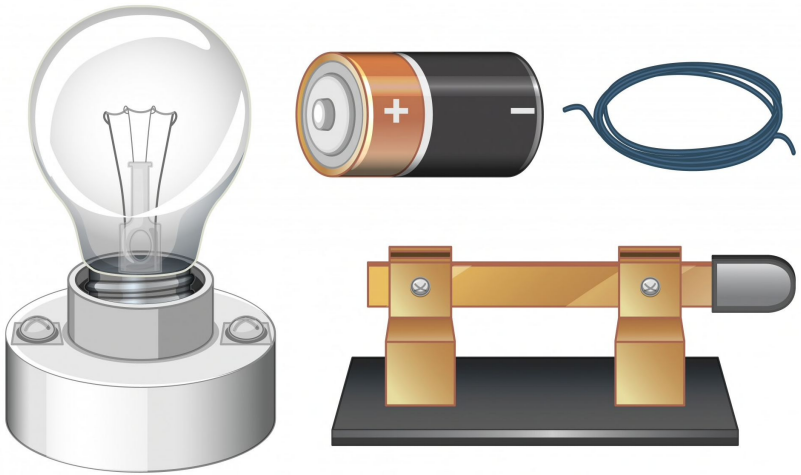
Electrical Engineering in Action

How can we solve this problem?

Step 2: Brainstorm

1. Put a lamp in the closet
    a. But you do not have a power cord long enough to do this.
1. Make an outlet in the closet
    b. But you do not know how to do this, and you do not have the supplies to complete this.
2. Use a flashlight
    b. You do not have a flashlight. But maybe you can make one.
    c. This is portable, small enough to be handheld, reliable, and you can use a light bulb that is bright.

Electrical Engineering in Action

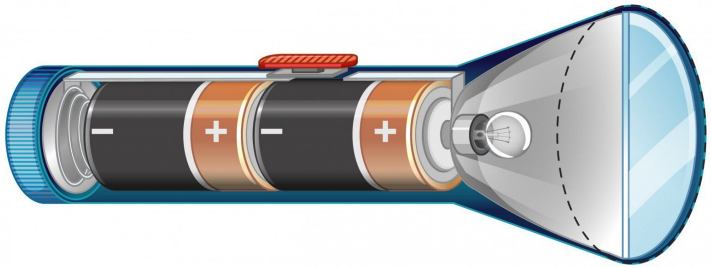


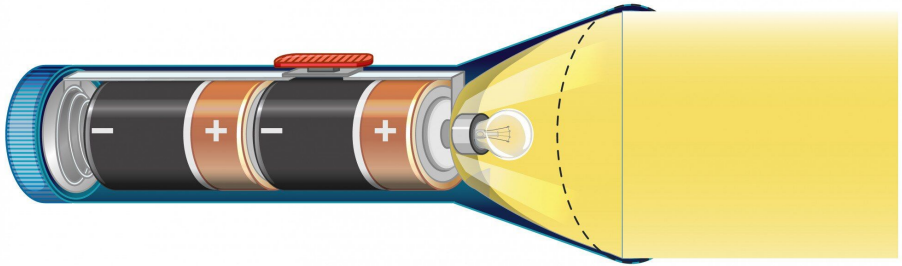
The best solution is to make a flashlight out of supplies that you have at home.

Steps 3 and 4: Plan and Create

Using items that you have around the house, you can make a working flashlight.

Electrical Engineering in Action





You put your design to the test. It works! The problem is it is not easy to hold and move around.

Step 5 and 6: Test, Evaluate, & Redesign

Still using items around the house, you are able to fix your design so that it works better to solve your problem.

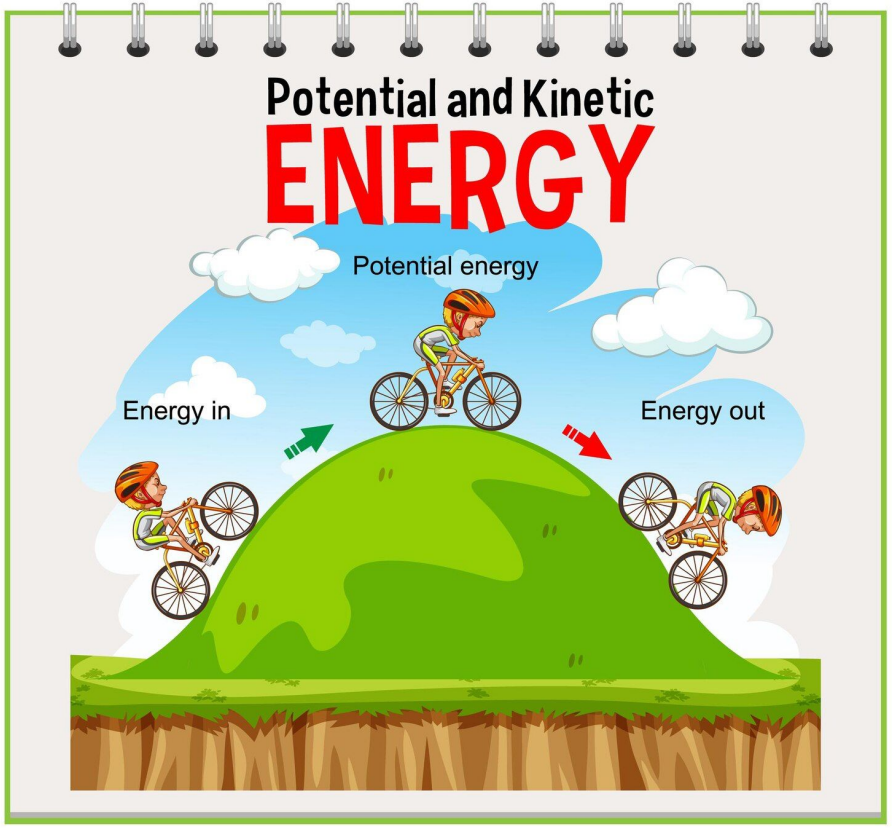
Activity Time!

Let’s be engineers!

You will be completing an activity called Balloon vs. Wind Powered Cars. In this activity, you will design and build cars that are powered by balloons or wind. You will use the engineering design process to help you complete this activity.

Balloon
vs.
Wind Powered Cars

Energy



Kinetic energy is the energy from moving objects. The motion of the student's legs is making energy for the bike to go up the hill.

Potential energy is the energy stored in an object based on its position. The bike has potential energy based on its height. Its potential energy is greatest at the top of the hill.

Car’s Energy

The cars that you are going to make today also have kinetic and potential energy.

The car with the fully inflated balloon has potential energy. When the air is released, the car’s potential energy changes to kinetic energy. The more potential energy the car and balloon have initially, the greater the amount of kinetic energy the car will have when the air is released.

The car with the sail has potential energy. The kinetic energy of the wind pushes on the sail, passing kinetic energy to the car. The more kinetic energy the wind has initially, the greater the amount of kinetic energy the car will have when the wind hits the sail.

Let's Power a Car

Which car will move faster? The balloon powered car or the wind powered car? Let's find out! Here's some items that you could use:

Balloon Powered Car

- two straws
- a wooden skewer, cut into two halves
- a plastic bottle
- four plastic bottle caps
- a balloon
- scissors and tape
- hammer and nail

Wind Powered Car

- a fan
- cardboard, cut into a 5 x 3 inch rectangle
- two straws
- four plastic bottle caps
- three wooden skewers
- scissors, paper, and tape
- hammer and nail

Step 1: Ask

Begin with Step 1 of the Engineering Design Process.

Ask:

- What is the problem?
- What are the constraints?
- What are the criteria for success?

Step 2: Brainstorm

Complete Step 2 of the Engineering Design Process.

Brainstorm:

- How can you build the cars?
- How can you make the cars move?

Step 3: Plan

Move onto Step 3 of the Engineering Design Process.

Plan:

- What is your best idea(s) for solving this problem?
- Develop a plan to help make your idea come to life.

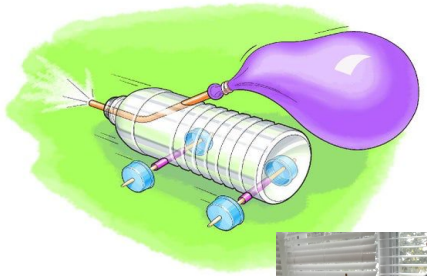
kids in tech
EXCITE. EDUCATE. EMPOWER

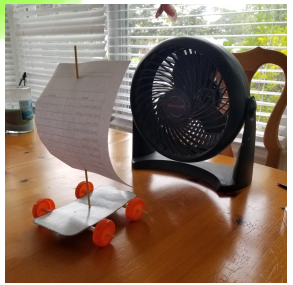
Step 4: Create

Now you are ready for Step 4 of the Engineering Design Process.

Create:

- get your supplies together
- make a prototype of each car:
  - balloon powered car
  - wind powered car





Step 5: Test and Evaluate

Next, complete Step 5 of the Engineering Design Process.

Test and Evaluate:

- What worked?
- What did not work?
- Did you solve your problem?
- Were the criteria and constraints met?

Step 6: Redesign

Now, Step 6 of the Engineering Design Process.

Redesign:

- What can you do to improve your designs?

Reflect and Share

All good scientists reflect on their experiments.

- How did the experiment work?
- Which car was faster?
- Why do you think that car was faster?
- How did energy relate to this project?
- How did this project relate to electrical engineering?

Share your designs and results with others:

@kidsintechorg

#MassSTEMWeek