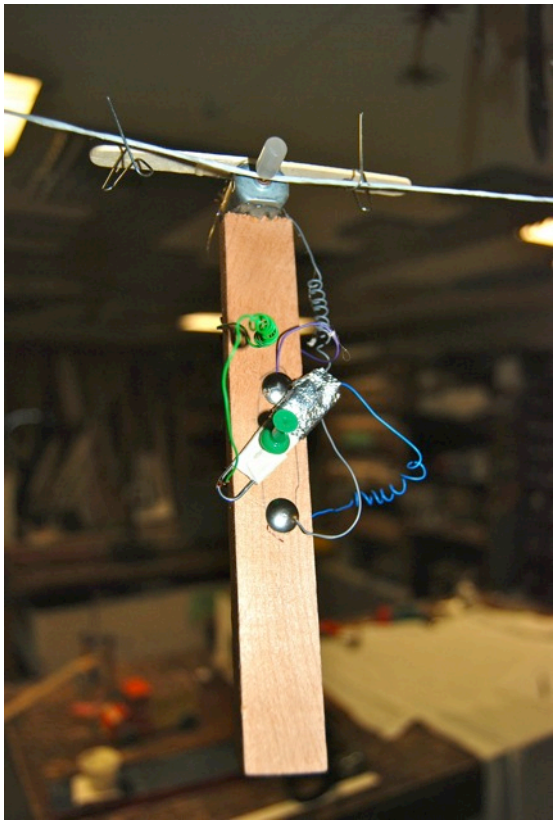
Cable Car

Category: Physics: Balance & Center of Mass, Electricity and Magnetism, Force and Motion

Type: Make & Take



Rough Parts List:

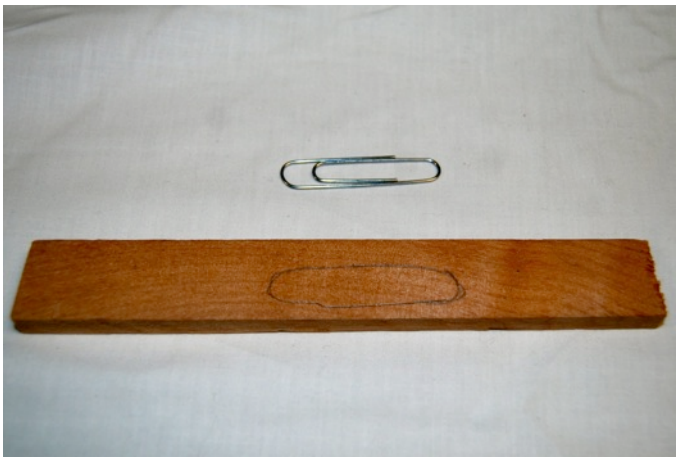
1	Paperclip, large
2	Paperclips, small
1	Wood stick, 1” x 2” x 6”
4	Electrical wires
1	AA battery
2	Craft sticks
2	Tacks
1	Glue stick, 1/8” long
	Foil
	Tape, masking & electrical
	Suspended string or wire to hang the cable car

Video: **http://youtu.be/_JeG8QdcVmE**

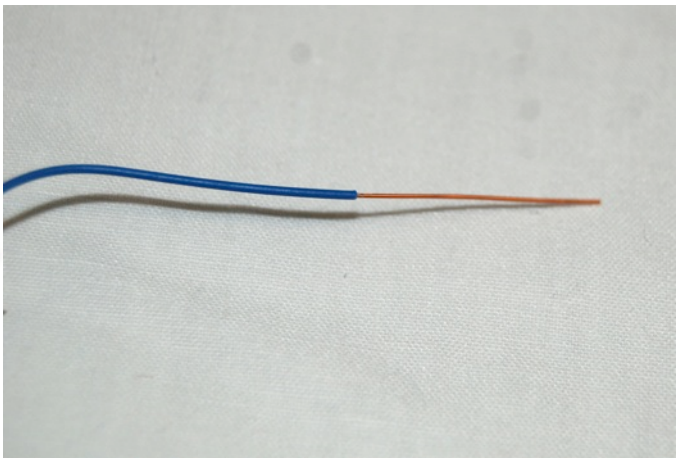
Tools:

Hot glue gun

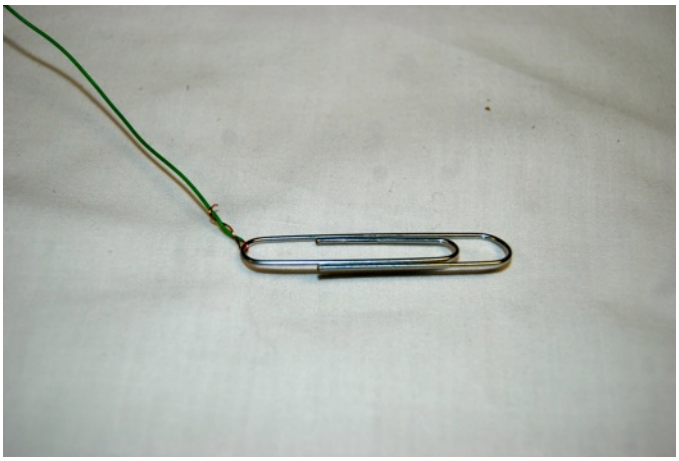
How To:



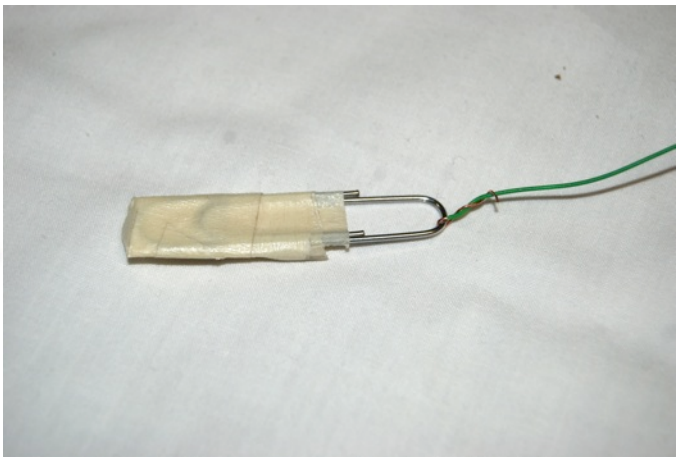
Trace the outline of the large paperclip in the center of the wood.



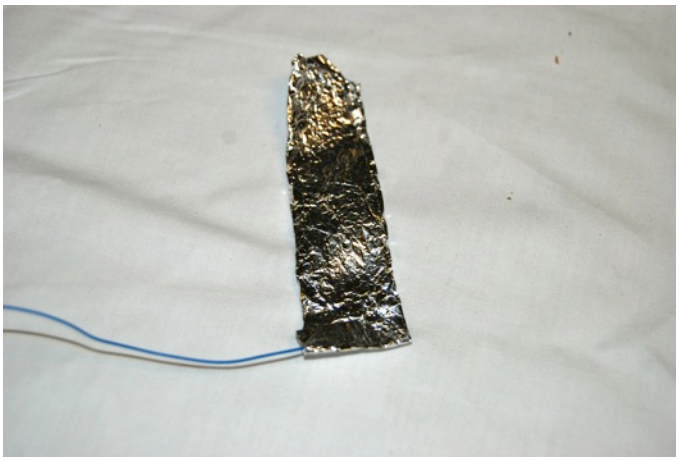
Strip both ends of all the electrical wires.



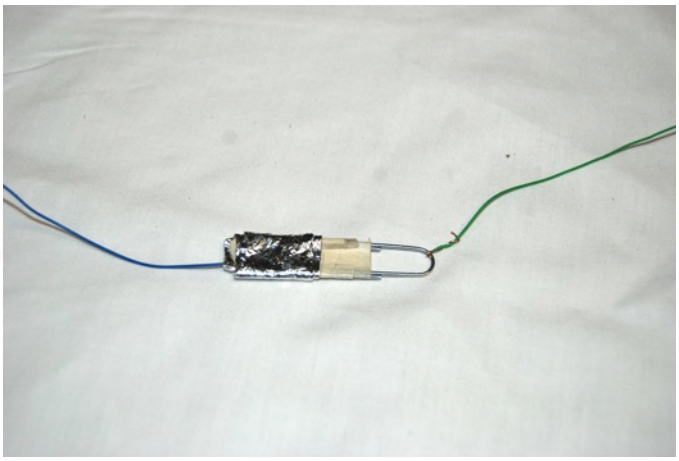
Attach 1 wire to the large paperclip.



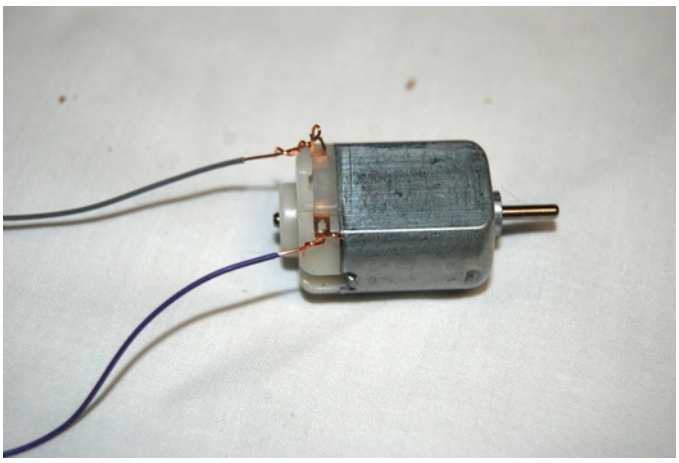
Wrap tape around the
opposite end of the paperclip.



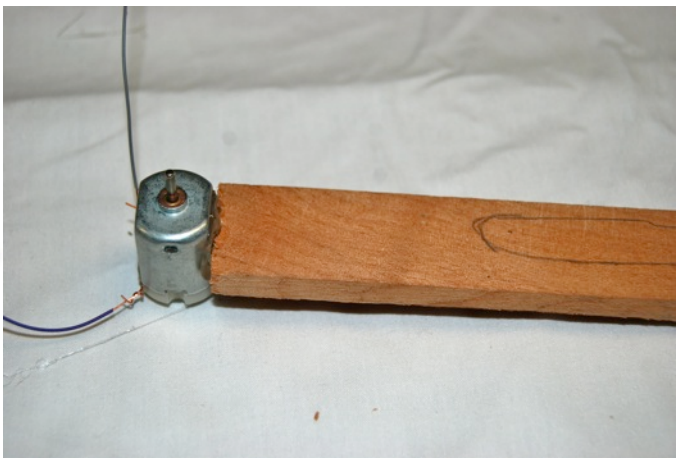
Wrap foil around one end of a 2nd wire.



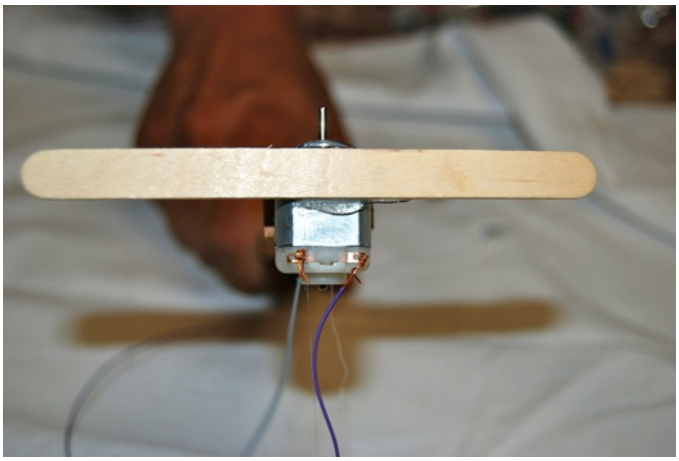
Wrap the foil and wire
around the taped end of the paperclip.



Connect the other two wires to the motor.

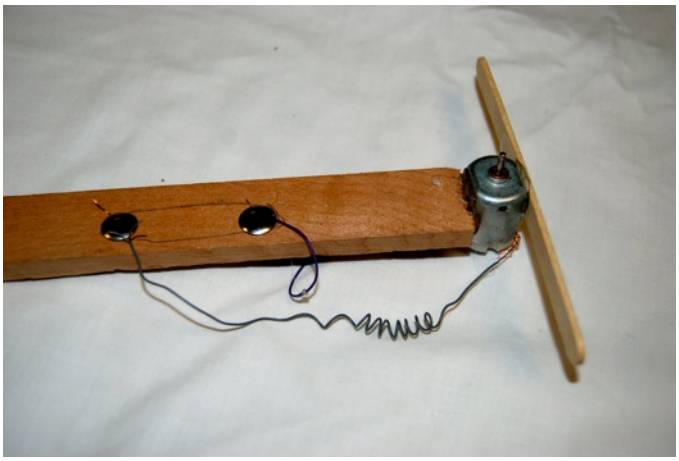


Glue the motor to the end of the wood.

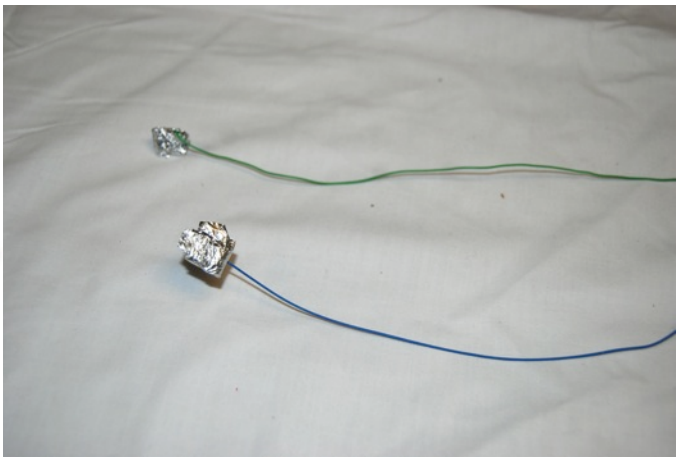


Glue a craftstick to the motor, making sure the stick is close to the edge of the motor.

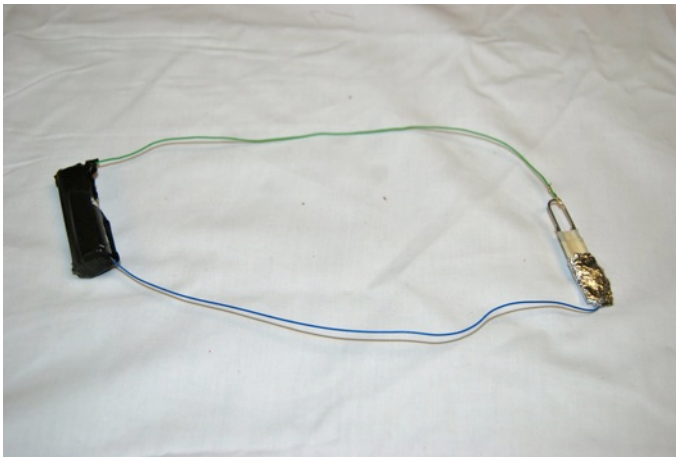
If the electrical wires are too long, wrap them around a nail to coil and shorten the wires.



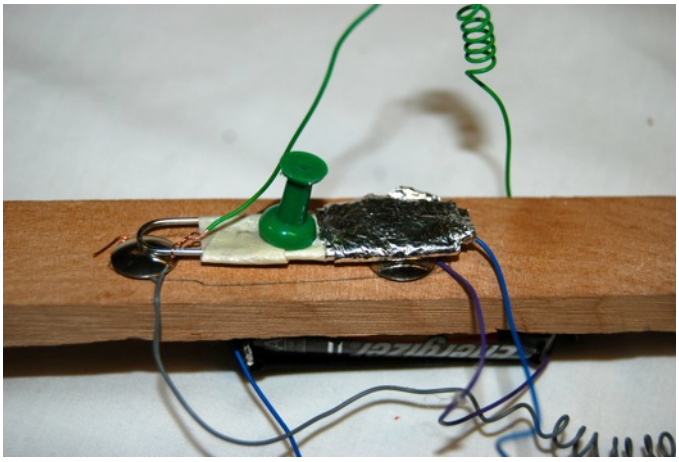
Insert tacks into the wood right at the tips of the paperclip outline. Wrap each wire from the motor around one tack.



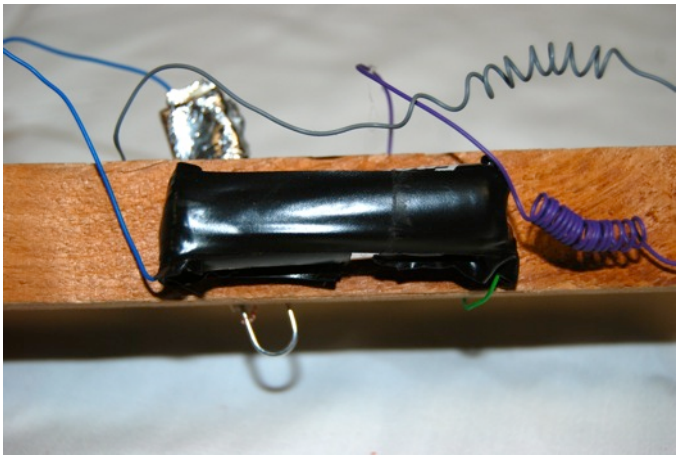
Wrap foil around the ends of each wire connected to the paperclip.



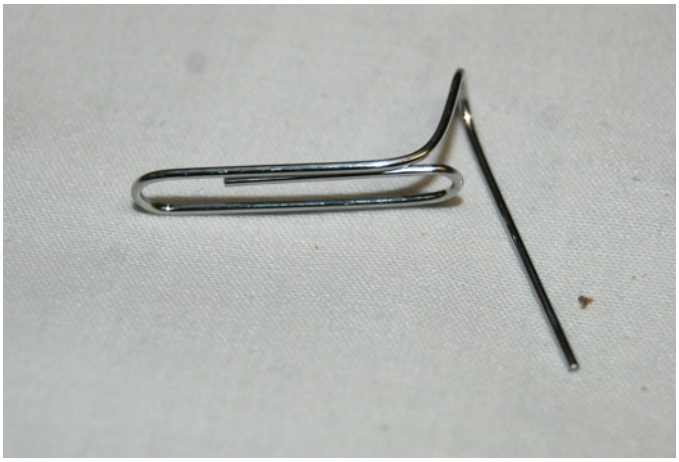
Tape the foiled ends to the positive and negative terminals of the battery.



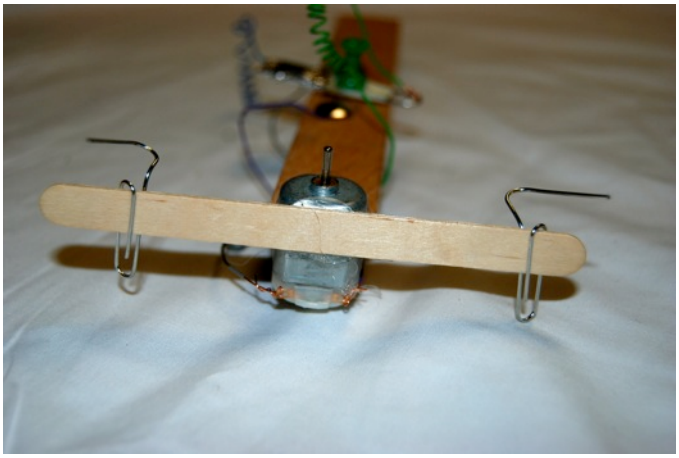
Tack the paperclip onto the paperclip outline on the wood.



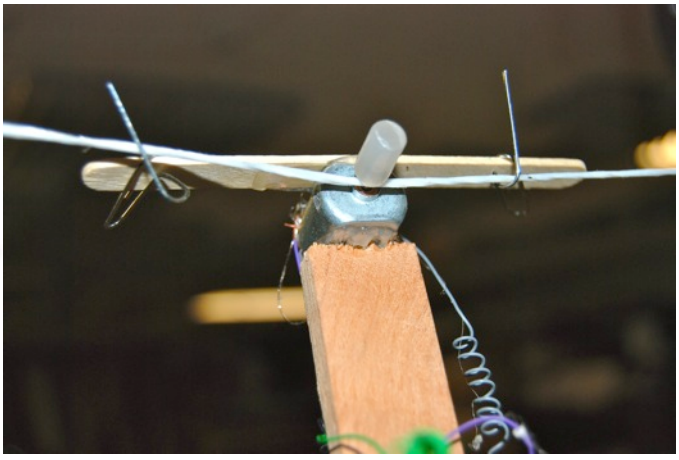
Glue the battery to the other side of the wood stick.



Bend the tips of the 2 small paperclips.



Clip a paperclip onto each end of the craftstick.



Push the gluestick onto the motor.
Hang the cable car by hooking a long string under the motor and over the paperclips.

Fine Points:

→ Be careful to keep the paperclip switch in a horizontal position when the cable car is not running or else the battery will drain.

→ You may have to mess with the paper clips on the craft stick to find the right shape to balance the cable car on the string. Experiment with different shapes for the bent ends of the paper clips.

Concepts Involved:

- Rotational motion can be converted to linear motion when a turning wheel or shaft comes in contact with a straight surface.
- A cable car arrangement is sometimes the best for travel over rough surfaces.
- A double-pole double-throw switch can reverse the direction of a motor

Focus Questions:

1. How could you make the cable car go faster?
2. Would it be possible to put the motor and battery above the cable, instead of hanging down below it?
3. This cable car sometimes falls off its cable. How do you think real cable cars avoid falling off?
4. How could you reverse the direction of the cable car if you only had a regular off-on switch?

Elaboration:

Vehicles that hang from a cable are called aerial tramways or gondola lifts. They are used regularly in ski resorts and in many mountainous areas of Europe. Cable cars are used to take people and cargo across rough terrain. After the difficulty of stringing cable across a treacherous patch of land, it is ultra-efficient to travel along the cable. Like a train on a track, friction is low and the ride is smooth. The Palm Springs Aerial Tramway in southern California goes from the desert at 2,500 feet above sea level to snowy mountaintops at 8,500 feet above sea level in twelve and a half minutes.

Cable cars are rarely set up like this one for safety reasons: one bump of the cable and your car will plummet to the ground. Real cable cars are either locked onto a long loop of cable, or riding on one cable or set of cables while being pulled along by another cable.

The motor shaft on the cable car is moving in a circular direction, but the cable car goes in a straight line. This is because the cable car translates rotational motion into linear motion by connecting the outside of the spinning shaft to a long straight surface: the string.

A double-pole, double-throw switch is used in this project. It breaks the circuit into poles, and enables you to connect them in two different places, or throw them two different ways – moving the cable car both forward and backward. You could also disconnect the battery and connect it the other way or remove the cable car from the string and turn it around, but the switch makes changing directions easier.

Links to k-12 California Content Standards:

Grades k-8 Standard Set Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

Grades k-12 Mathematical Reasoning:

1.0 Students make decisions about how to approach problems:
1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:
2.1 Use estimation to verify the reasonableness of calculated results.
2.2 Apply strategies and results from simpler problems to more complex problems.
2.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:
3.1 Evaluate the reasonableness of the solution in the context of the original situation.
3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
3.3 Develop generalizations of the results obtained and apply them in other circumstances.

Grade 2 Standard Set 1. Physical Sciences:

The motion of objects can be observed and measured.

1.a Students know the position of an object can be described by locating it in relation to another object or to the background.

1.b Students know an object's motion can be described by recording the change in position of the object over time.

1.c Students know the way to change how something is moving is by giving it a push or a pull. The size of the change is related to the strength, or the amount of force, of the push or pull.

1.d Students know tools and machines are used to apply pushes and pulls (forces) to make things move.

Grade 3 Standard Set 1. Physical Sciences (Energy & Matter):

1.b Students know machines and living things convert stored energy to motion and heat.

1.c Students know machines and living things convert stored energy to motion and heat.

1.d Students know energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

Grade 4 Standard Set 1. Physical Sciences

Electricity and magnetism are related effects that have many useful applications in everyday life.

1.a Students know how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.

1.g Students know electrical energy can be converted to heat, light, and motion.

Grade 9-12 Physics Standard Set 1. Motion & Forces

Newton's laws predict the motion of most objects.

1.b Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's First Law).