Name:_____ Period:_____ Date:_____

"Keep it Moving!" Challenge

From Electron to Electric Motor

Purpose: To understand how the fundamental principles of the electron & electric current relate to the use of batteries and motors and to apply this understanding in an engineering design challenge to build a motorized vehicle.

Have you ever wondered how your cell phone, lab top, or I-pod works? What source of energy do they need in order power them? Because these items have electrical components, none of them would be able to function without electricity; the movement of electrons. In chemistry, you learned that all atoms consist of three particles: protons (which are "+"), electrons (which are "-"), and neutrons (which are neutral). Protons and electrons are attracted to each other because of their opposite charges. In metals, electrons move freely and produce an electric current. This flow of electricity is necessary for any electrical appliance to operate weather it be an X-box 360 or a battery-operated toy car. In this challenge, you will have the opportunity to observe this phenomenon as you construction your own battery-powered vehicle.

You are going to be an engineer and design a motorized vehicle that meets the following design constraints:

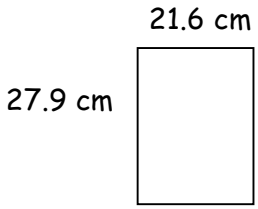
1) You can only use the materials provided
2) You want your vehicle to be the lightest (lowest in weight) and fastest vehicle in the class
3) Your vehicle has to move at least 1 meter.

Available Materials:

- Battery(ies) (9 volt, D-cell, AA)
- Cardboard
- 2- 3Alligator clip wires
- Rubber bands
- Double-sided tape
- Electrical and/or regular tape
- Sand paper
- Construction paper
- 4 metal shelf brackets
- 2 wooden dowels
- at least 1 spool
- 4 wheels or disks
- glue sticks
- glue gun
- markers
- ruler
- 1.3-6v motor

More Design Constraints:

- A card board or wooden board must be used as the base of the car. It should be no bigger than 27.9 cm length/ 21.6 cm width and no smaller than 20.3 cm length/ 10.6 cm width.



- The car must have wheels and be able to move on its own once all wires & motor are connected.

Safety!!!!: Be very careful using glue-guns. The nozzle becomes very HOT, <u>and could cause burns if touched.</u> When not in use, rest glue gun on a stand away from others and flammable objects.

Possible Design:

(NOTE: There are many ways this vehicle can be designed, but here are some basic steps you can follow. REMEMBER: you must be an engineer and apply what you know to design your vehicles. Be creative!)

1) Cut out a rectangular piece of cardboard.
2) Glue or tape down (use mounting tape) the L-shaped shelf brackets to each corner.
3) Place wooden dowel (stick) through the loops of the L-shaped bracket.
4) Put regular tape around each end of the wooden dowel, until the wheels fit snuggly around the wooden dowel, and glue the edges.
5) On the drive shaft dowel (the one that will be connected to the motor), wrap the middle with tape and place a spool in the middle of the dowel.
6) Place a rubber band around the spool.
7) Cut a square or rectangle out of the cardboard above the spool axle, about 1-2 inches back.
8) Position your motor on top of the cardboard.
9) Pull the rubber band through the opening, place it around the needle, and pull back far enough where the rubber band is tight.
10) Glue or tape down your motor.
11) Glue or tape down your battery (or batteries). (Note: If you're using D cell, C cell batteries, etc., then you need to create electrodes for the "+"/ "-"terminals. Using small pieces from two different metals, like Aluminum & Copper, will work. Tape the copper to the "+" terminal; aluminum to the "-"terminal.)
12) Place alligator clips on each end of the battery to each prong on the motor.
13) If everything is set up right, the car should move!

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Follow-up Questions:

A) From your observations of the groups vehicles, which motor was the most powerful: 1.5v or 6v? Battery type: D-cell or 9 volt?

- Assuming enough current would be provided, the 6 volt motor would be more powerful than the 1.5 v motor, because it has a greater potential to do more work. The D-cell battery has a voltage rating of 1.5, compared to the 9 volt battery. So assuming the circuit (wiring system) used was the same, the 9 volt battery would seem to provide a greater electrical charge. Also, D-cell batteries would require two different metals (copper/aluminum work well) to be attached at both terminals in order to work with the alligator clip wires.

B) What solutions would you suggest to increase the speed of your vehicle? What other variables would you have to control to make those changes?

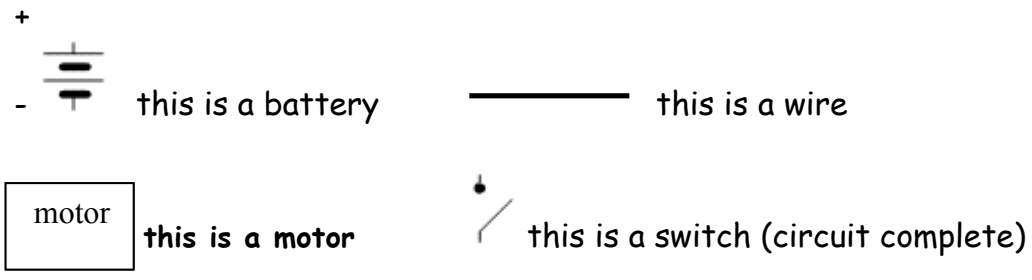
- Use a more powerful motor (current supplied must be sufficient, therefore the battery used may need to be of a higher voltage); Increase the number of batteries used (more wires would be needed to make a series of connections between batteries and more batteries would increase vehicle weight); Make the cardboard base of the vehicle smaller (less weight); Use smaller wires for the connections (smaller wire; more current)

C) Explain the difference in the performance of your vehicle if you were to add an extra battery vs. adding an extra motor.

- Adding an extra battery would increase the voltage and overall power (wattage) supplied to the motor. Adding an extra motor without providing an additional energy source would be impractical.

D) When you hook up both alligator clips from your positive and negative battery terminals to both terminals on your motor, you probably noticed your engine began to turn. This is because you created a circuit: a pathway in which electrons are able to flow.

Draw in and label the parts of the diagram that represents the circuit for your vehicle.



E) In your own words, write a brief paragraph describing the process of the flow of electrons from the battery, through the wires, to the motor. Also, describe the energy transformations that taking place.

- When the battery, wires, and motor are connected to make a complete circuit, an electro-chemical potential difference is created within the compounds found in the battery. Because the battery contains different metals (alkali or alkaline), charged ions are produced, and valence electrons began to be transferred and produce an electric current. Therefore, stored chemical energy is being transformed into electrical energy. The current of electrons travel through the wire towards the positive terminal. As the electrons flow through the motor, an electro-magnetic process occurs, causing the motor to turn, which is torque. So at this point, electrical energy is being converted into mechanical energy. This is turn, allows the drive shaft of the car to turn, which puts the car in motion.

F) Engineers apply what they know to solve problems. In this activity, what did you need to know in order to design the lightest, fastest car? SUMMARIZE the key concepts.

Students should discuss the basics of electrons, electricity, and how energy can be converted. See powerpoint for specific concepts covered.