Get Your Motor Running

National Energy Foundation

Objective:

Students will experience energy transformations as they build a direct current (DC) motor.

Materials and Curriculum Correlations ▼

▶ Introduction

In this activity, students investigate multiple energy transformations while constructing a simple direct current (DC) motor. The most difficult part of this activity is building a properly shaped coil. You may wish to build the coils for students in advance, then keep them for future use.

Procedure

1. Explain to students that a motor is a device that transforms electrical energy into mechanical energy. Motors are used in many household appliances such as hair dryers, vacuum cleaners and blenders.
2. Place students in pairs or small groups and provide them with their materials. Each group will need approximately 2 feet of wire, one battery, two paper clips and magnets. The number of magnets needed will vary with the strength of the magnet and the age of the batteries. Two small ceramic magnets are usually sufficient. To save time, you may want to make a class set of coils in advance so students just have to place the coil into the paperclips.
3. Pass out the student sheet and allow students to work through the motor design and answer the questions. Students will have to be persistent to get the coil to turn. Stress the importance of the coil being straight and level to get the motor to work properly.
4. As a class, discuss the importance of each piece of the motor and trace the energy conversions needed to make the motor work using batteries (chemical to electrical to mechanical, sound and thermal). Note that the coil will show a preference to spin in one direction.
5. If time permits, allow students to investigate on their own, the effect of different variables on the motor such as the gauge (thickness) of wire used, number of magnets, number of windings in the coil, type of battery used, etc. As a class, determine which variables affected motor performance and why that may be. For example, what are the advantages and disadvantages of using a heavier gauge of wire? What is the best balance between weight and electrical resistance? How do you keep the motor cost-effective? Students should formulate a question, make a hypothesis and design an experiment to test that hypothesis.
6. Have students share their observations and conclusions on the variables which affect motor performance.

To Know and Do More

1. Allow students to view motors taken from household appliances and compare them to the motors they built. How do DC and alternating current (AC) motors differ?
2. In addition to demonstrating energy transformations, this activity can be used to show an electric circuit, assist in a discussion about DC versus AC circuits, show an application of an electromagnet (the coil of wire) and let students experience heating due to resistance of a wire!

Answers to Questions on "Get Your Motor Running"

1. The coil should wobble and eventually spin if it has been balanced correctly.
2. The battery contains chemical potential energy, which is converted to electrical kinetic energy in the paper clips and coil. The electricity is then converted to mechanical kinetic energy in the movement of the coil, thermal kinetic energy (heat) due to resistance in the wire and a bit of sound energy. You may want to point out that heat and sound are not usable forms of energy, so the energy transfer is not 100 percent efficient.
3. It will spin in only one direction (direct current).
4. Variables include the number of turns on the coil, thickness of the wire, strength of the permanent magnets and voltage of the battery.
5. By increasing any of the above factors, you increase the speed of the motor. New batteries work better than old ones, but they lead to much more thermal energy.

Materials Needed:

- C or D dry cell batteries
- Large paper clips
- Sandpaper
- Student sheet
- Ceramic magnets
- Enamel-coated wire of varying thicknesses
- Tape or rubber bands (optional)

Curriculum Correlations

K-ETS1 - 1
1-ETS1 - 1
2-ETS1 - 1
3-PS2 - 3
3-ETS1 - 1
4-PS3 - 2
4-PS3 - 4
4-ESS3 - 1
4-ETS1 - 1
5-PS1 - 3
5-ETS1 - 1
5-ETS1 - 2
MS-PS1 - 6
MS-PS2 - 3
MS-PS2 - 5
MS-PS3 - 1
MS-PS3 - 2
MS-PS3 - 3
MS-PS3 - 4
MS-PS3 - 5
HS-PS2 - 5

▶ STUDENT SHEET

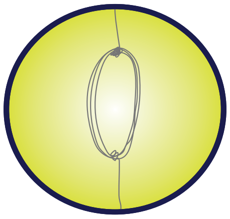
Get Your Motor Running

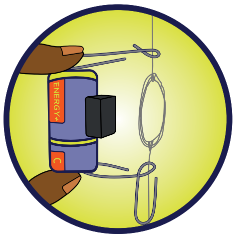
This activity lets you create your own direct current (DC) motor and see many energy transformations firsthand.

Materials

C or D dry cell battery, two large paper clips, ceramic magnet, fine sandpaper, enamel-coated wire, wire cutters or scissors, rubber band or tape (optional)

Procedure





1. Cut about 2 feet of wire and wrap it around the battery five times (be sure to leave wire sticking out on both ends).
2. Trim the ends of the wire so that they are about 1 inch long and stick out from opposite sides of the coil as shown to the right.
3. Remove the coil from the battery and wrap the ends around the coil two or three times to help hold the shape. It is very important that the ends are directly opposite each other as in the diagram.
4. Using sandpaper, remove the insulation coating from the ends of the wire, from coil to tips. The wire should now be shiny. Be sure the ends are straight as shown in the top picture. Crooked coils will not work!
5. Bend the paper clips into an L-shape (be sure to bend it in the direction that forms a loop in the clip) and place the longer end of the clips on the ends of the battery, sticking up into the air as high as possible. You can use a rubber band or tape to hold the paper clips or just squeeze them with your fingers.
6. Place the magnet on the battery as shown in the picture at right and put the ends of the coil through the ring formed by the paper clips. Do not bend the coil when inserting it. Be sure the coil is level on both sides and can spin without hitting the magnet.

Questions

1. What happens to the coil when the magnet is added to the battery?

2. What energy transformations do you see and feel? Write the types and forms of energy beginning with the battery and ending with the coil.

3. Will the coil spin in either direction or just one?

4. What variables affect the speed of the coil?

5. How could you make the coil spin faster?

To Know and Do More

1. Pick one of the variables from your answer to question 4 and design an experiment to test the outcome of changing this variable. Be sure to record your independent variable, dependent variable, variables controlled, data table and results in the space below. How do your conclusions compare to those of your classmates? How would you determine if your experiment and those of your classmates have valid results?
2. Research how the motor was invented and developed. What scientific principles does it use? What household devices contain motors? How do DC and alternating current (AC) motors differ?