# Motors

**Lesson Concept** Electric energy may be transferred into heat, light, sound, and motion.

**Link** In the previous lesson students learned how a circuit made with a bare copper wire produced heat.

**Time** 50 minutes

**Materials**

Whole class

Demonstration motor

Per Group (groups of 4-6)

Gallon sized plastic bag

2 - Needle nosed pliers (available at most 99 Cents Only Stores)

2 – Wire cutters

1 – Roll of masking tape (1 inch width)

Prepared battery (2 large safety pins masking tape, and 1 D-Cell Battery)

39 inches of #22 AWG Enamel copper wire (also called magnet wire) or Radio Shack wire #278-1345

1x1" Square of 100 grit sandpaper

1 AA Battery

1/2 "x 1/16" inch Magnet (3 lb neodymium disc magnet http://www.magnet4less.com/product_info.php?products_id=117 for about 30 @ $0.23 each)

I Plastic zip-top bag

Teacher Note: A Toy Motor Kit (Item No. CZZ99991508P001) may be purchased from www.sciplus.com for $10.

**Advance Preparation**

1. Arrange for 1 volunteer per group to help with this lesson.
2. Visit the following web site for background information on how to build a motor: http://scitoys.com/scitoys/scitoys/electro/electro.html
3. Prepare a demonstration motor (See Figures1-4): Using pliers and wire cutters, cut off two large safety pins which will be used to make the "brushes" for the motor. Tape the ends of the arms of the first safety pin to the positive end of the battery terminal.

The arms should be touching the metal portion of the terminal. Use the second safety pin to do the same to the negative end of the battery terminal. The spiral at the ends of the safety pin should be aligned.

4. Prepare plastic zip-top bags containing prepared battery, one magnet, one piece of sandpaper, one AA battery, and #22 AWG enamel copper wire.

   (Adapted from a lesson from The Society of Hispanic Professional Engineers, Member: Armando Veloz)

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**Procedure:**

***Engage*** ***(5 minutes) Electrical current produces a magnetic field.***

1. Have students refer to their science notebooks to recall the electromagnet investigation. Ask students to think-pair-share the differences between an electromagnet and a permanent magnet. Ask, "When was the electromagnet able to pick up staples and safety pins?" [Expected Student Response (ESR): The electromagnet was able to pick up staples and safety pins when electricity was going through the wire.]

***Explore*** ***(15 minutes) A motor uses magnets to produce motion.***

2. Ask students devices at home or school that use motors. Chart student ideas.
3. Explain to students that in this lesson they will make a motor that uses magnets to create motion.
4. Demonstrate how to build a motor: Position the magnet between the two posts created by the safety pins. It should stick to the battery without tape
5. Wrap the center of the AWG wire around the AA battery with 2 inches of wire left out of both ends. Bend the wire so that the circle created by the wrapping of the wire sits exactly in the middle of two ends. It should look like this:

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6. Slide out the AA battery. Loop a knot on each side of the circle to keep the shape. Align the coil made in step 2 above in the vertical direction.
7. Sand off the enamel from the top half of the protruding ends of the AWG wire. Leave the enamel on the bottom half of the AWG wire.
8. Slide the AWG wire into the spiral ends of the safety pin posts. Straighten and clip using the group tools if necessary.
9. The coil of wire should begin to turn on its own. If it does not, give it a tiny push to get it started. It should continue on its own.
10. Distribute all of the materials to students. Allow students to make their own motors. Observe and assist students as necessary.

Teacher Note: Use a parent helper for each group. Students may have difficulty with bending, cutting, or sanding the wire

***Explain*** ***(15 minutes) A motor changes electrical energy into motion.***

11. Ask the students, “What forces are at work here?”. “Why is sanding the enamel off of the wire necessary?” Use the concepts of electromagnetism as well as attraction and repulsion between the magnet and the electromagnet to direct a conversation that will explain how the wire and the magnet are both attracted and repelled by one another. (ESR): The wire and the magnet are both attracted and repelled by one another. Sanding is necessary for the rotation of the loop to occur by allowing electric current to flow through the coil of wire.

***Extend/Evaluate*** ***(10 minutes extend; 5 minutes evaluate) A motor changes electrical energy into motion.***

12. Extend. Ask students, “Will the motor work without the coil of wire? Why or why not?” Have students build a motor without the coil. Build another without sanding the wire.
13. Evaluate. Have students refer to the chart of devices that use motors. Ask students to select one of the devices, e.g., a motorized toy car. Have students respond in their science notebooks to the following prompt, “Explain how a motor is used in the (toy car). (ESR): A motor changes electrical energy into motion so the (toy car) moves.

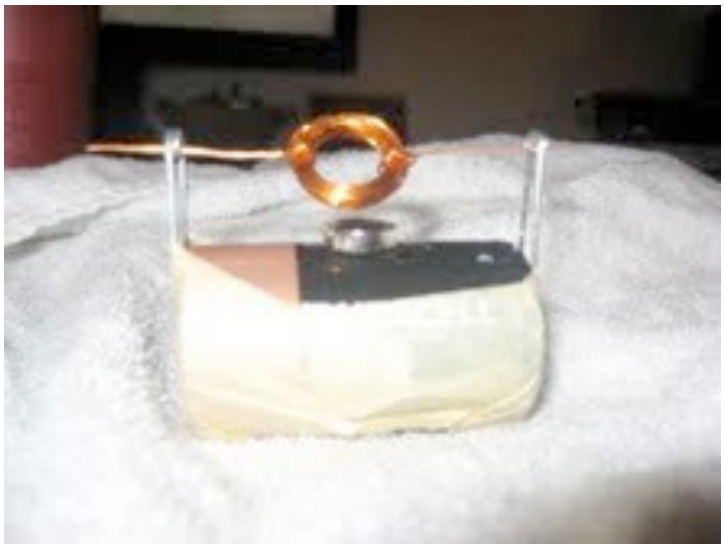

Figure 1 - the finished electromotor

Figure 2 - students may need assistance sanding, and tying the wire

Figure 3 - student materials

Figure 4 - coiling wire

Figure 5 - electromotor in action!

SOME DEVICES THAT USE MOTORS: