Engineering & Robotics: Electric Motor Exploration

Legacy SeaPerch Resource *www.seaperch.org*

Grade Level: 8th – 12th grade

Length of Lesson: 1-2 hours

Goals:

- Build a single electric motor
- Explore electric currents and magnets, and the forces they exert
- Relate motors to the electromagnetic forces in Earth's core

National Science Standards:

- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- PS2.C: Stability and Instability in Physical Systems
- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship between Energy and Forces

Materials:

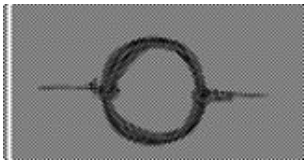
- 1 meter (3 feet) of 22-gauge or 24-gauge solid-core insulated wire
- 2 disk magnets
- 2 insulated test cables with a clip on each end (2 pieces of above insulated wire can also be used)
- 1 plastic cup
- 2 large rubber bands
- 2 jumbo size (2-inch) paper clips
- 1 D-cell battery
- wire strippers
- waterproof marking pen

Background:

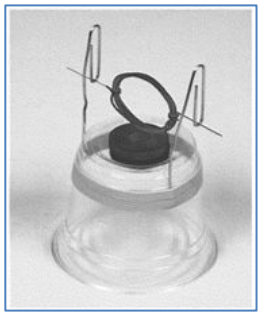
A coil of wire with an electric current produces a magnetic field. The coil then acts like a small magnet. When the coil is near a stronger magnet, the coil will move to align with the stronger magnet due to the magnetic force of the stronger magnet. In a motor, the current in the coil switches direction over and over again, so the coil keeps spinning as it tries to align with the magnetic field. In this experiment you will build a simple electric motor.

Lesson: LAUNCH

1. Take the 1-meter piece of insulated wire. Starting about 6 cm from the end of the wire, wrap it seven times around the D-cell battery to form a coil. Wrap the ends of the wire a couple of times around the coil to hold it together.
2. Use the wire strippers to remove the insulation from the two ends of the coil.



3. Straighten the larger loops of two paper clips.
4. Turn the cup upside down and place a magnet on top in the center.
5. Attach another magnet inside the cup, directly beneath the original magnet. This will create a stronger magnetic field as well as hold the top magnet in place.
6. Put two large rubber bands around the base of the cup.
7. Insert the straightened paper clips into the rubber bands, so they stand upright over the bottom of the cup.
8. Rest the ends of the coil in the cradles formed by the paper clips.
9. Adjust the height of the paper clips so that when the coil spins, it just clears the magnets.
10. Adjust the coil and the clips until the coil stays balanced and centered while spinning freely on the clips. Good balance is important in getting the motor to operate well.
11. Once you have determined how long the projecting ends of the coil must be to rest in the paper-clip cradles, you may trim off any excess wire.
12. Attach one of the clip cables to each paper clip just above the rubber bands. You may need to readjust the clips to make sure the coil still spins freely.
13. Hold the other ends of the clip leads against the two poles of the D-cell battery. If the coil is well balanced on the clips, it will rotate to a near horizontal position. The magnetic field created by the electric current in the coil aligns itself with the magnets.



14. The coil may not continue to turn, because the current continues to flow through the coil its magnetic fields stays aligned with the magnets. To get the coil to continue rotating, the current should be turned off when the coil is aligned with the magnets. This can be done by coating part of one of the bare wire ends of the coil.
15. Remove the coil from the paper clips. Hold the coil vertically. Use the permanent marker to paint the TOP HALF of one of the two end wires. Allow the ink to dry for a few seconds, and apply a second coat. Allow several seconds again for the ink to dry, and then hang the coil on the paper clips again.
16. Connect the D-cell battery again, and give the coil a gentle spin.

Lesson: INVESTIGATE

Troubleshoot the motor if it does not keep spinning on its own:

- Check the coil assembly and make sure it is balanced.
- Check that the projecting end has been painted with black pen as described in step #15.
- Check that the coil and magnet are close to each other but not touching.
- Try adjusting the distance separating the cradles. There should be constant contact between the coil and cradles as it spins.

Lesson: PRACTICE

This very simple motor is related to the motors you have attached to your Sea Perch. If you opened a motor up you would find coils of wire and magnets. When the wires are connected to a power supply the motor would spin.

Take the motor you have built in the experiment and turn your battery around. This runs the current in the opposite direction through the loops of wire. What happens to the direction in which the loop spins? You will want to put your motors in reverse at times. Later you will learn how to build a circuit where you can change the direction of the current.

For a very simple introduction to what Oersted observed about the relationship between electric fields and magnetic fields, place a compass close to a wire. Connect the wire to a power supply and see that the compass needle is deflected. Change the position of the compass. Notice it is deflected in a different direction.