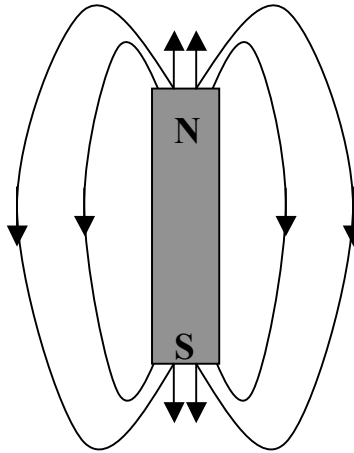


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## Turning Electricity and Magnetism into Mechanical Work: Simple Motor<sup>1</sup>

### **Background:**

Electricity and magnetism are important and deeply related topics in science. **Electricity** refers generally to the presence and flow of electric charge. A subatomic particle, such as an electron, has an **electric charge**. Electric **current** is the flow of charged particles and a measure of how fast the particles are flowing. Current is what runs from the outlets on your walls through the cords and wires connected to all your electronic devices. It provides the energy that enables these things (everything from your computer to your toaster) to run. **Magnetism** refers to the attractive and repulsive forces that certain materials produce on other materials. Some common magnetic materials include nickel, cobalt, and iron. These forces are due to the **magnetic field** surrounding a magnetic material. If you hold two magnets close to each other, you will find that depending on the direction you are holding them, they will either pull toward each other or push away from each other. This is due to the direction of the magnetic field. A magnet has a north and south pole. The direction of the magnetic field flows out of the north pole and into the south pole as is depicted in the diagram below:



When two magnets are repelling each other, their magnetic fields are pointing towards each other. Therefore a north pole of one magnet will push away from the north pole of another magnet. Similarly, two magnets are attracted to each other when their magnetic fields are pointing in the same direction, i.e. a north pole of one magnet is attracted to the south pole of another magnet.

The interaction between electric charges and magnetic fields creates forces. Now that you understand some of the basic concepts, let's apply what you've read create a force from interacting electricity and magnetism.

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<sup>1</sup> This laboratory is based on one developed by Prof. Krishna Chowdary for the introductory physics labs at Bucknell University. We are grateful for his willingness to share the lab description.

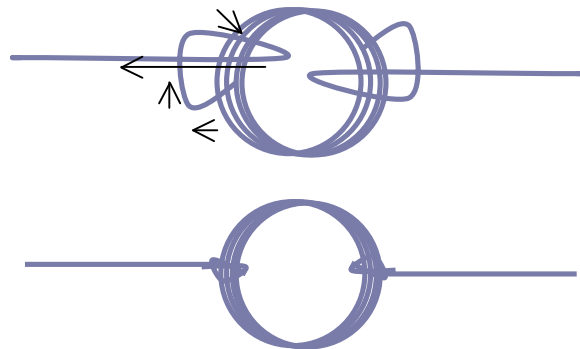
## Equipment:

For this lab you will need the following materials:

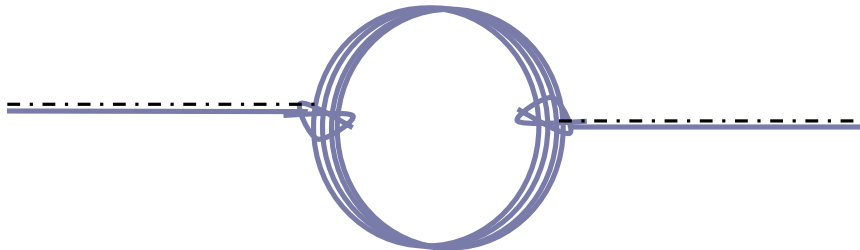
- Magnetic wire
- Pencil or pen
- Paper cup
- 2 safety pins
- Tape
- Two small magnets
- Wire, preferably with alligator clips
- Battery

## Procedure:

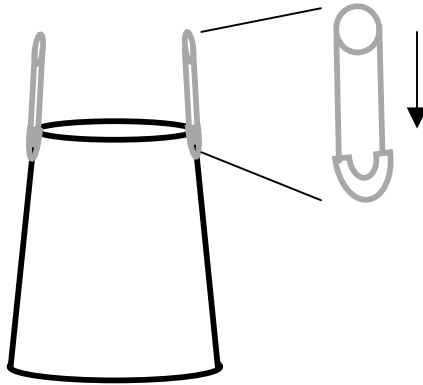
1. Cut a piece of the magnetic wire about 2 feet long.
2. Wrap the wire around a pen or pencil as many times as possible while still leaving about 2 inches of wire on each side of the coil. Slide the coiled wire off the pencil and secure the coil by tying the ends of the wire around the coil as shown below



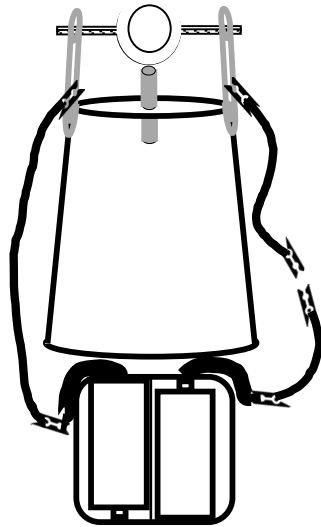
3. Sand the enamel off the **top halves** of the straight ends of the magnetic wire with coil kept vertical (the dashed areas in the figure below). **It is very important not to strip the enamel entirely off the wire but just on this top half.**



4. Now that the motor is built, the base for the motor needs to be built. Take a paper cup and turn it upside down. Tape two safety pins on the cup, across from each other, with the pin part facing down.



5. Next combine the motor and base for the final product. Attach the two magnets on either side of the bottom of the cup. Slide the straight ends of the loop of wires into the top holes of the safety pins. Connect the wires with alligator clips to the safety pins and to the battery. Configuration shown below.



6. Once connected to the battery, the coil should start to spin (you might have to give it a little flick to get it started). If it does not, there are a few things to try:
- A) Make sure that you have sanded the correct side of both ends of the coil. A new coil may need to be constructed.
  - B) Ensure that the straight ends of the coil are at  $180^\circ$  from each other and as straight as possible.
  - C) Adjust the safety pins to lower the coil closer to the magnets without bumping into the magnets.

## **Conclusions and Questions:**

The reason the coil is spinning is due to the force created from the interaction between the current flowing through the coil and the magnetic field of the magnets. Answer the following questions to ensure your understanding of the motor.

1. List two different ways you could get your motor to spin in the other direction. If you are unsure, try various configurations in order to determine how to make the motor spin in the other direction.

a. \_\_\_\_\_

b. \_\_\_\_\_

2. Explain what you think would happen if instead of sanding only half the enamel off the ends of the coil, you sanded all of it. (Hint: When the enamel is making contact with the safety pins, there is no current running through the coil. In other words, the current is only flowing through the coil when the bare wire is making contact to the safety pins)

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3. What could you change about the motor that would cause the coil to spin faster?

\_\_\_\_\_

\_\_\_\_\_

4. Look at the list of suggested adjustments listed in Step 6 of the procedure. Explain how suggestion B) “Ensure that the straight ends of the coil are at 180° from each other and as straight as possible.” enables the motor to spin more efficiently.

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5. Look at the list of suggested adjustments listed in Step 6 of the procedure. Explain how suggestion C) “Adjust the safety pins to lower the coil closer to the magnets without bumping into the magnets.” enables the motor to spin more efficiently.

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