Simple DC Motors
Spring 2026

Introduction

The purpose of this experiment is to build a DC motor and understand its operation. Your report will consist of a detailed sketch of your motor and the answers to a few questions about it. You may build a motor by yourself or with your group. WARNING: The magnets are very strong and can pinch your fingers AND the wires can get very HOT.

Building the motor

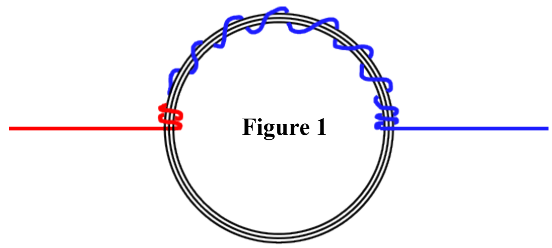
Figure 1

The motor you will construct consists of a 1.5V D-cell battery, a magnet, two large safety pins, a rubber band and a double-Miller arm length of wire that you will now fashion into a coil.

1. *The coil:*

   a. Wrap the copper wire around your battery 10 to 15 times, being sure to leave 2 or 3 inches of wire sticking straight out on each side. Cut off any excess wire as needed (check with your instructor about how much to remove). Remove the loop from the battery when it is finished.

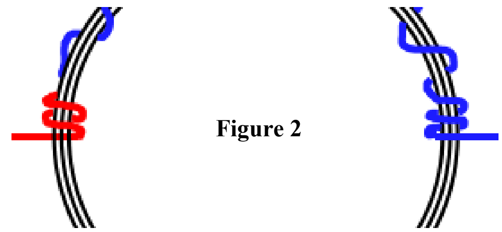
Figure 2

   b. Wrap the left end of the wire around the loop at least twice, as shown in red in **Figure 1** above. Wrap the other end of the wire around the top of the loop several times, then finish off by wrapping it around the right side of the loop a couple of times, as shown with the blue wire segment in **Figure 1**. A detailed view of the way the wire is wrapped is shown in **Figure 2**; note that the wire is wrapped *behind* the loop on the left side, and in *front* of the loop on the right side.

      Note: The wires in both figures have been color-coded to distinguish between the ends. In order to make your coil well balanced, it is important that the two tie-offs are *exactly opposite each other*, in the middle of the loop, as shown in **Figure 1**.

   c. Place your coil on the wood board and use sandpaper to remove *all* the copper-colored insulation from the straight wire at the left end of the coil. The wire becomes shiny when the insulation is removed. *It is important that you remove all the insulation on the straight wire, right up to the edge of the loop*; this will ensure that your motor turns continuously.

   d. Now hold your coil so the straight segment on the right side is on the wood board, but the loop sits vertically off the left side of the board (**Figure 3** below). Use sandpaper to remove **ONLY THE TOP HALF** of the insulation along the straight segment, again right up to the edge of the loop (**Figure 4**).

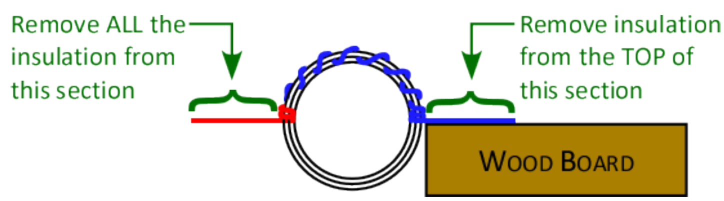

Figure 3

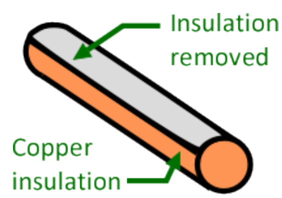

Figure 4

2. *The motor:*
   a. Determine the way your compass points using the known pole on the horseshoe magnet in the lab. Use your compass to determine the poles of your magnet.
   b. Stick the magnet on the center of the side of the battery with the north side up (**Figure 5**).
   c. Wrap a rubber band around the battery twice and attach a safety pin to each end of the battery so that the small loop at the end of each safety pin sticks up (**Figure 5**).
   d. Place your coil through the loops of the safety pins so that it is supported above the magnet. Make sure the 'red' end of the coil is on the positive side of the battery, and the 'blue' end of the coil is on the negative side (this will ensure that everyone in lab assembles their motor the same way – much easier to troubleshoot!).
   e. Check to see if your motor works by spinning the coil; it should continue to spin by itself. You may need to hold the safety pins against the battery to make a better electrical contact.

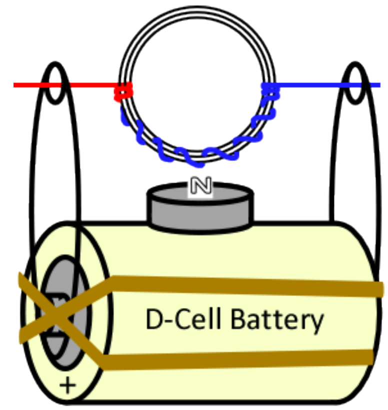

Figure 5

Playing with the motor

1. Make a sketch of your motor (like **Figure 5**) that shows the polarity of the battery, the poles of the magnet and the direction of the magnet's $\vec{B}$ field.
2. Does your motor spin in both directions, or just one direction? Looking from the positive end of the battery, indicate the direction the motor spins (clockwise or counterclockwise) and add this in your sketch from the previous step.
3. Use the right hand rule to check the direction that the current, I moves in the loop by considering the force exerted on the loop and the magnetic field direction (*what is the direction of* $\vec{F}$ *on the bottom of the loop? On the top?*) Indicate the directions of I, $\vec{B}$ and $\vec{F}$ in a simplified sketch (**Figure 6**) and explain how they are determined.

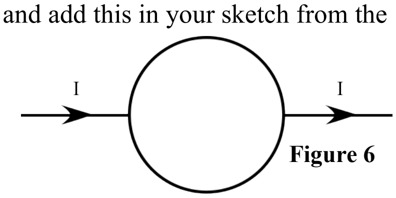

Figure 6

4. If *all* the insulation was removed from both straight sides, what would happen to the current direction in the loop and the force on the loop after it rotates 180° from your sketch (**Figure 5**)? As you think about this, explain why on one side of the loop you only removed half of the insulation. What would happen if you didn't remove any insulation?
5. Hold another magnet above the loop on your motor. How does it affect the spinning loop? Flip the orientation of the magnet. What happens? (You may want a partner to help you here.)
6. Remove your motor from the v-block holder and try turning it upside down. If you move too fast (or too slow), the motor will stop. What happens to the rotation of the coil…it should do more than just stop. Does it spin in the same direction or the opposite direction? Draw another sketch like Figure 6 of your upside-down motor, and explain what is happening.

More Fun!

- For some easy fun you can build a homopolar motor out of a battery, a short single wire, screw and magnet. Assemble these parts as shown in **Figure 7**.

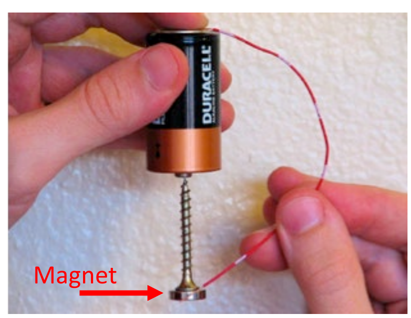

Figure 7