

# A Simple Motor

## Materials Required:

One 'D' Cell Alkaline Battery	One Wide Rubber Band
Two Large Paper Clips	One Ceramic Magnet
Fine Sandpaper	
Heavy Gauge Magnet Wire (the kind with red enamel insulation, not plastic coated)	

## Procedure:

1. Starting about 3 inches from the end of the wire, wrap it 7 times around the battery or similar circle. Remove the tube (you don't need it any more). Cut the wire, leaving a 3 inch tail opposite the original starting point. Wrap the two tails around the coil so that the coil is held together and the two tails extend perpendicular to the coil. See illustration below:

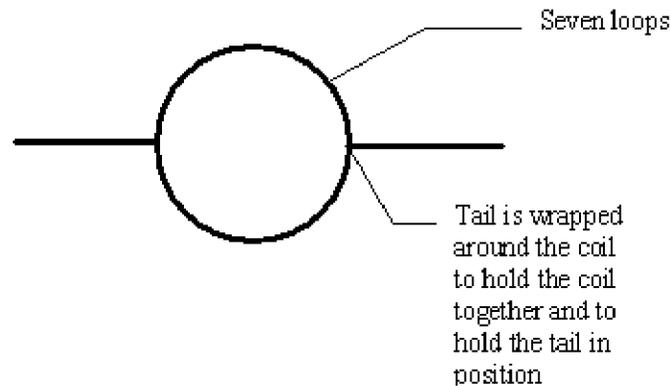


Fig 1

Note: Be sure to center the two tails on either side of the coil. Balance is important. You might need to put a drop of glue where the tail meets the coil to prevent slipping.

2. On **one tail**, use fine sandpaper to completely remove the insulation from the wire. Leave about 1/4" of insulation on the end and where the wire meets to coil. On the **other tail**, lay the coil down flat and lightly sand off the insulation from the top half of the wire only. Again, leave 1/4" of full insulation on the end and where the wire meets the coil.

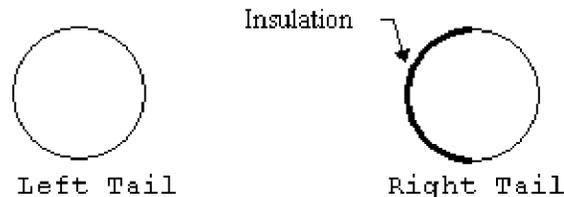


Figure 2

3. Bend the two paper clips into the following shape (needle-nosed pliers may be useful here):

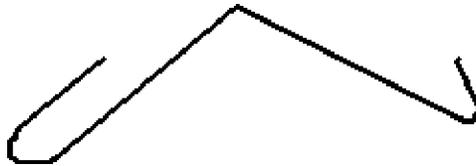
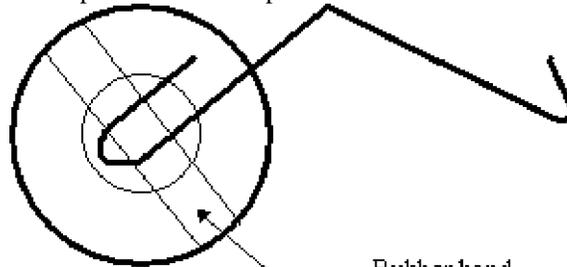


Figure 3

4. Use the rubber band and/or tape to hold the loop ends to the terminals of the "D" Cell battery:



Rubber band  
may need to be  
looped a few  
times for a snug  
fit.

Figure 4

5. Stick the ceramic magnet on the side of the battery as shown:

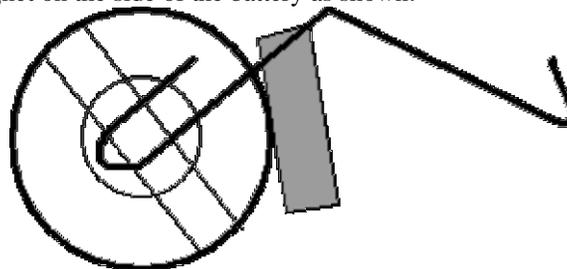


Figure 5

6. Place the coil in the cradle formed by the right ends of the paper clips. You may have to give it a gentle push to get it started, but it should begin to spin rapidly. If it doesn't spin, check to make sure that you sanded the ends correctly on the wire ends. If it spins erratically, make sure that the tails on the coil are centered on the sides of the coil. Note: the motor is "in phase" only when it is held horizontally (as shown in the drawing).

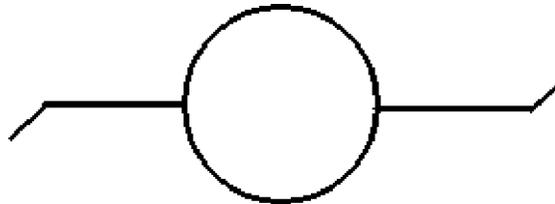


Figure 6

7. For display, you will probably need to build a small cradle to hold the motor in the proper position. It might also help to bend the ends of the coil a bit so that as it slips right or left, the bends keep it in the proper position:

**Analysis:**

*Write each of the following as a question/answer statement.*

1. Why do you use multiple coils?
2. Why do you sand the ends differently?
3. How long can you get the motor to run before it falls off the cradle?
4. What happens if you turn the coil around swapping the left and right sides?
5. What happens if you swap the magnet North & South ends?
6. Turn the coil by hand and feel the magnetic attraction at various positions. Draw the different positions and describe how the attractions vary at each position.
7. Measure the speed of the motor in revolutions per minute (RPM).
8. How could you get the motor to do work for you?
9. How efficient do you think it is?
10. Do you think the shape of the coil has anything to do with how well it works? Try experimenting.
11. Do you think the voltage of the battery has anything to do with how well it works?
12. Calculate the magnetic field,  $B$ , using the mechanics, electricity and magnetic induction. Show a step by step analysis.