Project: Make an Electric Motor

Materials you supply

- Wood or Styrofoam block, dimensions approx. 10 cm × 15 cm × 8 cm or smaller.
- Two alkaline D cell batteries

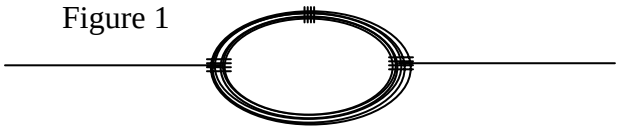
Materials we supply

- 14-gauge, single-thread wire, 50 cm in length
- Thin motor wire, 50 cm in length
- Wire strippers
- Sand paper
- A two-battery holder for D cell batteries (if available)
- Two alligator clips
- One rectangular magnet about 6 cm by 3 cm (the stronger the magnet, the better)
- Electrical tape
- A drill, if using the wood base platform

Assembly

1. Make the coil … this is the part that will spin around. Wrap the motor wire in a circle or rectangle with area about the size of the magnet. Make between 5 to 20 turns. You can start with a coil of 5 turns and then try more, especially if you have a strong magnet.
2. After you have finished wrapping the wire to make a coil, you should have 8 cm of wire left over on each side of the coil. Use this to wrap around the coil on either side (this is to keep the coil together). See Figure 1 below.
3. You should still have about 6 cm of wire left that sticks straight out on either side (this is the axle). Sand the same half of the axle on both sides until the insulation is removed. It is very important that you do this correctly, so don't sand until you understand *why* you are sanding only one side of the wire. Make sure each side of the axle has half the wire sanded (so you have electrical flow when the coil is oriented that way) and half insulated (no electrical flow when the coil spins over to the other side).
4. Wrap a small piece of the motor wire around the top of the coil 3 times to act as a counter weight, to get it going.

Figure 1



5. Assemble the base of the motor. Strip the insulation off the 14 gauge wire, cut it in half and bend both wires exactly the same into the shape. (See our example motor.)
6. Wrap electrical tape around the 14-gauge wire in all areas except where the coil will attach (the bent part) and where the battery will make contact with it. This prevents short circuits.
7. Position the two 14 gauge pieces of wire 10 cm apart from each other and stick them firmly into the Styrofoam or the predrilled holes in the wood. The height should be such that the coil is about 1 cm away from the magnet at its closest approach.

8. Place the batteries in the holder (if available) and attach them to the 14 gauge wires. You will attach the battery's positive terminal to one wire and the negative to the other. You can use the alligator clips.
9. Place the coil on the 14-gauge wire as shown in our example motor, and watch it spin!

Helpful hints

- If it's not spinning at all make sure you have good electrical contacts and that only half (and the same half on each side) of the axle of the coil has its insulation sanded off. The coil should make electrical contact on *half* of its cycle.
- If it's only spinning weakly or struggling to spin, try sanding off a little more than half on each side.
- If it's moving to one side as it spins make sure the coil is perfectly balanced on the 14-gauge wire.

To Do and Notice

1. Watch it spin!
2. Try smaller and bigger coils and different geometries for the coil to see how fast you can get it spinning and how heavy a coil you can make spin.
3. Attach a paper made fan to one of your coils –you now have an electrical mini fan.
4. If you are really motivated attach light wheels and a casing for the axle, you just built an electric car.
5. Sand both sides of the axle (that is all the way around the wire), now it will simply wobble back and forth. Why is this? (See the 'What's Going On' section below)

What's going on?

The battery provides a steady DC current. When the coil has the bare side of its axle touching the 14-gauge wire, electricity can flow in the coil. Current going in a circle creates a magnetic field that points directly through the center of the circle. The magnetic field of the coil is repulsed[*] by the magnetic field of the magnet and thus makes the coil flip away from it. This repulsion flips the coil. After the coil has flipped it is not making contact with the wire anymore so no electricity is flowing and instead of staying aligned with the magnet, it keeps turning on its own momentum.

This cycle continues endlessly until the battery goes dead or the coil loses contact with the 14-gauge wire. The moral of the story is that the coil wants to align itself perfectly with the magnet, but the counter weight gives it torque, and once it starts spinning you have a repulsion or attraction to make it flip and keep spinning.

[*]OR the coil is aligned such that it's magnetic field is aligned with the magnets magnetic field and its attracted to it, causing it to flip the other way