



How to Build a Motor

Ages 6 and up

Supplies you will need:

- ★ Large rubber band
- ★ Magnet
- ★ 2 jumbo-sized paper clips
- ★ Small gauge magnet wire (enameled wire)
- ★ Marker
- ★ Connecting wire
- ★ D-cell battery
- ★ Packing foam or rubber eraser to use for the base
- ★ Sandpaper (medium grit)

Instructions

Do not attach wires or paperclips to your battery before the motor is ready! This could drain the battery very quickly. If you drain your battery, your motor will not spin, and that's frustrating.

1. Wind the wire around the marker about 12 times. (More doesn't help, the coil gets too heavy for the ends to hold it steady.)
2. Straighten each lead so that you can hold one in each hand and spin the coil without causing it to wobble. Be patient, the coil must spin smoothly for the motor to work.
3. Sand one lead so that it is shiny on all sides, the entire length of the lead.
4. Sand the whole length of the other lead, only on the top half. The sanded parts of both leads should be shiny.
5. With your eraser or foam block flat on the desk, set your magnet on the center of the block. The curved magnet should open "up" like a bowl.



6. Stab one end of each paperclip into the block, and bend the other end so that one lead can rest on each paperclip. With the leads resting on the clips, the coil should be suspended just above the magnet without touching it. For best results, keep the clips just far enough apart so the coil does not touch them when it spins.
7. Each wire gets clipped to one paperclip. Clip the other end of each wire to the battery. The electricity must pass through your coil to complete the circuit. If your coil jumps when you connect the battery, that is a good sign!
8. Give the coil a push start to start it spinning. The half-sanded end works like an on-off switch each time the coil turns over, so that it gets pushed a bit faster each time it goes around.

Motor not working? Try these steps:

1. Check the sanding on the coil. Is the top half of each lead sanded?
2. Is the coil centered and straight?
3. Are the paper clips lined up evenly?
4. Is the battery working?
5. Do all the connections have good metal-to-metal contact?
6. Is the coil as close to the magnet as possible without touching it?
7. If the magnet hits the paper clips, put a rubber band around the magnet and foam.

How the motor works

This motor is actually a half-motor.

Half of the time the coil is an electromagnet. This happens when the sanded side of each lead is in contact with the paper clips.

To show this, put a compass near the coil. The compass needle should move and point at the coil. This shows that electricity is flowing through the coil and that the coil is an electromagnet.

When the enameled side of each lead is pressed against the paper clips, the coil is not an electromagnet.

You can see this for yourself by holding the enameled side of the coil's leads against the paper clips. No electricity will flow through the coil. The coil will not move the compass needle. The compass will point north.

This is how the on again/off again of the coil creates motion. When the coil is an electromagnet, it turns to line up with the bar magnet and the motion begins. Just as this happens, the enameled halves of the leads touch the paper clips. Electricity stops flowing through the coil. The electromagnet is off, but the coil is moving and it keeps moving long enough for the cycle to repeat.

So half the time the coil is an electromagnet that moves to line up with the permanent magnet below and half the time the coil is just coasting. Hence you have made a half motor. In a full motor the coil is never off.