

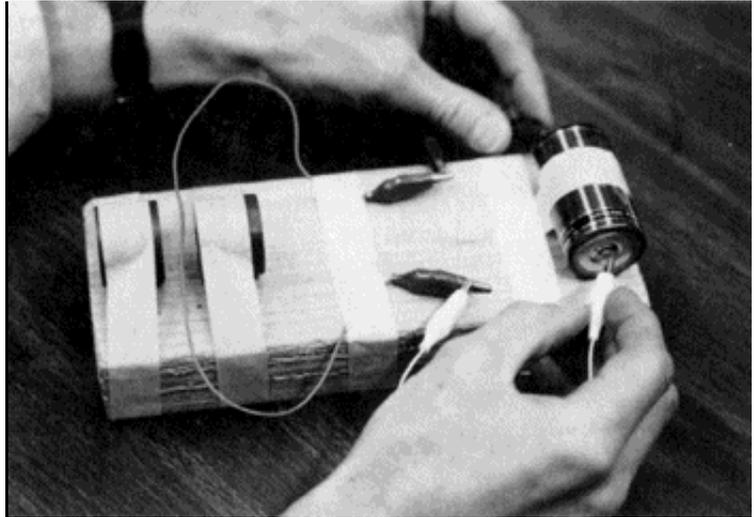
Motor Effect

A magnet exerts a force on current-carrying wire.

This simple device shows that when an electrical current flows through a magnetic field, a force is exerted on the current. This force can be used to make an electric motor.

materials

- **4 to 6 small disk magnets.** (Radio Shack sells inexpensive 1-inch (2.5 cm) diameter disk magnets.)
- **One or two 1.5 volt flashlight batteries.**
- **Approximately 2 feet (60 cm) of flexible wire,** such as solid or multistranded hookup wire, or magnet wire (available at Radio Shack).
- **Masking tape.**
- **A wooden board** approximately 2 x 4 x 6 inches (5 x 10 x 15 cm).
- **A knife or sandpaper.**
- **Adult help.**



Magnetism



Electricity

assembly

(15 minutes or less)

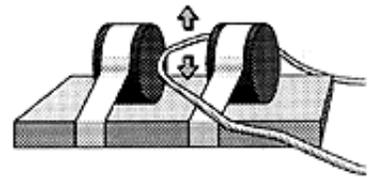
Group the disk magnets into a single cylindrical pile. Place the pile on the board so that it can be rolled along the board. Split the pile in the middle, leaving a gap of about 1/2 inch (1.3 cm) between the faces of the two groups. Tape the two groups to the board. A north pole will face a south pole across the gap.

Tape the battery onto the board as shown in the photo. Remove the insulation from the ends of the wire. (Use a knife for stranded wire, or use sandpaper to remove the nearly invisible insulating enamel from magnet wire.) Loop the wire through the gap between the magnets, with the ends of the wire close enough to the battery to touch it.

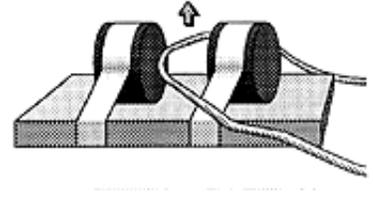
to do and notice

(5 minutes or more)

Touch one end of the wire to the positive side of the battery and simultaneously touch the other end of the wire to the negative side. The wire loop will jump either up or down.



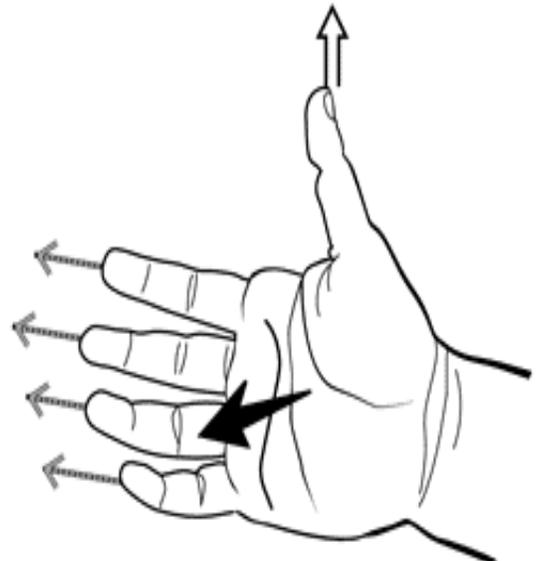
If you reverse the direction of current flow, the wire will jump in the opposite direction. To reverse the current, attach the lead that was connected to the positive end of the battery to the negative end and vice versa.



what's going on? _____

The magnetic field of the disk magnets exerts a force on the electric current flowing in the wire. The wire will move up or down, depending on the direction of the current and the direction of the disks' magnetic field.

To predict the direction of movement, you can use a mathematical tool called the *right-hand rule*. Put your right hand near the section of wire that goes between the disk magnets. Make your hand flat, with your thumb sticking out to the side. (Your thumb should be at a right angle to your fingers.) Place your hand so that your thumb points along the wire in the direction that the electric current is flowing (current flows from the positive terminal of the battery to the negative terminal) and so that your fingers point from the north pole of the disk magnets toward their south pole. (You can find the north pole of the magnets by using a compass; the south end of a compass will point toward the north pole of a magnet.) Your palm will then naturally "push" in the direction of the magnetic force on the wire.



The deflecting force that a magnet exerts on a current-carrying wire is the mechanism behind the operation of most electric motors. Curiously (and happily for our sense of symmetry!), the reverse effect is also true: Move a loop of wire across the pole of a magnet, and a current will begin to flow in the wire. This, of course, is the principle of the electric generator. The electric current you generate by moving this single loop of wire through the weak magnetic field of the disk magnets is too weak to detect with all but the most sensitive of microammeters.

etcetera _____

This experiment creates just a short pulse of motion. A motor requires continuous motion. This problem was solved originally in the early 1800s by the invention of commutators. A commutator is a sliding contact that not only makes electrical contact with a rotating loop of wire but also allows the current direction to reverse every half-cycle of rotation.

The first electric motors were constructed in 1821 by Michael Faraday in England and improved in 1831 by Joseph Henry in the United States.