Curiosity Guide #509
Circulatory System

Accompanies Curious Crew, Season 5, Episode 9 (#509)

Electromagnetic Fields

Investigation #4

Description

Compasses always point North. Or do they? Let's find out!

Materials

- Toilet paper tube
- 1 meter of insulated copper wire, 22-gauge or higher
- Electrical tape
- Drill or awl
- D-cell battery
- 9-volt battery
- Wire stripper
- Battery holders
- Alligator clips
- Compass
- Large paper clip
- Small paper clips

Procedure

1) Place the batteries in holders and set aside.
2) Use wire strippers to expose one inch of copper from one end of the wire.
3) Leaving 4 inches of wire loose at the beginning for a lead, wrap a series of 12 to 15 coils around the middle third of the toilet paper tube until the wire is down to 4 inches of loose wire at the end.

When you are done wrapping, you should have two lead wires, one at either end of the coil around the tube. The wire coil should overlap on itself and only cover about 1 ½ inches of the center of the tube.

4) Drill or poke a top and a bottom hole through the toilet paper tube on either side of the coil.
5) Feed the lead wires through the holes to keep the coils securely in place.
6) Use a small amount of tape, if necessary, to hold the wires in place.
7) Attach one lead wire to a battery pole with the alligator clip.
8) Attach the second lead wire to an alligator clip. Connect the clip to the battery ONLY when conducting the experiment. Leaving the connection too long will drain the battery and make it very hot.
9) Hold a compass near the tube.
10) What do you notice?
11) Suspend a small paper clip from a larger one over the tube. What do you notice?
12) What happens when you try the experiments with a higher-voltage battery?

My Results

Explanation

When electrons flow through the coiled wire, called a solenoid, a magnetic field is created inside and around that loop. As a result, the compass needles point parallel to the wire and in line with the circular magnetic field that is occurring around the coil.

When the battery poles are reversed, the direction of the needles goes the opposite way, due to the change in flow of electricity. Increasing the number of coils of wire in the square makes the magnetic field stronger. Increasing the current flow from a higher voltage battery can also increase the strength of the electromagnetic field. Because the compass is so close to the wire's magnetic field, the compass reacts to the wire's magnetic field rather than to the magnetic field of the Earth. The suspended paper clip wobbles and changes direction because its magnetic properties are being attracted to the magnetic field of the coiled wire. This is true no matter which way the electrical flow is going. Make sure the battery is not left connected too long because doing so will drain the battery and get hot.

Think about this. It's amazing to think that when electricity flows, a magnetic field is produced. This relationship between magnetism and electricity was discovered by a Danish scientist named Hans Christian Oersted in 1820. Oersted connected a wire to a battery, and because the wire was near a compass, the compass needle turned around to line up with the magnetic field. This helped Oersted understand that electricity produces magnetism. Electromagnets are all around us from the motors in your appliances, to your doorbell, computer hard drives, speakers, sewing machines, vacuum cleaners, and DVD players. What a useful discovery! Thanks, Hans Christian Oersted!

Parents and Educators: use #CuriousCrew #CuriosityGuide to share what your Curious Crew learned!

WKAR

Curious Crew is a production of Michigan State University.
Learn more at WKAR.org.