Curiosity Guide #509
Electromagnetism

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

Straw Suction

Investigation #1

Description

Watch out for the power of magnetism in this investigation.

Materials

- Plastic straw with $\frac{1}{4}$-inch diameter
- Scissors
- Ruler
- 35 to 40 feet of insulated bell wire
- 6-volt lamp battery
- 2 alligator clips
- Wire strippers
- Shiny steel nail, NOT stainless steel, sized so the shank fits loosely inside the straw
- A friend
- Paper clip

Procedure

1) Use the scissors to cut the straw to six inches in length.
2) Use wire strippers to strip one inch of insulation off one end of the bell wire.
3) Leave a 6-inch lead from the stripped end of the wire and begin to coil the wire around the straw. We will call this end the first lead wire.

4) Continue to coil wire around the straw from one end to the other. Keep wrapping up and down the straw with additional layers of wire coil, until about 6 inches of wire remain.
5) Use the wire strippers to remove one inch of the insulation of the second loose end of wire. This will be the second lead wire.
6) Attach an alligator clip from the first lead wire to one terminal of the battery.
7) Attach the second alligator clip to the second lead wire, but do not attach the alligator clip to the battery yet.
8) Place the tip of the nail just inside the straw.
9) Have a friend predict what will happen when the alligator clip is attached to the battery.
10) What did you notice?
11) What would happen if you reversed the alligator clips on the two battery poles?
12) Can you keep the leads connected but hold the straw vertically to see if the nail still gets pulled in?
13) What else might work besides a nail?
14) Is the magnetized nail strong enough to pick up a paper clip when you remove the nail from the straw? Try it.

My Results

Explanation

When electrons flow through a coiled wire, a magnetic field is created inside and around that loop. Increasing the number of coils of wire in the loop creates a stronger magnetic field. As a result, the coil itself behaves similarly to a bar magnet that has a defined north and south pole. Atoms themselves behave like little electromagnets because the charged atoms are constantly repelling one another while spinning around the nucleus. The atoms in the iron nail generally spin in random directions. However, when the nail is inserted into the magnetic coil, the north polarized atoms shift so that the north ends are attracted to the south end of the electromagnet. When the nail's atoms line up with one another, the nail is magnetized and gets pulled into the straw due to magnetic attraction. Conducting the experiment again when the poles are reversed has the same result. The nail is still drawn into the straw. This is because the atoms in the nail are able to reorient themselves so the south poles in the nail attract to the north pole of the electromagnet. The nail won't repel because the nail is not a permanent magnet, so it will always be drawn into the straw.

A stronger power source can also increase the strength of the magnetic field, increasing the rate at which the nail is pulled into the straw. If the magnetized nail is removed from the straw, the nail may act like a temporary magnet and be able to pick up a paper clip. Eventually, the nail's atoms will shift and demagnetize. Dropping the nail will cause the atoms to shift and demagnetize the nail quickly.

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