Curiosity Guide #509
Electromagnetism

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

Magnetic Flow

Investigation #3

Description

Can you change the way a compass behaves?

Materials

- Half-inch PVC pipe, two feet long
- Hack saw
- 3 half-inch T joints
- 2 half-inch elbow joints
- 12 Feet of 12-gauge insulated wire
- Wire stripper
- Twist ties or cable ties
- Electrical tape
- D-cell battery
- Battery holder
- 2 alligator clips
- Cardboard or foam board cut to 8 by 8 inches
- Scissors
- Measuring tape
- 5 or 6 compasses

Procedures

Build the stand

1) Using the hack saw, cut the PVC into the following pieces: one 6-inch piece, two 4-inch pieces, two 3-inch pieces, and two 2-inch pieces.
2) Slide one end of a three-inch piece into an elbow. Keep the other end free.
3) Repeat with another elbow and the other three-inch piece.
4) On the open ends of the elbows, secure the two-inch pieces. Then connect the 2-inch pieces with one of the T joints. The opening of the T joint should face up. This will be the base of the stand.
5) In the T joint, attach a 4-inch straight piece, a T joint, and the 6-inch piece so that the T joint opening goes the same direction as the feet of the base.
6) Connect the last 4-inch piece in the open T and add the final T joint so that it is turned parallel to the floor.

Make the cardboard platform

1) Cut the cardboard into an 8 by 8-inch square.
2) Cut a slit $\frac{1}{4}$-inch wide from one edge of the cardboard just past the center of the board. Set the cardboard square aside.

Form the solenoid (a square of coiled wire)

1) Strip 1 and $\frac{1}{2}$ inches of insulation from the end of the 12-gauge wire.
2) From the exposed copper, measure 10 inches and bend the wire 90 degrees.
3) From the bend, measure 10 inches and make another 90-degree bend.
4) Continue to measure and bend the wire so that it is bent into a square with 10-inch sides.
5) Continue the square until each side is made of three sections of wire.
6) Then bend one last side, making this piece 11 and $\frac{1}{2}$ inches long. This side of the square will have four wires instead of three.
7) Cut the wire there and remove the insulation on the final 1 and $\frac{1}{2}$ inches.
8) Use twist ties, cable ties, or electrical tape to secure the wire square together.

Place the platform and attach the solenoid

1) Lay the cardboard platform on the center T of the PVC stand so that the slit is on the outside of the stand.
2) Carefully slide the center of the 4-wire side of the wire square all the way in the cardboard slit.
3) Secure the back side of the square against the vertical post with a twist tie.
4) Secure the bottom part of the wire square on the base of the stand with another twist tie.
5) Level the cardboard.

Perform the investigation

1) Place the compasses around the wire.
2) Which way do the compasses point?
3) Rotate the platform. What do you notice?
4) Put the battery in the battery holder.
5) Attach an alligator clip from the wire lead to the battery holder.
6) Attach the second clip from the second lead to the other battery holder lead. Do not leave the battery attached long as it will begin to get hot.
7) What do you notice?
8) Rotate the platform again. What do you notice this time?
9) Reverse the clips on the battery holder. What happens?

My Results

Explanation

A compass is a tiny suspended or floating magnet that naturally lines up with the Earth's magnetic poles, even when the platform is rotated. However, when electrons flow through the square 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, in line with the circular magnetic field occurring around the coil. The compass needles will keep pointing in that circular fashion even when the platform is rotated. 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 creates a stronger magnetic field. Because the compasses are so close to the wire's magnetic field, they react to it rather than the Earth.

The Right-Hand Rule is a great way to figure out the direction a magnetic field is going when caused by a current. Imagine holding the insulated wire in your hand with your thumb up pointing toward the current's flow from positive to negative. The circle of your fingers around the wire resembles the direction of the magnetic field. The compass will also point in that same circular path.

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