Lab 2. FIELDS

1.1. Problem

- What are electric and magnetic fields?
- How can we understand the shape and properties of fields?
- How do electric and magnetic fields affect matter?

1.2. Equipment

1. two balloons, one suspended by a thread, fur
2. electric field visualizer bottle, stand, glass and plastic rods, balloons
3. glass or plastic rod, fur, bubble soap, stream of water, empty aluminum can, bar magnet
4. two bar magnets
5. bar magnet, thread, magnetic compass
6. electromagnet, white paper, iron filings, magnetic compasses
7. magnets of different configurations, white paper, iron filings

1.3. Activities

Here we look at electric and magnetic fields, particularly to visualize them and understand the direction and magnitude of forces on items subject to the fields.

This lab consists of several stations. You may do them in any order.

1. Charge-Charge Forces

1.1. Charge a balloon suspended by a thread by rubbing it with fur. Hold another balloon in your hand and charge it in the same manner. Slowly bring the balloon in your hand toward the suspended balloon. What happens?

1.2. Re-charge the suspended balloon by rubbing it with fur. Remove the fur piece and then slowly bring it toward the balloon. What happens?

1.3. Rub a balloon in your hair. Slowly pull the balloon away from your head. What happens?

2. Electric Field Visualizer

Place the visualizer bottle on a stand to isolate it. Charge a balloon by rubbing it with fur. Hold it next to the electric field visualizer bottle. In a little while, the fibers suspended in the oil in the bottle will align with the electric field surrounding the charge.

2.1. Sketch the pattern of the fibers in the bottle, also indicating the position of the charged object.

2.2. Generate a different field around the visualizer bottle. You may do this by placing two balloons in different positions around the bottle, placing opposite charges in different positions around the bottle, placing an uncharged piece of metal under the bottle as a charged rod is held near the bottle, and so on. Sketch the pattern of the fibers in the bottle, also identifying and indicating the positions of the other objects.

3. Electric Charge Polarization

Charge a balloon by rubbing it with fur.

3.1. Hold the charged object near a thin stream of falling water. What happens?

3.2. Blow soap bubbles in air. Bring the charged balloon near the bubbles. What happens?

3.3. Place an empty aluminum can on its side on a level surface, so that it can roll freely. Bring the charged balloon near the side of the can. What happens?

3.4. Bring a magnet near a falling stream of water, soap bubbles in air, and an empty aluminum can on its side. What happens?

4. Bar Magnets

4.1. Place one bar magnet flat on the table. Individually, bring each end of the other magnet slowly toward each end of the magnet on the table. What happens in each of the four cases?

5. Earth's Magnetic Field

5.1. Tie a thread around the middle of a bar magnet. Pick up the magnet by the thread and adjust the position of the thread loop so that the hanging magnet balances horizontally. In what orientation (north-south, east-west, etc.) does the hanging magnet eventually come to rest?

5.2. Bring a compass toward each end of the bar magnet. How does the compass react to each of the two ends of the magnet?

6. Electromagnet

Run a direct electrical current from a battery or other DC power supply through the coil.

6.1. Bring each end of a bar magnet toward each end of the energized coil. What happens in each of the four cases?

6.2. Bring a compass toward each end of the energized coil. How does the compass react to each of the two ends?

6.3. Place the energized coil on a piece of white paper and sprinkle iron filings around it. Sketch the pattern of the filings.

6.4. What happens to the shape, direction, and poles of the magnetic field when you reverse the current through the coil?

Disconnect the DC power source from the coil.

7. Magnets and Iron Filings

7.1. Place a magnet under a sheet of paper and sprinkle a small amount of iron filings evenly on the paper. Filings should be on the paper in locations away from the magnet as well as directly atop it. Sketch the pattern that is formed.

7.2. Repeat with a different magnet.

8. Magnetic Field Around a Straight Wire

8.1. What direction(s) do the compasses point before the current is turned on? After the current is turned on?

8.2. Draw a diagram of the magnetic field around the current-carrying straight wire. Remember that magnetic field lines point in the direction a compass needle in the field points.

8.3. What happens to the shape and direction of the magnetic field when the current through the wire is reversed?

8.4. Does the straight wire have a north or south magnetic pole associated with it? (Magnetic field lines *diverge from* a north pole and *converge to* a south magnetic pole.) If so, where are the poles?