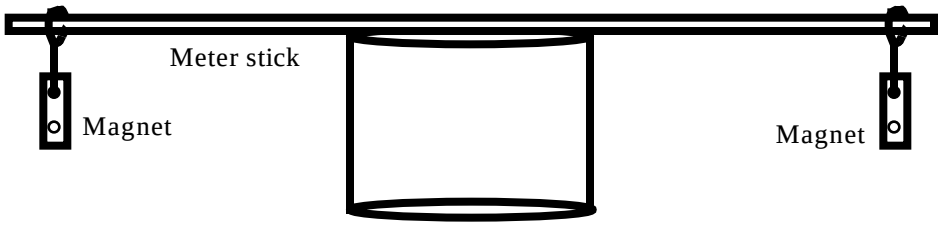
Magnetism I – Lesson 4
Permanent Magnets and Compasses

Summer 2004 Cal Poly Pomona

Objective: To investigate "permanent" magnets and their properties, and to construct magnetic compasses.

Experiment 1

1. Rest a meter stick on the large plastic, water-filled bowl (water gives it weight and stability). At each end of the meter stick, hang a 2-holed rectangular magnet from a thin string through the upper magnet hole, as illustrated. Be sure the magnets can rotate freely.



Note: For drawing simplicity, the magnets are shown facing out of the paper, and no rolled-paper indicators are shown in the lower magnet holes.

2. Stick rolled up pieces of paper, approximately 4 inches long, through each lower magnet hole, to act as direction indicators.

3. Rotate the meter stick so that it lines up with one of the direction indicators.

a. What is the orientation of the other indicator? Make a sketch of what you observe.

b. Compare the orientation of your meter stick with the orientations of other experimenters' meter sticks. Record your results.

4. Use a RED marker to mark the end of each direction indicator that faces northward. The RED marks will act as arrows on the direction indicators, and we can refer to the indicator ends as RED (arrowhead) and WHITE (arrow tail).

5. Bring the magnetic compass near a ring magnet's RED side and then to its opposite side.

a. Observe the effect of the ring magnet on the compass needle in each case. Sketch your findings and write a paragraph describing what you have found.

b. Bring your suspended ring magnet close to a neighbor's suspended ring magnet and observe the effects when the RED sides approach one another, and when a RED side approaches a WHITE side.

c. Write a paragraph explaining your findings, including sketches wherever they are helpful.

d. Scientists call the part of a magnet that points northward a North magnetic pole. The opposite end of the magnet is a South magnetic pole. Is the RED side of your magnet a North or South pole?

e. Based on your findings above, indicate whether the magnets ATTRACT or REPEL for each case shown below..

When NORTH approaches NORTH _____
When NORTH approaches SOUTH _____
When SOUTH approaches SOUTH _____

f. How do your findings above differ from those for electrically charged objects?

g. Does magnetism near Earth's geographic North pole originate from a North or South magnetic pole? Provide a written explanation.

Experiment 2

1. Cut off the top of a styrofoam cup to obtain a shorter cup with a height of about 1 cm.

2. Unbend a #1 paper clip until it is in the shape of a "J." Place the paper clip horizontally in the cup, and place the cup in the plastic bowl of water, where it will float. Watch the cup for a while to see if it rotates.

a. After the clip comes to rest, observe the direction in which the straight end points.

b. Point the clip in another direction and see if it returns to the direction found in part **a**. Compare your finding with that of other experimenters and also with the direction(s) found in Experiment 1 above.

3. Place the clip's straight end through one of the magnet holes, moving <u>from</u> the magnet's SOUTH pole <u>to</u> its NORTH pole. Move the clip as far as it will go. Then <u>slowly</u> remove the paper clip from magnet. Place the paper clip horizontally in the cup, watch the cup for a while to see if it rotates.

a. Observe the direction in which the straight end points.

b. Point the clip in another direction and see if it returns to the direction found in part **a**. Compare your finding with that of other experimenters and also with the direction(s) found in Experiment 1 above.

c. Discuss with your partner what was accomplished by moving the paper clip through the magnet hole and then extracting it. Record your conclusions in writing.

d. After the steps in item 3 are performed, is the straight end of your paper clip a NORTH pole, a SOUTH pole, or something else? Explain how you know in writing.

e. Observe a horizontal magnetic compass that is separated from all nearby magnets by at least one meter, and compare the orientation of the compass needle with that of your J-shaped paper clip. Illustrate your findings with a sketch.

5. Predict what happens if a magnetized paper clip is cut in half. Discuss this with your partner and then with the class.

a. Write down the dominant class prediction.

b. Watch a demonstration of a magnetized paper clip being cut in half and record the results. Was the class prediction correct?

Summary Questions

a. Explain in writing how a magnetic compass works and answer these questions: (i) Is the suspended magnet in Experiment 1 a compass? (ii) Is the J-shaped paper clip in Experiment 2 a compass? How do you know?

b. Near what geographic and magnetic poles does Santa Claus live? Explain in writing.

c. What similarities and differences exist between electric attraction and repulsion and magnetic attraction and repulsion?

d. Given that matter is made of atoms, does this mean that a permanent magnet's atoms are themselves little magnets? And if atoms are magnets, might electrons, protons, and/or neutrons be even tinier magnets? Explain your reasoning in writing.