UNIT 13
MAGNETS

(from Lillian C. McDermott, Peter S. Shaffer and the Physics Education Group, *Tutorials in Introductory Physics (Homework)*, Prentice Hall, NJ, 1998)

Objectives

- to be able to class materials or objects as magnetic, ferromagnetic or non-magnetic and understand how different classes of materials interact
- to understand how magnets interact with charged objects and how magnetic poles are different from positive and negative charges
- to be able to develop a method to measure the strength of a magnet
- to understand how a compass works
- to understand the Earth as a magnet

Equipment:

1 set of materials for observing interactions between different type of objects

1.1 Obtain a set of materials from the instructor. Observe the interactions between the different objects that you have been given and separate the objects into three classes based on their interactions with each other.

a. List the objects in each of your classes.

class 1 class 2 class 3

b. Fill out the table below describing the interaction between members of the same and different classes.

	Class 1	Class 2	Class 3
Class 1			
Class 2			
Class 3			

c. Are all metals in the same class?

Equipment:

1 permanent magnet
1 set of materials for observing interactions between different type of objects
3 unlabeled magnets
1 pithball

1 paper clip on string
1 styrofoam cup covered with aluminum foil

2.1 Obtain a permanent magnet and an object that is attracted to the magnet but not repelled. Imagine that you do not know which object is the magnet. Using only these two objects, find a way to determine which object is the permanent magnet.

The parts of a permanent magnet that interact most strongly with other materials are called the *poles* of the magnets.

2.2

a. How many different types of poles do you have evidence for so far? Explain.

b. Obtain three unlabeled magnets and find a consistent way to label the poles.

2.3

a. Describe how an uncharged pith ball suspended from a string can be used to test whether an object is charged.

b. Predict what will happen when an uncharged pith ball is brought near one of the poles of the magnet. Explain.

c. Obtain a pith ball and test your prediction in part **b**.

d. Suspend a paper clip from a string inside a Styrofoam cup surrounded by aluminum foil. Predict what will happen to the paperclip when a charged rod is brought near the cup.

e. Predict what will happen when one of the poles is brought near the cup? Explain.

f. Test your predictions in parts **d** and **e**.

g. Based on your observations in part **c**, **d**, and **e**, are the poles of a magnet the same as net positive and net negative charge? Explain.

Discuss your observations and reasoning with an instructor.

Materials that appear to have two different kinds of pole and exhibit attraction and repulsion in interactions with other materials are called magnets. Materials that only exhibit attraction with other materials are called ferromagnets. Materials that do not interact with other materials are non magnetic.

Equipment:

Necessary materials

3.1

a. Devise a method to determine the strength of a magnet.

b. Obtain materials and test your method.

Discuss your method with an instructor.

Equipment:
6 permanent magnets
6 small compasses
string

5.1 Hang bar magnets, labeled with your labeling system in part **2.2.b** from different parts of the ceiling (spread them out), free to rotate.

a. After the magnets have stopped rotating, observe the direction each of the magnets are pointing.

b. Place compasses near a bar magnet. Observe the direction of the compasses in different positions. To which category in Section **1.1** do compasses belong? Explain.

c. Place compasses far away from any known magnets (including other compasses). Observe the direction that the compasses point.

It is common to label the end of a magnet which points towards the Earth's geographic north pole as the north pole of the magnet. (This is a convention.) Label your magnets this way.

If you were to hang magnets all over the Earth, you would find that the Earth acts like a magnet with north and south poles.

d. Based on your observations in parts **a** above, is the north pole of the Earth's magnet in the northern or southern hemisphere? Explain.

SUMMARY

You should to be able to class materials or objects as magnetic, ferromagnetic or non-magnetic and understand how different classes of materials interact with each other. You should understand how magnets interact with charged objects and how magnetic poles are different from positive and negative charges. You should be able to develop a method to measure the strength of a magnet. You should understand how a compass works. You should understand the Earth as a magnet.