

## **Activity: Magnets and Magnetic Fields** (11/2/15) (approx. completion time: 1 hr. 15 min.)

### ***Introduction***

In this activity you will investigate the properties of permanent magnets, the magnetic fields they produce and the forces between magnets and other objects.

### ***Equipment***

- Two permanent bar magnets
- Set of 6 to 8 small ceramic (non-conducting!) magnets.
- Horseshoe magnets
- Objects of conducting material: iron, steel, copper, aluminum, or similar.
- Objects of insulating material: glass, plastic, ceramic, or similar.
- Compasses
- String with loops on ends & masking tape
- Iron filings in liquid, in sealed transparent containers
- String with loops on ends

### **1. Permanent Magnets and Forces**

***Equipment:*** bar magnets, conducting and insulating objects.

Permanent magnets interact with each other as well as other objects. Begin with at least two permanent magnets (with poles labeled “N” and “S”) and other objects from the list above. (Metal objects should include at least iron, copper and aluminum. Insulators can be glass, plastic, wood, ceramic, etc.) Systematically investigate the interaction between the magnets and the other objects.

What happens when you bring “unlike” ends of the magnets together?

What happens when you bring “like” ends of the magnets together?

Compare the magnets to an electric dipole.

Describe the interactions of the magnets with conducting materials. Is the interaction with different ends of the magnet the same or different?

Describe the interactions of the magnets with the insulating materials.

How does the magnetic “behavior” of the materials compare to their electrical properties?

Is the comparison simple (i.e. always the same rule)?

## **2. Magnet Orientation**

**Equipment:** two magnets, string with loop, compass

Now you will investigate how a magnet orients itself in space relative to another magnet. Push one end of the string thru the loop on the other end to form a new loop. Place the new loop around the center of a bar magnet and secure it by pulling the new loop tight. Suspend the magnet. Bring a second magnet near and move it around to observe the effect.

Describe the effect:

Does the effect vary with distance?

Next place a compass on the table and observe the effect of bringing a magnet near it. Move the magnet around.

What do you think the compass needle is made of?

Which end of the compass needle points to the south pole of the bar magnet?

If Earth is considered to be a giant magnet with north and south magnetic poles, which of Earth's magnetic poles is near the geographic North Pole?

## **3. Magnetic Field Lines**

**Equipment:** Bar magnets, "horseshoe" magnet", iron filings in liquid, sealed in a flat, plastic container.

If the filings are mostly clumped together, hold the container in the vertical plane and keep re-orienting it until you get a more even distribution. Place a permanent bar magnet on the desk, beneath the container. The needle-shaped iron filings should align themselves along the magnetic field lines so you can visualize the magnetic field around the magnet. (Note: The magnetic field itself is smooth, not made of "field lines". The lines you see are simply the result of the iron filings aligning themselves with each other end to end.)

Lift the container and remove the magnet. Sketch the observed magnetic field lines:

Compare your sketch to the electric field lines around an electric dipole. (Look in your text or on the internet for an illustration of an electric dipole field if necessary.)

How are they similar?

If they differ, how so?

On the next page, repeat the sketching part (above), but using a "horseshoe" magnet.

#### **4. Breaking Apart a Magnet**

**Equipment:** Six to eight small ceramic disc (or rectangular) magnets, two bar magnets, pieces of iron or steel.

Investigate the small ceramic magnets.

- a) Does each appear to have both a “North” and a “South” pole? Explain how your observations reveal this.

Assemble the magnets into a stack. Investigate the behavior of the stack of magnets compared to the single bar magnet.

- b) How does the stack behave compared to a single bar magnet? Does it have a “North” and “South” pole?

Now divide your magnets into two smaller stacks. Investigate their behavior.

- c) How does each small stack behave compared to either the larger stack or the single magnet?

- d) Is the behavior of a single disc magnet by itself the same as the behavior of a disc when it is in the center of a stack? If not, how does it differ?

Pull the stacks completely apart again.

- e) Speculate on what might happen if you continued to divide the magnets in half. (If available, use pieces of broken bar magnets to test your speculation.)