**VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE**

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**Magnetism**

**Spring 2016**

**Goal:**

**Fits Tn State standards**

Materials

8 3-D Magnetic field viewers

1. bags containing labeled vials of nickel, cobalt, zinc and iron

4 pieces of magnetite (lodestone)

30 observation sheets

30 Magnetic wands labelled N & S

15 jars containing twist tie, paper clip, soda bottle cap, copper wire, steel washer, aluminum foil, penny, nickel, rubber band, steel nail, zinc (white colored) nail

15 plastic bags containing squares of paper, cardboard, plastic, aluminum, steel, wood, jar of water, 1 paper clip

15 large plastic plates

1 empty soup can and 1 empty soda pop can

15 bags containing 8 paper clips

15 paper clips with 12 inch piece of thread tied to it

1. roll tape
2. Petri dishes containing white paper in bottom
3. plastic bags containing different shaped magnets – round, round with hole,

4 ferrofluid tubes

8 sets of ring magnets

**1. Background Information**

* Man has been fascinated by magnetic properties since 600 B.C. (One story tells of a Greek shepherd boy called Magnes who discovered that the iron tip on his staff was mysteriously attracted to a rock.) This rock was a naturally occurring magnetic rock called lodestone.

Show students a piece of magnetite, and show them that a small magnet is attracted to it.

* The mariners compass was the first important magnetic device. It is thought to have come from the Chinese, who had discovered that a free-hanging magnet always pointed in the same N/S direction.
* There are 4 types of magnets. The most common ones are made from an alloy called alnico (Al, Ni, Co). Others are Ceramic (strontium ferrite), Samarium Cobalt, and Neodymium.
* Uses for magnets: Ask students some everyday uses for magnets.

Magnets are everywhere – they help seal refrigerator doors tight, compasses, used in the production of electricity, Car ignition, ….

Ask students:

**"Why do Magnets stick to the refrigerator?"**

Magnets attract other magnetic materials. The most common magnetic metal is iron. You don't see too many products made of pure iron but you do see a lot of products made of steel. Since steel has a lot of iron in it, steel is attracted to a magnet.

**“How are magnets made?”**

The most common magnetic materials are the metals iron, cobalt, and nickel or combinations of these with other materials. To make any of these substances into magnets, the material to be magnetized is placed into a device called a magnetizer. The magnetizer has a powerful electric current traveling through coils of wire. The electricity of the magnetizer creates a strong magnetic field, which magnetizes the material.

**"What do you know about magnets and magnetism?"**

Magnets have north and south poles.

The south poles on 2 magnets will repel each other.

The north poles on 2 magnets will repel each other.

The north and south pole on 2 magnets will attract each other. This attraction and repulsion is called **magnetism**.

**II.** What Materials Will Magnets Attract?

Materials: 13 bags containing labeled vials of nickel, cobalt, zinc and iron

 26 Magnetic wands

 13 jars containing twist tie, paper clip, soda cap, copper wire, aluminum wire, steel washer, aluminum foil, penny, nickel, rubber band, steel nail, zinc nail (white color)

 13 large plastic plates

**Demonstration:**

Why will a magnet pick up a soup can and not a soda pop can? (Demonstrate this to students.)

**Magnets will only pick up objects if they contain a particular metal – iron, cobalt, or nickel (and their alloys).**

Soda pop cans are made from aluminum, soup cans contain iron.

Divide students into pairs. Give each **pair** 2 magnet wands, 1 set of vials, 1 plate, and 1 jar of materials.

**Activity:**

Tell students to take out the vials in the plastic bag.

Tell them that these vials contain examples of 4 metals.

Three of the metals (**iron, cobalt, nickel)** are attracted to the magnet - these 3 elements are called **ferromagnetic** (which means they are attracted to a magnet).

Tell students to place the magnet next to the vial and try to move the metal pieces around. The zinc metal cannot be moved.

 Most everyday materials attracted to a magnet contain iron.

 **Collect the vials.**

**Activity:**

Tell students to:

1. Pour the materials from the jars onto the plate and test each item to determine if it is magnetic. It is magnetic if it is attracted to, and sticks to the magnetic wand.
2. Separate the magnetic items from the non-magnetic ones into 2 groups (on either side of the plate).
3. Record the results by placing a check beside the name of each item if it is magnetic. Young students may need help identifying the items and their names. OR, VSVS members will record the results on the board.
4. Ask them if they can identify anything the magnetic items have in common?
* All the items are metallic and contain iron.
* Point out that there are several other metals that are not magnetic (copper, aluminum, zinc)

Tell students to put all materials back into the jar, and to keep the magnetic wand for the next experiment.

**Collect all jars.**

**Discussion:**

* Why is a nickel coin NOT attracted to a magnet?
* There is not enough nickel in the coin for it to be magnetic. It is now made from 75% copper and 25% nickel. On the other hand, most Canadian coins (but not pennies) are attracted to a magnet because they contain nickel.
* Are any American coins magnetic?
* No, except for 1943 US pennies.
* British coins are made from magnetic material.
* Soda machines in the US detect fake coins (such as washers, Canadian coins) by testing them to see if the item is magnetic and reject any that are.
* US dollar bills have magnetic ink to prevent counterfeiting.

**III. What Can Magnetism Travel Through?**

Materials: 15 Magnetic wands

 30 observation sheets

15 plastic bags containing squares of paper, cardboard, plastic, aluminum, steel, wood, jar of water, 1 paper clip

1. Tell students to place the paper clip in the black rectangle at the left hand side of the ruler on the observation sheet.
2. Hold the magnetic wand at the other end of the ruler. The wand is oriented so that a flat surface is vertical (see picture on observation sheet).
3. SLOWLY move the magnet towards the paper clip and stop as soon as the clip moves and sticks to the magnet.
4. Mark the position that the magnet was moved to.
5. Repeat steps 1-4 to make sure that the position is correct.
6. Hold one item at a time on the marked position. The item is held vertically so that it represents a “barrier” to the magnetic field from the magnet.
7. Repeat steps 1-4 to test if the “barrier” prevents the paper clip from being attracted to the magnet.

Only one item will prevent the magnetic field from reaching the paper clip– the iron

square. The iron does not block the magnetic field, but redirects it so that it does not

reach the paper clip.

Tell students to place all materials into their plastic bag ( VSVSers will collect them).

**IV. Finding the Poles of a Magnet.**

Materials 30 labeled wand magnets

Tell students to:

1. Look at the magnets and find the labeled north (N) and south (S) poles.
2. Hold the magnets so that the “N”’s are facing each other.
3. Tell the pair to move the magnets towards each other. What happens?
4. Have 1 partner turn the second bar magnet around (180 degrees) so that an “N” and “S” face each other, and move the 2 magnets towards each other. What happens?

Magnets have north and south poles.

The south poles on 2 magnets will repel each other.

The north poles on 2 magnets will repel each other.

The north and south pole on 2 magnets will attract each other.

Opposites attract, like repels. You can now find the poles on any unmarked magnet.

**VI. How Strong Is The Attraction or Repulsion in a Magnet?**

Materials:

Magnetic wand

several paper clips

**Test how many paper clips a magnet will hold**.

1. Place the first paper clip on one end of the magnet. This paper clip is now magnetic (by induction)
2. Add a second paper clip to the bottom of the 1st clip.
3. Try adding a 3rd and 4th.
4. Does gravity always win after same number paper clips?

**How Strong is Repulsion?**

Materials:

8 sets of ring magnets

24 washers (4 per group)

Look at ring magnets on rod.

1. Place 2 magnets on rod so that they repel each other
2. Measure distance between magnets
3. Put washers on top of magnet (slide onto rod) until magnets touch. Record the # of washers.

**What Is Stronger - Magnetic Attraction Or Gravity?**

1. Tape free end of thread and paper clip to table.
2. Hold paper clip up in air and bring magnet to within ½ inch above it.
3. Let go clip.
4. What happens?
5. Move magnet back and forth and up.
6. How far can the magnet be moved before the paper clip falls?

**V. Seeing the Magnetic Field**

A magnetic field is the area around magnet where the magnetic force acts.

What does the magnetic field look like for the different shapes?

Where is the magnetic force the strongest? Weakest?

Materials: **3d magnetic field generator**

1. Put the magnet in the slot in the plastic.
2. Gently shake the plastic container around so that all the iron particles interact with the magnet.
3. This represents what the magnetic field of that magnet looks like.

Materials: 15 Petri dishes containing white paper in bottom

15 bar magnets

15 plastic bags containing different shaped magnets – round, round with hole,

1. Place a bar magnet on table.
2. Place the petri dish on top of the magnet so that the magnet is in the center.
3. Slowly shake the iron filings over the paper until you can see a pattern.
4. Look at the shape of the pattern the filings form around the bar magnet.
5. Repeat for the different shaped magnets.
6. Return ALL materials to VSVS member.

**Activity 5 Ferrofluids**

1. *Ask students what a typical magnet looks like.*
2. Show them the simple illustration of the magnets, and explain that permanent magnets have a North and South Pole (N & S), and the magnetic force lines of produced by the invisible magnetic field travel from the north pole of a permanent magnet to the south pole:



1. Have students hold the ferrofluid display cell and magnets as seen below:

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1. *Emphasize that in the presence of the magnet, the material behaves more like a solid, and let them play with the display cell to see that what seems like a fluid can in fact be guided around the tube with a magnet.*
2. Have students flip the magnet around and notice the different shape of the ferrofluid when the magnetic lines of force are parallel to it.

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**Finding the north and south poles in magnets**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Place magnet # here**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Place magnet # 2 here**

Place magnetic wand here.

**What materials can “block” magnetic fields?**

Place paper clip in rectangle