Berkeley Engineers and Mentors

Lesson Plan: Compasses and Magnetism
Lesson type: Module
Author: Anika Singh

Lesson Overview: In this lesson, students will use household objects to build a compass and explore the phenomenon of magnetism. Through this lesson plan students will gain a better understanding of magnetism as a material property as well as the role of magnetism in navigation.

Teaching Goals

- What is a magnet? What is a magnetic field?
- How do magnets behave with different materials and with each other? What is ferromagnetism?
- For high school: Discuss ways that magnetic fields can be created

Agenda

- Do a 5 minute intro of magnets and magnetism (explain what these concepts are, draw diagrams etc)
- Module 1: Magnets, Pennies and Nails => Students will experiment with magnets and various materials that are present in the classroom as well as materials provided by mentors. They will observe how certain objects are attracted to the magnet will others are not. Give students 5 minutes to play with magnets to see how they behave. This module will also introduce students to the concept of ferromagnetism.
- Module 2: Levitating Paper Clip => Students will use a magnet to make it appear that a paper clip attached to a string can levitate. This module can be used to introduce students to the idea of magnetism and how it is an inherent property of certain materials (particularly metals)
    - 10 minutes to build
    - 5 minutes to discuss observations
- Module 3: Make your own compass => Using a needle, magnet and bowl of water students will make their own compass. Through this experiment mentor and mentees can not only discuss magnetism but also the earth's magnetic field and how compasses can be used for navigation.
    - 10 minutes to discuss
    - 5 minutes to build

Module #1: Magnets, Pennies and Nails

Introduction: In this module students will use magnets and various household objects to demonstrate the idea of magnetism and how certain materials are attracted to a magnet while others are not. Students will also get a chance to play with two magnets and see how magnets behave with one another.

Materials (amount per group)

- 2 magnets
- penny
- iron nail
- assortment of other materials readily available in classroom (chalkboard, desks, chairs etc)

Teaching material: In this experiments will observe how certain objects are attracted to the magnet will other are not. They will also observe the polar nature of magnets and how this affects how magnets behave with one another. Most objects that are affected by an magnetic field are metal; however there are some metals that are not magnetic. The iron nail will be attracted to the magnet while the copper coated penny will not be. Iron is a ferromagnetic material meaning that in a certain domain all of the molecules line up and point and have the same directionality. This occurs in the presence of an external magnetic field. This creates the attraction between the iron nail and a magnet. *To explain this to the kids:*

- tell them about the molecules in the iron nail
- describe how each molecule is polar (has a negative and positive pole)
- Usually there is no organizational pattern for these molecules; however in the presence of the magnetic field produced by a magnet, these molecules will align in the same direction creating a polar attraction between the magnet and iron nail.

* Copper does not have this ferromagnetic property and so is not attracted to the magnet.

Procedures

- Give students magnets, iron nail and penny
- Ask them to test whether the objects are attracted to the magnet or not
- Also test what happens when two magnets are brought close together
- discuss results
- Let students also test out different materials in the room (i.e. chair and table legs, chalkboard etc)

Module #2: Levitating Paper Clip

***Introduction*:** In this module students will use a cup, string and magnet to make a paper clip levitate. Through this activity they will learn about magnetism and how magnets interact differently with various materials.

Materials (amount per group)

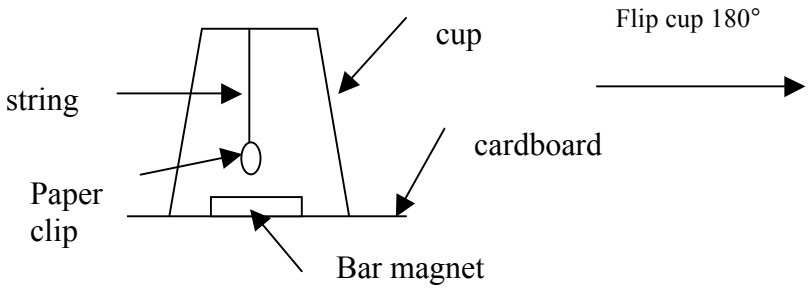
- 1 Paper clip
- 1 String (approximately same length as height of cup)

- 1 Cup (transparent)
- 1 piece of cardboard
- 1 magnet
- Scissors (1 per site)

Teaching material: Magnets have a north and south pole. Opposites poles of a magnet are attracted to one another while like poles of a magnet repel each other. Magnets are able to attract object such as an iron nail at a distance because magnets create their own magnetic field that extends around them. This is what allows the magnet to be attracted to the paper clip and make it look like it is levitating.

Procedure

1. tape one end of string to the paper clip and attach other end to the inside bottom of the cup
2. attach magnet to piece of cardboard
3. place this piece of cardboard over the opening of the cup with the magnet inside the cup
4. turn the cup upside down letting the paper clip hang from the string
5. slowly turn the cup right side up and observe what happens to the paper clip



<u>Module #3: Make your own Compass</u>

Introduction: In this module, students will use a sewing needle, bowl of water and a magnet to create their own compass. They will be able to see how the earth's magnetic field affects the direction that the needle is pointing and how the needle will always point north. They can then compare the behavior of there own compass to the behavior of a store-bought compass.

Materials (amount per group)

- 1 bar magnet
- 1 sewing needle
- 1 bowl
- water
- wax paper (1 piece)
- scissors (1 per site)
- 1 regular compass

Teaching Material: The earth creates it own magnetic field. For this reason it can attract objects from a distance. (discussed in previous module). By rubbing the sewing needle with a bar

magnet we are able to magnetize the needle. This is possible because of the physical properties of the needle. (ferromagnetic) When the magnetic field created by the needle interacts with the magnetic field created by earth there is an attraction between the south pole of the needle and the magnetic north pole of the earth. This is what causes the compass to always point north.

Procedure

1. Take the "North" side of your bar magnet and place it perpendicular to your needle. Starting at the top of the needle, slide the side of the bar magnet along the length of the needle. Do not slide back and forth, but rather slide from one end to the other. Stop and start back at the end you began with. Repeat *several* times (like fifty).
2. Turn the needle upside down and use the opposite end of the magnet and repeat the same process until the needle is magnetized.
3. Thread the needle through a circular piece of wax paper. (mentors need to cut circle pieces of wax paper first)
4. Place the needle in a bowl filled with water and observe what happens.
5. Compare the behavior the your home-made compass to that of a regular compass

Summary of Materials

Material	Amount Per Group	Cost	Vendor
iron nail	1	??	ACE Hardware
pennies	1	??	Site mentors can provide this
Magnet (bar magnet)	2	??	Still looking for a good place to buy these
Paper clips	1	??	Office supply store
String (long as the height of the cup)	1	??	BEAM already has this??
Clear plastic cups	1	??	BEAM already has some of these??
Tape	1 roll per site	N/A	BEAM
Piece of cardboard (big enough to fit over the opening of the cup)	1		Site leader will provide this or BEAM
scissors	1 per site	N/A	Site leader or BEAM
Sewing needle	1	??	Walgreens??
bowl	1	??	BEAM already has this??
Wax paper	1 roll per site	??	Grocery store
water		N/A	Site leader brings or get at site
compass	1	??	Looking at options