Names:_____ Date: _____

Module 3C: Make a Magnetometer Lab Sheet

Overview

Solar activity can affect the Earth's magnetic field causing small changes in its direction at Earth's surface, which are called magnetic storms. A magnetometer operates like a sensitive compass and can sense slight changes in the magnetic field that surrounds our planet. Your team will build a simple magnetometer to measure changes in Earth's magnetosphere (magnetic field) over a 7-10 day period of time by following the directions below.

This activity is adapted from National Geographic Education - Build a Magnetometer:
http://education.nationalgeographic.com/education/activity/build-a-magnetometer/?ar_a=4

IMPORTANT SAFETY TIP: **DO NOT** point the laser pointer at other students' or at your own eyes. Lasers can cause permanent damage to the retina of the eye.

Materials:

- Quart size jar or 2L plastic bottle
- Sand (about ½ pound/500g)
- Index card (3"x5")
- Scissors
- Small bar magnet (about 2.5cm x 0.7cm)
- Small round craft mirror or large sequin
- Straw
- Low-melt glue or Super Glue
- Thread
- Clear packing tape
- Meter stick
- Metric ruler
- Laser pointer OR adjustable gooseneck desk lamp with clear bulb
- Nail & hammer
- Large sheet white paper
- Pencil

Procedure:

1. Refer to the magnetometer model and illustrated instructions when building your magnetometer.

2. Remove labels, clean, and dry a quart size jar or 2L plastic bottle. If using a 2L bottle, use scissors to carefully cut around the circumference of the bottle about ¼ of the distance below the bend in the neck of the bottle.

3. Review Diagram A “Magnetometer” details. Fill the bottom of the jar or bottle with enough sand to cover and stabilze it.

4. Use the nail and hammer to pierce a small hole in the center of the jar or bottle lid. It should be just large enough to allow you to pass the thread through.

5. Measure the diameter of the jar and subtract 4 centimeters to determine the length of the card to ensure the card will not touch the sides of the jar or bottle. Measure and cut the index card so that it will fit inside the jar without touching the sides.

6. With a ruler, draw diagonal pencil lines from corner to corner on the front of the index card. The intersection of the lines marks the center of the index card. Glue the craft mirror in the center of the index card.

7. Glue the magnet so that it is centered along the top edge of the front side of the index card.

8. Review Diagram B “Magnetometer Sensor Card” details. Measure and cut a 2.5cm section of a plastic straw and glue the straw to the top of the magnet, not the front of the magnet. The straw is your guide for the string to keep your magnet and mirror in a level position.

9. Run the thread through the straw and tie into a triangle with two 5cm sides. Run the other end of the thread through the lid of the jar. Make sure the “Magnetometer Sensor Card” hangs freely inside the jar or bottle. Tape or glue the thread securely to the outside of the lid so that the thread does not slip or move down, which ensures your data will be accurate. If you use a 2L plastic bottle, tape the top and bottom bottle sections together with clear packing tape and adjust the thread so that the “Sensor Card” is free to swing with the round mirror situated below the bottle’s cut seam. Tape or glue the string in place on the outside of the bottle cap.

10. Review Diagram C “Magnetometer Station Set-Up” details. Place the magnetometer on a flat surface, where it will not be disturbed or moved. After the magnet aligns North-South, shine the laser pointer so that a reflected spot shows on a nearby wall about 2 meters (6 feet) away. Tape a large piece of white paper on the wall with the reflected spot centered in the paper (DO NOT look directly at the laser, ever!) and leave this paper up for the duration of your investigation. Use a pencil to mark the point where the light is reflected on the paper and write the date and time below the mark. This point is your reference point for future measurements, but it isn’t necessary to record this point on your data sheet. NOTE: If you don’t have a laser pointer, use a gooseneck lamp with a clear light bulb instead.

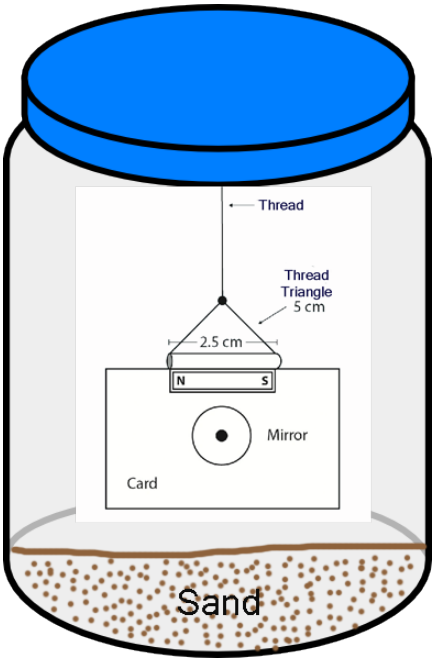
11. The magnetometer is sensitive to changes in the Earth’s magnetic field. When magnetic solar storms affect Earth’s magnetosphere, you will see the reflection point change by several cm/degrees within a few hours from the initial reference point location and then return back to its original orientation, which normally points towards the magnetic north pole.

12. For each subsequent measurement, use the laser pointer or desk lamp to shine a reflected spot onto the white paper taped on the wall. Mark the reflected spot’s location onto the paper and write the date and time the measurement was taken below the mark. Use a ruler to measure the change from the original reference spot position to the current reflected spot position. Measure this distance in cm (0.0 cm) and record the measurement in the “Measured Change in Reflection” column on your data table.

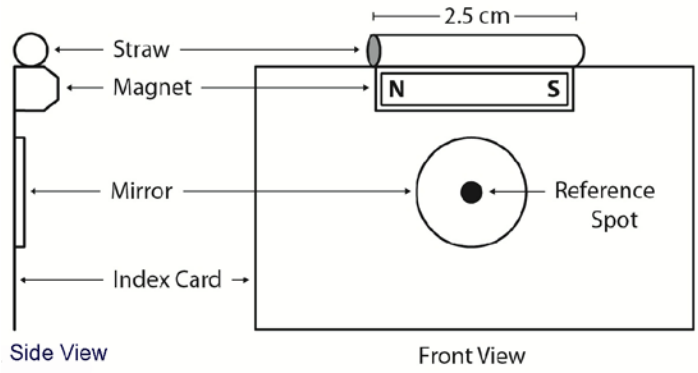
13. Convert the “Measured Change in Reflection” measurement to “Degrees of Deflection” by multiplying each cm of distance changed by 0.25 degrees (i.e. 2.7cm of distance changed multiplied by 0.25 degrees equals 0.675 degrees of deflection). Record this measurement in the “Degrees of Deflection” column on your data table. This calculates the shift in Earth’s magnetic field that is caused by magnetic solar storms affecting Earth’s magnetosphere.

14. Check your magnetometer 2-3 times a day for a period of 7-10 days and accurately measure and record a total of 15 measurements of Earth’s invisible magnetic field.

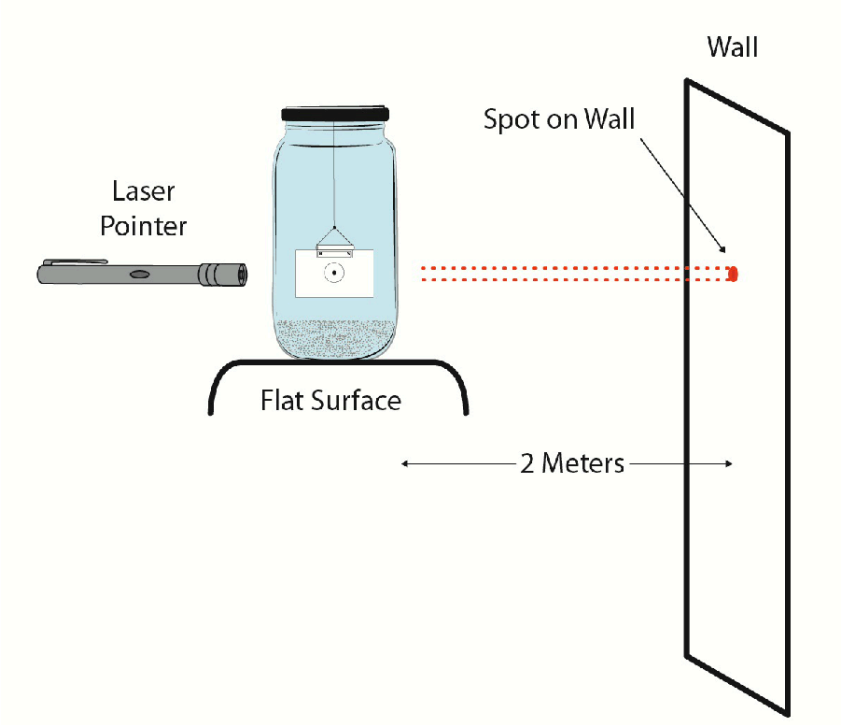
A) Magnetometer:



B) Magnetometer Sensor Card Detail:



C) Magnetometer Station Set Up:
(Magnet aligns N/S and jar is approx.1m above floor)



Magnetometer Data Collection: Part 1 Data Table

For each measurement, mark the new reflection point on the paper and write the date and time below it. Next, measure the distance from the original reference point to the new reflection mark in cm; record this in the "Measured Change in Reflection" column. Convert the "Measured Change in Reflection" measurement to "Degrees of Deflection" by multiplying each centimeter of "Measured Change" in reflection by 0.25 degrees. Take 2-3 measurements per day for 7-10 days. (This form can be copied for extra data).

Data Point	Date	Local Time (am/pm)	UTC	Measured Change in Reflection (0.0 cm)	Degrees of Deflection (0.00°)
1 Reference					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Magnetometer Data Collection: Part 2 Graph

After recording 15 measurements, plot the data from Part 1 on the graph below. The variables plotted include the “Collection Date” (independent variable on x-axis) and the “Degrees of Deflection” (dependent variable on y-axis). Evenly space and label the x-axis with the data collection dates. Evenly space and label the scale and units (degrees) for “Degrees of Deflection” on the y-axis. You can also choose to plot “Collection Date” vs. “Measured Change in Reflection” in cm. Accurately plot the data points and then connect the points to create a line graph, which represents changes in Earth’s magnetic field over time.

Changes in Earth’s Magnetic Field