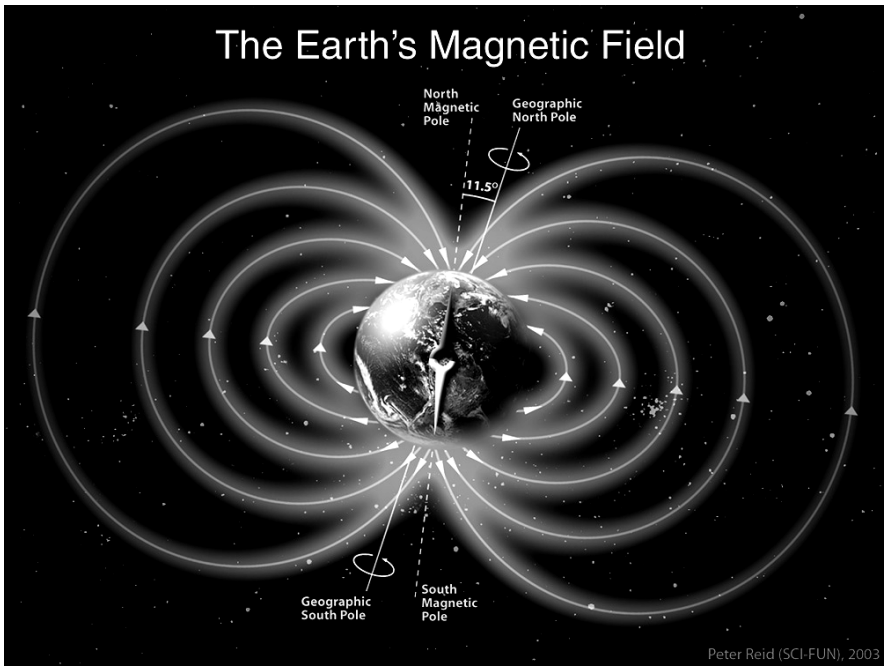
Name _____ Date _____ Partners_____

The Earth's Magnetic Field

The magnetic field of the Earth may have a more complex structure than you might think. For example, the magnetic field extends far out into space. This is a good thing, because it deflects most of the cosmic rays that otherwise might strike Earth. As shown in the figure below, the Earth's magnetic field doesn't just go from the geographic South Pole to the geographic North Pole. It goes in and out of the Earth. In this brief experiment we want to measure the magnitude of the Earth's magnetic field and find this inclination (or dip) angle of the Earth's magnetic field locally. The inclination angle is the angle between the field direction and the surface of the Earth. If the magnetic field is perpendicular to the Earth, the inclination or dip angle is 90^0. It varies from about 72^0 in Toronto to 64^0 in Atlanta, for example. Animals are believed to use the inclination angle for navigation.



Purpose: To observe the magnetic field of the Earth by measuring the inclination or dip angle the Earth's magnetic field makes with the horizontal (Earth's plane) at our location. To measure the magnitude of the Earth's magnetic field.

Materials:
CBL unit or Vernier Data Logger
TI-83 with Datamate or PHYSICS installed
Vernier magnetic field sensor (MG-DIN)
Magnetic compass
Protractor
Earth globe

Procedure:

Set-Up:

1. Connect CBL or Data Logger to calculator with unit to unit link cable. We will use the CBL.
2. Connect magnetic field sensor into CH 1 port on CBL or Data Logger.
3. Turn on both units.
4. Select PHYSICS from the "PRGM" menu on the calculator or DataMate from the "APPS" menu. Choose PHYSICS and press Enter until you come to the MAIN MENU screen.
5. Choose "SET UP PROBES" from the menu options.
6. Choose "ONE" for the number of probes.
7. Scroll through the probe options and select "MAGNETIC FIELD".
8. Choose "USE STORED" for the calibration.

9. Select "HIGH(MTESLA)" setting (here the M stands for milli) and make sure the switch on the sensor box is turned to high amplification. You will be measuring the magnetic field in units of millitesla (mT).
10. Hold the probe so the sensor (white oval near the end of the probe) is facing east or west. See Figure 1. Select "ZERO PROBES" from the Main Menu on the calculator to zero the probe, select "CHANNEL ONE" and follow the directions given by the program and trigger the CBL.

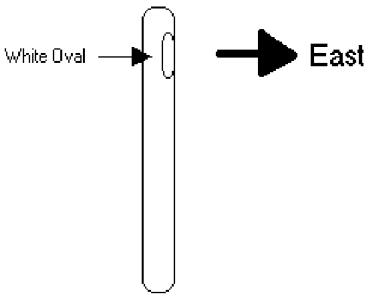


Figure 1

Question 1: Why do the directions say to point the sensor in the east direction to zero the magnetic field sensor?

Investigation: Angle of Dip and Magnitude of Earth's Magnetic Field

1. Hold the probe upright so that the sensor is facing North. See Figure 2. Avoid placing sensor near metal. Rotate the sensor back and forth slightly to maximize the signal.

2. In this step follow the set of directions for the program you are using.

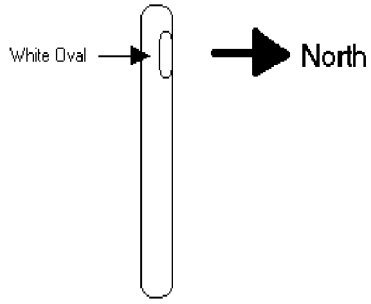


Figure 2

Data Mate: On the top right hand corner of the main screen there should be a continuously updating readout from the probe. Slowly dip the sensor to the floor. See Figure 3. You should notice a change in the magnetic field intensity. Adjust the probe to maximize the intensity. Have your partner measure this angle with a protractor. Record this value as the dip angle.

PHYSICS: From the main menu select "COLLECT DATA." On the following screen select "MONITOR INPUT." This should give a continuously updated readout from the probe. To be consistent read the data from the calculator rather than the CBL.

3. Place the sensor flush against the side of a notebook in line with north. Hold the sensor in one hand and the book in another. This will help considerably in a few moments when you are trying to measure the angle of the sensor. Trace the line of the sensor while it is completely vertical. Slowly dip the sensor to the floor. See Figure 3. The white oval on the sensor should always be pointing north. You should notice a change in the magnetic field intensity. Adjust the probe to maximize the intensity. Have your partner trace the line of the sensor on your notebook paper. Record the

maximum intensity found by the sensor. Set the sensor aside and measure the angle you marked with a protractor. Record this value as the dip angle.

Maximum Intensity:_____mT

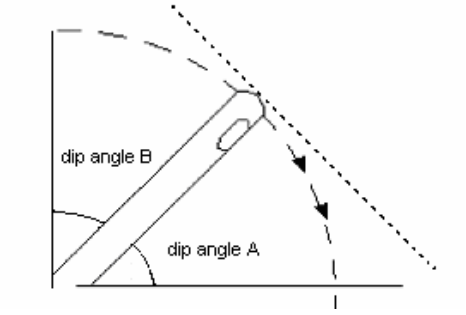


Figure 3

Question 2: What exactly is the dip angle measuring? In Figure 3, which angle is correctly marked as the dip angle: dip angle A or dip angle B? Explain.

4. Determine your current latitude in degrees from a globe. Compare this angle to your measured angle of dip.

Latitude:_____ Angle of Dip:_____

Question 3: How do the values compare? What relationship would you expect between the latitude and dip angle? Is the relationship that you found a mathematical link or just a correlation?

Question 4: Compare your maximum intensity value for the magnetic field to the known value of the Earth's magnetic field in Charlottesville (52.4 μT). How do they compare? Describe possible errors that could have lead to the value being incorrect.
See http://www.ngdc.noaa.gov/seg/geomag/jsp/struts/calcPointIGRF for values.