MATERIALS

LabPro interface
Palm handheld
Data Pro program
Vernier Magnetic Field Sensor
protractor
ruler
degree wheel
pointer
tape

PROCEDURE

Part I Finding Magnetic North

1. Tape the pointer on top of the white dot of the magnetic Field Sensor and bend it so that it is perpendicular to the sensor as shown in Figure 1.

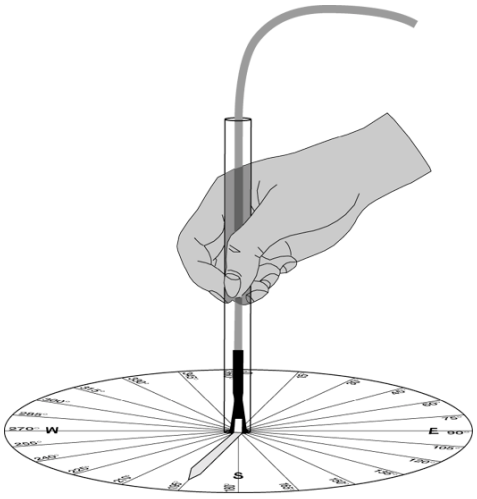


Figure 1

2. Plug the Magnetic Field Sensor into Channel 1 of the LabPro interface. Connect the handheld to the LabPro using the interface cable. Firmly press in the cable ends. Set the switch on the sensor to the HIGH x 200 amplification setting.

3. Press the power button on the handheld to turn it on. To start Data Pro, tap the Data Pro icon on the Applications screen. Choose New from the Data Pro menu or tap (New) to reset the program.

4. Set up the handheld and interface for the Magnetic Field Sensor.
   a. Tap [Setup].
   b. If the handheld displays MAGNET F(mT) in CH1, proceed directly to Step 5. If it does not, continue with this step to set up your sensor manually.
   c. Tap [CH1:] to select Channel 1.
   d. Choose MAGNETIC FIELD HI(mT) from the list of sensors.

5. Set up the handheld and interface for data collection.
   a. On the Setup screen, tap [Mode:], then choose Events with Entry.
   b. Enter the Event Label (Position) and Unit (deg). You can enter this information using the onscreen keyboard (tap "abc"), or by using the Graffiti writing area.
   c. Tap [OK] twice to return to the Main screen.

6. Place the tip of the Magnetic Field Sensor on the center of the degree wheel with the pointer pointing toward 0^o. Hold the sensor vertically.

7. Tap [Start] to begin data collection.

8. Measure the magnetic field at the zero degree position.
   a. When the magnetic field readings displayed on the screen stabilize, tap [Keep].
   b. Enter "0" (the position in degrees). Tap [Enter] to save this data pair.

9. Rotate the Magnetic Field Sensor so that the pointer points toward 15° and repeat Step 8 entering the current pointer position. Continue to repeat Step 8 until 360° is reached.

10. When data collection is complete, tap Stop to end data collection. Tap OK to display a graph of magnetic field strength *vs.* position.

11. To examine the data pairs on the displayed graph, tap ▶ or any data point. As you move the examine line, the magnetic field strength and position values of each data point are displayed to the right of the graph. Locate the point with the greatest magnetic field intensity. Record the corresponding direction in the Data table. This location is magnetic north.

12. Sketch or print a copy of the graph as directed by your teacher.

Part II Magnetic Inclination (Dip Angle)

13. Tap OK to return to the Main screen.

14. Place the tip of the Magnetic Field Sensor at the center of the degree wheel with the pointer pointing toward magnetic north. Make sure the sensor is held vertically.

15. Slowly tilt the sensor down in the direction of magnetic north. Monitor the magnetic field intensity at the top of the main screen. Continue to tilt until a maximum reading is displayed. Hold the sensor in that position.

16. Use a protractor to measure the angle between vertical and the Magnetic Field Sensor. This is the magnetic inclination for your location. Record this value in the data table.

DATA

Magnetic north direction (°)	
Magnetic inclination (°)	

PROCESSING THE DATA

1. The difference between the measured magnetic north and true north is called magnetic declination. What is the magnetic declination for your location? What modifications would be needed on a compass in your location to keep you on course when following a map?

2. How does the measured magnetic inclination compare with the accepted magnetic inclination for your location?

3. Scientists have found that the magnetic field of the Earth is continually changing. What would be the implications of a big change?

EXTENSION

1. Compare the magnetic declinations of various locations on your continent and discuss the adjustments needed on a compass at each location to stay on course.

2. Research current theories on why the magnetic north pole moves.

TEACHER INFORMATION

Where IS North?

1. The student pages with complete instructions for data collection using LabQuest App, Logger *Pro* (computers), EasyData or DataMate (calculators), and DataPro (Palm handhelds) can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. Make one copy of the degree wheel and pointer for each student group. Tape the circle to each group's work space with 0^{o} aligned with true north. True north can be located using a GPS or blue prints for your school. If these are not available, you can determine true north by using a compass to find magnetic north, then correct for the magnetic declination. If you don't know the magnetic declination at your location, it can be calculated at several locations on the Internet, including www.ngdc.noaa.gov/seg/potfld/java/GeoMag.shtml.

3. The Magnetic Field Sensor needs to remain vertical the entire time during Part I. Students should be careful to keep the sensor centered on the dot.

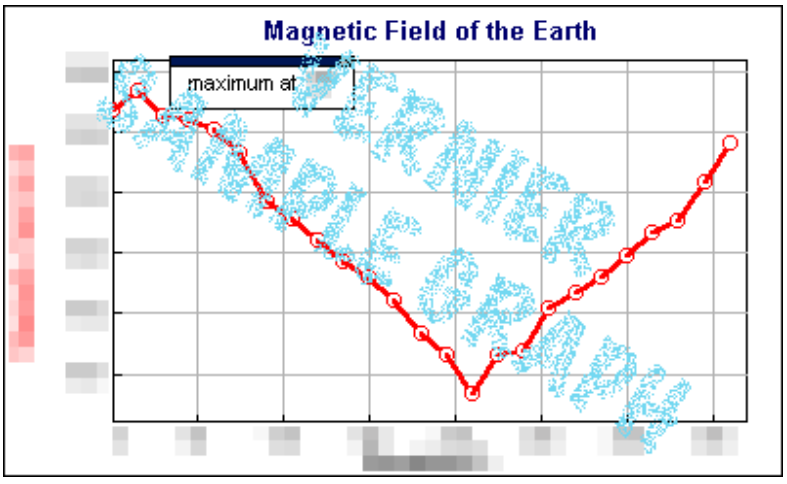
4. Readings may fluctuate due to deviation, the influence of the immediate environment upon your sensor, caused by things such as electrical currents, computer monitors, or metal brackets. Try to avoid these influences.

5. A paper protractor cut in half makes it easy to measure the magnetic inclination.

6. The magnetic inclination can be calculated using the length of the Magnetic Field Sensor and the distance from the top of the sensor to the table instead of measuring the angle directly.

7. The Magnetic Field Sensor does not need to be zeroed at any time during this experiment since you are looking for a peak reading location rather than the actual magnetic field intensity.

SAMPLE RESULTS



Magnetic north direction (^{o})	xx^o
Magnetic inclination (^{o})	xx^o

ANSWERS TO QUESTIONS

Answers have been removed from the online versions of Vernier curriculum material in order to prevent inappropriate student use. Graphs and data tables have also been obscured. Full answers and sample data are available in the print versions of these labs.