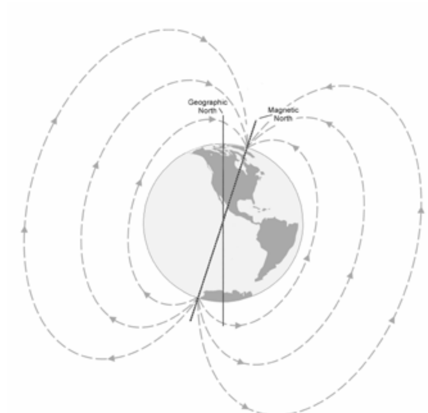
Where IS North?

It depends. Do you mean geographic north or magnetic north? The geographic (true) north pole is the point at 90° N latitude. It is aligned with the rotational axis of the Earth. The Earth is surrounded by a magnetic field with a north and south magnetic pole. The magnetic north pole is the point to which a compass needle points. It is currently in northern Canada, but moves at an average rate of 15 km per year due to complex fluid motion in the outer core of Earth. Depending on your location, the difference between magnetic north and geographic north, called *magnetic declination,* can range from 0° to 30°.

Similar to a bar magnet, the Earth is surrounded by 3-dimensional magnetic field lines. The field lines of the Earth start near the south pole, curve around in space and converge again near the north pole. A compass needle aligns itself along the direction of the magnetic field lines. *Magnetic inclination,* or dip angle, is the angle that the Earth's magnetic field makes with the horizontal plane at a specified location. Magnetic inclination is 0° at the magnetic equator and 90° at each of the magnetic poles.



Earth's magnetic field

The Earth's magnetic field is used by many animals to determine direction. Every location on Earth has its own unique combination of magnetic field intensity and inclination. The Loggerhead turtle detects magnetic field intensity and magnetic inclination and uses this information on its 10 year migration around the Atlantic Ocean. Many birds use both stars and the magnetic field of the Earth to navigate. The birds can detect magnetic inclination. Birds in the northern hemisphere follow a line of decreasing dip angle that guides them on their southerly migration path.

In Part I of this experiment, you will measure the magnetic field of the Earth. You will use this data to determine magnetic north. Knowing the direction of true north, you will calculate the magnetic declination at your location. In Part II you will measure the magnetic inclination of your location.

OBJECTIVES

In this experiment, you will

- Use a Magnetic Field Sensor to measure the magnetic field of the Earth.
- Calculate magnetic declination for your location.
- Measure the magnetic inclination of your location.

MATERIALS

TI-Nspire handheld **or**
computer and TI-Nspire software
data-collection interface
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.

2. Set the switch on the Magnetic Field Sensor to 0.3 mT (high amplification). Connect the Magnetic Field Sensor to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer.

3. Choose New Experiment from the Experiment menu. Choose Collection Mode ► Events with Entry from the Experiment menu. Enter **Position** as the Name and **deg** as the Units. Select OK.

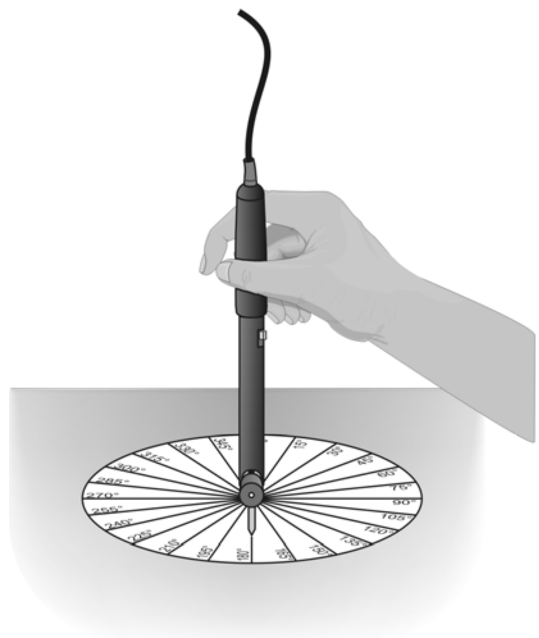


Figure 1

4. Place the tip of the Magnetic Field Sensor on the center of the degree wheel with the pointer pointing toward 0°. Hold the sensor vertically. When placing your sensor, avoid things such as electrical wires, computer monitors, or metal brackets as these can interfere with your sensor.

5. Start data collection ( ).

6. Measure the magnetic field at the zero degree position.
   a. When the magnetic field readings stabilize, click the Keep button ( ).
   b. Enter **0** (the position in degrees). Select OK to save this data pair.

7. Rotate the Magnetic Field Sensor so that the pointer points toward 15° and repeat Step 6 entering the current pointer position. Continue to repeat Step 6 until 360° is reached.

8. When you have reached 360°, stop data collection ( ).

9. To examine the data pairs on the displayed graph, click any data point. Use ► and ◄ to locate the point with the greatest magnetic field intensity. Record the corresponding direction in the data table. This location is magnetic north.

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

Part II Magnetic Inclination (Dip Angle)

11. Click the Meter View tab ( ).

12. 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.

13. Slowly tilt the sensor toward and away from the direction of magnetic north. Monitor the magnetic field intensity on the screen. Continue to adjust the tilt until a maximum reading is displayed. Hold the sensor in that position. See Figure 2.

14. 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.

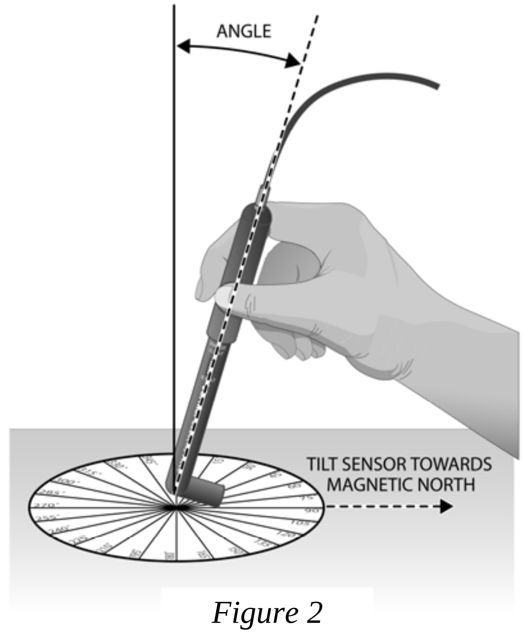


Figure 2

DATA

Magnetic north direction (°)	
Magnetic inclination (°)	

QUESTIONS

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?

EXTENSIONS

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.