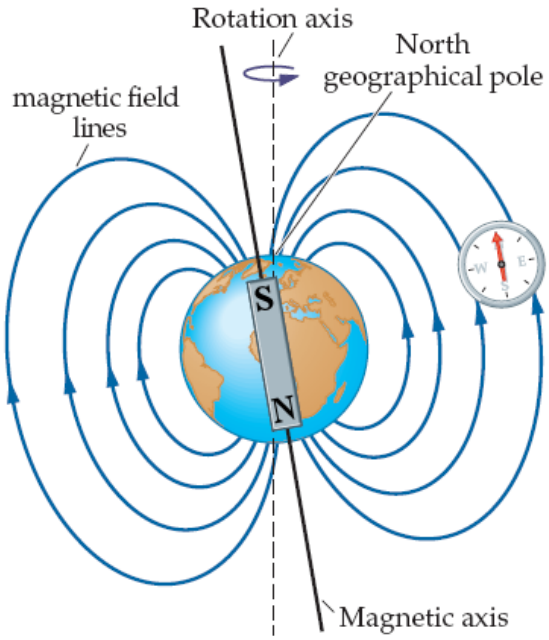
Name: _____ Section: _____ Date: _____

Worksheet - Exp 18: Earth's Magnetic Field

Objective: Measure the magnitude and direction of the Earth's magnetic field at this location.

Theory: The magnetic field of Earth resembles the field of a bar magnet. All magnetic field lines form a closed loop: a field line originates at the north pole of a magnet, enters the south pole, then moves through the magnet itself back to the north pole. Although we usually think of this field as two-dimensional (north, south, east, west), remember that it is, in fact, a three-dimensional vector field.

We will measure the horizontal component of Earth's magnetic field, $\vec{\mathbf{B}}_\mathbf{e}$, then use this information to determine the magnitude of the total magnetic field of Earth, $\vec{\mathbf{B}}_\mathbf{t}$.

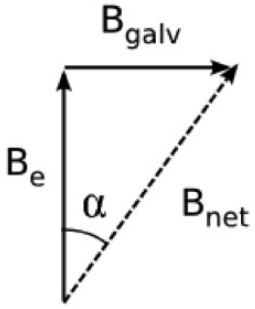


Procedure:

Part 1: Horizontal Component

1. Connect the galvanometer (N=5), ammeter (20A DCA), and power supply in series
2. Align the galvanometer such that it creates a magnetic field perpendicular to that of Earth's field (the compass needle should be parallel to the wire loop). Do not move the galvanometer while taking data.
3. Turn on the power supply to flow current through the galvanometer. Adjust the current until the compass needle on the galvanometer moves by 30°, 40°, and 50°, record the current required for each angular position in the data table provided.
4. Repeat this process for $N = 10$ and $N = 15$ (a total of nine trials). What happens to the current required as N increases? Is this a linear relationship? (8 pts)

5. Calculate B_e for each of the nine trials. The galvanometer generates a magnetic field whose strength depends on current, number of loops, and loop radius as follows: $B_{galv} = \mu_0 IN/2r$. The <u>diameter</u> of the coils is approximately 20 cm. [$\mu_0 = 4\pi \times 10^{-7}$ Tm/A]



	$\alpha = 30°$	$\alpha = 40°$	$\alpha = 50°$
N = 5	I: B_e:	I: B_e:	I: B_e:
N = 10	I: B_e:	I: B_e:	I: B_e:
N = 15	I: B_e:	I: B_e:	I: B_e:

(54 pts)

6. Find the average value of B_e from your nine trials. (4 pts) Average B_e = _____

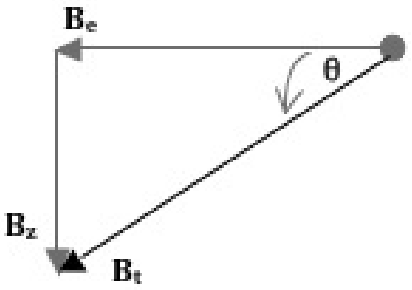
7. Beatrice aligned her galvanometer 90° off, so that its field was in line with (or against) Earth's own field. As she increased current, the needle remained stationary until it suddenly changed direction at one amount of current. How did the needle behave at this particular current? What can Beatrice conclude about the strength of B_{galv} at the instant when the needle moves? Draw a sketch of this setup. (14 pts)

Part 2: Field Inclination

8. magnetic inclination is the angle made with the horizontal by the Earth's magnetic field lines. In Oxford MS, the angle of magnetic inclination is approximately 63°.

9. Use this inclination to calculate the magnitude of the total magnetic field of the Earth in the lab. (4 pts)

   $B_t =$ _____



10. Compare your measured B_t from this experiment to a sample value of 43 μT, the magnitude of the magnetic field in Tucson, Arizona. (6 pts)

11. Tucson is approximately two degrees (latitude) south of this lab. Would the inclination of Earth's magnetic field be greater or lesser than it is here? How do you know? (8 pts)