Experiment: 12

DETERMINATION OF MAGNETIC FIELD INTENSITY

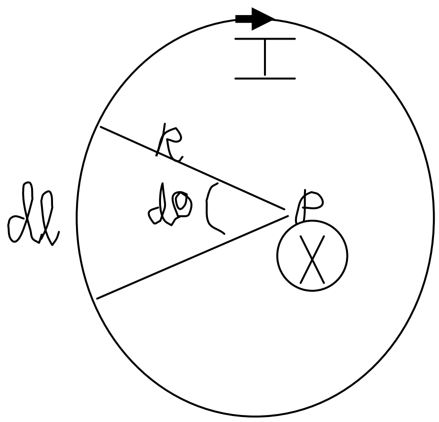
AIM: a) To determine Magnetic field Intensity at the centre of a circular coil carrying current using deflection method.

b) To determine Radius of the circular coil

APPARATUS: Circular coil, Power supply, Switching keys, Magnetic needle, Sliding compass box

INTRODUCTION:

Magnetic field Intensity at any point on the axis of a plane circular current loop



Consider a current loop of radius R carrying current I.For the small current element dl subtending an angle θ, the flux density at P is

$$dB = \vec{dB} = \frac{\mu I dl \sin\theta}{4\pi r^2}$$

$$\vec{dB} = \frac{\mu I R d\theta}{4\pi r^2} \qquad dl = R\, d\theta$$

$$\vec{B} = \int dB = \frac{\mu I}{4\pi R}\int_0^{2\pi} d\theta$$

$$\vec{B} = \frac{\mu I}{2R}\hat{a}$$

$$\vec{H} = \frac{I}{2R}\hat{a}$$

The direction is perpendicular to plane containing dl and the radius vector and in to the page.

A vertical circular coil carrying current produces a magnetic field at right angles to the plane of the circle. The plane of the circle is placed in magnetic meridian so that the magnet experiences a couple twisting it out of the meridian, while the Earth's horizontal component of magnetic field B_H tends to retain it in the meridian.

Deflecting couple = $B_{Coil}.m.\cos\theta$

Restoring couple = $B_H.m.\sin\theta$

Here m is the magnetic moment of the magnet of the magnetometer

$$B_{Coil}.m.\cos\theta = B_H.m.\sin\theta$$
$$\mu H = B_H.\tan\theta$$
$$H = \frac{B_H}{\mu}\tan\theta$$
$$H_{centre} = \frac{nI}{2r}$$
$$Current = \frac{2rH}{n}$$

FORMULA:

Magnetic field Intensity $H = \dfrac{B_H \tan\theta}{\mu_o}$ (A/m)

Where B_H is the horizontal component of earth's magnetic field in T

θ is the angle of deflection in the magnetometer in degree

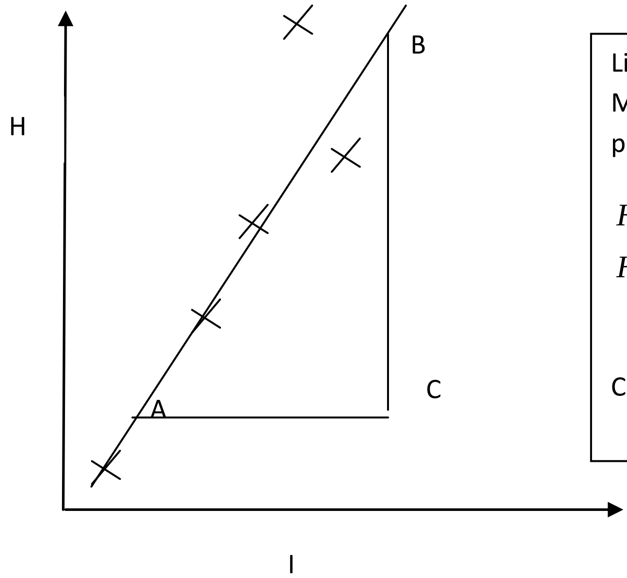
μ_0 is the permeability of free space in Hm^{-1}

Radius of the circular coil $R = \frac{n}{2} \times \frac{1}{Slope}$ (m)

n is number of turns in the coil

$$Slope = \frac{BC}{AC}$$

Nature of graph:



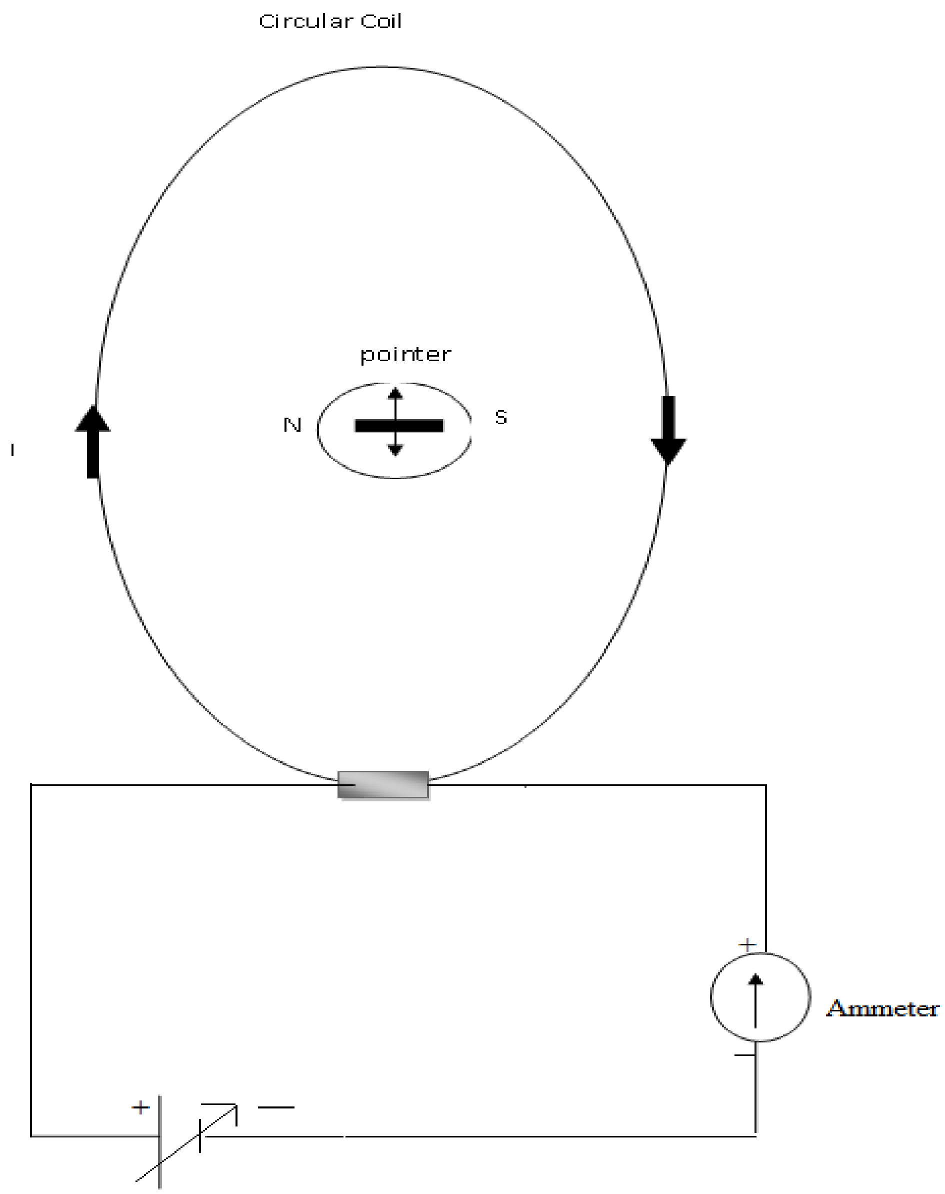
Linear graph indicates that Magnetic field Intensity is directly proportional to Current

$$H \;\alpha\; I$$

$$H = CI$$

C is the slope

CIRCUIT DIAGRAM:



OBSERVATIONS:

Permeability of free space $\mu_o = 4\pi \times 10^{-7}$ H/m

Relative permittivity $\mu_r = 1$ (for Air)

Number of turns in the circular coil n =……….

$$\text{Magnetic field Intensity } H = \frac{B_H}{\mu} \tan\theta$$

B_H is the Horizontal component of Earth's field = 0.36 X 10^{-4} T

TABULAR COLUMN:

Tr. no	Current I (A)	Magnetometer reading Θ (deg)	tanΘ	$H = \frac{B_H}{\mu_0} \tan\theta$ (A/m)
1		10		
2		20		
3		30		
4		40		
5		50		
6		60		

PROCEDURE:

1. The coil is set in magnetic meridian by orienting the plane of the coil parallel to the North-South direction. Look a little above the coil and rotate the instrument till the coil, magnetic needle and its image in the mirror lie in same vertical plane.
2. Rotate the magnetometer so that the pointer reads 0^0-0^0.
3. Connect the circuit as shown in the figure.
4. Adjust the current so the magnetometer gives a deflection of the order 60^0-70^0.

RESULT: The Magnetic field Intensity at the centre of the given coil of …… turns per unit current is found to be …………..A/m.