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EXPERIMENT NO. 6

NAME OF EXPERIMENT: TO COMPARE THE MAGNETIC MOMENTS OF TWO MAGNETS BY OSCILLATION MAGNETOMETER.

APPARATUS REQUIRED

1. Weight box
2. Oscillation magnetometer
3. Stop watch
4. Compass needle
5. Bar magnet

THEORY

When a magnet is suspended freely in a uniform magnetic field, it comes to rest in a direction parallel to the field. When the magnet is slightly displaced, it begins to vibrate in simple harmonic motion with a time period,

$$T = 2\pi\sqrt{\frac{I}{MB_H}} \quad \text{——— (i)}$$

where, M is the magnetic moment, I is the moment of Inertia and B_H is the horizontal component of earth's magnetic field.

And, $I = \frac{a^2+b^2}{12} \times$ mass of magnet of length 'a' and breadth 'b'.

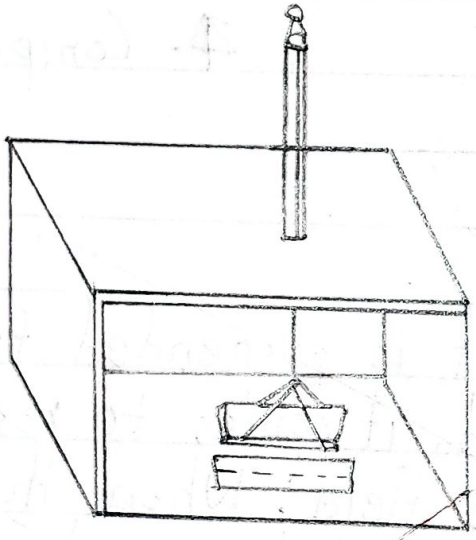

fig. Oscillation magnetometer

From (i)

$$M = \frac{4\pi}{T^2} \frac{I}{B_H} \quad \text{—— (ii)}$$

If M_1 and M_2 are magnetic moments, I_1 and I_2 are the moment of Inertia and T_1 and T_2 are the time period for two magnets respectively, then,

$$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \frac{T_2^2}{T_1^2} \quad \text{—— (iii)}$$

PROCEDURE

1. The leveling screw of the box were adjusted to make box horizontal and all magnetic substances were removed.
2. A compass needle was used to make a reference line to make the box parallel with the magnetic meridian.
3. A brass bar was kept on the stirrup and the torsion head was adjusted to make the bar parallel to reference line.
4. The brass bar was replaced with the bar magnet with N-pole pointing north. The sliding door was closed and the magnet was left to come at rest.
5. The magnet was slightly disturbed from outside with another magnet.

6. The time for 20 oscillations of the magnet was noted.
7. The process was repeated for four more times.
8. Steps (4-7) were repeated by replacing the magnet with another bar magnet.

OBSERVATIONS

For first magnet,

Length (a) = 5.1 cm

Breadth (b) = 1.24 cm

Mass (m) = 33.13 gm

$\therefore$ Moment of Inertia $(I_1) = \frac{a^2+b^2}{12} \times m$

$= \frac{5.1^2+1.24^2}{12} \times 33.13$

$= 76.05 \text{ gcm}^2$

For second magnet,

Length (a) = 5.1 cm

Breadth (b) = 1.15 cm

Mass (m) = 29.99 gm

$\therefore$ Moment of Inertia $(I_2) = \frac{a^2+b^2}{12} \times m$

$= \frac{5.1^2+1.15^2}{12} \times 29.99$

$= 68.31 \text{ gcm}^2$

OBSERVATION TABLE

Magnet	No. of Obs.	Time for 20 oscillations secs	Time period t secs	Mean t	$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \frac{T_2^2}{T_1^2}$
	1	66.75	3.34		
1st	2	62.53	3.31		
Magnet	3	65.63	3.08	3.2	
	4	63.62	3.18		
	5	61.65	3.08		0.85 : 1
	1	56.13	2.81		
2nd	2	55.27	2.77		
magnet	3	56.91	2.85	2.8	
	4	55.75	2.79		
	5	55.28	2.76		

CALCULATIONS

Mean time for 1st mag. $(T_1) = \frac{3.34+3.31+3.08+3.18+3.08}{5}$

$= 3.2$ sec

Mean time for 2nd mag. $(T_2) = \frac{2.81+2.77+2.85+2.79+2.76}{5}$

$= 2.8$ sec

$$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \frac{T_2^2}{T_1^2} = \frac{76.05}{68.31} \times \left(\frac{2.8}{3.2}\right)^2$$

$= 0.85 : 1$

RESULT

From the above experiment, the ratio of magnetic moment of the given two magnets was found to be 0.85:1.

SOURCES OF ERROR

1. The magnetic stirrup may not be horizontal.
2. There may be presence of magnetic substances on working table.
3. The reference line may not be parallel to magnetic meridian.

PRECAUTIONS

1. The magnetic stirrup must be horizontal.
2. Every magnetic substances should be removed from the working table.
3. The reference line must be drawn parallel to the magnetic meridian.