Introduction

A field trip is a very good way of learning because it helps us to see and experience things outside the classroom. It gives us the chance to explore, observe, and understand lessons in a more practical way.

Our field trip was to Syntung, a beautiful village known for its natural surroundings and peaceful environment. The trip was both enjoyable and educational. We got the chance to see the place closely, learn about its features, and understand many things that we cannot learn only from books. This report explains our visit to Syntung, the activities we did, the things we observed, and the knowledge we gained from the trip. On this field trip we did an experiment determination of the earth's horizontal intensity and the magnetic moment of a magnet by employing magneto meters. In this experiment materials used Magneto-meters(a) Deflection magneto meter and (b) Vibration magneto meters.

a) **Deflection magneto-meter:**

A Deflection Magnetometer (or Deflection Magnetometer Instrument) is a simple device used in physics to study the magnetic field and magnetic properties of bar magnets. It works on the principle of deflection of a compass needle when placed in the magnetic field of a magnet.

Construction:

It usually consists of a small magnetic compass needle mounted on a pivot so that it can rotate freely in a horizontal plane.The needle is enclosed in a small box with a circular scale (0°–360°) marked to measure the angle of deflection.A long wooden box or bar with a central line is used to place the bar magnet exactly in line with the compass needle.

Working Principle:

- A compass needle normally points along the Earth’s magnetic field.
- When a bar magnet is placed near it, the needle experiences two forces:
  - The horizontal component of Earth’s magnetic field.
  - The magnetic field of the bar magnet.
- Due to the combination of these two fields, the needle gets deflected from its usual north–south position.
- The angle of deflection can be measured on the circular scale.

Applications / Uses:

- ❖ To compare the strengths of two magnets.
- ❖ To determine the magnetic moment of a bar magnet.
- ❖ To study the inverse square law of magnetism (field $\propto 1/d^2$).
- ❖ To find the horizontal component of Earth's magnetic field at a place.

Simple Explanation: In short, a deflection magnetometer is an instrument that shows how much a compass needle turns (deflects) when another magnet is brought near it. By studying this deflection, we can learn about the strength of the magnet and Earth's magnetic field.

b) Vibration Magnetometer:

A vibration magnetometer is a scientific instrument used to measure the magnetic moment of a magnet or the horizontal component of Earth's magnetic field (H).

Principle: It works on the principle that:

- When a magnetic needle is suspended freely in a uniform magnetic field, it vibrates about the equilibrium position.
- The time period (T) of vibration depends on the moment of inertia (I) of the magnet and the restoring torque due to the horizontal magnetic field.

The relation is:

$$T = 2\pi\sqrt{\frac{I}{M.H}}$$

where,T = Time period of vibration

I = Moment of inertia of the magnet

M = Magnetic moment of the magnet

H = Horizontal component of Earth's magnetic field

Construction:

- ❖ A rectangular bar magnet is suspended horizontally by a thin silk thread inside a wooden box (to protect from air currents).
- ❖ A mirror is sometimes attached for reading oscillations precisely.
- ❖ A stopwatch is used to record the time for a number of oscillations.

Working

- ❖ The magnet is slightly displaced from its equilibrium position and released.
- ❖ Its starts vibrating to and fro about the equilibrium position.
- ❖ The time taken for a fixed number of oscillations (say 20 or 30) is measured using a stopwatch.
- ❖ From the observed time period, the magnetic moment or the horizontal component of Earth's field can be calculated using the formula.

Uses:

- To determine the magnetic moment of a bar magnet.
- To measure the horizontal component of Earth's magnetic field (H).
- To compare strengths of different bar magnets.

Experiment

Aim: Determination of the earth's horizontal intensity and the magnetic moment of a magnet by employing magneto meters.

Theory: In figure, the magnetic needle is in equilibrium under the action of two equal and opposite couples. One couple is due to earth’s horizontal field H running along the magnetic meridian, while couple is due to the field F of a magnet of moment M whose axis is kept at right angles to the magnetics meridian. If θ be the angle of deflection of the needle from the magnetic meridian, then it can be shown that,

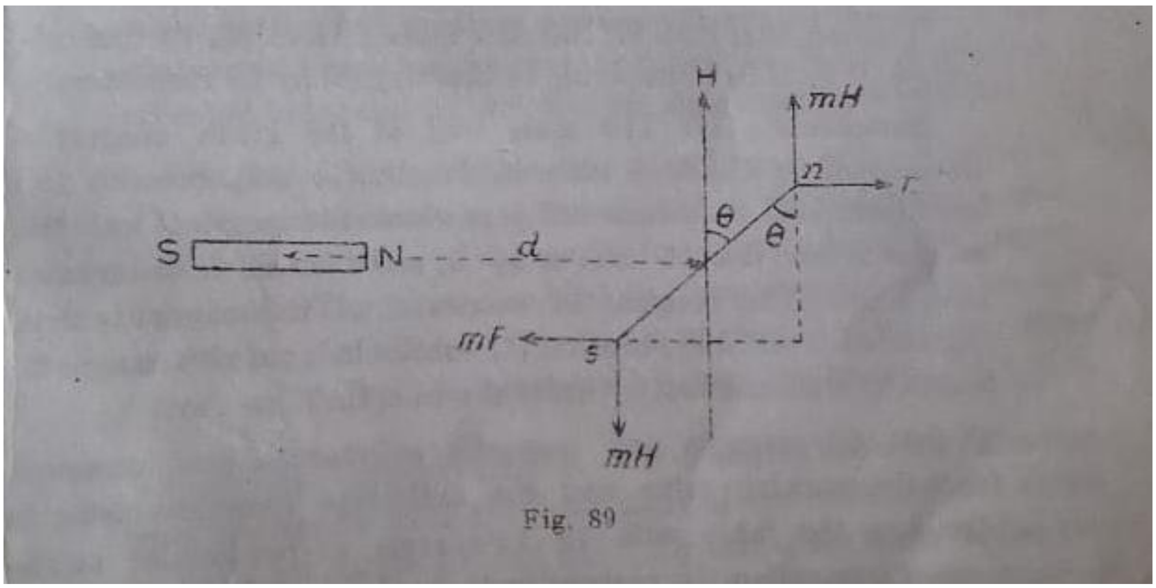

Fig. 89

$$\frac{M}{H} = \frac{(d^2-l^2)^2}{2d}\tan\theta \ldots\ldots\ldots\ldots\ (1)$$

Here d=distance between the centre of the magnet and the needle

l=half the magnetic length of the magnet

Or, $l=\frac{Actual\ length\ of\ the\ magnet\ \times 0.85}{2} \ldots\ldots\ldots\ldots\ldots (2)$

If the magnet be allowed to oscillate with a small amplitude on a horizontal plane under the action of earth’s horizontal intensity only, then the period of oscillation is given by,

$$T = 2\pi\sqrt{\frac{I}{M.H}}$$

Or, $MH = \frac{4\pi^2 I}{T^2} \ldots\ldots\ldots\ldots (3)$

As the magnet oscillates about a vertical axis passing through its centre of gravity, the moment of inertia of the given magnet of rectangular cross-section is given by,

$$I=\frac{Mass}{12}\{(length^2+breadth^2)\} = \frac{m'}{12}(l'^2\text{-}b'^2) \ldots\ldots\ldots\ldots\ldots (4)$$

Finding M/H from (1) and MH from (3) and (4) we can calculate M or H by multiplying or dividing (3) by (1) respectively.

Procedure: (for vibration magnetometer)

1. Suspend the magnet
   - Place the bar magnet inside the vibration magnetometer.
   - Suspend it freely using the silk fibre /thread provided in the instrument.
   - Ensure it can oscillate without obstruction.
2. Align the magnet
   - Allow the suspended magnet to come to rest.
   - It will align itself along the magnetic meridian (North–South direction).
3. Displace the magnet
   - Gently twist or displace the magnet slightly from its equilibrium position (not too much, only by a small angle).
4. Start oscillation
   - Release it smoothly.
   - The magnet will begin to vibrate (oscillate) about the mean position.
5. Measure the time
   - Using a stopwatch, note the time taken for 20 complete oscillations (or any convenient large number, say 10, 15, 20).
   - Repeat the measurement at least 3 times for accuracy.
6. Calculate the average
   - Find the average time taken for 20 oscillations.
   - Divide this value by 20 to get the time period (T) of one oscillation.

     $T = \frac{Total\ time\ for\ n\ oscillation}{n}$
7. Repeat for accuracy
   - Repeat the experiment and take the mean of the results to minimize error.

Procedure: (for deflection magnetometer)

1) Place the magnetometer on a wooden table away from magnetic materials.
2) .Align it along the magnetic meridian and adjust so that the needle shows (0-0) deflection.
3) Place the bar magnet on the axial line of the magnetometer at a known distance and note the deflection of the needle.
4) Repeat the observations for different distances of the magnet.
5) Suspend the same bar magnet so that it oscillates freely in the horizontal plane.
6) Displace the magnet slightly and record the time for a number of oscillations using a stopwatch.

7) Repeat the oscillation reading and take the mean value of the time period.
8) Use the deflection and oscillation data together to calculate the magnetic moment of the bar magnet and the horizontal components of the earth's magnetic field.

OBSERVATION:

A. Table 1

Mass of magnet m'	Length of the magnet in cm l'	Breadth of the magnet in cm b'	Moment of inertia of the magnet $I=\frac{m'}{12}(l'^2+b'^2)$	Half the magnetic length of the magnet = $l=\frac{l'\times\cdot 85}{2}$
45gm	7.54	1.28	219.34	3.18

OBSERVATION:

A. Determination of MH Table 1

No of Obs.	Time for 20 oscillation	Mean time	Period T in second	Moment of Inertia(I)	$MH=\frac{4\pi^2 I}{T^2}$
1)	1 min 33 sec	$=\frac{551}{6}$ = 91.83s	$T=\frac{91.83}{20}$ =4.59	I=7.54	MH=14.12
2)	1min 32sec				
3)	1min34sec				
4)	1min31sec				
5)	1min30sec				
6)	1min31sec				

No of obs.	Mean of the scale reading for the two ends of the magnet d= $(d1 + d2)^2$ position of the magnetometer	Deflection of the needles in degree when the magnet is								Mean deflection in degrees (θ)	Values of M/H	Mean M/H
		On the east arm of the magnetometer				On the west arm of magnetometer						
		N-pole pointing the needle		S-pole pointing the needle		N-pole pointing the needle		S-pole pointing the needle				
		End I	End II	End I	End II	End I	End II	End I	End II			
1.	**d 1=14.3** **d2=21.8**	45 46	44 46	46 46	49 49	50 52	54 55	40 41	41 42	46.62	2399.851	
2.	**d 1=14.8** **d2=22.3**	43 48	43 47	44 45	47 47	53 54	56 57	44 40	44 41	47.07	2805.27	2924.72
3.	**d 1=16.1** **d2=23.1**	42 41	42 41	44 44	42 41	46 41	44 40	40 36	40 41	41.57	3569.03	

Discussion:

From the experiment using the deflection magnetometer and the vibration magnetometer, we successfully determined:

I. The horizontal component of earth's magnetic field (H) by applying the tangent law in the deflection magnetometer set up.
II. The magnetic moment (M) of the given bar magnet by analyzing it's oscillations in the vibration magnetometer and applying the relation involving time period, moment of inertia, and horizontal intensity.

The two methods, when used together, allow for accurate calculation of both H and M, since one provides a relationship between them and the other allows the independent determination of one value.

Thus, the experiment verifies the principles of magneto statics and demonstrates a practical way to measure magnetic properties using simple instruments.

Conclusion:

The field trip to Syntung village was a memorable and enriching experience. Surrounded by natural beauty, especially the breathtaking waterfall, we were able to appreciate the importance of preserving nature and its resources. The visit not only gave us relaxation and joy but also helped us understand the cultural and environmental value of the village. Spending time together in such a peaceful place strengthened our bond and gave us new energy. Overall, it was both educational and refreshing, leaving us with lasting memories and a deeper respect for nature's beauty.

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