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Lecturer

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Course Title: Physics-I, Electricity, Magnetism & Properties of Matter Sessional

Rationale:

This course provides hands-on experience with fundamental physics concepts through practical experiments. It covers mechanics, electricity, magnetism, and material properties, helping students understand oscillations, resistance, and magnetic fields. Participants will develop experimental skills, learn to operate instruments and analyze data. The course emphasizes problem-solving and the practical applications of physics, building a strong foundation in experimental and analytical methods.

ASSESSMENT STRATEGY

Assessment Method	(100%)	
Class Assessment		
Conduct of Lab Test /Class Performance	**25%**	
Report Writing/Programming	**15%**	
Mid-Term Evaluation (Exam/Project/assignment)	**20%**	
Final Evaluation (Exam/Project/assignment)	**30%**	
Viva Voce / Presentation	**10%**	
Total	**100%**	

Course learning outcomes (CLO):

After successful completion of the course Physics-I, Electricity, Magnetism & Properties of Matter, students will be able to

CLO 1:

Demonstrate the ability to measure physical quantities such as acceleration due to gravity, spring constant, resistance, and modulus of rigidity using standard experimental techniques and apparatus.

CLO 2:

Analyze and interpret experimental data to determine electrical properties like specific resistance, internal resistance, and EMF, applying concepts of electricity and magnetism effectively.

CLO 3:

Apply problem-solving skills to verify fundamental laws of physics, such as the laws of series and parallel resistances and the principles of oscillatory motion and magnetism.

CLO 4:

Develop proficiency in using laboratory instruments and tools, while enhancing data accuracy, teamwork, and reporting skills through experimental practice.

TEACHING METHODOLOGY

Weeks	Intended topics to be covered	Teaching and Learning Strategy	Corresponding CLOs
1	Introductory class: Brief discussion on the total syllabus, basic requirements of the course, evaluation system of the course, grouping, visit to different sections of the laboratory, introduction to different basic equipment	Lecture and Oral Presentation	CLO1, CLO2
2	Determination of the gravitational acceleration g using a simple pendulum.	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
3	Determination of the spring constant and effective mass and hence to calculate the rigidity modulus of the material of the spring	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
4	Determination of the modulus of rigidity of a wire by the method of oscillation (dynamic method)	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4

TEACHING METHODOLOGY			
Weeks	Intended topics to be covered	Teaching and Learning Strategy	Corresponding CLOs
5	Determination of the specific resistance of a wire using a meter Bridge.	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
6	To determine the resistance of a galvanometer by the half-deflection method.	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
7	To determine a high resistance by the method of deflection.	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
8	To determine the value of an unknown resistance and verify the law of series and parallel resistances using a post office box	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4

TEACHING METHODOLOGY			
Weeks	Intended topics to be covered	Teaching and Learning Strategy	Corresponding CLOs
9	To determine the internal resistance of a cell by a Potentiometer.	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
10	To compare the EMF of two cells with a Potentiometer	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
11	To determine the horizontal component of the earth's magnetic field and the magnetic moment of a magnet by improving the magnetometer	Lecture and Oral Presentation	CLO1, CLO2
	Experimental Work	Experimental	CLO3, CLO4
12	Review Class	Lecture	
13	Review Class	Lecture	
14	Student Practice Class	Observation	
15	Student Practice Class	Observation	
16	Student Practice Class	Observation	
17	Lab Exam	Observation	

Reference Book

1. Practical Physics by Dr.Giasuddin Ahmad and,Md. Shahabuddin.

2.B.Sc Practical Physics- C.L Arora.

3. B.Sc Practical Physics-Harnam Singh.

4. B.Sc Practical Physics-Kalimuddin

List of the Experiments

Expt.01 Determination of the gravitational acceleration g using a simple pendulum.

Expt.02 Determination of the spring constant and effective mass and hence to calculate the rigidity modulus of the material of the spring

Expt.03 Determination of the modulus of rigidity of a wire by the method of oscillation (dynamic method)

Expt.04 Determination of the specific resistance of a wire using a meter Bridge.

Expt.05 To determine the resistance of a galvanometer by the half-deflection method.

Expt.06 To determine a high resistance by the method of deflection.

Expt.07 To determine the value of an unknown resistance and verify the law of series and parallel resistances using a post office box.

Expt.08 To determine the internal resistance of a cell by a Potentiometer.

Expt.09 To compare the EMF of two cells with a Potentiometer.

Expt.10 To determine the horizontal component of the earth's magnetic field and the magnetic moment of a magnet by improving the magnetometer

1st Week

Topic:
Introductory Class

- Introductory Class:
- A brief discussion on the total syllabus,
- Basic requirements of the course, evaluation system of the course, grouping, visit to different sections of the laboratory,
- Introduction to different basic equipment

Course Requirements

Let me outline the key expectations:

- **Attendance:** You must attend at least 75% of the classes to be eligible for evaluation. Missing sessions will impact your grade unless excused for valid reasons.
- **Preparation:** Before coming to the lab, review the experiment assigned for the week. Bring the manual, take notes, and be ready to experiment.
- **Lab Reports:** You'll submit a report detailing your observations and conclusions for every experiment. These reports are critical for your learning and will contribute 30% of your final grade.

Active Participation:

Engage in discussions and group activities.

- **Laboratory Grouping:**
- To make the sessions efficient and collaborative, you'll work in small groups. Each group will share equipment and responsibilities. Group assignments will be shared later today.
- In your groups, ensure tasks are evenly distributed.

For example:

- One person handles measurements.
- Another records observations.
- A third ensures calculations are correct.
- Teamwork is critical for your success.

Laboratory Tour and Equipment Introduction:

Tour: Show students the various sections of the lab: optics, thermodynamics, and acoustics.

Equipment Demonstration:

- Optical Bench: Used for precise optical measurements.
- Spectrometer: For prism and diffraction grating experiments.
- Sonometer: To study sound and frequency.
- Acoustic Transducer: Measures sound velocity.
- Electrical Apparatus: For experiments related to heat and energy transfer.

Laboratory Safety Guidelines:

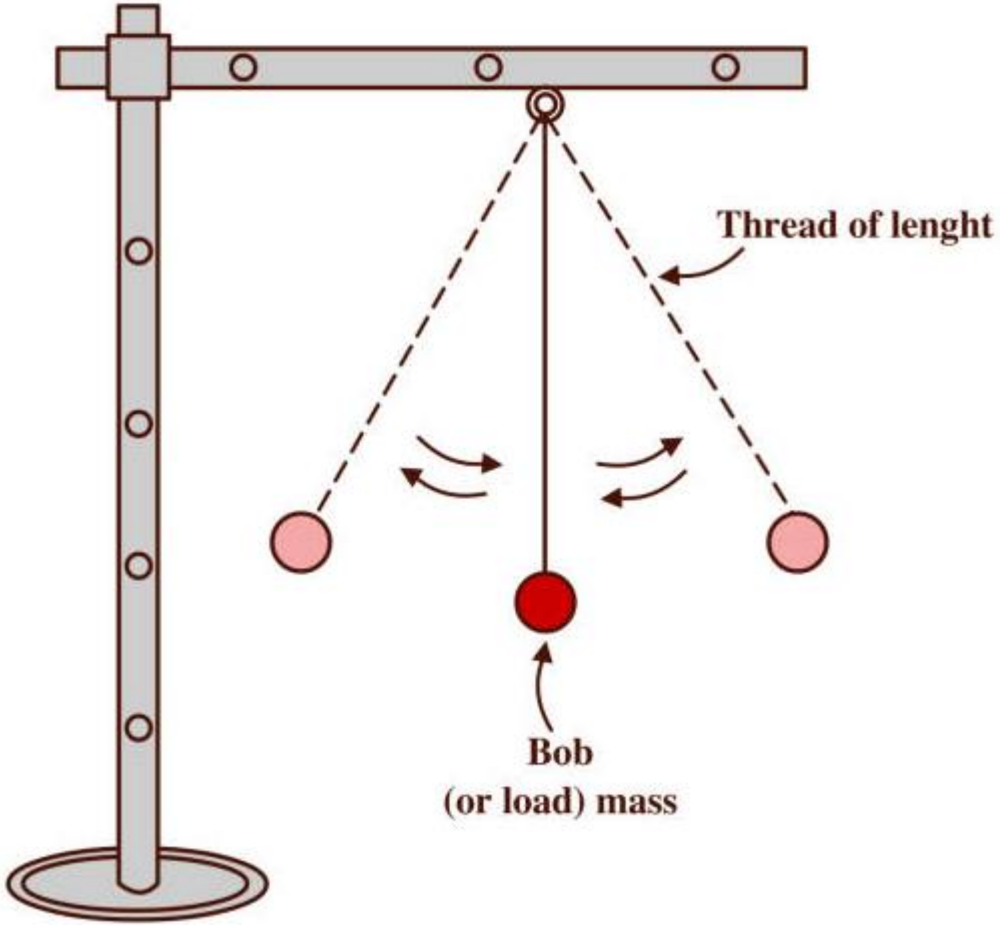
Safety is a priority in our lab. Here are some essential rules:

1. **Wear appropriate attire:** Lab coats and closed-toe shoes are mandatory.
2. **Handle equipment carefully:** If you’re unsure about using any apparatus, ask for help.
3. **Keep the lab clean:** No food, drinks, or distractions like mobile phones.
4. **Emergency procedures:** Familiarize yourself with the location of fire extinguishers, first aid kits, and emergency exits.

2^{nd} Week

Topic:

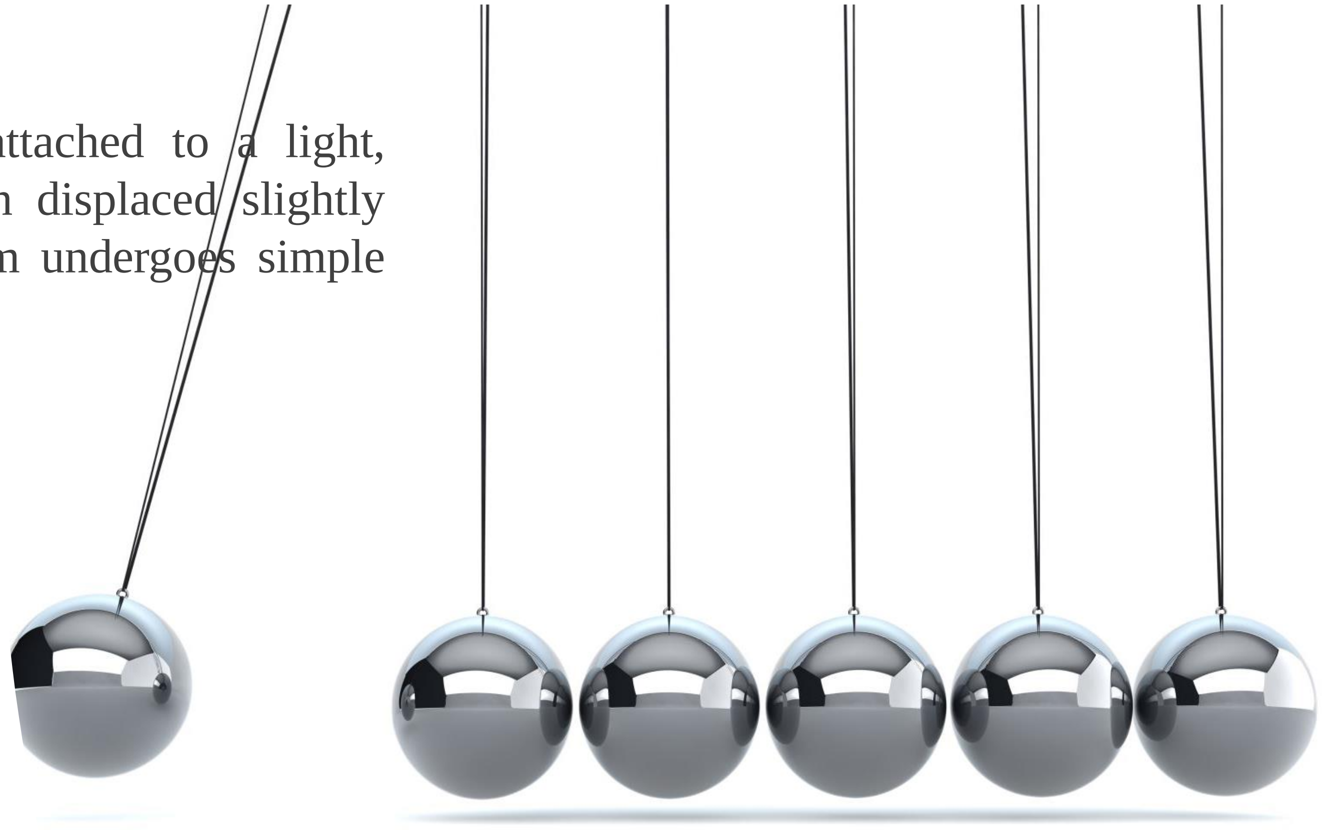
Determination of the gravitational acceleration g using a simple pendulum



- Experiment:

Determination of Gravitational Acceleration (g) Using a Simple Pendulum

- Theory



A simple pendulum consists of a small mass (bob) attached to a light, inextensible string suspended from a fixed point. When displaced slightly from its equilibrium position and released, the pendulum undergoes simple harmonic motion.

The time period T of a simple pendulum is given by:

$T = 2\pi \sqrt{(L/g)}$

where:

T = Time period of the pendulum

L = Length of the pendulum

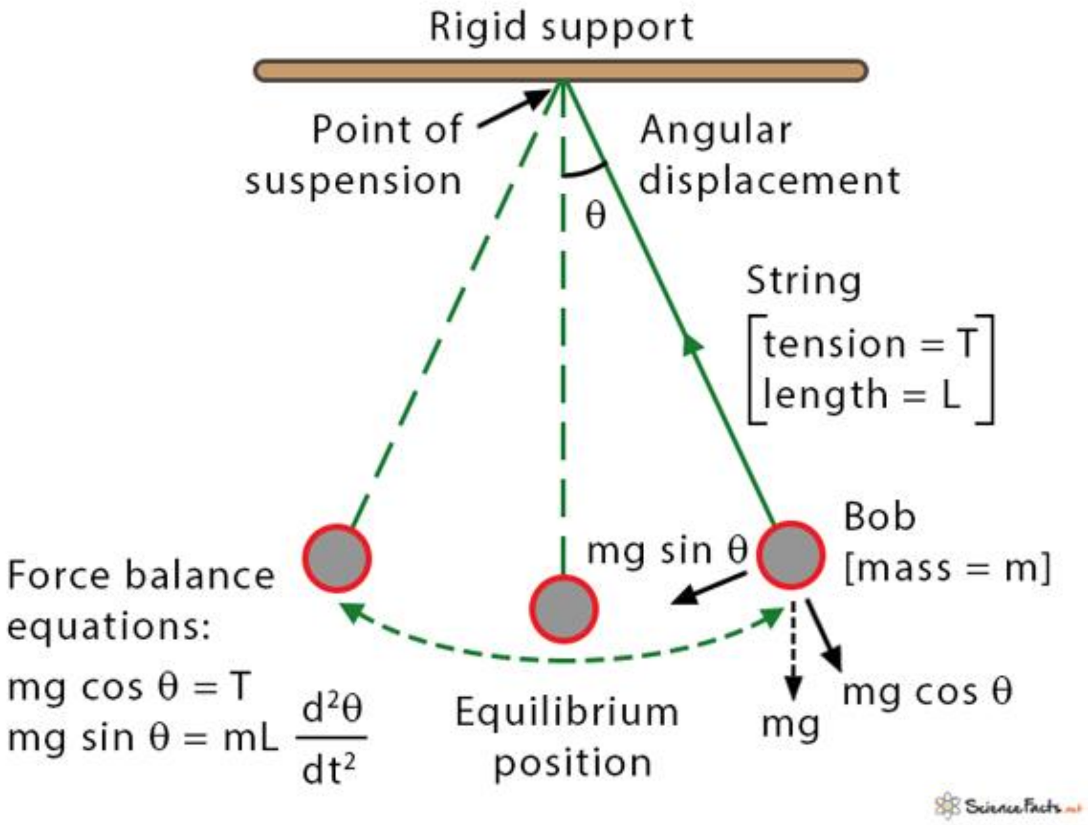
g= Acceleration due to gravity

Squaring both sides:

$T^2 = 4\pi^2 (L/g)$

By plotting T^2 vs. L, we can determine g from the slope.

Simple Pendulum



- Apparatus

1. A rigid stand with a clamp
2. A long inextensible string
3. A small metal bob
4. A stopwatch
5. A meter scale
6. A protractor (optional for precise angular displacement)

Procedure

Set up the simple pendulum by suspending the bob from fixed support using the string.

Measure the length L of the pendulum from the fixed support to the center of the bob using a meter scale.

Displace the bob slightly (about 5∘ to 10∘) and release it gently to ensure simple harmonic motion.

Start the stopwatch when the bob crosses the mean position and record the time for 10 complete oscillations.

Repeat the measurement for at least five different lengths of the pendulum.

Calculate T = Time for 10 oscillations / 10.

7. Plot T^2 vs. L and find the slope to determine g.

Serial No.	Length (L) (m)	Time for 10 Oscillations (s)	Time Period (T) (s)	T^2 (s^2)

3rd Week

Topic:

Determination of the spring constant and effective mass and hence to calculate the rigidity modulus of the material of the spring

- Exptiment.02

Determination of the spring constant and effective mass and hence to calculate the rigidity modulus of the material of the spring

- Theory

When a mass is suspended from a vertical spring, it undergoes simple harmonic motion. The time period T of oscillation is given by:

T=2π√{$(m + m_e)$/k}

where:

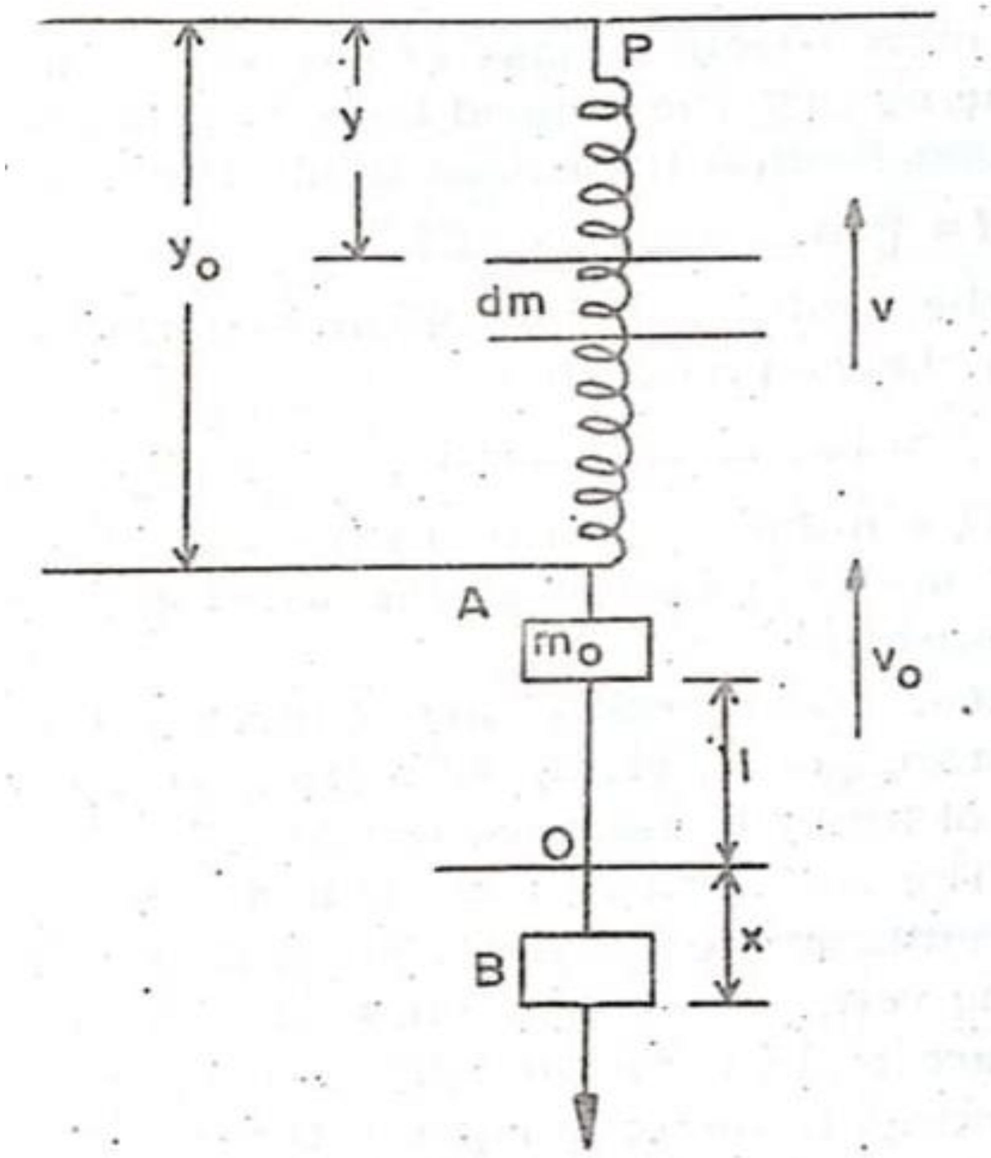
k = Spring constant

m = Mass attached to the springmem

e = Effective mass of the spring

From the graph of T square vs. m, the slope helps determine k, and the intercept gives mem e .The rigidity modulus η of the material of the spring is given by:

$$\eta = \frac{4NR^3K}{r^4}$$



P
y
y_o
dm
v
A
m_o
v_o
l
O
x
B

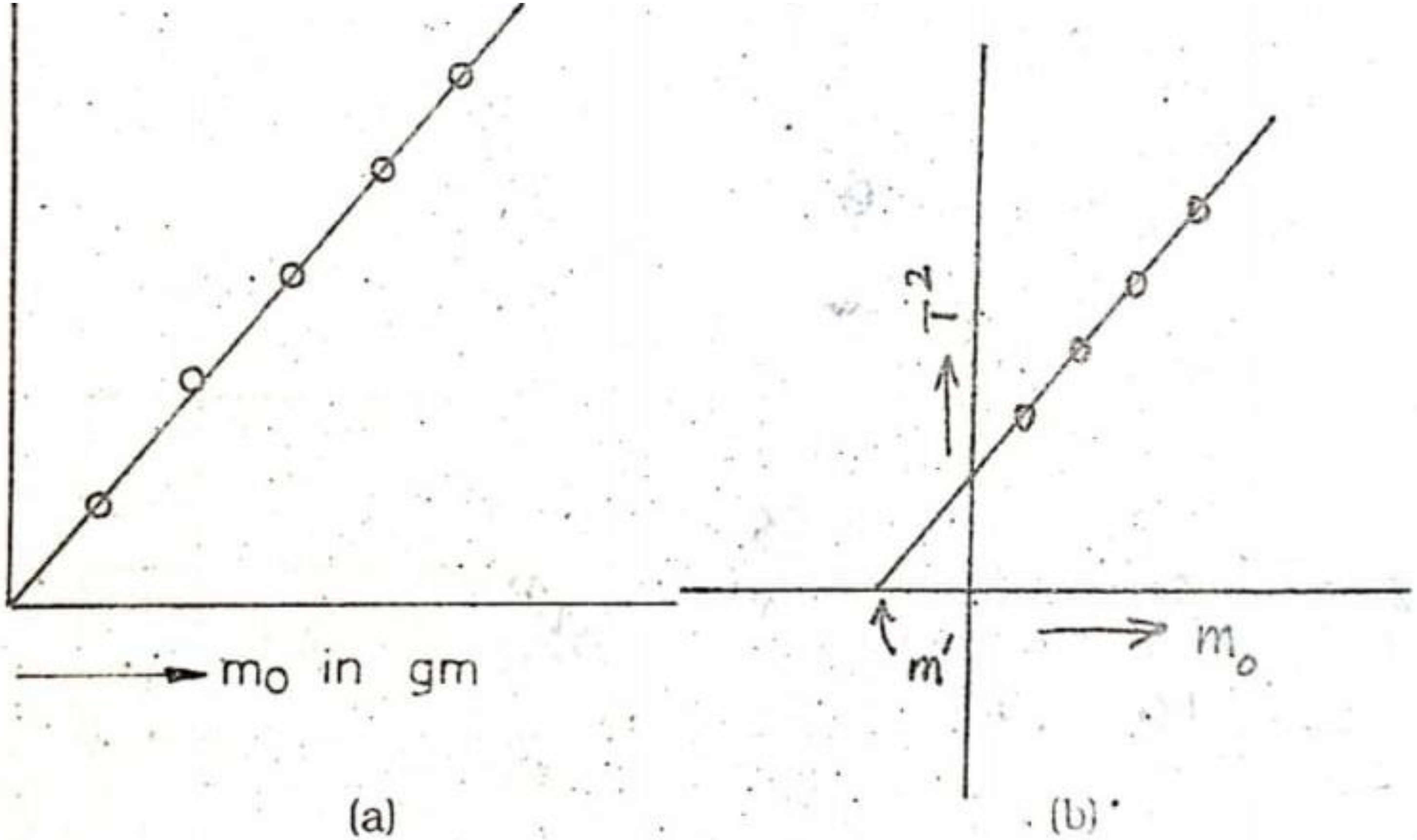


Fig. 2.20

(vii) From the first graph determine the slope of the line by choosing two points on it, one near the origin with co-ordinates x_1 cm and y_1 gm-wt and the other near the upper end of the line with co-ordinates x_2 cm and y_2 gm-wt.

Data for calculation of n, the rigidity modulus of the material of the spring.

No. of turns N in the spring = ...

Radius of the spring R:

External diameter of the spring (mean) D =...........cm.

Internal diameter of the spring (mean) d = ...cm.

Radius of the spring, $R = \frac{D+d}{4}$ ....cm.

Radius of the wire of the spring (mean) r =.......cm.

Calculation : $n = \frac{4NR^3k}{r^4}$ =.................. dynes/sq.cm.

From graph 1, $\frac{y_2 - y_1}{x_2 - x_1}$ =................. gm-wt/cm. =M (say).

Spring constant k= Mg =.............dynes/cm.

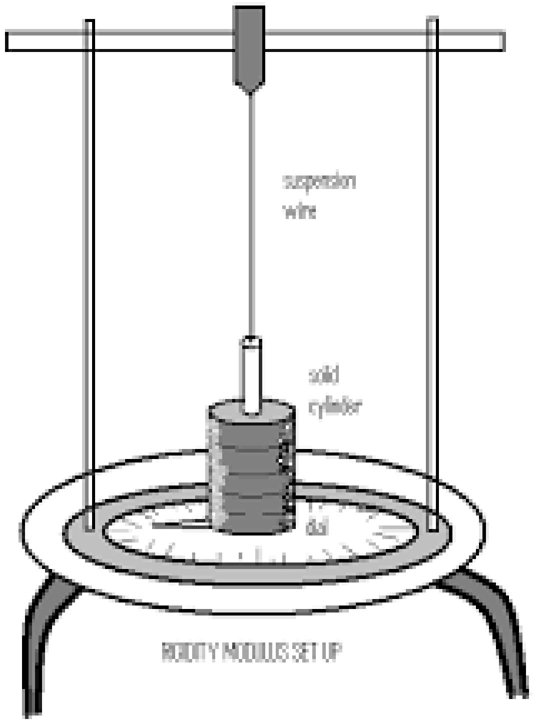
From Fig. 2.20b, effective mass of spring, m'= ....gms.

Serial No.	Mass (kg)	Extension (m)	Time for 10 Oscillations (s)	Time Period (T) (s)	T^2 (s^2)

4^{th} Week

Topic:

Determination of the modulus of rigidity of a wire by the method of oscillation (dynamic method)



▶Experiment.03

Determination of the modulus of rigidity of a wire by the method of oscillation (dynamic method)

- Theory

When a wire is twisted about its axis and released, it undergoes torsional oscillations.

The time period T of these oscillations is given by:

$$T=2\pi\sqrt{\frac{I}{C}}$$

where:

I= Moment of inertia of the suspended mass

C = Torsional rigidity of the wire

The modulus of rigidity η (also known as shear modulus) is given by:

$$\eta=\frac{8\pi IL}{nr^4} \text{ Dynes/square cm}$$

where:

L = Length of the wire

R = Radius of the wire

By determining T, I and C, we can compute the modulus of rigidity η.

Apparatus

1. Torsion pendulum setup
2. Circular disc
3. Stopwatch
4. Vernier calipers
5. Screw gauge
6. Meter scale

Procedure

1. Suspend the circular disc using the wire from a rigid support.
2. Measure the radius R of the wire using a screw gauge.
3. Measure the length L of the wire using a meter scale.
4. Twist the disc slightly and release it gently to allow free torsional oscillations.
5. Measure the time for 10 complete oscillations using a stopwatch.
6. Calculate the time period T as:
7. T= {Time for 10 oscillations/10}
8. Calculate the moment of inertia III of the disc using:
9. torsional rigidity C using the equation for T, then determine the modulus of rigidity

Serial No.	Length of Wire (m)	Radius of Wire (m)	Time for 10 Oscillations (s)	Time Period (T) (s)	Modulus of Rigidity (η) (N/m^2)

5^{th} Week

Topic:

Determination of the specific resistance of a wire using a meter Bridge

- Experiment Name:

Determination of the Specific Resistance of a Wire Using a Meter Bridge

Theory:

A meter bridge is based on the principle of the Wheatstone bridge, which states that:

A meter bridge is based on the principle of the Wheatstone bridge, which states that:

$(R1 / R2) = (L1 / L2)$

Using this principle, the resistance of the given wire (R) is determined and then its specific resistance (ρ) is calculated using:

$\rho = (R \times A) / L$

where:

R = Resistance of the wire

A = Cross-sectional area of the wire

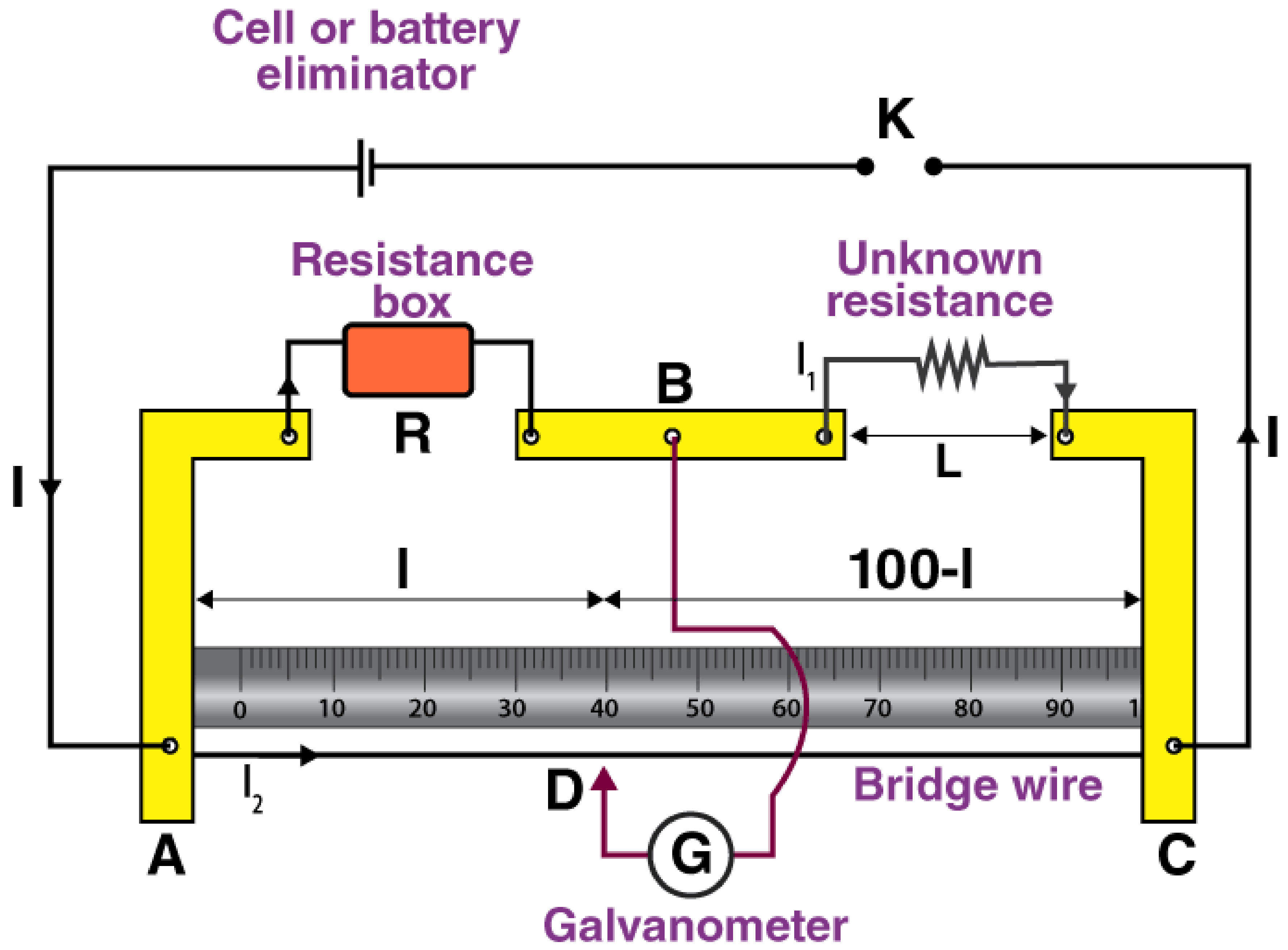
L = Length of the wire

Apparatus

1. Meter bridge
2. Galvanometer
3. Battery
4. Resistance box
5. Connecting wires
6. Vernier calipers
7. Screw gauge

❖ Procedure

1. Connect the unknown resistance (wire) in the right gap of the meter bridge.
2. Place a known resistance in the left gap.
3. Connect the battery, galvanometer, and jockey to form a Wheatstone bridge circuit.
4. Slide the jockey along the wire until the galvanometer shows zero deflection.


Cell or battery eliminator
K
Resistance box
R
Unknown resistance
B
I
L
l
100-l
0
10
20
30
40
50
60
70
80
90
D
Bridge wire
A
C
G
Galvanometer

5. Note the balancing length (L1 and L2).

6. Calculate R using the Wheatstone bridge principle.

7. Measure the diameter of the wire using a screw gauge and compute the cross-sectional area (A).

8. Compute the specific resistance (ρ) using the formula.

Serial No.	Balancing Length L1 (cm)	Balancing Length L2 (cm)	Resistance R (Ω)	Specific Resistance ρ (Ωm)

6^{th} Week

Topic:

Determination of the Resistance of a Galvanometer by the Half-Deflection Method

- **Experiment:**

Determination of the Resistance of a Galvanometer by the Half-Deflection Method

- **Theory:**

The half-deflection method is used to determine the resistance of a galvanometer (G) by connecting it in a circuit with a known resistance and measuring the deflections. The method is based on Ohm's law and Kirchhoff’s voltage law.

If the current through the galvanometer produces a deflection θ, and a shunt resistance Rs is connected in parallel with it, then the deflection reduces to half (θ/2). The resistance of the galvanometer is then given by:

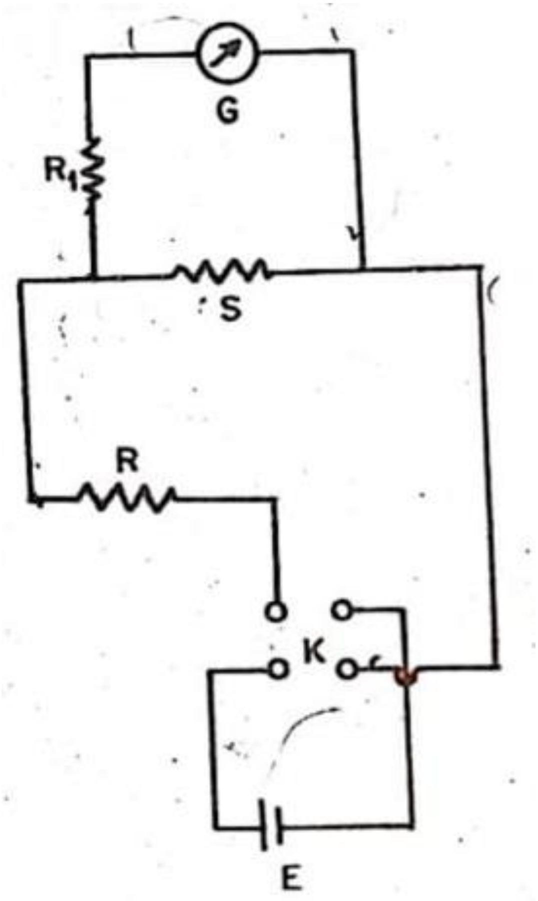
$$G = Rs(\theta/2\theta - 1) = Rs$$

Apparatus

- Galvanometer
- Battery (low voltage DC source)
- Rheostat
- High resistance box
- Low resistance box
- Key
- Connecting wires

Procedure

1. Connect the circuit as per the circuit diagram, ensuring the galvanometer is in series with the resistance box and the battery.
2. Adjust the rheostat to obtain a steady deflection θ in the galvanometer.
3. Insert a known shunt resistance Rs (from the resistance box) parallel to the galvanometer.
4. Note the new deflection θ ensuring it is approximately half of the initial deflection (θ/2).
5. Calculate the resistance of the galvanometer
6. Repeat the experiment with different values of Rs and take the average value of G.


G
R1
S
R
K
E

No. of ohs	Currents	Resistance R in ohms	Shunt resistance S in ohms	Resistance R_1 in ohms	Deflec-tions	$G = R_1$ ohms	Mean G in ohms
	Direct	1000 "	0.1 "	o 80	10.6 5.3	80	
1	Reverse	" "	" "	0 81	10.4 5.2	81	
	Direct "	" "	0.14	0 80	10.2 5.1	80	
2	Reverse	" "	" "	0 79	10.4 5.2	79	
	Direct	750 "	0.16 "	0 "	" "	"	
3	Reverse	" "	" "	0 "	" "	"	
etc.							

7^{th} Week

Topic:

To determine a high resistance by the method of deflection

Theory : In the arrangement of Fig.7.37, if the unknown resistance X (of the order of not less than 10^4 ohms) is included in the battery circuit by closing the gap OB_1 and if S_1 be the value of the shunt resistance S and d_1 cm be the deflection of the spot of light on the scale, then the current C_g flowing through the galvanometer is given by

$$C_g = \frac{ES_1}{X(S_1 + G) + S_1 G} = kd_1 \quad (1)$$

where k is the constant of proportionality.

If now the known resistance R is introduced in the battery circuit by closing the gap OB_2 and if S_2 be the shunt resistance and d_2 be the deflection (nearly equal to d_1) of the spot of light on the scale, then the galvanometer current C_g is given by

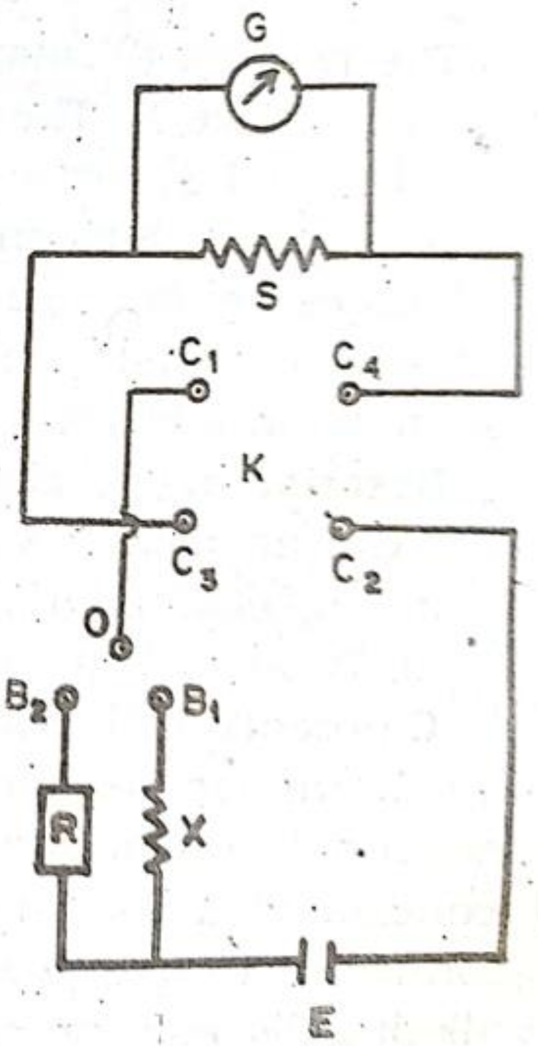


Fig. 7.37

$$C_g = \frac{ES_2}{R(S_2+G)+S_2G} = kd_2 \ \ldots\ldots\ldots\ldots (2)$$

Dividing (2) by (1) we get

$$\frac{X(S_1+G)+S_1G}{R(S_2+G)+S_2G} \times \frac{S_2}{S_1} = \frac{d_2}{d_1}$$

As S_1, S_2 and G are small in comparison with X and R we can neglect S_1G and S_2G. Hence we get

$$X = R\,\frac{S_1\,(S_2+G)}{S_2\,\,(S_1+G)} \times \frac{d_2}{d_1} \ \ldots\ldots\ldots\ldots (3)$$

$$\text{or } X = R\,\frac{S_2+G}{S_2(1+\frac{G}{S_1})} \times \frac{d_2}{d_1} \ \ldots\ldots\ldots\ldots (3a)$$

Again if X be very large so as to produce a measurable deflection d_1 without the shunt resistance S_1 (*i.e.*, by making $S_1 = \infty$),

$$\text{then } X = R\,\frac{S_2+G}{S_2} \times \frac{d_2}{d_1} \ \ldots\ldots\ldots (4)$$

The relation (3) may be employed to find the unknown high resistance X. The relation (4) may be used when X is very large and $S_1 = \infty$

Apparatus : Suspended coil galvanometer, battery, a high resistance to be measured, an ordinary resistance box containing resistances from 1 to 1000 ohms, a plug commutator, a two-way plug key.

Procedure : (i) Make connections as described above. Bring a sharp edge of the sopt of light to the zero mark of the scale. Insert the unknown resistance in the circuit by joining O with B_1 of the two-way key. With zero resistance in the shunt box, there should be no deflection of the galvanometer. In case of a deflection tighten the plugs of the shunt box.

(ii) Gradually increase the value of the shunt resistance to S_1 (say) till the deflection of the spot of light comes within the range of 8 to 12 cm of the scale. Note the deflection. Now reverse the current and note the deflection. The mean of the two deflections gives d_1.

(iii) In case the deflection is too small even after including all the resistances in the shunt box, disconnect one end of the shunt to make $S_1 = \infty$. Now the whole main current passes through the galvanometer. Note the deflection for both direct and reverse currents. d_1 is the mean of the two deflections.

(iv) Connect the shunt box (if it had been disconnected) and put zero resistance in it by tightening all its plugs. Join the binding screw O with B_2 thereby introducing the known high resistance (which should not be less than 10,000 ohms) in the circuit. Note the deflection which will be very small. Increase the value of the shunt resistance to S_2 (say)

Results :

E.M.F. of the battery = ... volts.

Galvanometer resistance (given), G = ... ohms.

No. of obs	Series resistance in ohms.	Shunt resistance in ohms.	Deflections in cm for current			Unknown resistance X in ohms.	Mean X in ohms.
			Direct	Reverse	Mean		
1	X	S_1 =					
	R	S_2=					
2	X	S_1 =					
	R	S_2=					
3	X	S_1 =					
	R	S_2=					

Calculation :

$$X = R \frac{S_1(S_2+G)}{S_2(S_1+G)} \times \frac{d_2}{d_1} \text{ ... ohms.}$$

Discussions : (i) A storage battery should be used.

(ii) The pair of deflection d_1 and d_2 for X and R for every set should be made nearly equal.

8th Week

Topic:

To determine the value of an unknown resistance and verify the law of series and parallel resistances using a post office box.

Experiment Name :

Determination of an Unknown Resistance and Verification of Series and Parallel Laws Using a Post Office Box

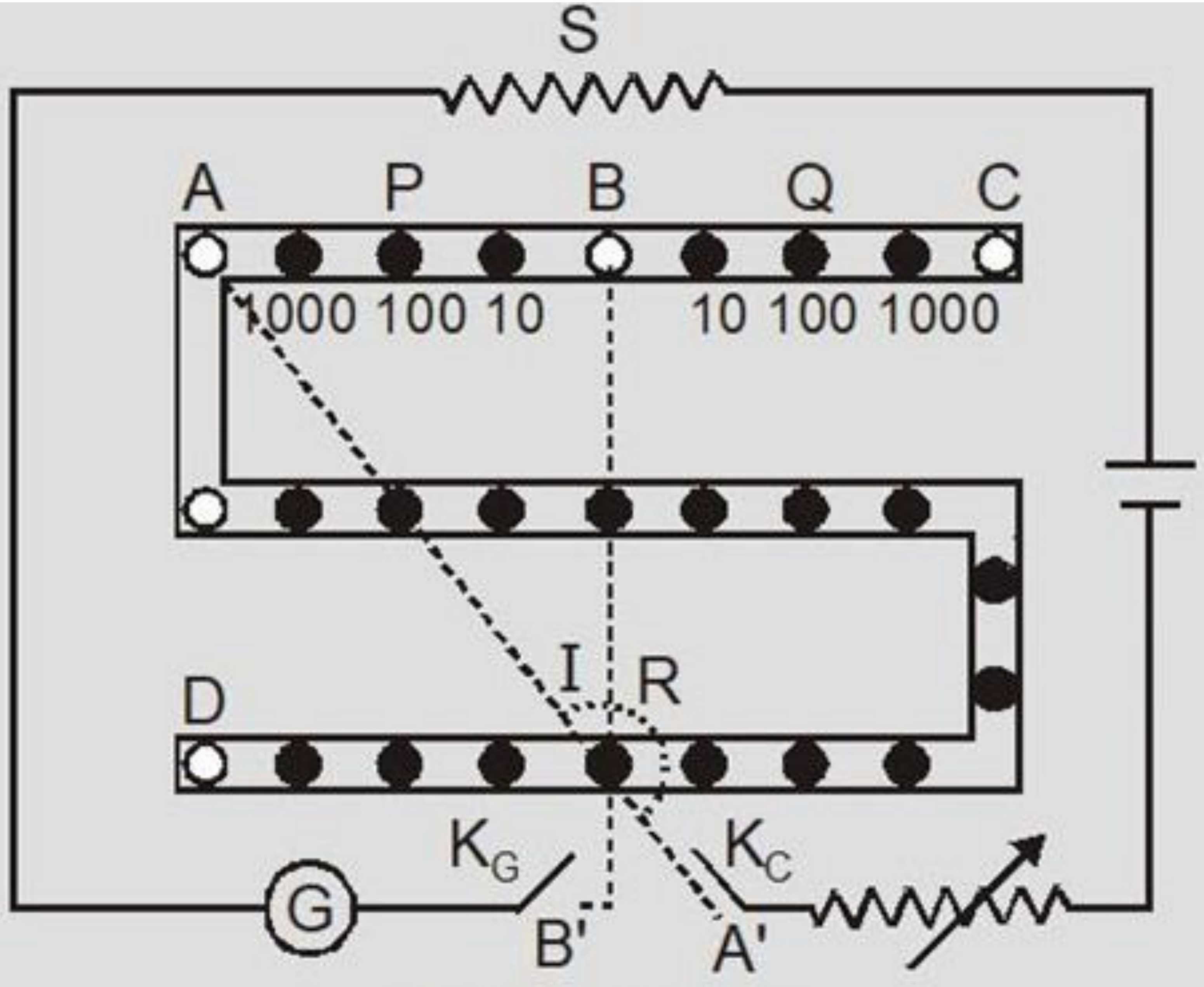
Theory

A Post Office Box is a practical application of the **Wheatstone Bridge** principle. The ratio of resistances in the bridge circuit is given by:

$P/Q=R/X$

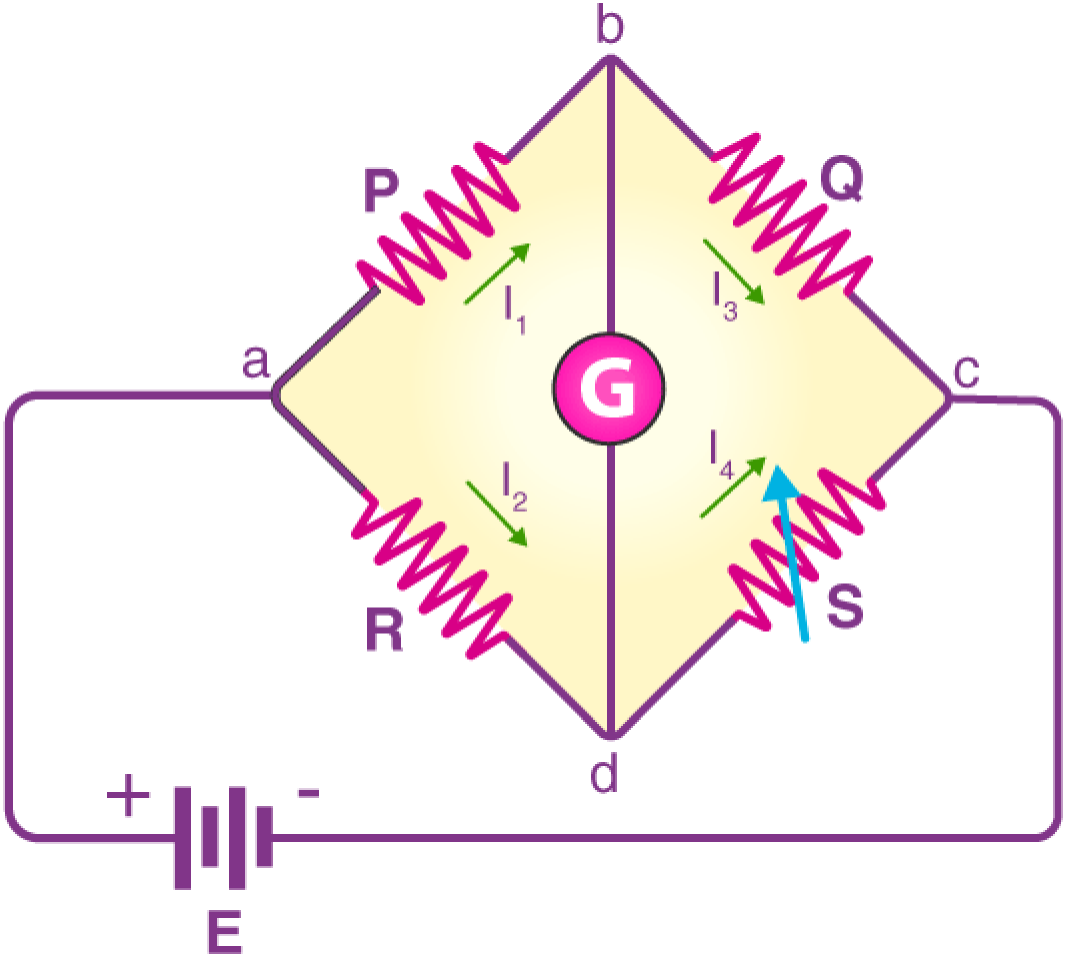
where:

- P and Q are known resistances,
- R is a standard resistance,
- X is the unknown resistance.



Post-office Box

WHEATSTONE BRIDGE



The bridge is balanced when no current flows through the galvanometer, allowing the unknown resistance to be calculated as:

$$X = R \times Q / P$$

The laws of series and parallel resistances are verified by measuring individual resistances and their combinations.

Apparatus

1. Post Office Box
2. Galvanometer
3. Battery
4. Jockey
5. Unknown resistance wire
6. Connecting wires

Procedure

1. Determination of Unknown Resistance

2. Connect the unknown resistance X in the right gap of the Post Office Box.

3. Select appropriate values for the known resistances P and Q.

4. Close the circuit and use the jockey to find the null point (zero deflection on the galvanometer).

5. Adjust P and Q until the null point is found.

6. Use the formula $X=R\times QP$ Measure two resistances

Resistance in ohms			Direction of Deflection.	Inference : Third arm resistance is
Arm Q	Arm P	Third arm R		
10	10	0	Left	Too small
			right	Too large
		100	"	"
		50	"	"
		20	"	"
		10	"	Large
		7	"	"
		6	"	"
		5	Left	Small
				The unknown resistance lies between 5 and 6 ohms

9^{th} Week

Topic:

Experiment Name: To determine the internal resistance of a cell by a Potentiometer.

Theory:

The internal resistance (r) of a cell is the resistance offered by the electrolyte inside the cell. When a cell is connected in an open circuit, the potential difference across its terminals is equal to its electromotive force (E). However, when the cell is supplying current to an external resistor, the terminal voltage (V) drops due to the internal resistance.

From Ohm's Law, the total current (I) in the circuit is given by:

$$I = \frac{E}{R + r}$$

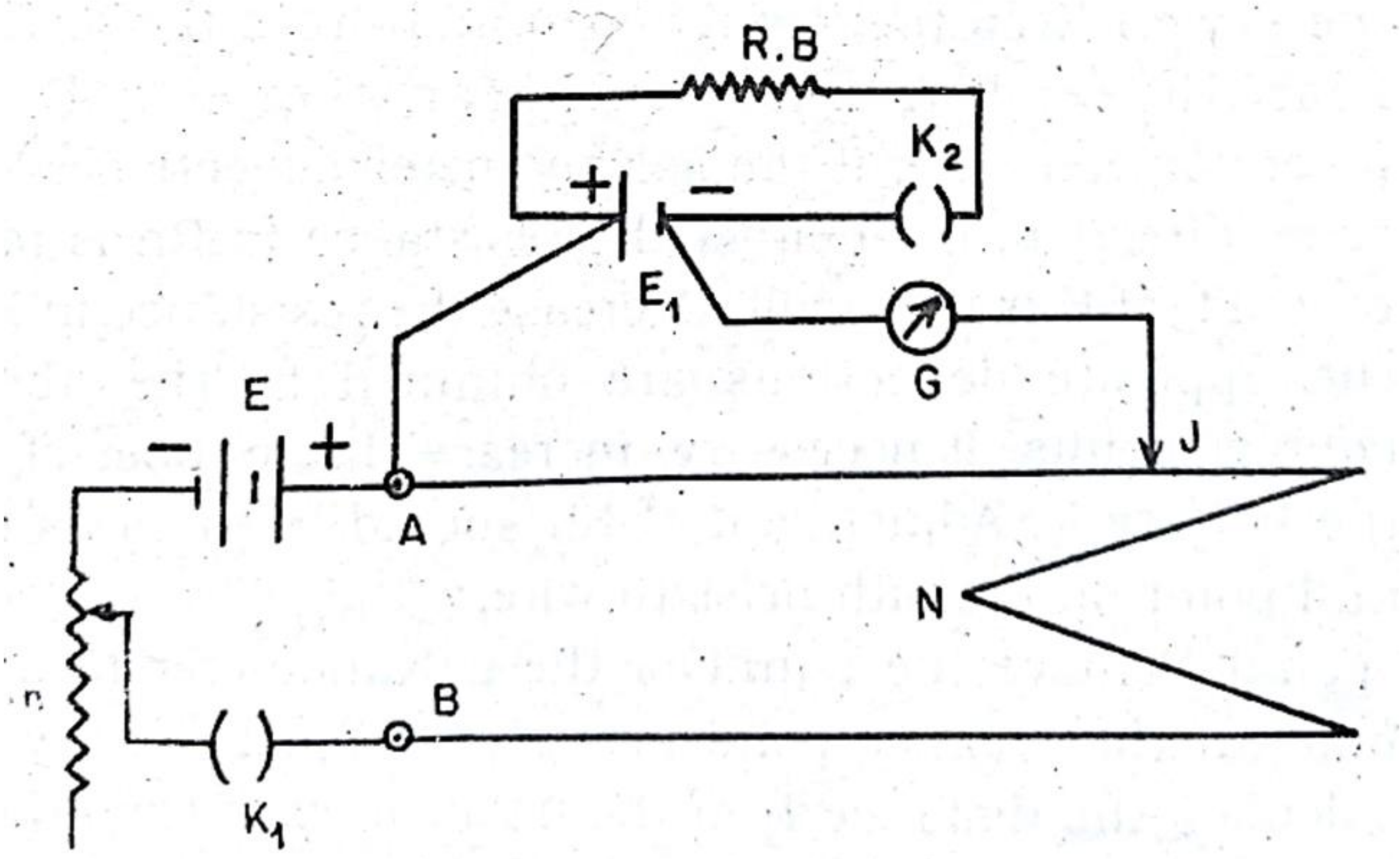
where:

- E = EMF of the cell
- V = Terminal voltage across the cell when connected to a resistance R
- r = Internal resistance of the cell
- R = External resistance connected in the circuit
- I = Current flowing through the circuit

The relation between E, V, and r is given by:

$$r = R\left(\frac{E}{V} - 1\right)$$

where E and V are determined using a potentiometer.


R.B
K2
+
−
E1
G
J
E
−
+
A
N
r
B
K1

❖ Apparatus:

1. Potentiometer (10-wire or a long uniform wire)
2. Battery (or accumulator)
3. A primary cell (whose internal resistance is to be determined)
4. Galvanometer
5. High resistance box
6. Rheostat
7. Key (switch)
8. Connecting wires
9. Jockey

Procedure:

1. Calibration of the Potentiometer:

•Connect the battery, key, rheostat, and potentiometer in series.

•Adjust the rheostat so that a steady current flows through the potentiometer wire.

•Use a jockey to find the null point for the standard cell and determine the potential gradient.

2. Measurement of EMF (E):

•Connect the positive terminal of the cell (whose internal resistance is to be found) to the positive end of the potentiometer.

•Use a galvanometer and jockey to find the balancing length l (where there is no deflection)..

3. Measurement of Terminal Voltage (V):

•Introduce a known external resistance R in series with the cell.

•Connect the cell back to the potentiometer circuit, ensuring the circuit is closed through R.

•Find the new balancing length l using the potentiometer.

•Determine the Voltage

4. Calculate of Internal Resistance (r)

Results :

No of obs	Circuit	Resistance in R ohms.	Value of			Internal resistance b of the cell	Mean b ohms
			l_1 cm	Mean l_1 cm	l_2 cm		
	open	infinity	... ...	...			
1	closed	10			...	...	
2	closed	20			...	...	
3	closed	30			...	...	
4	closed	40			...	...	
5	closed	50			...	...	

10th Week

Topic:

To compare the EMF of two cells with a Potentiometer.

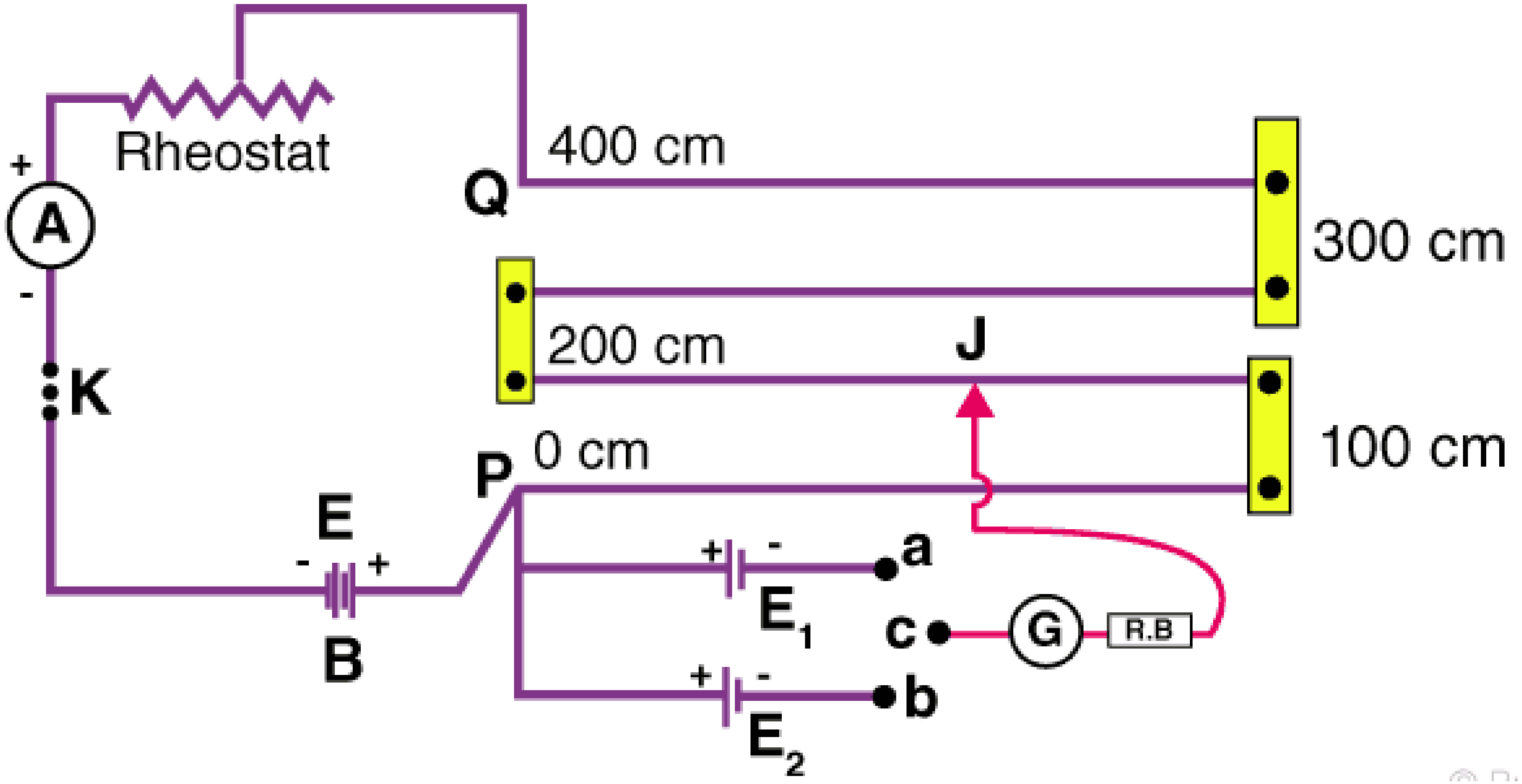
- **Experiment Name:**

  To compare the EMF of two cells with a Potentiometer

- **Theory:**

Using a voltmeter, it is possible to measure only the potential difference between the two terminals of a cell, but using a potentiometer, we can determine the value of emf of a given cell. Where E_1 and E_2 are EMFs of two cells, l_1 and l_2 are the balancing lengths when E_1 and E_2 are connected to the circuit respectively, and φ is the potential gradient along the potentiometer wire.

$E_1 / E_2 = \varphi\, l_1 / \varphi\, l_2 = l_1 / l_2$


Rheostat
400 cm
Q
300 cm
200 cm
J
100 cm
0 cm
P
E
B
K
A
+
-
E1
E2
a
b
c
G
R.B

Apparatus

1. Potentiometer

1. Daniel Cell
2. Leclanche Cell
3. low resistance Rheostat
4. Ammeter
5. Voltmeter
6. Galvanometer
7. Keys
8. Set Square
9. Jockey
10. Resistance Box
11. Connecting wires
12. Piece of sandpaper

Procedure

Connect the circuit as shown in the figure.

With the help of sandpaper, remove the insulation from the ends of connecting copper wire.

Measure the EMF (E) of the battery and the EMFs (E_1 and E_2) of the cell and see if $E_1 > E$ and $E_2 > E$.

the zero ends (P) of the potentiometer and the negative pole through the one-way key, low resistance rheostat, and the ammeter to the

Connect the positive poles of the cells to the terminal at the zero ends (P) and the negative poles to the terminals *a* and *b* of the two-way key.

Connect the common terminal *c* of the two-way key through a galvanometer (*G*) and a resistance box to the jockey *J*.

Take maximum current from the battery by making the rheostat resistance zero.

Insert the plugin, the one-way key through the resistance box and the galvanometer to the jockey *J*.

Take out the 2000 Ω plug from the resistance box.

Note down the direction of the deflection in the galvanometer by pressing the jockey at zero ends.

11. Now, press the jockey at the other end of the potentiometer wire. If the deflection is in the opposite direction to that in the first case, the connections are correct.

12. Push the jockey smoothly over the potentiometer up to a point where the galvanometer shows no deflection.

13. Put the 2000 Ω plug back into the resistance box and obtain the null point position accurately with the help of the set square.

14. Note the length l_1 of the wire for the cell E_1.15. Note the current as indicated by the ammeter.

15. Disconnect the cell E_1 from the plug

16. Connect E_2 by inserting the plug into the gap of the two-way key.

17. Take out a 2000 ohms plug from the resistance box and slide the jockey along the potentiometer wire and obtain no deflection position.

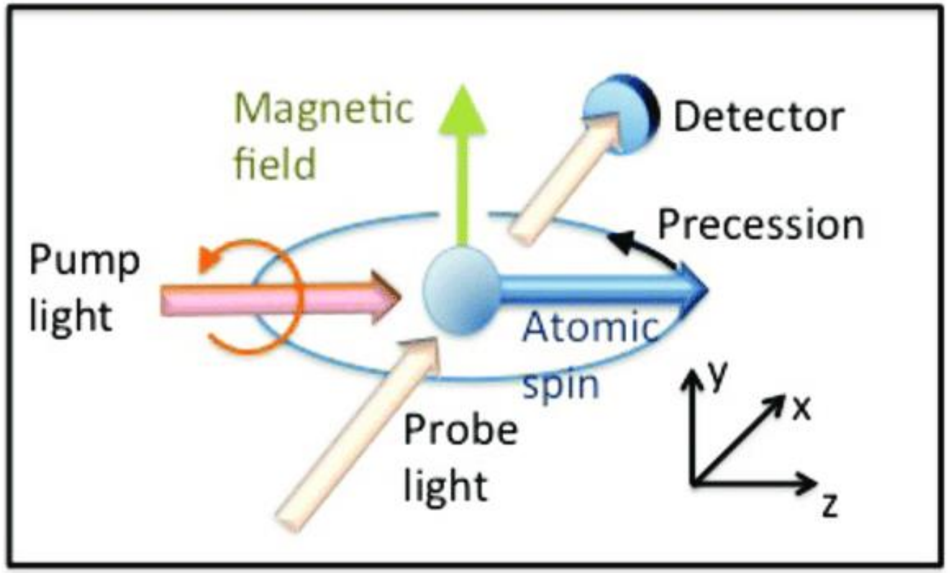
18. Put 2000 ohms plug back in the RB and obtain null for E_2.

19. Note the length L_2 of wire in this position for the cell E_2.

20. By increasing the current and adjusting the rheostat, we get three sets of observations.

Results :

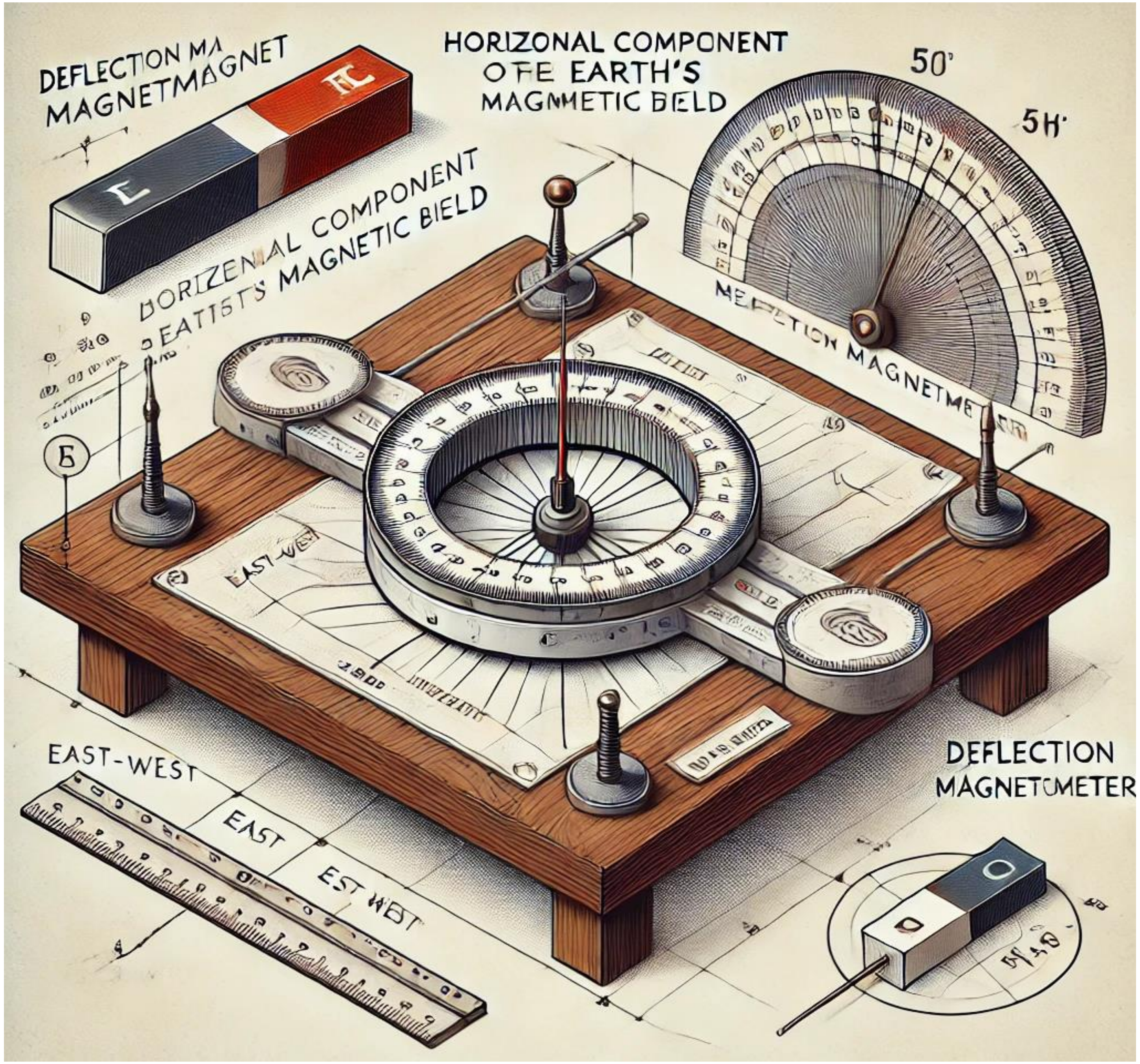
No. of obs.	Cell	Null points			Total length in cm.	E_1/E_2 $=l_1/l_2$	Mean E_1/E_2
		On wire number	Scale reading in cm.	Mean scale reading in cm			
1	First (E_1)	10th	…	…=(x_1)	900 +x_1		
	Second (E_2)	…	… …	…	….	…	
2	First (E_2)	9th	… …	… = (x_3)	800+x_3		
	Second (E_2)	…	… …	…	….	…	…
etc.							



11th Week

Topic:

To determine the horizontal component of the earth's magnetic field and the magnetic moment of a magnet by improving the magnetometer


DEFLECTION MA
MAGNETMAGNET
HORIZONAL COMPONENT
OFE EARTH'S
MAGNMETIC BELD
50'
5H'
HORIZENIAL COMPONENT
EATISTS MAGNETIC BIELD
DEFLECTION MAGNETMETER
EAST-WEST
EAST
EST WEST
DEFLECTION
MAGNETOMETER

- ❖ Experiment Name:

  To determine the horizontal component of the earth's magnetic field and the magnetic moment of a magnet by improving the magnetometer.

Theory:

The Earth's magnetic field has two components:

1. Horizontal Component – The part of the Earth's field acting parallel to the surface.
2. Vertical Component – The part acting perpendicular to the surface.

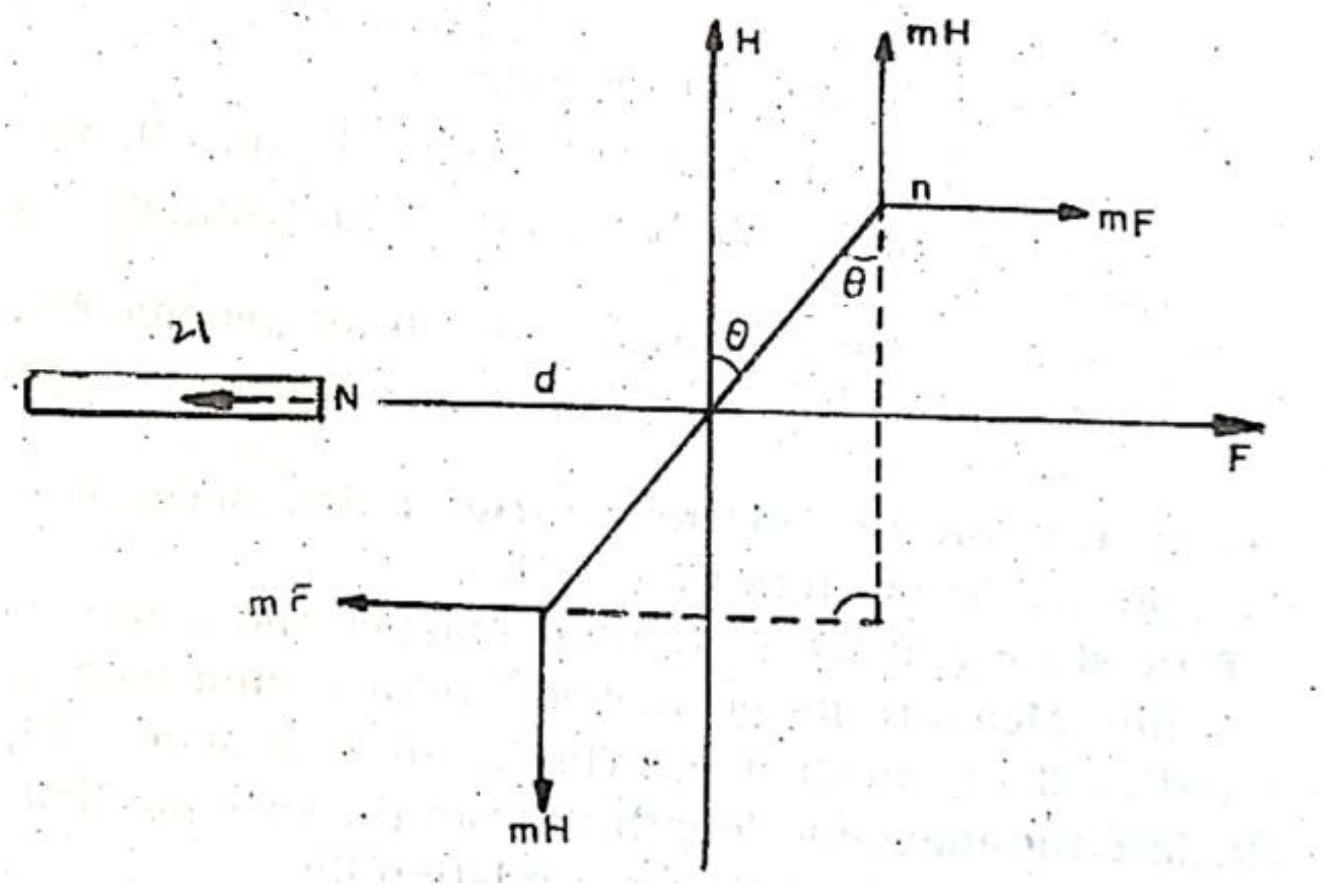
A bar magnet placed in a uniform magnetic field experiences a torque that aligns it with the field. Using a deflection magnetometer in the Tan-A position, we can determine BH and the magnetic moment (M) of the magnet.

The magnetic moment of a magnet is given by:

$M = md$

where

- m = pole strength of the magnet
- d = distance between poles (magnet length)


H
mH
n
mF
θ
θ
2l
d
N
F
mF
mH

From the deflection method, the horizontal component of Earth's magnetic field is:

$$B_H = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} \cdot \frac{1}{\tan\theta}$$

where:

- $\mu_0 = 4\pi \times 10^{-7}$ Tm/A (permeability of free space)
- θ = angle of deflection of the compass needle
- d = distance of the magnet from the center of the magnetometer
- M = magnetic moment of the bar magnet

Using the **vibration magnetometer**, we can determine M from the formula:

$$T = 2\pi\sqrt{\frac{I}{MB_H}}$$

where:

- T = time period of oscillations
- I = moment of inertia of the magnet

By combining both experiments, we can determine B_H and M.

❖ Apparatus:

1. Improved magnetometer (deflection and vibration magnetometer)
2. Bar magnet
3. Compass needle
4. Stopwatch
5. Meter scale
6. Stand with pivoted magnet system

Procedure:

1. Determination of B_H Using the Deflection Magnetometer (Tan-A Position):

- Place the deflection magnetometer on a **horizontal table** aligned along the Earth's magnetic north-south.
- Keep the magnet **east-west**, symmetrically at a distance d from the compass center.
- Observe the deflection angle θ of the compass needle.
- Repeat for different distances and find the average.
- Use the formula:

$$B_H = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} \cdot \frac{1}{\tan\theta}$$

  to determine B_H.

2. Determination of M Using the Vibration Magnetometer:

- Suspend the bar magnet **freely** using a fine thread.
- Displace it slightly and allow it to oscillate freely.
- Measure the **time period** (T) for 10 complete oscillations.
- Use the equation:

$$M = \frac{4\pi^2 I}{T^2 B_H}$$

  to determine the **magnetic moment** M.

Trial No.	Distance d (cm)	Deflection θ (°)	B_H (T)	Time for 10 Oscillations (s)	T (s)	Magnetic Moment M (A·m^2)
1						
2						
3						

11, 12, 13, 14, 16, 17th Weeks are Covered by Review class, Practice Class and Final Exam


Any Question ?

The End


شكراً جزيلاً
ngiyabonga
рахмат
danke
謝謝
teşekkür ederim
Баярлалаа
mersi
kia ora
barka
welalin
tack
spas
mahalo
спасибо
faafetai lava
vinaka
blagodaram
dank je
misaotra
paldies
grazzi
tapadh leat
kiitos
dankie
спасибі
matondo
thank you
gracias
хвала
nanni
nandri
dhanyavad
maururu
asante
manana
bedankt
hvala
köszönöm
dankon
aciū
obrigada
tenki
bayarlalaa
gràçie
murakoze
enkosi
djiere dieuf
tau
mochchakkeram
akun
дякую
mamnun
dziękuję
chnorakaloutioun
gratias ago
gràcies
sulpáy
go raibh maith agat
chokrane
sobodi
dėkuji
sukriya
kop khun krap
taiku
obrigado
sagolun
arigatô
takk
dakujem
trugarez
mèsi
didi madloba
ありがとう
tanemirt
grazie
najis tuke
terima kasih
rahmet
shukriya
mercé
мерси
kam sah hamnida
rahmat
ευχαριστώ
diolch
dhanyavadagalu
xièxie
তোমাকে ধন্যবাদ
감사합니다
merci