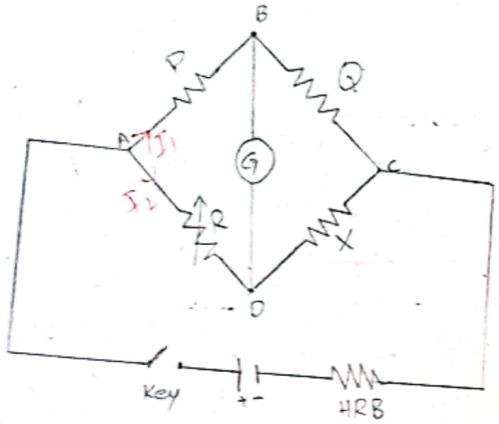
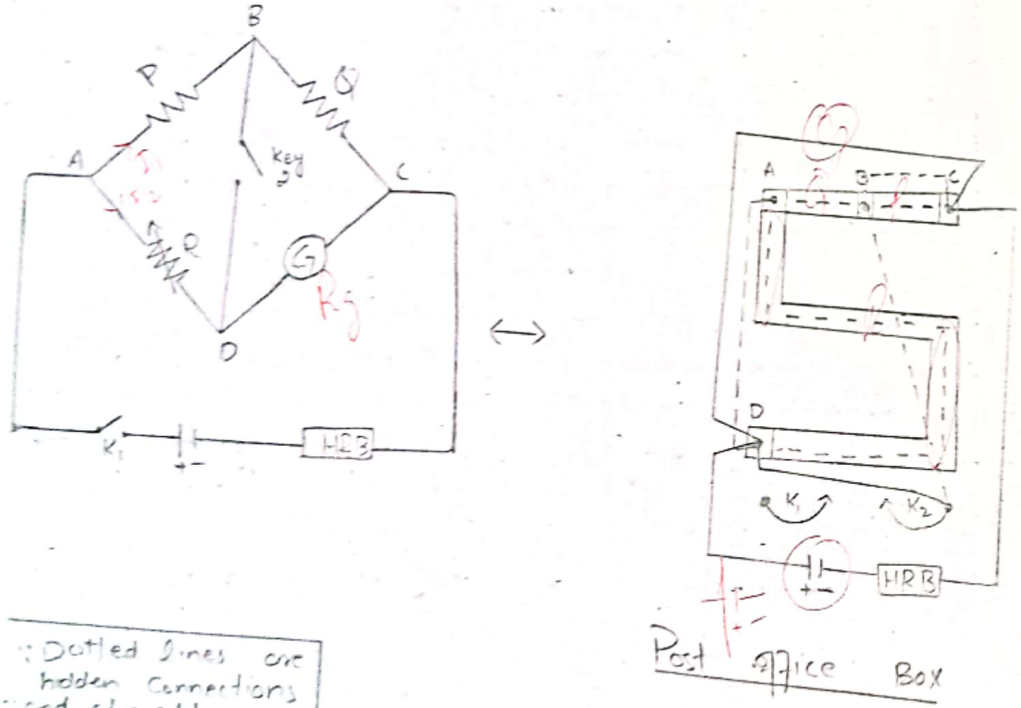


Diagram of Wheat Stone Bridge



: Dotted lines are hidden connections and straight line are connection of wires

Post Office Box

Experiment No. 01:-

To find Resistance of Galvanometer by Kelvin's Method.

Galvanometer:-

It is a device used for the detection of current

Mathematically:-

$$I \propto \theta$$

The above equation shows that current in galvanometer is directly proportional to angle of deflection of Scale.

Wheat Stone Bridge:

It is the device used to calculate and find unknown resistance is called wheat stone Bridge.

Mathematically:-

$$X = \frac{RQ}{P}$$

where 'X' is unknown resistance.

Post Office Box:-

It is a device which works on the same principle of Wheat Stone Bridg

Principle of Experiment:-

This experiment is based on the principle of wheat Stone Bridge

Observations and Calculations

S.No	P (Ω)	Q (Ω)	R (Ω)	$R_g = \frac{QR}{P}$ (Ω)
1	100 Ω	10 Ω	1000 Ω	$\frac{(10)(1000)}{100} = 100\,\Omega$
2-	1000 Ω	100 Ω	1100 Ω	$\frac{(1100)(100)}{1000} = 110\,\Omega$
3-	10 Ω	10 Ω	100 Ω	$\frac{(10)(100)}{10} = 100\,\Omega$
4-	1000 Ω	1000 Ω	100 Ω	$\frac{(1000)(100)}{1000} = 100\,\Omega$
5-	100 Ω	100 Ω	100 Ω	$\frac{(100)(100)}{100} = 100\,\Omega$
6-	110 Ω	100 Ω	110 Ω	$\frac{(110)(100)}{110} = 100\,\Omega$

$R_g = ?$

where we will use the following formula

$$X = R_g = \frac{RQ}{P}$$

where R_g is unknown resistance of Galvanometer

Apparatus :-

- Galvanometer
- Connecting Wires
- High Resistance Box
- Battery.
- Post office Box

Procedure of Experiment:-

1) First --- insert - P and Q resistance.
2) Connect K_1 and note the deflection. If it shows no deflection check for loose wires, key etc.
3) Insert resistance from HRB for with in scale deflection. e.g. Q = 20°.
4) Now connect K_2. If the scale shows no deflection circuit is balanced. Now note the reading of P, Q and R to find R_g. If circuit shows deflection then balance it by applying more resistance from R.
5) Find R_g by using $\frac{RQ}{P}$ mathematical Expression

$R_g = \frac{RQ}{P}$

One Ω

Experiment No. 02:

Conversion of Galvanometer into Ammeter (Range 0–40 mA, 0–50 mA, 0–60 mA)

Ammeter:-

An ammeter is a measuring device used for the measurment of current in a circuit. It has a very small internal Resistance.

Shunt Resistance :-

Shunt resistance is usually small resistance ranging from 1 to 100 or 500 ohms. It is represented by Rs.

Fractional Resistance:-

Fractional Resistance is very small resistance and is in fractions like 0.1, 0.2 ohms etc.

Principle of Experiment:-

The principle of experiment is when a Shunt Resistance is connected with galvanometer in parallel it is converted to Ammeter.

Apparatus:-

- Galvanometer
- Ammeter
- Voltmeter
- High Resistance Box

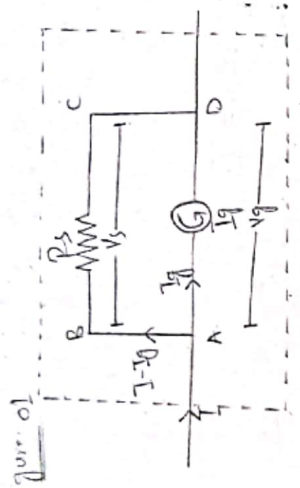
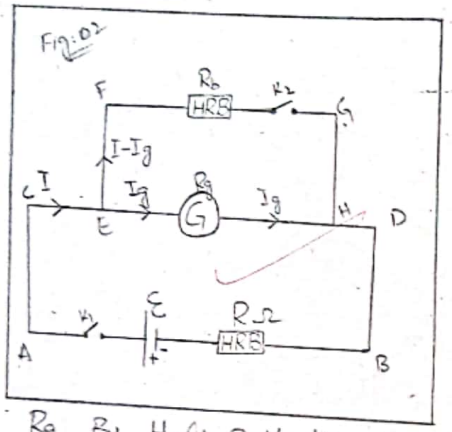


Figure: 01

Conversion of Galvanometer into Ammeter

Fig: 02



Rg By Half Deflection Method

For Circuit

$V_s = V_g$

$(I - I_g) R_s = I_g R_g$

$$R_s = \frac{I_g R_g}{I - I_g}$$

where R_s is Shunt resistance of Circuit

Table for value of (R_g)

S.No	$R\Omega$	θ_1	$\theta_2 = \theta_1/2$	$R_b(\Omega)$	$R_g = R_b(\Omega)$
1	7000 Ω	19	9.5	120 Ω	R_g = 120 Ω
2	8000 Ω	17	8.5	140 Ω	R_g = 140 Ω
3	10,000 Ω	14	7	140 Ω	R_g = 140 Ω
4	5000 Ω	30	15	140 Ω	R_g = 140 Ω
5	10,700 Ω	13	6.5	130 Ω	R_g = 130 Ω

For one value we will Take Average Value

$\langle R_g \rangle = 134\ \Omega$

↳ Small Resistance Box
↳ Fractional Resistance Box
↳ Connecting Wires
↳ Battery
↳ Keys

Procedure of Experiment:-

The experiment is performed in the following steps.

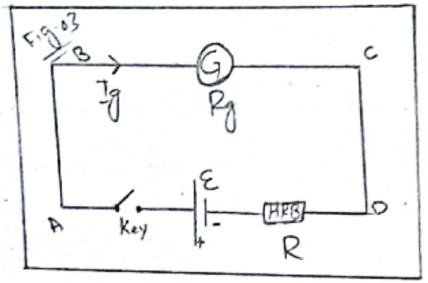
Step: 1: Calculating Resistance of galvanometer by half deflection method.

1) Connect the circuit as shown in figure. 02
2) First insert Key 1 and note ~~internal~~ Deflection of galvanometer. It should be out of Scale.
3) Apply resistance from R for with in Scale deflection.
4) Note the current deflection of galvanometer as θ_1.
5) Now plug Key 2. The deflection of galvanometer should be zero.
6) Apply resistance from R_b till the deflection of galvanometer become equal to half of θ_1 i.e $\theta_2 = \theta_1/2$
7) Note the resistance in R_b which is equal to resistance of galvanometer R_g.

Step No. 02: Calculating current through galvanometer (I_g) by full deflection method.

i- Connect the circuits as Shown in figure 03.
ii- Find the emf of the battery connected to circuit

Fig 03



Value of Ig By Full Deflection Method

Table For value of Ig.

S.No	Rg	R	E	$Ig = E/(R+Rg)$
1	134	4400	1.4V	$\frac{1.4}{134+4400} = 0.3mA$

So the value of Ig = 0.3mA or $308\times10^{-6}A$

For Shunt Resistance

$$Rs = \frac{Ig\,Rg}{I-Ig}$$

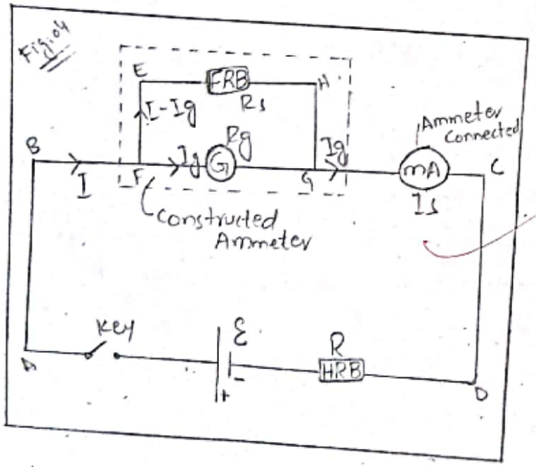
$$Rs = \frac{(0.3\times10^{-3}A)(134\ A)}{(30\times10^{-3}A - 0.3\times10^{-3}A)}$$

$$Rs = \frac{40\times10\times10^{-3}A}{29.7\times10^{-3}}$$

$$Rs = 1.3\Omega$$

Here 'I' was the range/maximum current measured by constructed/A.

Fig 04



Table

S.No	R(Ω)	Is (mA)	θ (div)	$Ic = \frac{Range}{30} \times div$	error Ic − Is
1	5000	19mA	26 div	$Ic = \frac{30}{30}\times26 = 26mA$	7mA

Result:- Hence we constructed an Ammeter of Range (0 − 30 mA)

with the help of voltmeter by connecting both terminals to it.

iii- Insert key and note the deflection of galvanometer. The deflection should be out of scale.

iv- Apply resistance from HRB for with in scale deflection till the needle reach to maximum reading on the galvanometer.

v- Rg is already calculated in above step So find the current in galvanometer by using formula $Ig = E/R+Rg$.

Step No. 03:- Calculation of Shunt Resistance.

i- Shunt resistance is calculated through a formula $Rs = IgRg/I-Ig$.

ii- Now connect the circuit as shown in figure number 04.

iii- Insert key and note the deflection of the galvanometer after applying Rs resistance.

iv- You must select range for your galvanometer for comparisen with ammeter for verification of result.

v- Note the current in Ammeter connected (Is)

vi- Now also note the deflections in galanmeter and count divisions (div)

vii- Find Ic by using formula $Ic = \frac{Rage}{30} \times div$ for galvanometer that has maximum 30 digits

viii- Now find the error in both circuits by using formula error = Ic - Is.

Precautions For Experiment:

i- Use a new battery or power source should be fully charged.

ii- Take Galvanometer and Ammeter without zero error.

iii- Try to keep length of shunt resistance same in parallel with galvonemter.

iv- Connect the wires and keys tight to minimize error probability in reading.

v- Do not alter or change galvanometer or Ammeter while experimenting.

A+

2/12/21

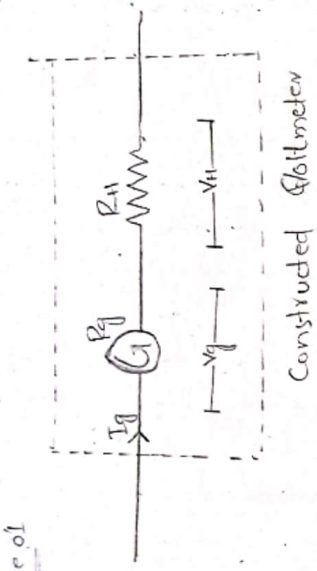


Figure of

Experiment NO: 03:-

Conversion of Galvanometer in voltmeter of Range 3-4 volts.

Voltmeter:-

It is an instrument used for the measurment of electric potential or potential difference between two points. It is connected across the components ends, potential difference across which is to be measured.

Principle of Experiment:-

When a high resistance is connected with a galvanometer in series, then the galvanometer act as voltmeter.

Mathematically:- $V = V_g + V_H$

$V = I_g R_g + I_g R_H \Rightarrow I_g(R_g + R_H)$

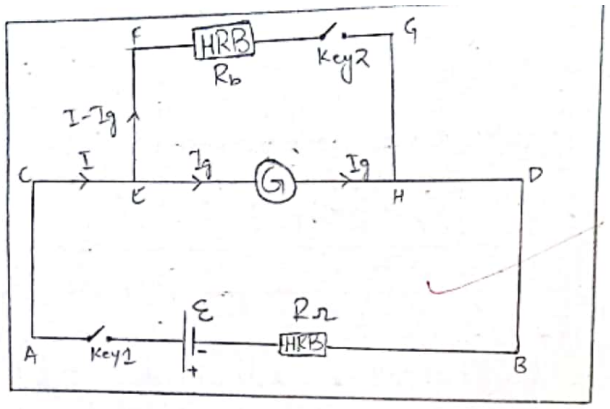
$$\frac{V}{I_g} = R_g + R_H$$

$$R_H = \frac{V}{I_g} - R_g$$ where "V" is range of constructed voltmeter.

Apparatus:-

- Galvanometer
- Voltmeter
- Battery
- Shunt Resistance Box
- HRB Boxes
- Connecting Wires
- Keys

Figure 02



Rg By Half-Deflection Method

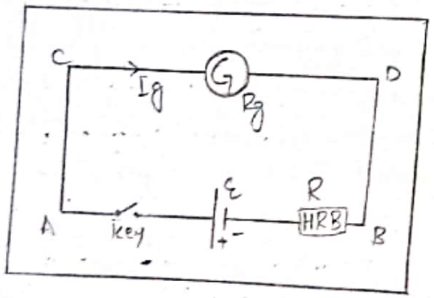
Table For Value of Rg

S.No	Rꭥ	θ_1	$\frac{\theta_1}{2}$	Rb(ꭥ)	$R_b = R_g$ (ꭥ)
1	7,000 ꭥ	17	8.5	120 ꭥ	120 ꭥ
2	10,000 ꭥ	12	6	110 ꭥ	110 ꭥ
3	5000 ꭥ	24	12	120 ꭥ	120 ꭥ

So To find Rg we will Take Average

$\langle R_g \rangle = 116.6\ \Omega$

Figure 03



Value of Ig By Full-Deflection Method

Procedure of Experiment:-

The total procedure of Experiment consist of following steps.

Step No.01: Calculating Resistance of galvanometer by half-Deflection Method.

i- Connect the circuit accordingly to figure 02

ii- Insert key 1 and note deflection of galvanometer. It should be out of Scale.

iii- Apply resistance from R for with in Scale deflection.

iv- Note the current deflection of galvanometer as θ_1

v- Now plug key 2. Note deflection of galvanometer. It should be zero.

vi- Apply resistance from to galvanometer from Rb till the current deflection θ_2 become equal to half of θ_1 i.e $\theta_2 = \theta_{1/2}$

vii- Note the resistance of Rb which is equal to the resistance of galvanometer Rg.

Step No.02:- Calculating current through galvanometer (Ig) by full deflection Method.

i- Connect the circuit according to Figure 03.

ii- Find the e.m.f of connected battery with the help of voltmeter by connected the both terminal to it.

iii- Insert key and note deflection of galvanometer. It should be out of Scale.

Table For value of I_g :

S.No	R_g	R	$\mathcal{E}$	$I_g = \mathcal{E}/R+R_g$
1	1166 Ω	3900 Ω	1.3V	0.3mA

(I_g = 0.3mA)

Now we have

$$R_H = \frac{V}{I_g} - R_g \Rightarrow \frac{3}{0.3\times10^{-3}A} \times 1166\,\Omega$$

$$R_H = 10{,}000 - 116.6 \Rightarrow \boxed{9883.4\,\Omega}$$

Figure 04

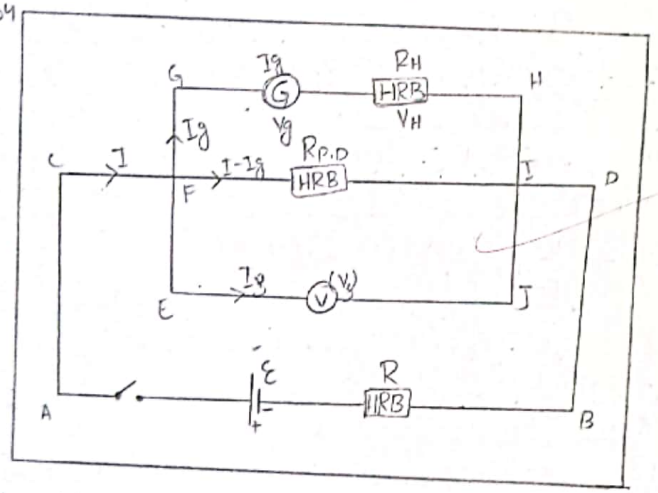


Table For V_g:

S.No	V(v)	Θ (div)	$V_g = \frac{Range}{30} \times div$	error
1	0.75V	7.5div	$\frac{3}{30} \times 7.5 = 0.75(V)$	0

Result:- Hence we constructed a voltmeter of Range 0–3 volts.

iv- Apply Resistance from HRB for with in scale deflection till the needle reach to maximum deflection of Galvanometer.

v- Calculate I_g by using the following formula $I_g = \mathcal{E}/R+R_g$

Step: 03: Calculation of High Resistance (R_H) :-

i- High Resistance is calculated through the following formula $R_H = \frac{V}{I_g} - R_g$ where as all the required values in I_g formula are already found.

ii- Now Connect the circuit according to figure 04

iii- The combination of galvanometer and R_H in series act as constructed ~~galvanometer~~ voltmeter while another voltmeter is connected to test the accuracy of constructed voltmeter.

iv- Insert key 1 and apply resistance of R_H and note the deflection of galvanometer in divisions.

v- Apply potential difference to the voltmeter from $R_{P.D}$ for measuring V.

vi- Convert the divisions of galvanometer to volts by using formula $V_g = \frac{Range}{30} \times div$

vii- Compare the values of V and V_g to find the error in the circuit.

Precautions of Experiments:-

i- The power Source or battery should be fully Charged.

ii- The galvanometer and voltmeter should be without zero error.
iii- Try to keep the length of High and Small resistance Same. to avoid resistance error.
iv- Connect the wires and keys tight across connections to minimize probability of error
v- Do not change galvanometer or Voltmeter during an experiment.

Group: A

Experiment No: 04:

To Study variation of photoelectric current with intensity of Incident Light.

Photoelectric Current:-

The phenomena in which electrons are released from the surface of conductor when (ultravoilet) light falls on it. The phenomena is known as photo electric effect and the current due to ejected electrons is photoelectric current. The light should be of particular frequency.

Mathematically:-

$$I = E/A = E/4\pi d^2 \Rightarrow I = K/d^2$$

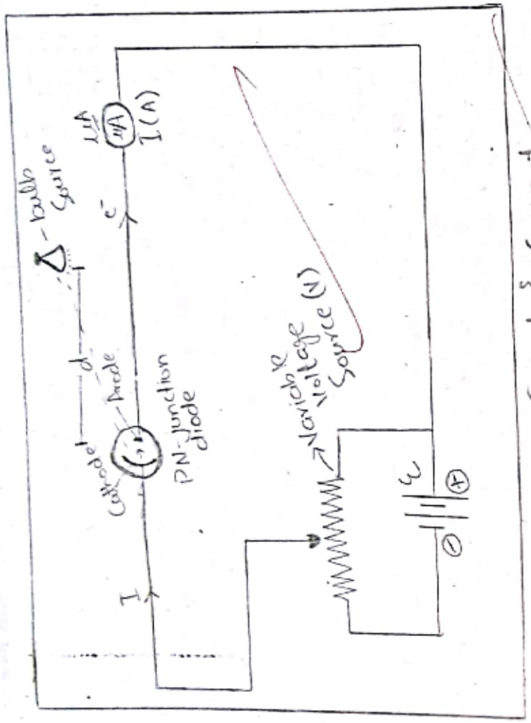
So $I \propto 1/d^2$ where I is intensity of light.

Principle of Experiment:

The experiment is based on the principle of photoelectric current. When light from light source falls on surface of conductor it emits electrons from metal surface. While the micro Ammeter connected in circuit measures the intensity of current due to emitted electrons.

Apparatus:-

- Voltmeter
- Power Supply
- Photoelectric Apparatus.
- Micrometer
- Meter Rod



Photoelectric Effect & Current

Mathematically

$E_i \geq E_e$

$E_i \geq \phi$ (work Function)

$hf \geq hf_0$

$f \geq f_0$ (Threshhold Frequency)

$E_c = \phi + K.E$

$hf = hf_0 + K.E$

Procedure of Experiment:

i- Light from Source fall into a metal Surface at Some particular distance measured by meter rod.

ii- Electrons emitted from a metal Surface due to incident beam are called photons and current produced due to photons is called photoelectric current.

iii- The micrometer will show deflection showing current flow through the circuit.

iv- The circuit figure Shows cathode and Anode. The diode tube cathode is connected to negative terminal of battery.

v- The microammeter is connected in Series with the circuit.

vi- If we increase or decrease distance between bulb and conductor plate the microammeter will show deflection.

vii- The intensity of beam depends upon the distance of Source from tube. $I \propto 1/d^2$

viii- The voltage is changed from different values and graph is plotted.

Precautions of Experiment:-

i- Take readings of I keeping d in regular and Same range of increase and decrease to increase accuracy.

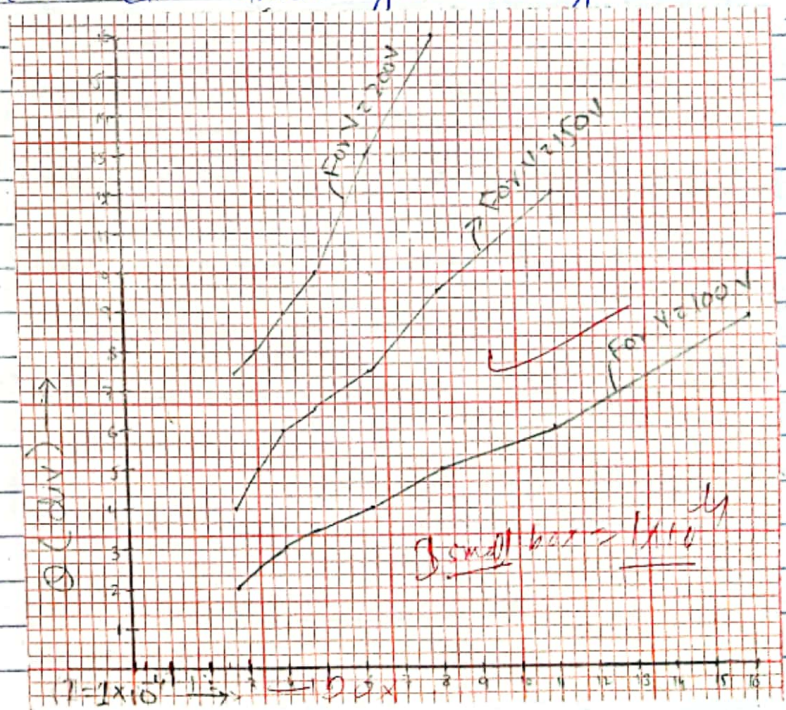
d(cm)	d^2	Q(μA)	$I = 1/d^2$
Given Voltage: 100V			
60 cm	3600 cm^2	2	2.7×10^{-4}
55	3025	2.5	3.3×10^{-4}
50	2500	3	4×10^{-4}
45	2025	3.5	4.9×10^{-4}
40	1600	4	6.25×10^{-4}
35	1225	5	8.1×10^{-4}
30	900	6	11.1×10^{-4}
25	625	8.5	16×10^{-4}
20	400	12	25×10^{-4}
15	225	19.5	44.4×10^{-4}
10	100	50	100×10^{-4}
Given Voltage: 150V			
60	3600	4 A 1A	2.7×10^{-4}
55	3025	5 AA	3.3×10^{-4}
10	2500	6	4×10^{-4}
45	2025	6.5	4.9×10^{-4}
40	1600	7.5	6.25×10^{-4}
35	1225	9.5	8.1×10^{-4}
30	900	12	11.1×10^{-4}
25	625	16.5	16×10^{-4}
20	400	22	25×10^{-4}
15	225	43	44.4×10^{-4}
10	100	105	100×10^{-4}
Given Voltage: 200V			
60	3600	7.4	2.7×10^{-4}
55	3025	8	3.3×10^{-4}
50	2500	9	4×10^{-4}
45	2025	10	4.9×10^{-4}
40	1600	13	6.25×10^{-4}
35	1225	16	8.1×10^{-4}
30	900	22	11.1×10^{-4}
25	625	31.5	16×10^{-4}
20	400	55	25×10^{-4}
15	225	95	44.4×10^{-4}
10	100	240	100×10^{-4}

ii- Do not change light source in between the experiment to keep frequency same for each reading.

iii- Do not use galvanometer converted to ammeter because galvanometer do not give precise value of current while microammeter gives more accurate reading.

iv- Only change the distance of source linearly. Do not change the angle of source to avoid inconsistency in current.

v- Do not expose the photocell to external/stray light. It can alter your readings.



Experiment No: 05:

To find the frequency of A.C main by Sonometer

Sonometer:-

It is a device used for demonstrating the relationship between the frequency of sound that is produced by the string when it is plucked and the tension, length and mass per unit length of the string. The sound is produced in transverse standing waves.

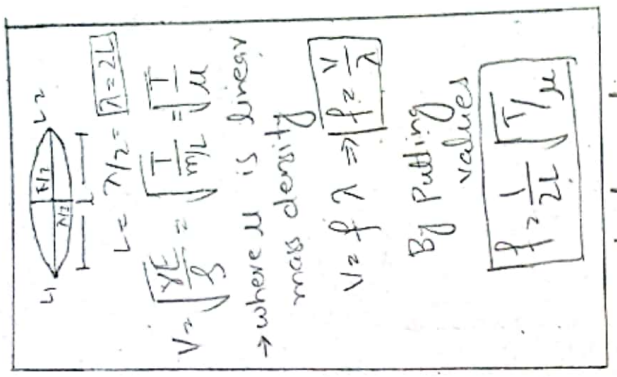
Principle of Experiment:

The experiment is based on the principle of resonance. When transverse waves are excited in a stretched wire the bridges act as a rigid reflection of these waves. Due to rigid reflection, stationary waves are formed at nodes at the bridges/wedges $l = \lambda/2 \Rightarrow (\lambda = 2L)$

$$f = \frac{1}{2L}\sqrt{T/\mu}$$

Apparatus:-

- Sonometer
- Weights
- Step down transformer
- Alternating Current (A.C) main Supply
- Ammeter
- Rheostate
- Wedges
- Magnet



Mathematical equation

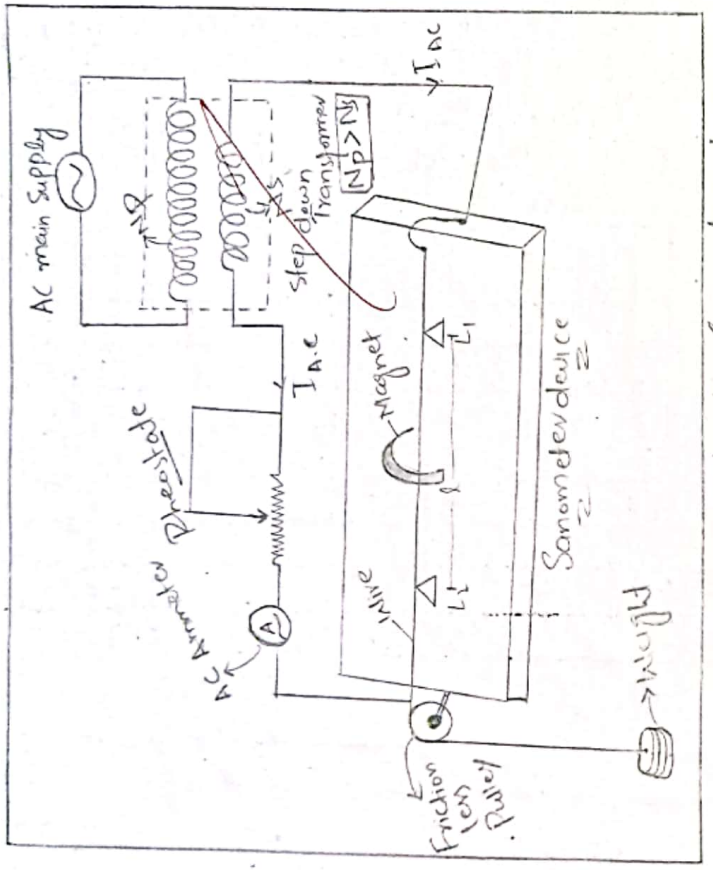


Figure of Experiment : Sonometer device

For Conducting Wire: $\mu = m/L = 0.052\ g/cm$

Table of Measurments

m(g)	T = mg (g/cm)	L_1 (cm)	L_2 (cm)	$L_2 - L_1$ (cm)	$\sqrt{T}$ (g/cm)	$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$ (Hz)
1000g	980,000 g/cm	7cm	50.2cm	43.2 cm	989.94	49.9 Hz
1500	1470,000	7	62.5	55.2	1212.43	48.1
2000	1960.000	7	69.5	62.5	1400	49.11
2250	2205000	7	70	63	1484.9	52.09
2500	2450000	7	75.5	68.5	1565.2	50.32
2750	2695000	7	79	72	1641.6	49.99
3000	2940000	7	83	76	1714.6	49.46
3500	3430000	7	86.5	79.5	1852	51.07
3750	3675000	7	90	83	1917	50.64

Average Frequency = $\langle f \rangle = 50.07$ Hz

Result :- So the frequency of Alternating Current is Approximately 50 Hz.

Procedure of Experiment:-

i- Arrange the Apparatus as shown in figure

ii- Switch on the Supply from A.C main.

iii- Start increasing distance between wedges L_1 & L_2 which are placed next to each other.

iv- At a particular point the wire has a maximum vibration which is found by moving L_2 back and forth.

v- L_1 is fixed while only L_2 is moved back and forth.

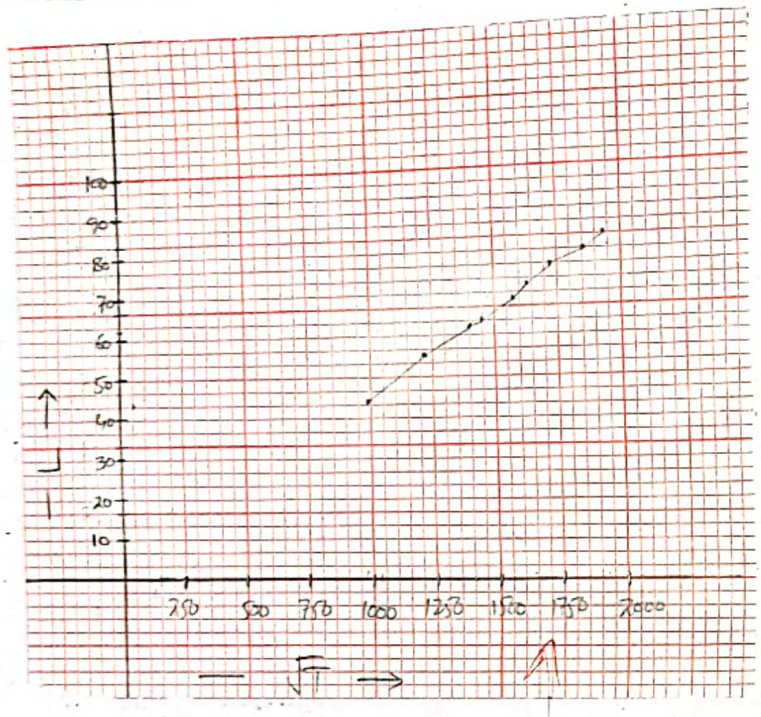
vi- The frequency of this maximum vibration is found by equation $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

where as 'T' is tension in the String and μ is linear mass density of wire.

vii- The vibration is due to the fact that current carrying conductor is placed in magnetic field. Force is experianced by the conductor perpendicular to both field and current.

viii- As we increase the length 'L' between L_1 wedge and L_2 wedge the wire vibration gradually increases. When the vibration of wire become equal to natural frequency of A.C, the wire vibration at that point increases than normal.

ix- At that point when frequency of Alternating



Scale For Graph

For Y- axis :- Length(L)

→ 3 small boxes = 10 cm Length

For X- axis = ($\sqrt{T}$) Tension in wire

→ One small box = 50 g/cm of Tension(T)

current and wire passing the current, we find frequency of wire by equation $f = 1/2L \sqrt{T/\mu}$ which is the required frequency of Alternating current.

Precautions of Experiment:-

i- Keep the hanging weight straight and in rest while experimenting to avoid error in Tension of string.

ii- There should be no kinks in wire of Sonometer.

iii- Keep the pulley of Sonometer frictionless.

iv- Change the position of L_2 slowley otherwise the resonance point will be missed.

v- Find the distance b/w L_1 & L_2 at various points by changing weight and tension in wire for multiple readings.

vi- The magnet should be placed in such position so that magnetic field is perpendicular to wire.

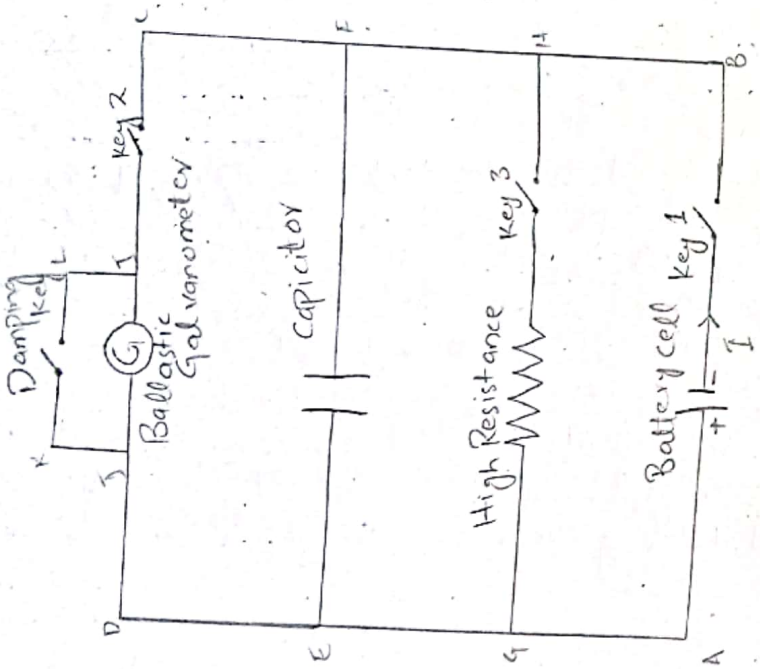


Diagram for Method of Leakage...

Experiment No: 06

To determine the given high Resistance by leakage Method.

Ballastic Galvanometer:-

The galvanometer which is used to estimate the quantity of charge flow through it is called ballastic galvanometer. It consist of moving coil which has a large moment of Inertia so that it respond to the quantity of charge passed (Rather than the size of the current). It is suitable for measuring very small currents.

Apparatus:-

- Ballastic Galvanometer
- Three keys
- Cell
- Stopwatch.
- High Resistance
- Capicitor ($1\mu F = 1 \times 10^{-6} F$)

Procedure:

i- Set the ballastic galvanometer on zero point.

ii- To get reading of galvanometer deflection draw out the damping key. So that the current should pass through ballastic galvanometer.

iii- Press key 1. The capicitor will charge for

Table For Experiment

S.No	Q_0	t(s)	Q_t	$R = \frac{t}{C \ln(Q_0/Q_t)}$ (Ω)
1	78	3.22	59	11.5×10^6 Ω
2	79	4.2	53	10.5×10^6 Ω
3	67	2.7	52	10.6×10^6 Ω
4	78	2.92	58	9.1×10^6 Ω
5	74	2.84	57	10.8×10^6 Ω
6	72	2.47	58	11.4×10^6 Ω
7	78	2.99	57	9.5×10^6 Ω

So the Average Resistance

$\langle R \rangle = \boxed{10.4 \times 10^6\ \Omega}$

Sometime. Then release key 1.

v- Now press key 2. The charge will leak capicitor to galvanometer and hence it will show reading.

v- Note the deflection Q_0. Q_0 for the first or highest deflection of pointer (light spot).

vi- Now put the damping key again and ~~on~~ charge the capicitor by pressing key 1.

vii- Now release key 1 and press key 3. for a known time 't'. Note the time 't' and release key 3.

viii- Now Again press key 2, the galvanometer will show deflection again. Note the reading at Q_t.

ix- This deflection will be less than Q_0 because some charge is already been leaked by pressing key 3 and remaining by key 2 again.

x- Use the formula $R = \frac{t}{C \ln(Q_0/Q_t)}$

to find the value of resistance where 'C' is the capicitance of capicitor whose value is 1×10^{-6} F. (1 μF).

Precautions of Experiment:

1- The galvanometer coil should be free

to rotate.

ii- Damping key should be pressed when the spot is ~~comming~~ crossing zero of the circle. Scale.

iii- Both the lower terminals of high resistance are to be connected.

iv- Charge the capicitor before taking reading of D.

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