Experiment no. 4

Name of the Experiment

Determination of Speed of Sound in air

38/40

Name M. Maheeth Reddy

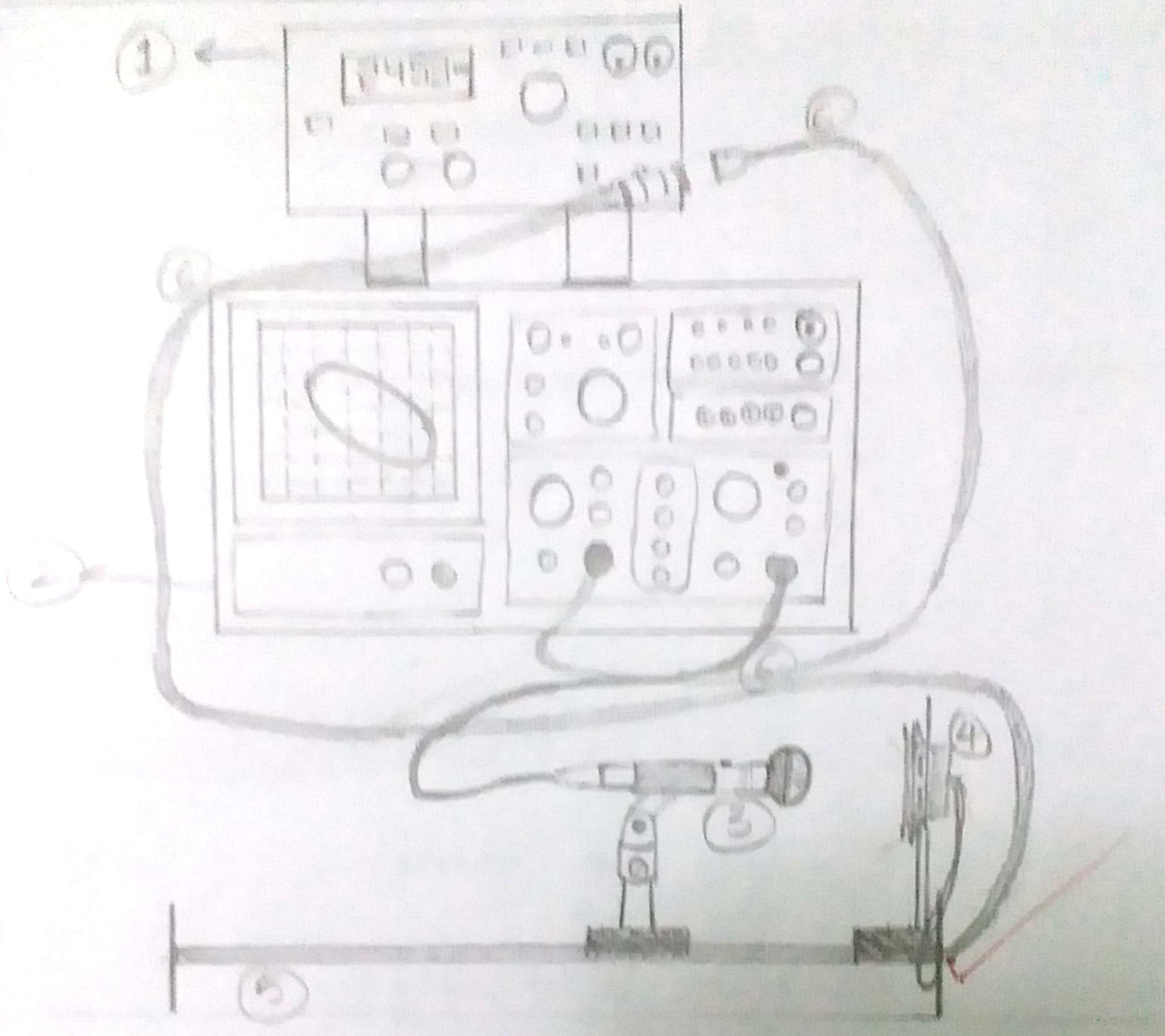
Roll No. 1801CS31

Lab Group LG5

Date 25.10.18

Experimental Setup:

DETERMINATION OF SPEED OF SOUND BY CATHODE RAY OSCILLOSCOPE



1 → Function Generator

2 → Cathode Ray Oscilloscope

3 → Receiver

4 → Transmitter

5 → Grill Grid & Meter Scale

6 → Wires

Objective:

To determine speed of sound in air at room temperature using a cathode ray oscilloscope.

Apparatus required:

Transmitter; Receiver; Function Generator; Cathode Ray Oscilloscope; Meter Scale & Grill Grid; Wires;

Working Formula:

$$\boxed{c = \nu \lambda}$$

where, $c \rightarrow$ speed of sound in air

$\nu \rightarrow$ frequency of sound wave / frequency inputted by function generator

$\lambda \rightarrow$ wavelength of sound wave

(P.T.O)

Least Count of Function Generator = 10^{-9} kHz

Observation Table: Least Count of meter scale of guide rail = 0.1cm

Sno.	ν(Hz)	$1/\nu$	l_1(cm)	l_2(cm)	$l_2-l_1=\lambda/2$ (cm)	λ (cm)	Mean λ(cm)
1.	2000	0.5×10^{-3}	24.5	33.7	9.2	18.4	18.72
			33.7	42.2	8.5	17	
			42.2	51.2	9.0	18	
			51.2	60.0	8.8	17.6	
			60.0	71.3	11.3	22.6	
2.	2200	0.45×10^{-3}	21.4	30.5	9.1	18.2	16.4
			30.5	38.5	8.0	16.0	
			38.5	46.3	7.8	15.6	
			46.5	55.1	8.8	17.6	
			55.1	62.4	7.3	14.6	
3.	2400	0.42×10^{-3}	27.6	35.2	7.6	15.2	14.56
			35.2	42.8	7.6	15.2	
			42.8	50.3	7.5	15.0	
			50.3	57.0	6.7	13.4	
			57.0	64.0	7.0	14.0	
4.	2600	0.38×10^{-3}	32.7	39.5	6.8	13.6	13.08
			39.5	45.9	6.4	12.8	
			45.9	53.6	7.7	15.4	
			53.6	59.5	5.9	11.8	
			59.5	65.4	5.9	11.8	

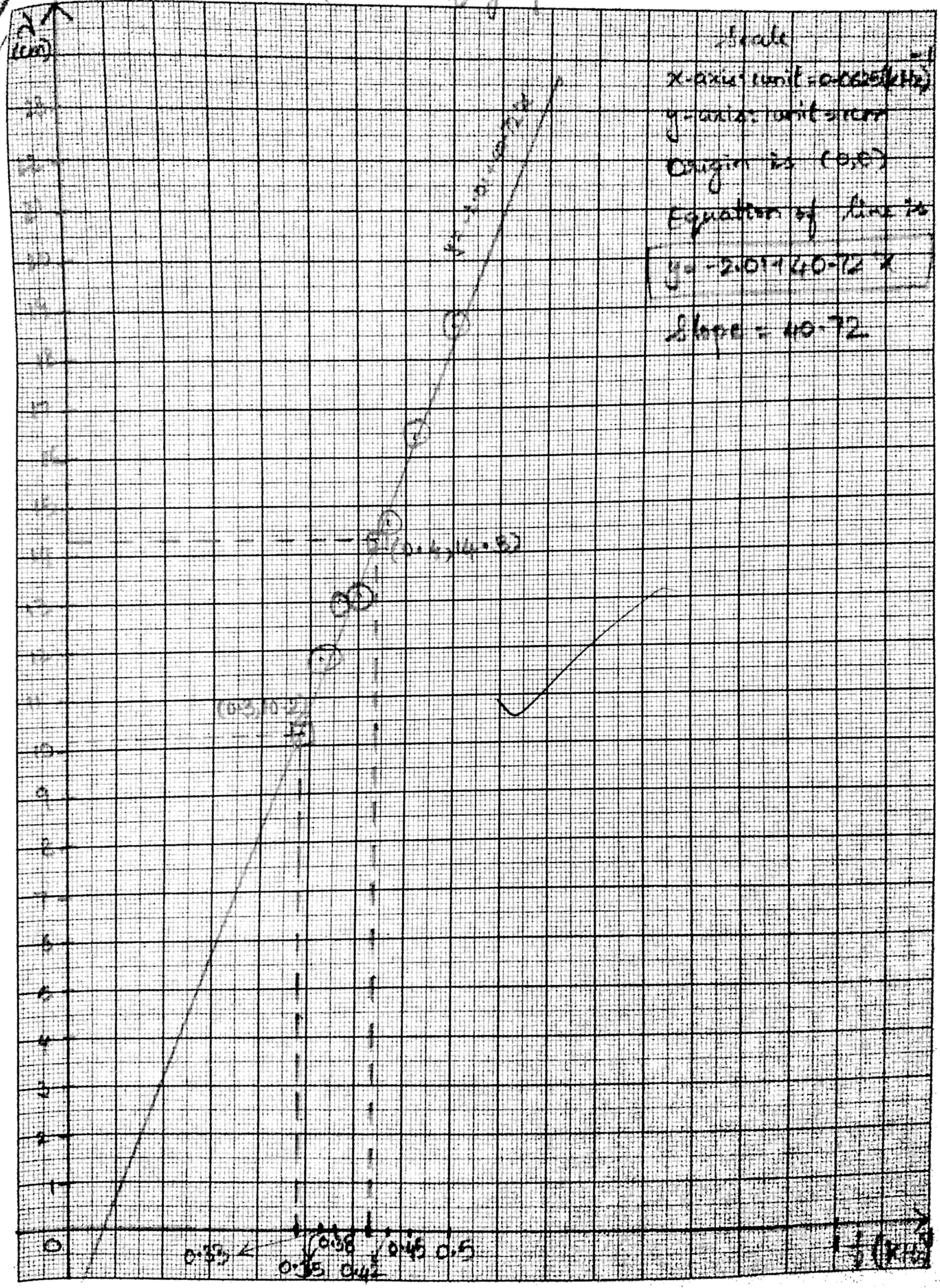
(P.T.O)

Observation Table (contd)

S.no.	ν (Hz)	$1/\nu$	l_1 (cm)	l_2 (cm)	$l_2 \sim l_1 = \frac{\lambda}{2}$ (cm)	λ (cm)	Mean λ (cm)
5.	2800	0.35×10^{-3}	37.0	43.3	6.3	12.6	
			43.3	49.6	6.3	12.6	
			49.6	56.0	6.4	12.8	12.96
			56.0	62.3	6.3	12.6	
			62.3	69.4	7.1	14.2	
6.	3000	0.33×10^{-3}	23.5	29.5	6.0	12.0	
			29.5	35.7	6.2	12.4	
			35.7	41.3	5.6	11.2	11.8
			41.3	47.0	5.7	11.4	
			47.0	53.0	6.0	12.0	

(P.T.O)

λ vs $\frac{1}{f}$ graph



Calculations:

Equation of straight line obtained in d vs $\frac{1}{v}$ graph is

$$\boxed{y = -2.01 + 40.72x}$$

By slope of graph, we determine speed of ~~space~~ sound

Slope = $40.72\ cm/ms$ $\Rightarrow$ $\boxed{\text{Speed of Sound} = 407.2\ ms^{-1}}$

Maximum Possible Error:

We know, $c = vd$

Taking logarithm on both sides,

$$\log c = \log v + \log d$$

Differentiating on both sides.

$$\frac{dc}{c} = \frac{dv}{v} + \frac{dd}{d} \qquad \frac{\Delta c}{c} = \frac{\Delta v}{v} + \frac{\Delta d}{d}$$

$\Delta v = 10^{-9}\ kHz$ and $\Delta d = 0.1\ cm$

Take $v = 3.0\ kHz$ and $d = 11.8\ cm$

$$\Rightarrow \frac{\Delta c}{c} = \frac{10^{-9}}{3} + \frac{0.1}{11.8} \Rightarrow \frac{\Delta c}{c} = 8.47 \times 10^{-3}$$

$$\Rightarrow \Delta c = 8.47 \times 10^{-3} \times 407.2\ ms^{-1} \Rightarrow \boxed{\Delta c = 3.45\ ms^{-1}}$$

Result:

Speed of Sound obtained from the experiment is

$$\boxed{c = (407.2 \pm 3.45)\ ms^{-1}}$$

Precautions:

→ Handle the Cathode Ray Oscilloscope with care. Use it in XY-mode only throughout the experiment.

→ Leave a gap of atleast 1 cm between transmitter and receiver for taking readings.

→ The transmitter's volume should be kept low for better results.

→ Don't move the apparatus while taking readings.

Sources of Error:

→ Parallax error while taking readings of l_1, l_2

→ Transmitter and receiver have magnetic fields which may cause slight distortion in the display of oscilloscope, hence not giving straight at the exact distance.

→ External Noise

→ May be error in experimental setup.

→ Don't put your hand in between transmitter and receiver for readings.

Experiment No.: 3

Name of the Experiment

STUDY OF HALL EFFECT

Crystal No. 6552

Name M. Maheeth Reddy

Roll No. 1801CS31

Lab Group LG5

Date 11.10.2018

38/40

Aim:

To study Hall Effect in extrinsic semiconductor samples and determine the type, density and mobility of majority charge carriers.

Apparatus Required:

Extrinsic Semiconducting sample, Compass.

Hall Effect Set-up Unit, Constant Current Power Supply.

Gaussmeter with sensor, ~~Wi~~Electromagnet, Connecting Wires

Working Formulae:

$$\boxed{R_H = \frac{V_H d}{IB}} \qquad \boxed{n = \frac{1}{R_H q}} \qquad \boxed{\mu = \sigma R_H}$$

$R_H \rightarrow$ Hall Co-efficient

$V_H \rightarrow$ measured Hall Voltage

$B \rightarrow$ Magnetic field generated

$q \rightarrow$ Charge magnitude $(1.6 \times 10^{-19} C)$

$d \rightarrow$ thickness of sample along current flow direction

$I \rightarrow$ Current in circuit

$\mu \rightarrow$ mobility of charge

$n \rightarrow$ charge density

$\sigma \rightarrow$ Conductivity of sample

Aim:

To study Hall Effect in extrinsic semiconductors samples and determine the type, density and mobility of majority charge carriers.

Apparatus Required:

Extrinsic Semiconducting Sample, Compass,
Hall Effect Set-up Unit, Constant Current Power Supply,
Gaussmeter with sensor, ~~Ele~~ Electromagnet, Connecting Wires

Working Formulae:

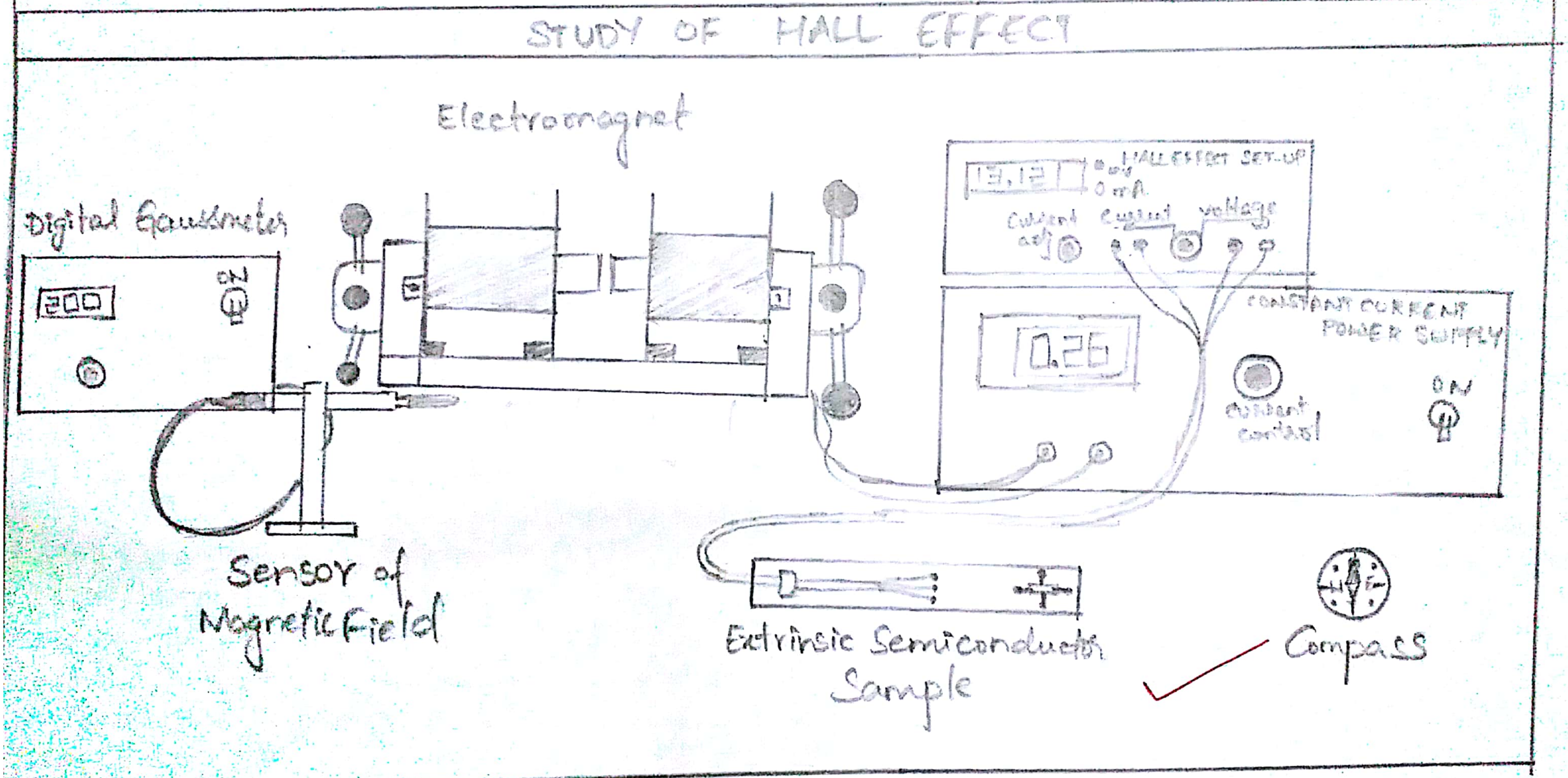
$$\boxed{R_H = \frac{V_H d}{IB}} \qquad \boxed{n = \frac{1}{R_H q}} \qquad \boxed{\mu = \sigma R_H}$$

$R_H \rightarrow$ Hall Co-efficient
$V_H \rightarrow$ measured Hall Voltage
$B \rightarrow$ Magnetic field generated
$q \rightarrow$ Charge magnitude $(1.6 \times 10^{-19} C)$

$d \rightarrow$ thickness of sample along current flow direction
$I \rightarrow$ Current in circuit
$\mu \rightarrow$ mobility of charge
$n \rightarrow$ charge density

$\sigma \rightarrow$ Conductivity of sample

Experimental Set-Up:



Observation Table: Least Count of Ammeter = 10^{-2} mA

Least Count of Voltmeter = 0.1 mV

Least Count of Gaussmeter = 10 Gauss

Resistivity of Crystal = 5 Ω cm

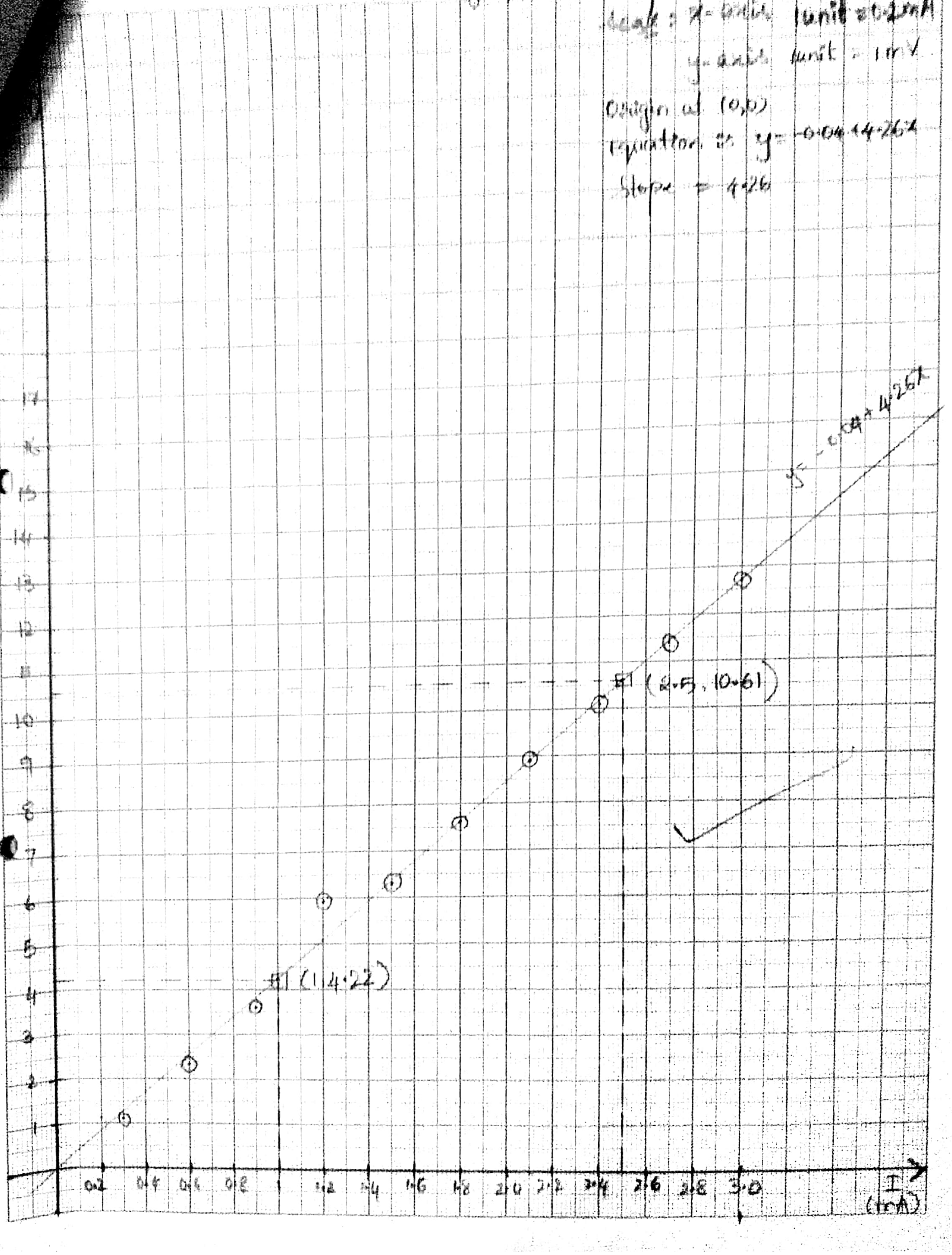
Thickness of Crystal = 0.5 mm

Crystal No. = $\boxed{6552}$

All voltages are in mV.

S No.	I (mA)	+B (left → right)				−B (right → left)				V_H
		$V_1(+V,+I)$	$V_2(+V,-I)$	$V_3(-V,+I)$	$V_4(-V,-I)$	$V_1(+V,+I)$	$V_2(+V,-I)$	$V_3(-V,+I)$	$V_4(-V,-I)$	
1.	0.3	1.1	−1.3			−1.2	0.8			1.1
2	0.6	2.4	−2.6			−2.4	1.8			2.3
3	0.9	3.7	−4.2			−3.6	2.9			3.6
4	1.2	5.0	−5.4			−4.8	4.3			5.9
5	1.5	6.5	−7.0			−6.3	5.5			6.3
6	1.8	7.8	−8.3			−7.6	6.7			7.6
7	2.1	9.3	−9.7			−8.7	7.9			8.9
8	2.4	10.6	−11.0			−9.8	9.0			10.1
9	2.7	11.8	−12.3			−11.1	10.3			11.4
10	3.0	13.3	−13.8			−12.3	11.4			12.7

V_H vs I graph


Scale : x-axis 1 unit = 0.2 mA
y-axis 1 unit = 1 mV
Origin at (0,0)
equation is y = -0.04 + 4.26x
Slope = 4.26
y = -0.04 + 4.26x
(2.5, 10.61)
(1, 4.22)
0.2
0.4
0.6
0.8
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
I (mA)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Calculations:

Equation of line in V_H vs I graph,

$$\boxed{y = -0.04 + 4.26x}$$

~~Slope of graph gives Hall Co-efficient, $R_H = 4.26\,\Omega$~~

$$R_H = \frac{V_H d}{IB} = \text{Slope} \times \frac{d}{B}$$

$$= 4.26 \times \frac{0.5 \times 10^{-3}}{2000}$$

$$\boxed{R_H = 1.065 \times 10^{-6}\,\Omega m G^{-1} = 1.065 \times 10^{-6}\,m^3/C}$$

Carrier density / Charge density,

$$\boxed{n = \frac{1}{R_H q} = 5.86 \times 10^{24} /m^3}$$

Mobility μ of charge,

$$\mu = \sigma R_H = \frac{R_H}{\rho}$$

$$= \frac{1.065 \times 10^{-6}\,m^3 C^{-1}}{5 \times 10^{-2}\,\Omega m}$$

$$\boxed{\mu = 2.13 \times 10^{-5}\,m^2 C^{-1}}$$

Error Analysis [Maximum Possible Error]:

$$R_H = \frac{V_H d}{IB}$$

Taking ln on both sides

$$\Rightarrow \ln R_H = \ln V_H + \ln d - \ln I - \ln B$$

differentiating on both sides

$$\Rightarrow \frac{dR_H}{R_H} = \frac{dV_H}{V_H} + \cancel{\frac{d(d)}{d}}^{0} + \frac{dI}{I} + \frac{dB}{B}$$

(d = constant)

~~(B = constant)~~

For the first reading,

$V_H = 1.1\,mV$ $\quad d = 0.5\,mm$ $\quad I = 0.3\,mA$ $\quad B = 2000\,G$

$dV_H = 0.1\,mV$ $\quad dI = 10^{-2}\,mA$ $\quad dB = 10\,G$

$$\Rightarrow \frac{dR_H}{R_H} = \frac{0.1}{1.1} + \frac{10^{-2}}{0.3} + \frac{10}{2000}$$

$$\Rightarrow \boxed{\frac{dR_H}{R_H} = 0.129} \Rightarrow \boxed{dR_H = 1.376 \times 10^{-7}\,m^3/C}$$

Result:

Hall Co-efficient obtained is

$$\boxed{R_H = (1.065 \times 10^{-6} \pm 1.376 \times 10^{-7})\,m^3/C}$$

The semiconductor sample was of P-type.

Scanned by CamScanner

Precautions:

(i) Do not exceed the current above 7mA, from Hall-Effect set up, it may damage the sample.

(ii) Current should be increased very slowly from current supply to electromagnet as it is a high current supplier.

(iii) Before changing polarity of current supply, switch it off.

(iv) Check magnetic field between electromagnet after changing polarity.

(v) Don't use the leads of wire rigorously, they may break.

(vi) Switch off the current supply after finishing the experiment.

Sources of Error:

(i) Rapid increase in current.

(ii) Improper setting of leads

(iii) Fluctuating readings on Hall-Effect Set-Up

(iv) Putting sensor in opposite directions for +B and -B.

Experiment No.: 2

Name of the Experiment:

Q-Factor of an LCR Circuit

$\frac{37}{40}$

Name	M.Maheeth Reddy
Roll No.	1801CS31
LabGroup	LG5
Date	04-10-2018

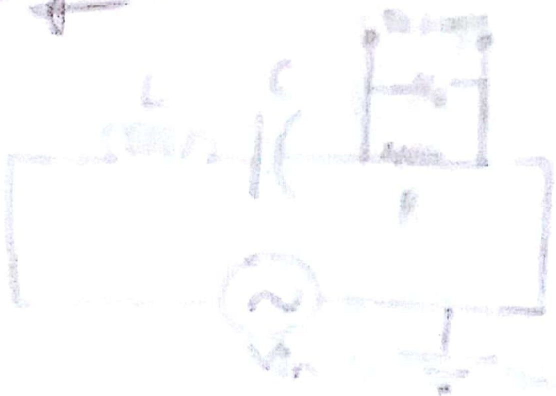
Objective:

To study forced damped oscillations using LCR circuit and determine the Q factor of the circuit.

Apparatus Required

Inductor (L), Capacitor (C), Resistor (R), Connecting wires, Key, Bread Board, Ammeter.

Diagram:



L → Inductor

C → Capacitor

R → Resistance

⊙ → Voltage Source

→ Grounding

—— → Connecting wires

Working Formula:

$$\boxed{Q = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

Q – Q-factor

R → Resistance value

L → Value of Inductance

C → Value of Capacitance

Observation Table:

L = ?
C = ?
R = ?

Least Count of Function Generator = 10^{-9} kHz

Least Count of Voltmeter = 0.01 mV ~~Least Count of~~

Value of Peak Voltage for Source = 2V

Value of Resistance = 9.88 Ω

S.no.	f(kHz)	V_R(V)	S.no.	f(kHz)	V_R(V)	S.no.	f(kHz)	V_R(V)
1	1	9.5	15	7.8	130.87	29	11	87.28
2	2	19.85	16	7.9	131.76	30	12	73.26
3	3	31.72	17	8	131.42	31	13	63.68
4	4	46.78	18	8.1	131.42	32	14	56.88
5	5	66.76	19	8.2	131.22	33	15	51.16
6	6	90.14	20	8.3	130.34	34	16	46.51
7	7	115.76	21	8.4	129.52	35	17	42.68
8	7.1	119.55	22	8.5	128.31	36	18	39.45
9	7.2	121.32	23	8.6	126.39	37	19	36.69
10	7.3	124.46	24	8.7	125.65	38	20	34.32
11	7.4	126.55	25	8.8	123.27			
12	7.5	128.67	26	8.9	120.27			
13	7.6	129.22	27	9	~~121.28~~			
14	7.7	129.42	28	10	103.20			

Observation Table

Least Count of Function Generator = 10^{-9} kHz

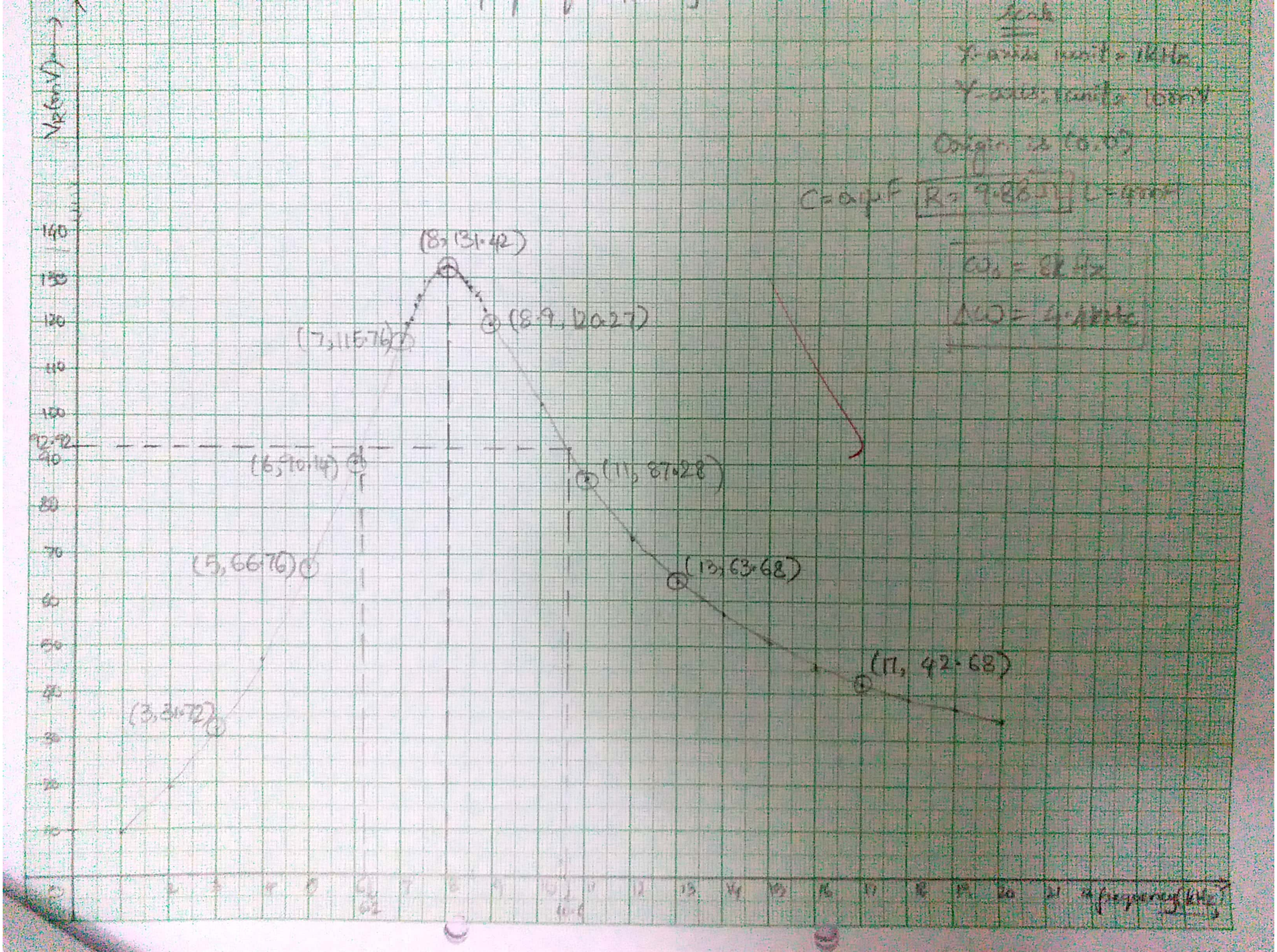
Least Count of Voltmeter = 0.01 mV

Value of Peak Voltage for Source = 2V

Value of Resistance = 3.27 Ω

S.no.	f (kHz)	V_R (mV)	S.no.	f (kHz)	V_R (mV)	S.no.	f (kHz)	V_R (mV)
1	1	3.23	14	7.7	52.73	28	10	39.07
2	2	6.83	15	7.8	53.03	29	11	32.01
3	3	11.03	16	7.9	53.23	30	12	27.04
4	4	16.54	17	8.0	53.28	31	13	23.28
5	5	24.04	18	8.1	53.19	32	14	20.46
6	6	34.40	19	8.2	52.45	33	15	18.27
7	7	47.03	20	8.3	52.61	34	16	16.53
8	7.1	48.14	21	8.4	52.15	35	17	15.10
9	7.2	49.14	22	8.5	52.49	36	18	13.92
10	7.3	50.09	23	8.6	50.26	37	19	12.92
11	7.4	50.92	24	8.7	50.16	38	20	12.06
12	7.5	51.66	25	8.8	49.41			
13	7.6	52.24	26	8.9	48.60			
			27	9	47.77			

(P.T.O)



Scale

X-axis: 1 unit = 1kHz

Y-axis: 1 unit = 10mV

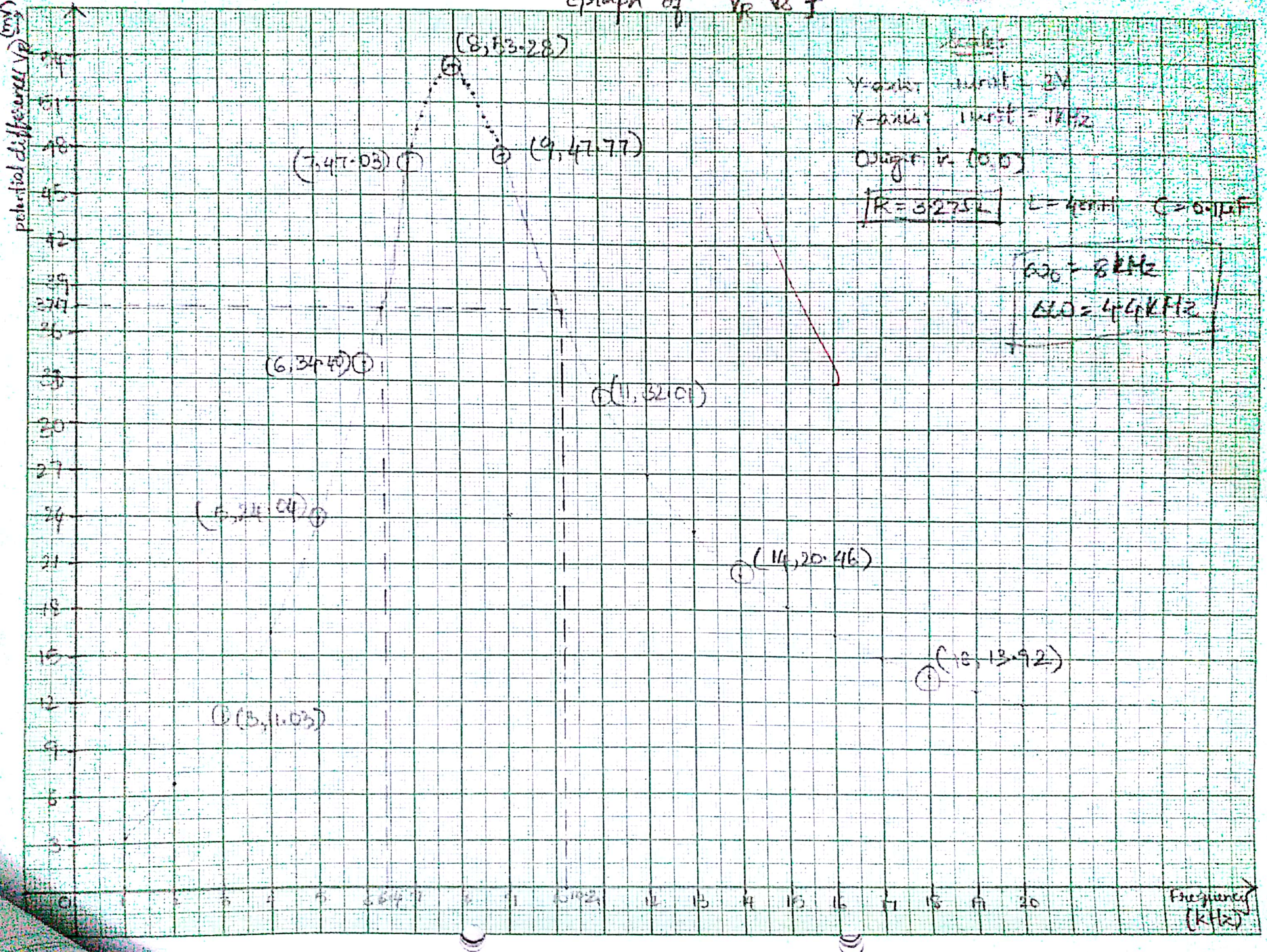
Origin is (0,0)

C = 0.1μF $\boxed{R = 9.86\Omega}$ L = 4mH

$\boxed{\omega_0 = 8kHz}$

$\boxed{\Delta\omega = 4.4kHz}$

Graph of V_R vs f



Calculation:

Case(i): $R = 9.88\,\Omega$ $(+50\Omega)$ $L = 4mH$ $C = 0.1\mu F$

Internal Resistance of Digital Function Generator 50Ω

Experimental Q-factor

$\omega_0 = 8\,kHz$

$\Delta\omega = (10.6 - 6.2)\,kHz = 4.4\,kHz$

$$\boxed{Q = \frac{\omega_0}{\Delta\omega} = 1.82}$$

Theoretical Q-factor

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} \Rightarrow Q = \frac{1}{59.88}\sqrt{\frac{4\times10^{-3}}{0.1\times10^{-6}}} \Rightarrow \boxed{Q = 3.34}$$

Maximum Possible Error:

$$Q = \frac{\omega_0}{\Delta\omega} \Rightarrow \ln Q = \ln\omega_0 - \ln\Delta\omega$$

$\cancel{\Delta\omega_0 = 10}$

$$\Rightarrow \frac{\Delta Q}{Q} = \frac{\Delta\omega_0}{\omega_0} + \frac{d(\Delta\omega)}{(\Delta\omega)}$$

$$= \frac{10^{-9}}{8} + \frac{2\times10^{-9}}{4.4} = 5.79\times10^{-10}$$

$$\Rightarrow \frac{\Delta Q}{Q} = 5.79\times10^{-10} \Rightarrow \boxed{\left(\frac{\Delta Q}{Q}\right)\% = 5.79\times10^{-8}\,\%}$$

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Calculation:

Case (ii): $R = 3.27\Omega$ $(+50\Omega)$ $L = 4mH$ $C = 0.1\mu F$

Internal Resistance of Digital Function Generator is 50Ω

Experimental Q-factor:

$\omega_0 = 8kHz$

$\Delta\omega = (10.2 - 6.4)\,kHz = 3.8kHz$

Q-factor, $Q = \frac{\omega_0}{\Delta\omega} = \frac{8}{3.8} = 2.10 \Rightarrow \boxed{Q = 2.10}$

Theoretical Q-factor:

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{53.27}\sqrt{\frac{4\times10^{-3}}{0.1\times10^{-6}}} = 3.75 \Rightarrow \boxed{Q = 3.75}$$

Maximum Possible Error:

$$Q = \frac{\omega_0}{\Delta\omega} \Rightarrow \ln Q = \ln\omega_0 - \ln(\Delta\omega)$$

$$\Rightarrow \frac{\Delta Q}{Q} = \frac{\Delta\omega_0}{\omega} + \frac{\Delta(\Delta\omega)}{\Delta\omega}$$

$$\Rightarrow = \frac{10^{-9}}{8} + \frac{2\times10^{-9}}{3.8}$$

$$\frac{\Delta Q}{Q} = 6.513\times10^{-10}$$

$$\Rightarrow \boxed{\left(\frac{\Delta Q}{Q}\right)\% = 6.513\times10^{-8}}$$

Result:

Q-factors obtained experimentally are:

$Q_1 = (1.82 \pm 5.79\times10^{-8}\%)$
$Q_2 = (2.10 \pm 6.51\times10^{-8}\%)$

Precautions:

① Don't touch the experimental setup, its table while performing the experiment.

② All the connecting wires should be tightly connected.

③ Don't forget to add the resistance of digital function generator while calculating theoretical Q-factor.

④ The knob that changes frequency, should be rotated as carefully as possible to avoid wrong readings.

Sources of Error:

① Error while taking readings

② Connecting wires also have resistance.

③ Inductance value is uncertain

④ Error in apparatus (in my case)

Experiment No: 1

Name of the experiment:

Decay of Current in a Capacitive Circuit

37/40

Name M. Maheeth Reddy

Roll No. 180CS31

LabGroup LG5

Date 20-9-2018

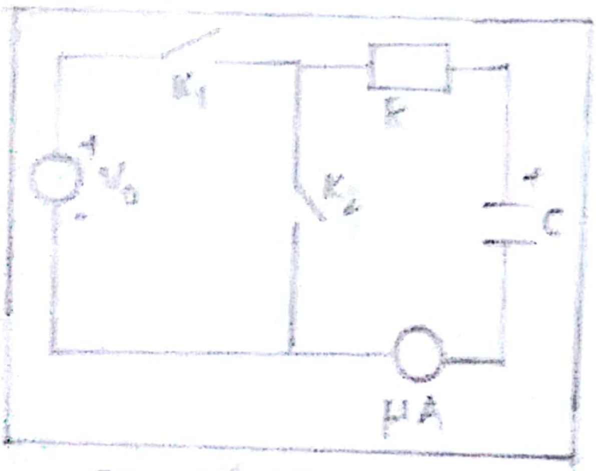
Objective:

To study the decay of current with time in RC circuit and to determine the time constant of the circuit

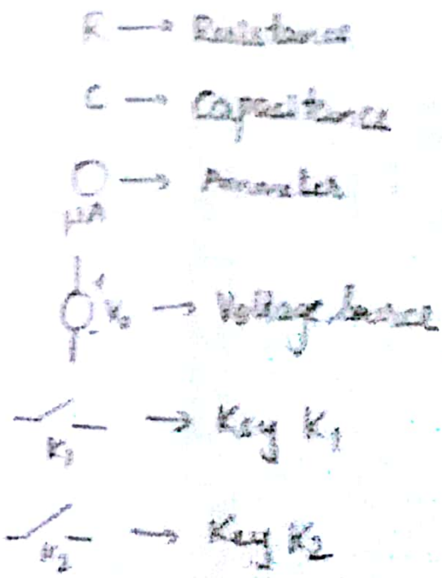
Apparatus Required:

Capacitance (C), Resistance (R), Ammeter, Power Supply, Switches/Keys (K_1 & K_2), Stopwatch, Connecting Wires,

Diagram:



Circuit Diagram



Working Formula:

For both charging as well as discharging circuits,

$$\boxed{\ln i = \ln\left(\frac{V_0}{R}\right) - \frac{t}{\tau}}$$

$i \rightarrow$ current in branch containing resistor and capacitor

$V_0 \rightarrow$ (charging) EMF of source of potential difference

$R \rightarrow$ value of resistance in circuit

$t \rightarrow$ time corresponding to current's reading.

$\tau \rightarrow$ time constant

V_0 (discharging) $\longrightarrow$ potential to which capacitor is charged

R = ?
C = ?

Observation table for charging circuit:

Least count for ammeter = 0.01μA   Least Count of stopwatch = 0.01s

S.no	t(S)	I(μA)	ln I	S.no	t(S)	I(μA)	ln I
1	0	86.84	4.464	17	160	5.60	1.722
2	10	75.69	4.326	18	170	4.76	1.560
3	20	63.20	4.146	19	180	4.03	1.393
4	30	52.81	3.966	20	190	3.46	1.241
5	40	44.17 ~~36.99~~	3.788	21	200	2.96	1.085
6	50	36.99	3.610	22	210	2.55	0.936
7	60	30.98	3.433	23	220	2.19	0.784
8	70	26.00	3.258	24	230	1.89	0.636
9	80	21.82	3.082	25	240	1.64	0.494
10	90	17.93	2.886	26	250	1.42	0.351
11	100	15.41	2.735	27	260	1.24	0.215
12	110	12.72	2.543	28	270	1.09	0.086
13	120	10.92	2.390	29	280	0.97	-0.030
14	130	9.23	2.222	30	290	0.86	-0.151
15	140	7.81	2.055	31	300	0.73	-0.315
16	150	6.61	1.888				

20.9.18

Observation table for discharging circuit:

Least Count of Ammeter = 0.01μA   Least Count of stopwatch = 0.01s

Sr no	t(s)	I(μA)	ln I	Sr no	t(s)	I(μA)	ln I
1	0	85.83	4.452	17	160	5.42	1.690
2	10	73.07	4.291	18	170	4.47	1.497
3	20	60.98	4.110	19	180	3.87	1.353
4	30	50.95	3.931	20	190	3.28	1.188
5	40	42.60	3.752	21	200	2.77	1.019
6	50	35.66	3.574	22	210	2.37	0.863
7	60	29.85	3.396	23	220	2.05	0.718
8	70	25.58	3.242	24	230	1.75	0.559
9	80	21.45	3.066	25	240	1.49	0.399
10	90	17.98	2.889	26	250	1.27	0.239
11	100	15.11	2.715	27	260	1.11	0.104
12	110	12.42	2.519	28	270	0.94	−0.062
13	120	10.68	2.368	29	280	0.82	−0.198
14	130	9.00	2.197	30	290	0.72	−0.328
15	140	7.59	2.027	31	300	0.62	−0.478
16	150	6.39	1.855				

20.9.18

lnI v/s t graph for charging RC circuit

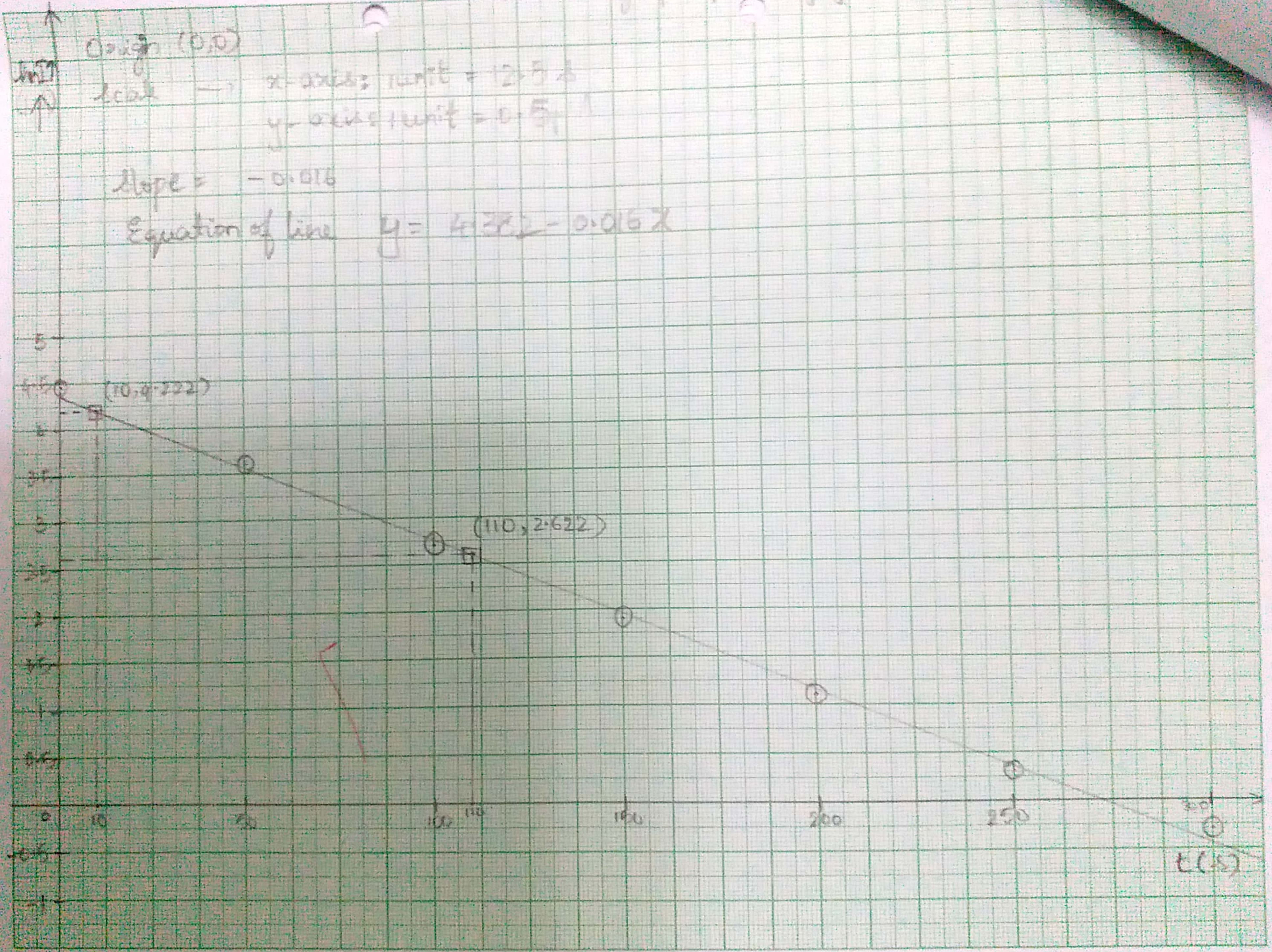
Origin (0,0)

Scale → x-axis: 1 unit = 12.5 s

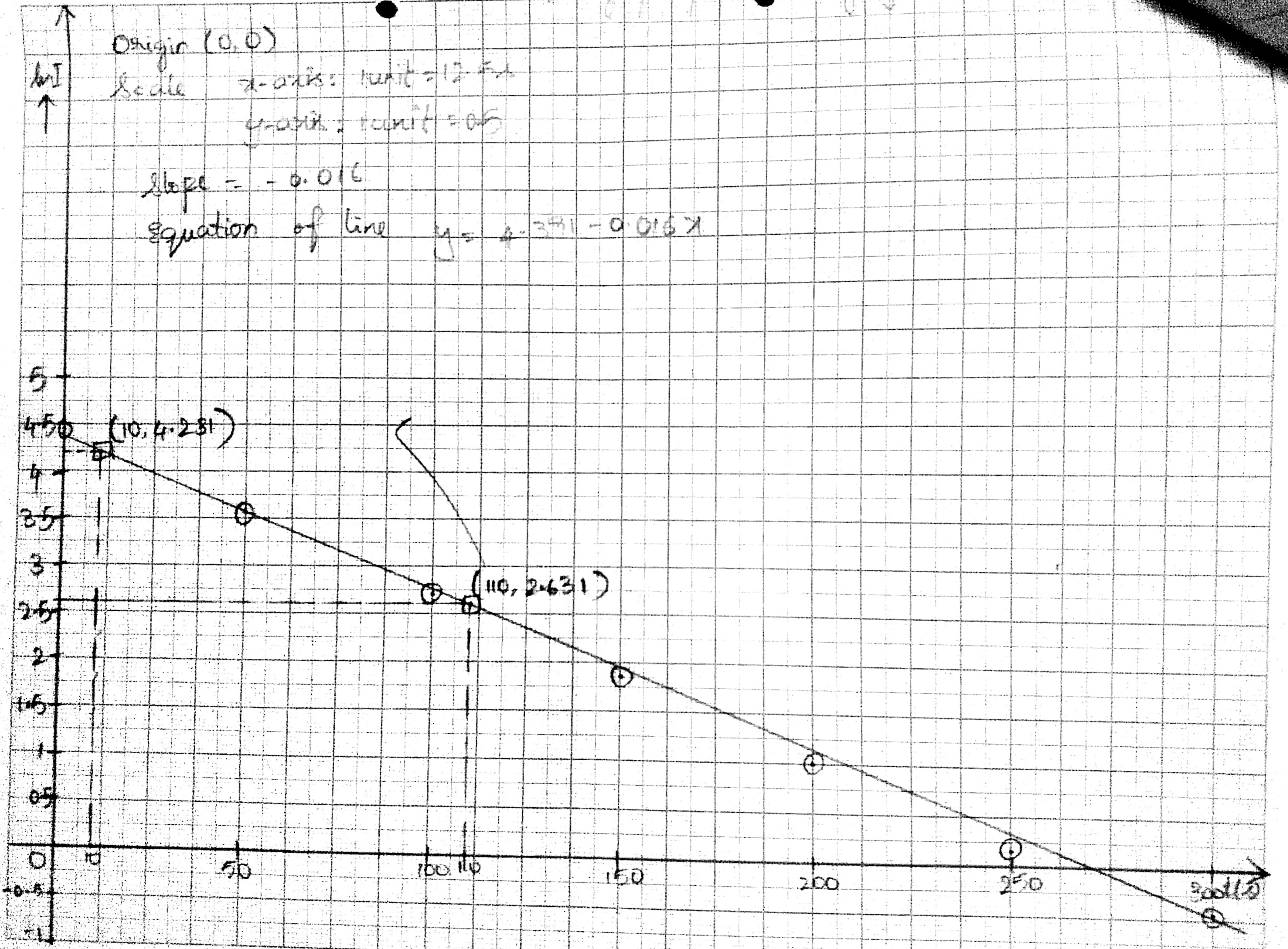
y-axis: 1 unit = 0.5

Slope = −0.016

Equation of line $y = 4.382 - 0.016x$



lnI vs t graph for discharging RC circuit



Calculation:

For Charging Circuit,

Formula: $\boxed{\ln i = \ln\left(\frac{V_0}{R}\right) - \frac{t}{\tau}}$

Equation of line obtained from ~~g~~ $\ln i$ vs. t graph is

$$\boxed{y = 4.382 - 0.016x}$$

Here 0.016 represents $\frac{1}{\tau}$ (by comparing the line equations)

$\Rightarrow \quad \frac{1}{\tau} \approx 0.016\ s^{-1} \quad \Rightarrow \quad \boxed{\tau \simeq 61.96\ s}$

For Discharging Circuit,

Formula: $\boxed{\ln i = \ln\left(\frac{V_0}{R}\right) - \frac{t}{\tau}}$

Equation of line obtained from $\ln i$ vs. t graph is

$$\boxed{y = 4.391 - 0.016x}$$

Here 0.016 represents $\frac{1}{\tau}$ (by comparing line equations)

$\Rightarrow \quad \frac{1}{\tau} \simeq 0.016\ s^{-1} \quad \Rightarrow \quad \boxed{\tau \simeq 60.25\ s}$

~~(P.T.O)~~

Theoretical Value of τ,

$\tau = RC$, Here $R = 22k\Omega$ $C = 2200\mu F$

$\Rightarrow \quad \boxed{\tau = 48.4\ s}$

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Error Analysis:

$$\ln i = \ln \frac{V_0}{R} - \frac{t}{\tau}$$

$$\Rightarrow \frac{t}{\tau} = \ln \frac{V_0}{R} - \ln i \Rightarrow \tau = \frac{t}{\ln \frac{V_0}{R} - \ln i}$$

$\Rightarrow$ taking logarithm on both sides

$$\Rightarrow \ln \tau = \ln t - \ln\left(\ln \frac{V_0}{R} - \ln i\right)$$

differentiating on both sides

$$\Rightarrow \frac{d\tau}{\tau} = \frac{dt}{t} - \frac{1}{\ln \frac{V_0}{R} - \ln i} \times \left(-\frac{di}{i}\right)$$

$\left[\ln\left(\frac{V_0}{R}\right) \text{ is constant}\right]$

$$\Rightarrow \boxed{\frac{d\tau}{\tau} = \frac{dt}{t} + \frac{di}{i\left(\ln \frac{V_0}{R} - \ln i\right)}}$$

$\Rightarrow$ $dt = 0.01\,s$ $\quad di = 0.01\,\mu A$ $\quad V_0 = 2V$ $\quad R = 22\,k\Omega$

Charging

taking $t = 100\,s$ and $i = 12.72\,\mu A$

$$\frac{d\tau}{\tau} = \frac{0.01}{100} + \frac{0.01}{12.72\left(\ln \frac{2}{22000} - \ln(12.72)\right)}$$

$\boxed{\frac{d\tau}{\tau} = 3.36 \times 10^{-5}}$; $\tau = 61.96\,s$

$\Rightarrow \boxed{d\tau = 2.08 \times 10^{-3}\,s}$

Discharging

$t = 100\,s$ and $i = 15.11\,\mu A$

$$\frac{d\tau}{\tau} = \frac{0.01}{100} + \frac{0.01}{15.11\left(\ln \frac{2}{22000} - \ln(15.11)\right)}$$

$\boxed{\frac{d\tau}{\tau} = 4.49 \times 10^{-5}}$; $\tau = 60.25\,s$

$\boxed{d\tau = 2.70 \times 10^{-3}}$

Result:

Time constant obtained for

Charging RC Circuit is $\boxed{\tau = (61.96 \pm 2.08\times10^{-3})\, s}$

Discharging RC Circuit is $\boxed{\tau = (60.25 \pm 2.70\times10^{-3})\, s}$

Precautions:

1. Don't reverse the polarity of capacitor.
2. The stopwatch should be simultaneously started with plugging in the key
3. Be Watchful while taking reading of current for every 10 seconds.

Sources of Error:

1. Delay in plugging in key and starting stopwatch.
2. Human error while taking readings.
3. Sometimes, overcharging of capacitor can cause error.

Experiment No.: 10

Name of the experiment:

Determination of Planck's Constant

38/40

Name M.Maheeth Reddy

Roll No. 1801CS31

LabGroup LG5

Date 19.09.2018

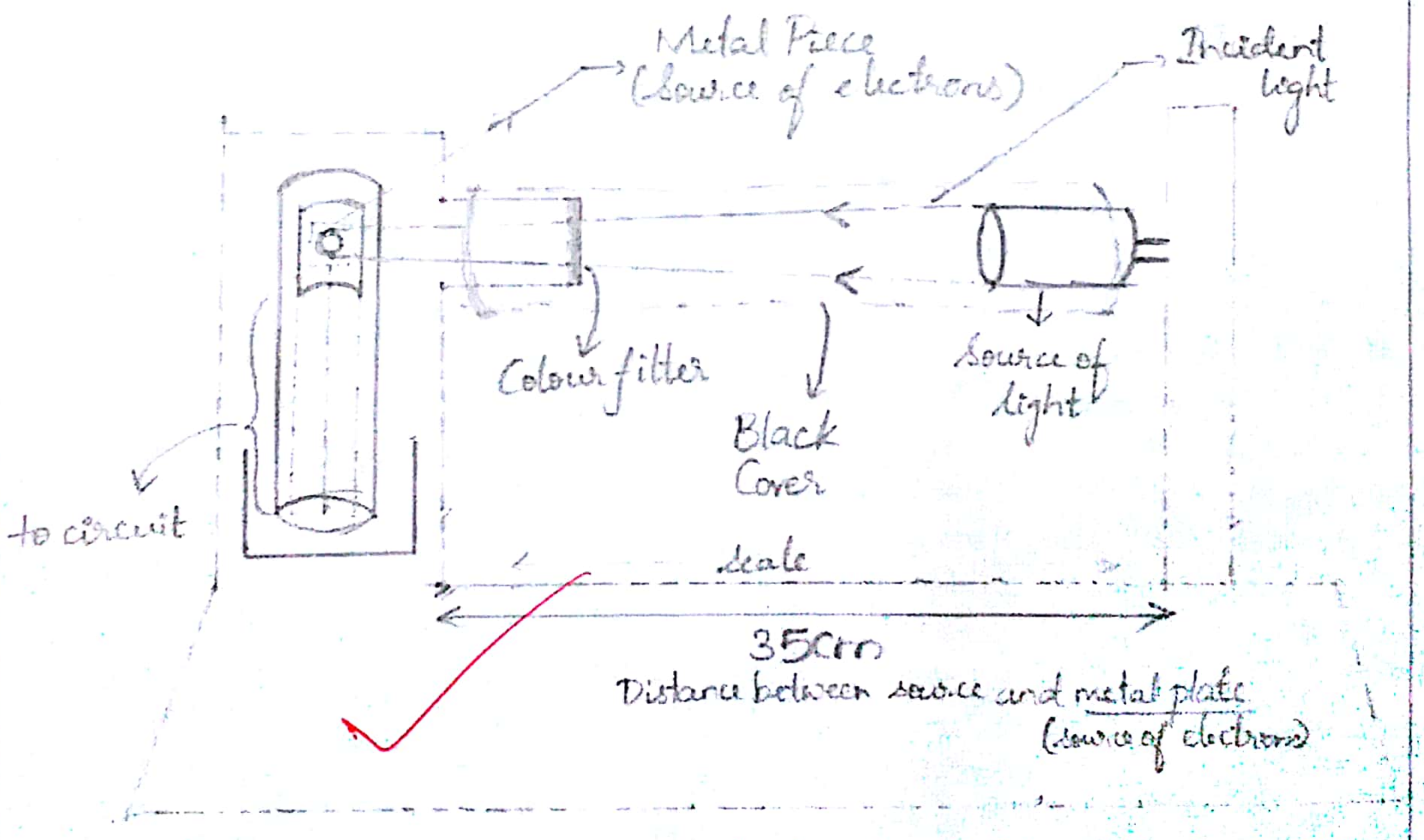
Objective

To determine Planck's constant

Apparatus Required:

Phototube, Colour filter, lens, absorbent cotton, alcohol (if not mandatory) lens cover

Diagram:



Experimental Setup for DETERMINATION OF PLANCK'S CONSTANT

Working Formula:

$$\boxed{V_s = \frac{h}{e}\nu - \frac{\phi}{e}}$$

$V_s \rightarrow$ stopping potential

$\nu \rightarrow$ frequency of light incident

$h \rightarrow$ planck's constant

$e \rightarrow$ charge on electron ($=-1.602 \times 10^{-19} C$)

$\phi \rightarrow$ workfunction of metal

Observation Table:

- Least Count of Voltmeter = 0.01V
- Least Count of a Ammeter (Nano-ammeter) = 1A

S.no.	Filter Wavelength (nm)	ν (sec^{-1}) ($\times 10^{14}$)	Stopping Voltage ($-V_s$)			Mean(V_s)
1	635	4.72	+0.32	+0.32	+0.32	+0.32
2	570	5.26	+0.53	+0.54	+0.53	+0.533
3	540	5.55	+0.69	+0.69	+0.70	+0.693
4	500	5.99	+0.90	+0.91	+0.90	+0.903
5	460	6.52	+1.10	+1.11	+1.11	+1.11

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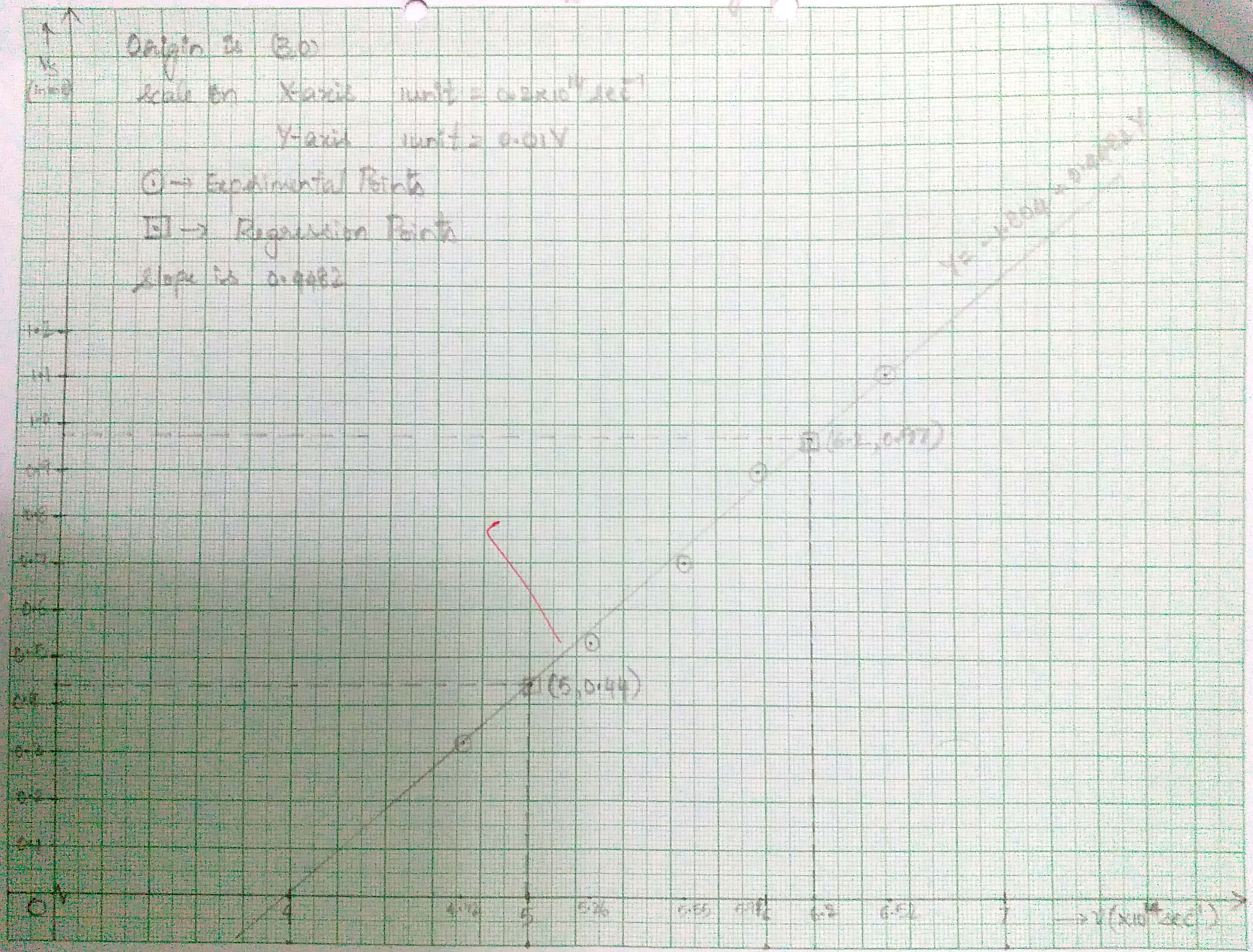
V_s vs. ν graph



Calculation:

Formula: $V_s = \frac{h}{e}\nu - \frac{\phi}{e}$

$\frac{h}{e}$ is obtained from slope of V_s vs. ν graph

Slope of graph = 0.4482

$\Rightarrow \quad \frac{h}{e} = 0.4482 \times 10^{-14} \ JsC^{-1}$

We know, $e = 1.602 \times 10^{-19} C$

$\Rightarrow \quad h = 0.4482 \times 10^{-14} JsC^{-1} \times 1.602 \times 10^{-19} C$

$\Rightarrow \quad \boxed{h \approx 7.182 \times 10^{-34} \ Js}$

Maximum Possible Error:

$$V_s = \frac{h}{e}\nu - \frac{\phi}{e}$$

differentiating on both sides

$\Rightarrow \quad \frac{\Delta V_s}{V_s} = \frac{\Delta h}{h}$ [$\nu \rightarrow$ constant for a given light, $e \rightarrow$ constant, $\phi \rightarrow$ material constant]

$\Rightarrow \Delta h = \frac{\Delta V_s}{V_s} \times h$

ΔV_s = least count of voltmeter = 0.01V

for maximum error, minimum V_s is taken

$\Rightarrow \quad V_s = 0.32V$

$\Rightarrow \quad \Delta h = \frac{0.01V}{0.32V} \times 7.182 \times 10^{-34} Js$

$\Rightarrow \quad \boxed{\Delta h = 2.244 \times 10^{-35} \ Js}$

Result:

The value of Planck's constant obtained ~~with~~ error is

$$\boxed{h = (7.182\times10^{-34} \pm 2.244\times10^{-35})\ \text{Js}}$$

Precautions:

- The instrument should be operated in a dry, cool, indoor space.
- Phototube shouldn't be exposed to direct light, particulary at the time of it's installation
- The room can be only dimly lit.
- Clean the dust (if present) on the phototube, colour filter, lens etc. by absorbent cotton with a few drops of alcohol.
- Colour filter should be stored in dry and dust proof envirornment.
- After finishing the experiment, switch off power, cover the drawtube with lens cover

Sources of Error:

- Lighting in the room
- Dust on phototube, colour filter, lens etc.
- Error in experimental setup
- Parallax while rotating the voltage adjustment knob

Experiment No.: 9

Name of the experiment:

Determination of Surface Tension of Water by method of CAPILLARY ASCENT

37/40

Name: M.Maheeth Reddy

Rollno.: 1801CS31

LabGroup: LG5

Date: 15.09.18

Objective:

To measure the surface tension of water by method of capillary ascent.

Apparatus Required:

2-3 capillary tubes, glass slide, travelling microscope, beaker/jar

Working Formula:

$$S = \frac{r\rho g}{2}\left[h + \frac{r}{3}\right]$$

$h \rightarrow$ height of capillary ascent (elevated liquid column)

$\rho \rightarrow$ density of liquid

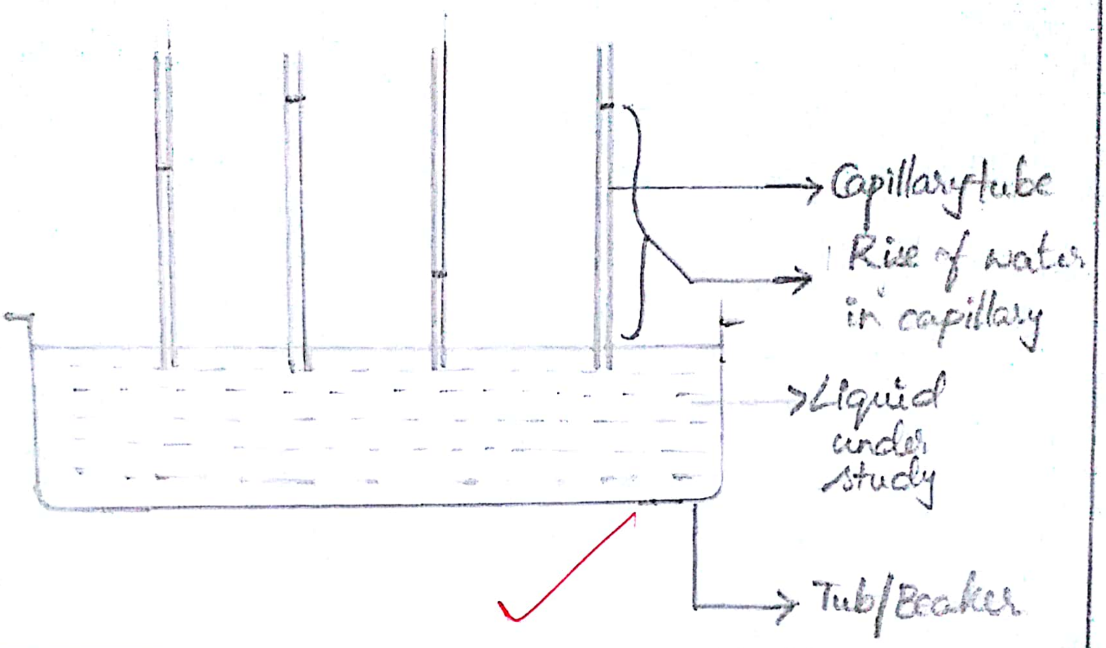
$r \rightarrow$ radius of capillary tube

$g \rightarrow$ acceleration due to gravity

$S \rightarrow$ surface tension of liquid.

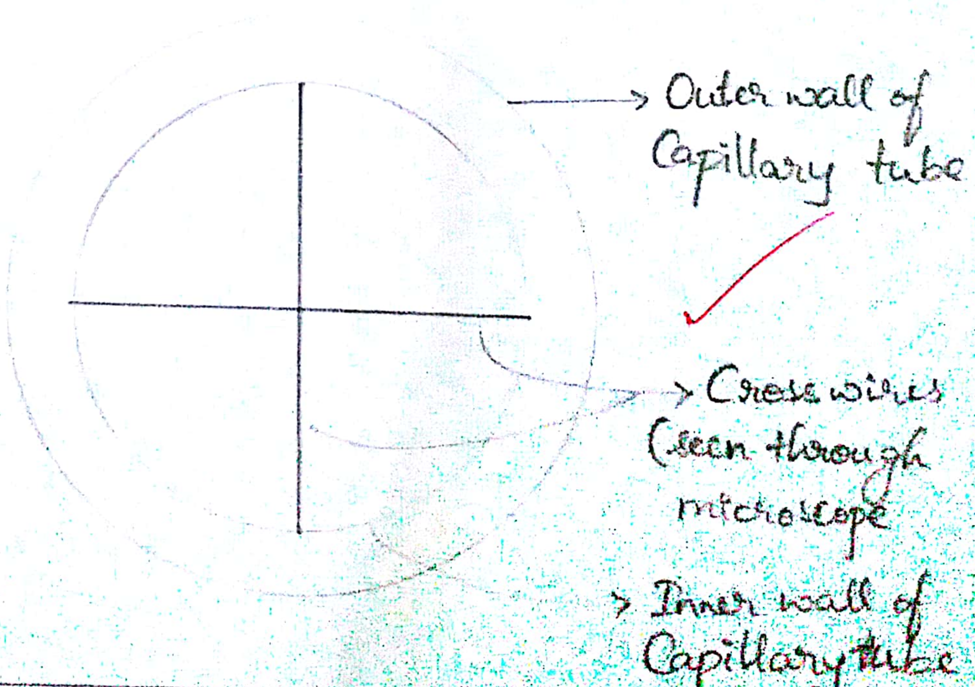
Diagram:

EXPERIMENTAL SETUP



Determination of Surface Tension

Positioning of Crosswires for Readings for inner and outer radii of Capillary tube.



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Observation Table:

Least Count of travelling microscope = ?

READINGS OF RADIUS OF CAPILLARY TUBE:

	S NO	Horizontal Diameter - H1							Vertical Diameter - V1							Mean of e & f (final inner diameter) (cm)
		LHS(a)			RHS(b)			Diff = b-a=e (cm)	Upward (c)			Downward (d)			Diff = d-c=f (cm)	
		MSR	VSR	TOTAL READING	MSR	VSR	TOTAL READING (cm)		MSR	VSR	TOTAL READING (cm)	MSR	VSR	TOTAL READING (cm)		
Capillary 1	1	5.7	35	5.735	5.6	48	5.648	0.087	7.1	17	7.117	7.2	0	7.200	0.083	
	2	5.7	34	5.734	5.6	51	5.651	0.083	7.1	22	7.122	7.2	4	7.204	0.082	0.083
	3	5.7	31	5.731	5.6	50	5.650	0.081	7.1	19	7.119	7.2	4	7.204	0.085	
Capillary 2	1	5.8	86	5.886	5.7	85	5.785	0.101	7.0	29	7.029	7.1	36	7.136	0.107	
	2	5.8	85	5.885	5.7	86	5.786	0.099	7.0	31	7.031	7.1	36	7.136	0.105	0.102
	3	5.8	85	5.885	5.7	87	5.787	0.098	7.0	31	7.031	7.1	35	7.135	0.104	

READINGS FOR ASCENT IN TUBES:

	S NO	Readings for A				Readings for B				Rise, C=B-A (cm)
		Water Level			Mean A(cm)	Rise in Capillary Tube			Mean B(cm)	
		MSR	VSR	Total Reading (cm)		MSR	VSR	Total Reading (cm)		
Capillary 1	1	4.6	17	4.617		6.6	28	6.628		
	2	4.6	18	4.618	4.617	6.6	28	6.628	6.628	2.011
	3	4.6	17	4.617		6.6	29	6.629		
Capillary 2	1	4.6	21	4.621		5.7	25	5.725		
	2	4.6	18	4.618	4.619	5.7	23	5.723	5.725	1.106
	3	4.6	20	4.620		5.7	28	5.728		

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Calculations

Formula: $S = \frac{r\rho g}{2}\left[h + \frac{r}{3}\right]$

For capillary tube 1,

diameter (inner), $d_1 = 0.083\,cm$

$\Rightarrow$ radius (inner), $r_1 = \frac{0.083}{2}\,cm \simeq 0.042\,cm$

$\Rightarrow \boxed{r_1 = 4.2\times10^{-4}\,m}$

rise of water, $h_1 = 2.011\,cm$

$\Rightarrow \boxed{h_1 = 2.011\times10^{-2}\,m}$

$\Rightarrow$ Surface tension of water, $S_1 = \frac{r_1\rho g}{2}\left[h_1 + \frac{r_1}{3}\right]$

$\Rightarrow S_1 = \frac{(4.2\times10^{-4})\times1000\times9.8}{2}\left[2.011\times10^{-2} + \frac{4.2\times10^{-4}}{3}\right]$

$\Rightarrow S_1 = 0.0416\,N/m \Rightarrow \boxed{S_1 = 41.6\ mN/m}$

For capillary tube 2,

diameter (inner), $d_2 = 0.102\,cm$

$\Rightarrow$ radius (inner), $r_2 = \frac{0.102}{2}\,cm \simeq 0.051\,cm$

$\Rightarrow \boxed{r_2 = 5.1\times10^{-4}\,m}$

rise of water, $h_2 = 1.016\,cm$

$\Rightarrow \boxed{h_2 = 1.016\times10^{-2}\,m}$

$\Rightarrow$ Surface tension of water, $S_2 = \frac{r_2 \rho g}{2}\left[h_2 + \frac{r_2}{3}\right]$

$$\Rightarrow S_2 = \frac{5.1\times10^{-4} \times 10^3 \times 9.8}{2}\left[1.016\times10^{-2} + \frac{5.1\times10^{-4}}{3}\right]$$

$$\Rightarrow \boxed{S_2 \approx 25.8 \text{ mN/m}}$$

Maximum Possible Error:

$$S = \frac{r\rho g}{2}\left[h + \frac{r}{3}\right]$$

$$\Rightarrow \log S = \log r + \log \rho + \log g + \log\left(h + \frac{r}{3}\right) - \log 2$$

differentiate on both sides

$$\Rightarrow \frac{\Delta S}{S} = \frac{\Delta r}{r} + \frac{\Delta\left(h + \frac{r}{3}\right)}{h + \frac{r}{3}} \qquad \left[\begin{array}{l}\rho, g, 2 \text{ are constants} \\ \therefore \Delta\rho = 0 \text{ and } \Delta g = 0\end{array}\right]$$

For Tube 1,

$$\Rightarrow \left(\frac{\Delta S}{S}\right)_1 = \frac{0.001}{0.042} + \frac{0.001}{2.025}$$

$$\Rightarrow \left(\frac{\Delta S}{S}\right)_1 = 0.0243$$

$$\Rightarrow \Delta S_1 = 0.0243 S_1$$

$$\boxed{\Delta S_1 = 1.011 \text{ mN/m}}$$

$$\therefore \boxed{S_1 = (41.6 \pm 1.011) \text{ mN/m}}$$

For Tube 2,

$$\left(\frac{\Delta S}{S}\right)_2 = \frac{0.001}{0.051} + \frac{0.001}{1.033}$$

$$\Rightarrow \left(\frac{\Delta S}{S}\right)_2 = 0.0205$$

$$\Rightarrow \Delta S_2 = 0.0205 S_2$$

$$\Delta S_2 = 0.529 \text{ mN/m}$$

$$\therefore \boxed{S_2 = (25.8 \pm 0.529) \text{ mN/m}}$$

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Result:

$$\boxed{S_1 = (41.6 \pm 1.011)\ mN/m}$$

and

$$\boxed{S_2 = (25.8 \pm 0.529)\ mN/m}$$

are the measured values of surface tension of water from the experiment

Precautions:

1. Avoid parallax error
2. Avoid backlash error
3. Don't move apparatus while performing the experiment.
4. Avoid mishandling of apparatus.

Sources of Error:

1. Parallax Error
2. Backlash error
3. Moving apparatus while taking measurements

PH110: Physics Laboratory

Experiment No.: 8

Name of Experiment:

Interference of Light:

NEWTON'S RING

Name: M. Maheeth Reddy

Roll no.: 1801CS31

LabGroup: LG5

Date: 06.09.2018

38/40

Objective:

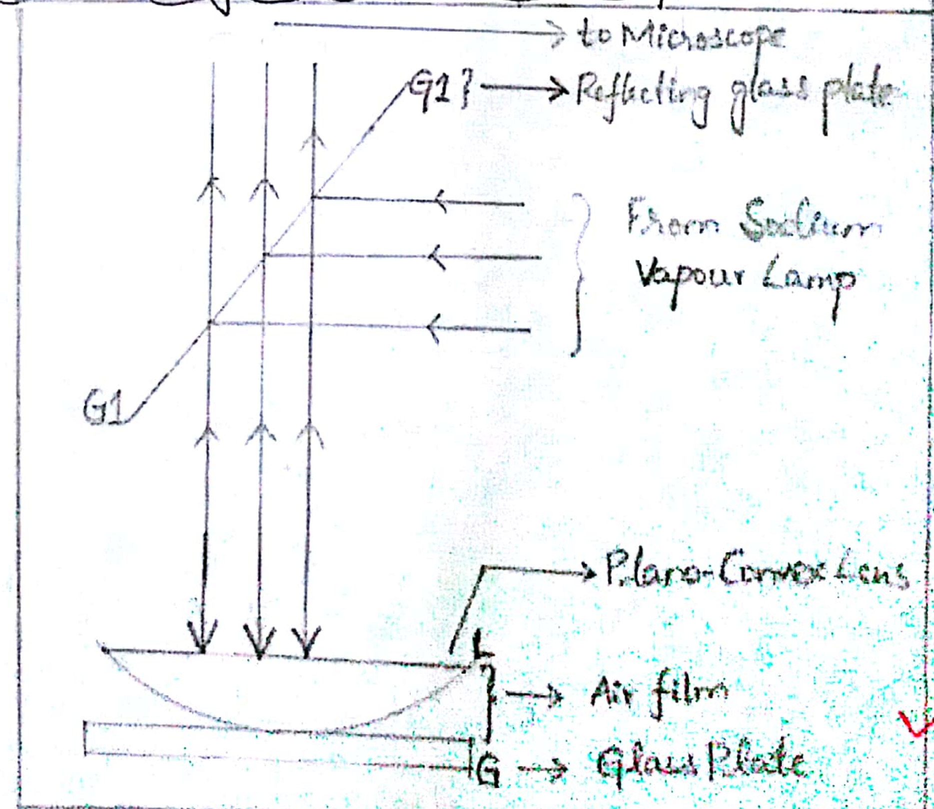
To study the interference of light by division of amplitude using the method of Newton's rings and determine the radius of curvature of the lens.

Apparatus Required:

Microscope, Glass Plate, Sodium vapour lamp, Plano-Convex Lens, Reflecting Glass Plate

Working Formula:

Diagram/Experimental Setup:



Interference of Light : Newton's Ring

Working Formula:

$$R = \frac{\rho_m^2}{m\lambda} \quad \text{for dark fringe}$$

$$R = \frac{\rho_m^2}{(2m+1)\lambda} \quad \text{for bright fringe}$$

where R is radius of m^{th} dark/bright fringe

ρ_m is radius of m^{th} ring

λ is wavelength of light used

6/9/18

Observation Table:

Pitch of circular scale of travelling microscope:

0.01 mm

MSR = Main Scale Reading

CSR = Circular Scale Reading

TR = Total Reading

(P.T.O)

Observation Table

mth ring no.	LHS (mm) MS	LHS (mm) CS	LHS (mm) TR	RHS (mm) MS	RHS (mm) CS	RHS (mm) TR	D = RHS - LHS (mm)	D/2 = ρ_m (mm)	ρ_m^2 (mm^2)
19	31	45	31.45	25	42	25.42	6.03	3.02	9.12
18	31	08	31.08	25	50	25.50	5.58	2.79	7.78
17	31	01	31.01	25	55	25.55	5.46	2.73	7.45
16	30	94	30.94	25	61	25.61	5.33	2.66	7.07
15	30	89	30.89	25	66	25.66	5.23	2.61	6.81
14	30	82	30.82	25	72	25.72	5.10	2.55	6.50
13	30	76	30.76	25	78	25.78	4.98	2.49	6.20
12	30	69	30.69	25	86	25.86	4.83	2.41	5.80
11	30	62	30.62	25	95	25.95	4.67	2.34	5.47
10	30	55	30.55	26	02	26.02	4.53	2.26	5.10
9	30	39	30.39	26	09	26.09	4.30	2.15	4.62
8	30	24	30.24	26	21	26.21	4.03	2.01	4.09
7	30	14	30.14	26	30	26.30	3.84	1.92	3.69
6	30	05	30.05	26	39	26.39	3.66	1.83	3.35
5	29	93	29.93	26	51	26.51	3.42	1.71	2.92
4	29	82	29.82	26	63	26.63	3.19	1.59	2.53
3	29	70	29.70	26	74	26.74	2.96	1.48	2.19
2	29	58	29.58	26	86	26.86	2.72	1.36	1.85
1	29	39	29.39	27	16	27.16	2.23	1.12	1.25

R 6/9/18

Calculations:

Equation of linear obtained by regression is

$$\boxed{y = 1.04 + 0.38x}$$

Slope of graph = 0.38

So $R = \frac{\text{slope}}{\lambda}$;

λ is wavelength of sodium lamp i.e., 5893 Å

$\Rightarrow R = \frac{0.38 \text{ mm}^2}{5893 \text{ Å}}$

$\Rightarrow \boxed{R = 0.64 \text{ m}}$

Maximum Possible Error:

Given $R = \frac{l_m^2}{m \lambda}$

taking logarithm & differentiating,

$$\frac{\Delta R}{R} = 2\left|\frac{\Delta l_m}{l_m}\right| + \left|\frac{\Delta m}{m}\right| + \left|\frac{\Delta \lambda}{\lambda}\right|$$

$\Delta m = 0$ [Random error]

$\Delta \lambda = 0$ [A constant]

$$\frac{\Delta R}{R} = 2\frac{\Delta l_m}{l_m} = 2 \times \frac{0.01 \times 10^{-3}}{0.64}$$

$$\Rightarrow \boxed{\frac{\Delta R}{R} = 0.03\%}$$

Result:

The radius of curvature of lens is

$$\boxed{0.64 \pm 0.03\% \ m}$$

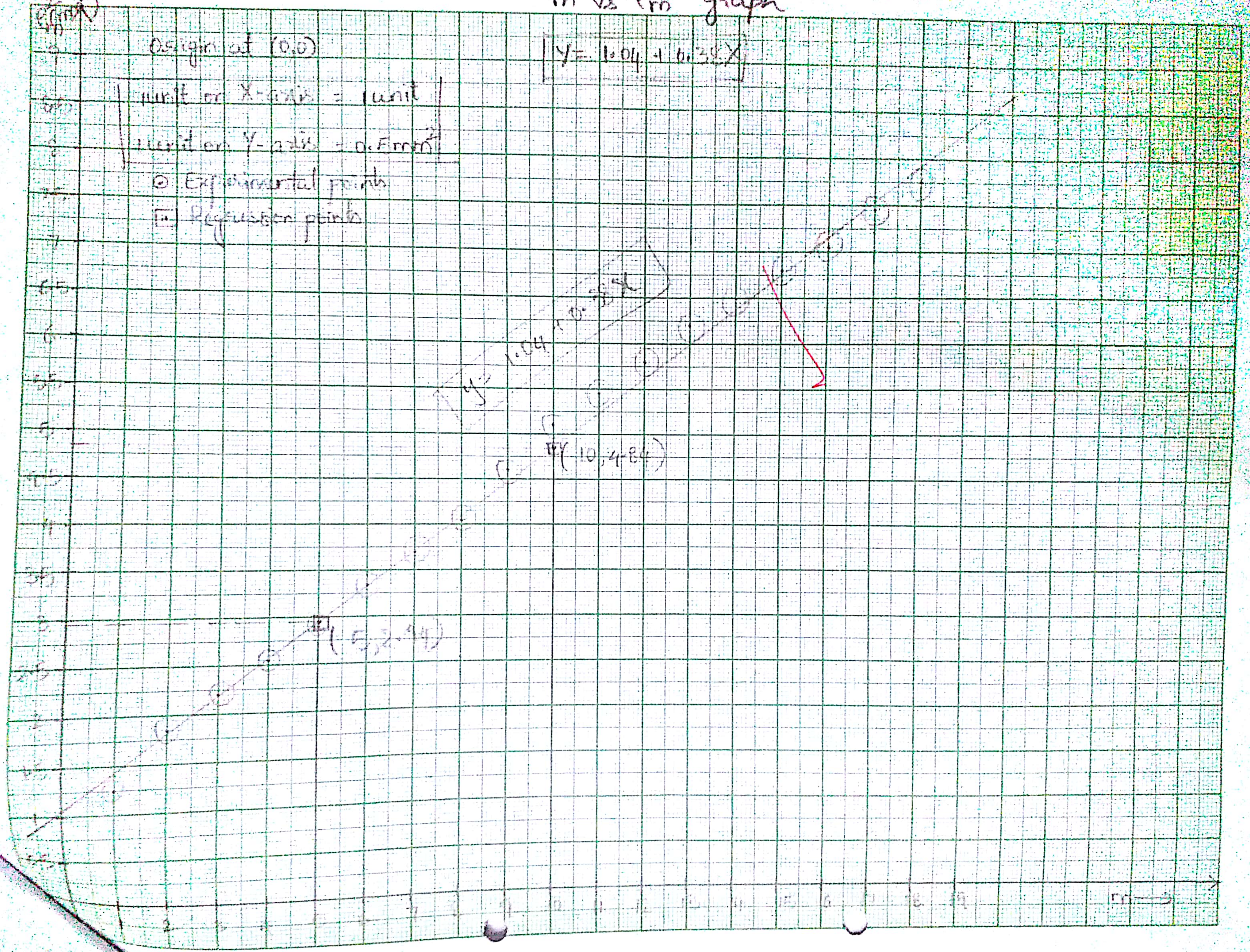
Precautions:

1. Avoid parallax error
2. Take readings from extreme left or extreme right 20th dark fringe to avoid backlash error.

Sources of Error:

1. Pushing the apparatus while taking readings
2. Backlash error.

m vs ρ_m^2 graph



PH110 : Physics Laboratory

Experiment No.: 7

Name of Experiment :

DETERMINATION OF e/m

38/40

Name: M. Maheeth Reddy

Roll No.: 1801CS31

Lab Group: LG5

Date: 30.08.2018

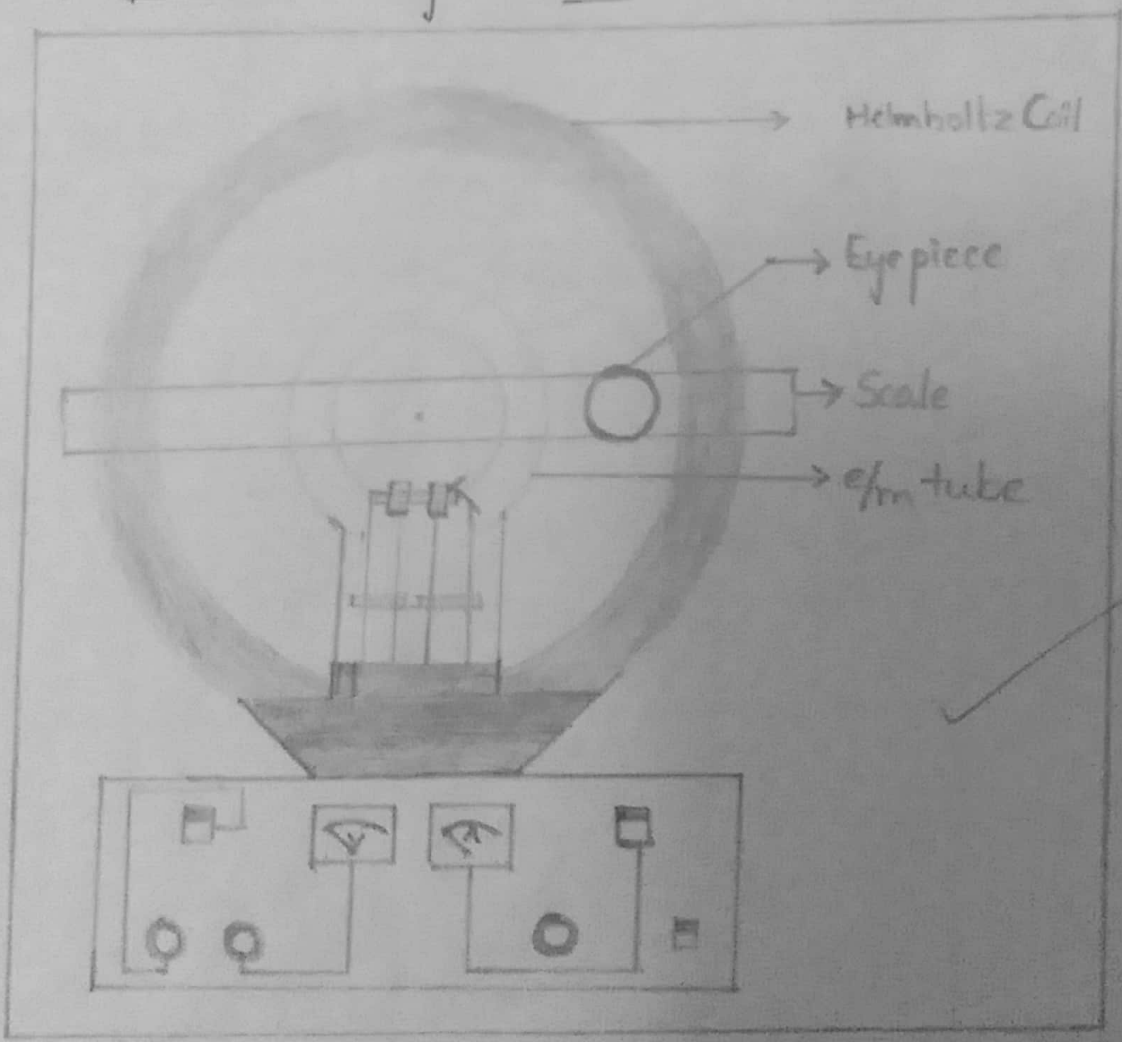
Objective:

To measure e/m ratio by Thomson's method

Apparatus Required:

e/m tube (EMX-01), Scale, Eyepiece, Torch light

Diagram/Experimental Setup: EMX-01, e/m experiment



2/8/18

Working Formula:

$$\cancel{B = 2 \times \frac{\mu_0 I n}{2\left(\frac{5}{4}\right)^{3/2} a}}$$

$$\boxed{\frac{e}{m} = (7.576 \times 10^{6}) \frac{V}{I^2 d^2}}$$

here,

$e \rightarrow$ charge on electron

$m \rightarrow$ mass of electron

$V \rightarrow$ accelerating potential

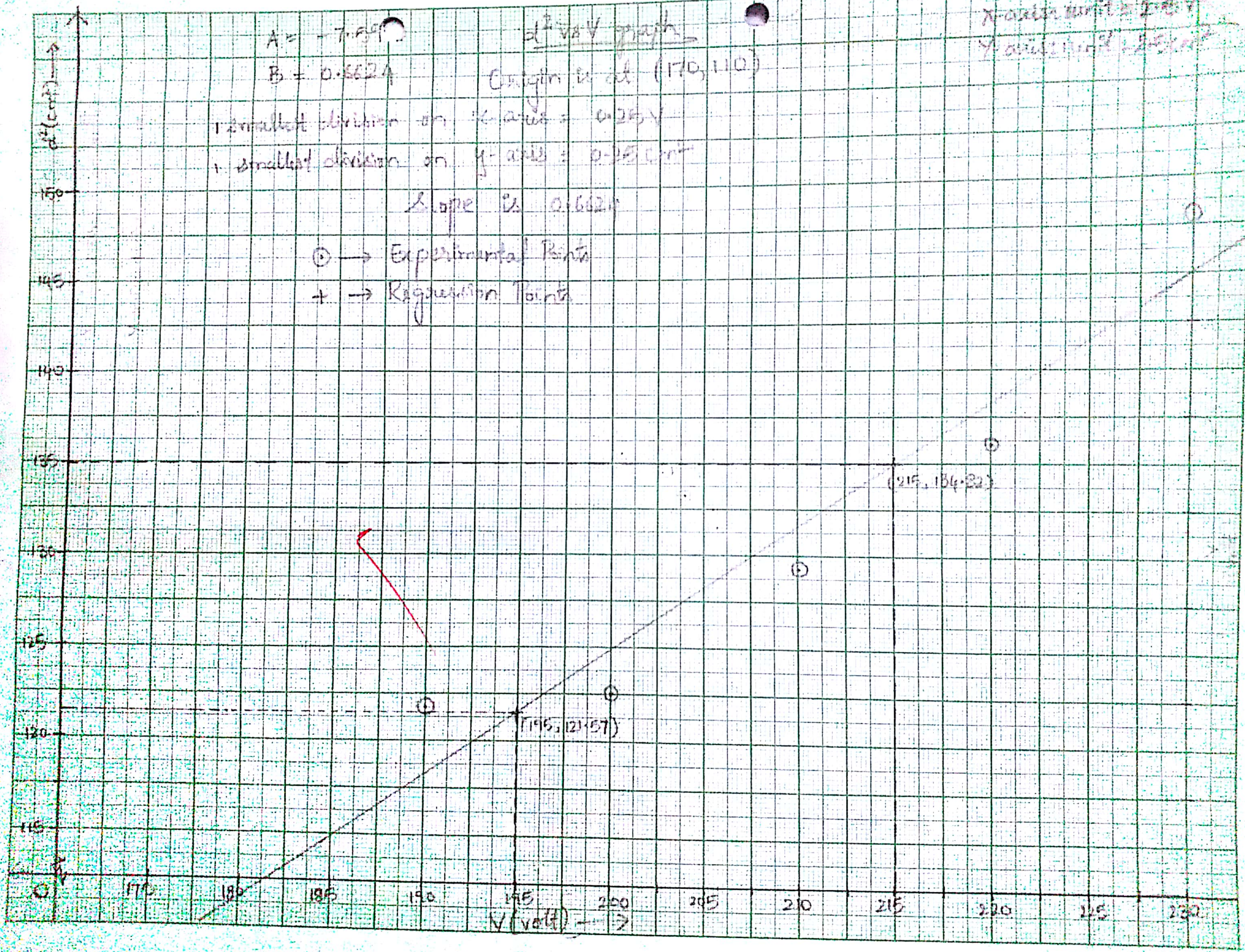
$I \rightarrow$ current flowing in coils

$d \rightarrow$ diameter of circular path of electron

$\frac{e}{m} \rightarrow$ specific charge on electron

Observation Table:

S.no.	V(Volt)	I(A)	D(cm)	Mean D(cm)	D^2 (cm^2)
1 2	230	1 A	12.1 12.3 12.1	12.17	148.03
3 4	220	1	11.8 11.8 11.4	11.67	136.11
5 6	210	1	11.6 11.1 11.4	11.37	129.20
7 8	200	1	11.1 11.0 11.1	11.07	122.47
9 10	190	1	11.0 11.0 11.1	11.03	121.73


d^2 vs V graph
A = -7.69
B = 0.6621
Origin is at (170, 110)
1 smallest division on x axis = 0.25 V
1 smallest division on y axis = 0.25 cm²
Slope is 0.6621
⊙ → Experimental Points
+ → Regression Points
(215, 134.82)
(195, 121.57)
d^2 (cm²)
V (volt)
170
180
185
190
195
200
205
210
215
220
225
230
115
120
125
130
135
140
145
150

Calculations:

Specific charge of electron,

$$\frac{e}{m} = (7.576\times10^6)\ \frac{V(\text{volt})}{I^2(\text{amp}^2)\,d^2(\text{m}^2)}$$

Now slope of graph, $B = 0.6624 = \cancel{\frac{V}{d^2}}\ \frac{d^2}{V}$ in $\frac{\text{cm}^2}{\text{volt}}$

$$\Rightarrow \boxed{B = 0.6624\times10^{-4}\ \text{m}^2\text{volt}^{-1}}$$

throughout experiment, $\boxed{I = 1\text{amp}}$

$$\Rightarrow \frac{e}{m} = \frac{7.576\times10^6}{0.6624\times10^{-4}} \times \cancel{\frac{0.6624}{1^2}}$$

$$\Rightarrow \frac{e}{m} = 5.018\times10^6\ \frac{\text{volt}}{\text{amp}^2\,\text{m}^2}$$

$$\Rightarrow \frac{e}{m} = 11.43\times10^{10}\ \frac{\text{volt}}{\text{amp}^2\text{m}^2}\quad (\text{SI})$$

$$\Rightarrow \boxed{\begin{aligned}\frac{e}{m} &= 1.143\times10^{11}\ \text{Ckg}^{-1}\\ &= 1.143\times10^{11}\ \frac{\text{volt}}{\text{amp}^2\text{m}^2}\end{aligned}}\quad (\text{SI})$$

Maximum Possible Error:

$$\frac{e}{m} = (7.576\times10^6)\ \frac{V}{I^2 d^2}$$

$$\Rightarrow \ln\left(\frac{e}{m}\right) = \ln(7.576\times10^6) + \ln V - \ln I^2 - \ln d^2$$

$$\Rightarrow \boxed{\frac{\Delta\left(\frac{e}{m}\right)}{\left(\frac{e}{m}\right)} = \frac{\Delta V}{V} + 2\,\frac{\Delta d}{d}}$$

$\Delta V = 10\text{volt}$ $V = 200\text{volt}$

$\Delta d = 0.1\text{cm}$ $d = 11.07\text{cm}$

$$\Rightarrow \frac{\Delta\left(\frac{e}{m}\right)}{\left(\frac{e}{m}\right)} = \frac{10}{200} + 2\times\frac{0.1}{11.07}$$

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$$\Rightarrow \frac{\Delta(\frac{e}{m})}{(\frac{e}{m})} = 0.05 + 0.018$$

$$\Rightarrow \boxed{\frac{\Delta(\frac{e}{m})}{(\frac{e}{m})} = 0.068}$$

Result:

Hence, the specific charge of electron is $1.143 \times 10^{11}\ C kg^{-1}$ with max. possible error of 6.8%.

$$\boxed{\frac{e}{m} = 1.143 \times 10^{11} \pm 6.8\%}$$

Precautions:

1. Put all power knobs at minimum positions before switching off apparatus.
2. Don't leave the beam ON for long durations.
3. Take only readings of outer diameter of electron beam path.
4. ~~Atas~~ Parallax Error is to be avoided

Sources of Error:

1. Parallax Error
2. Heating Effect of coils

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PH110 : Physics Laboratory

Experiment No.: $\boxed{6}$

Name of the experiment :

Speed of Light in Glass

35/40

Name M.MAHEETH REDDY

Roll No. 1801CS31

Lab Group LG5

Date 23.8.18

Objective:

To determine the speed of propogation of light waves in glass.

Apporatus Required:

Spectrometer (with circular vernier scales)

Glass Prism

Sodium Lamp

Magnifying Glass with torch

Working Formula:

$$\boxed{v = \frac{c \sin\left(\frac{\alpha}{2}\right)}{\sin\left(\frac{\alpha + \delta_m}{2}\right)}}$$

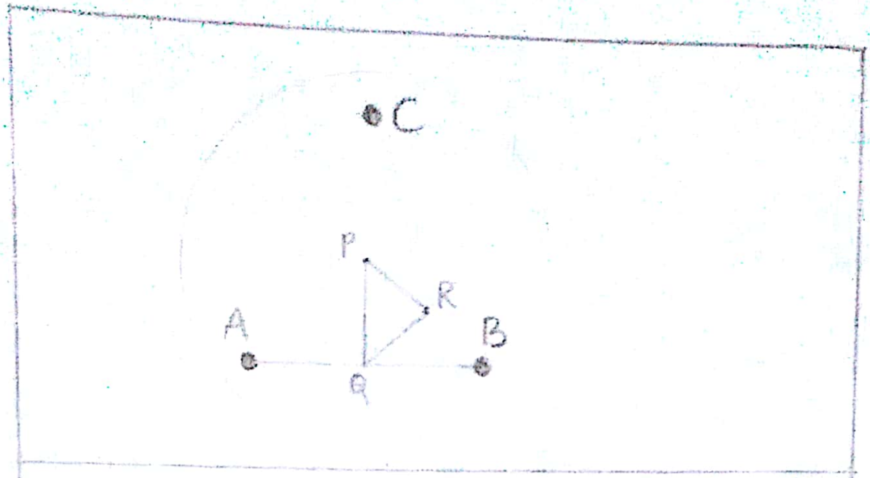
Here, $v \longrightarrow$ speed of light in glass

$c \longrightarrow$ speed of light in vacuum $(c = 2.998 \times 10^8 \ m/s)$

$\alpha \longrightarrow$ angle of prism

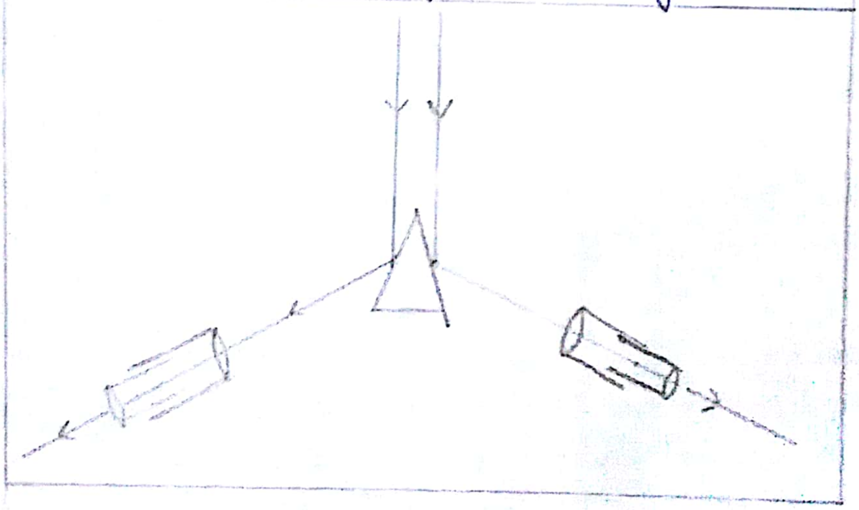
$\delta_m \longrightarrow$ angle of minimum deviation

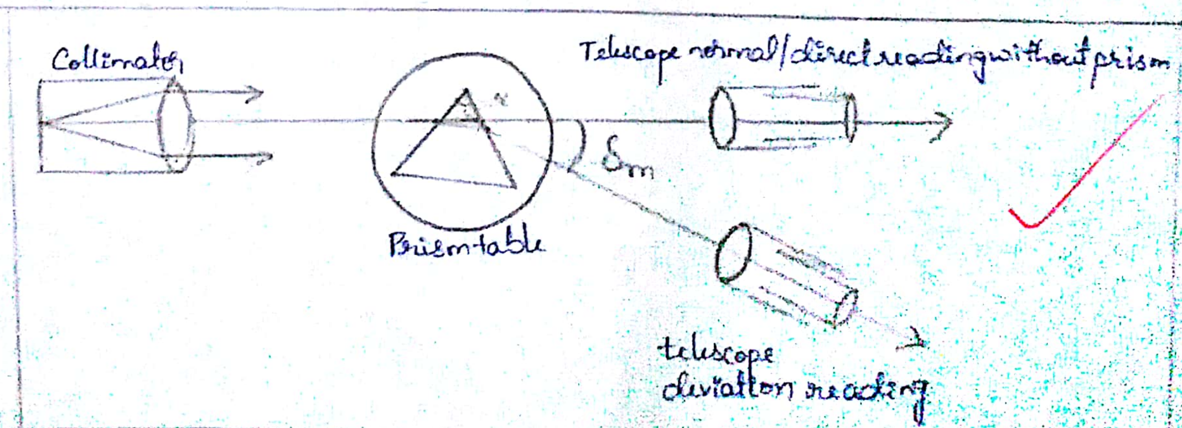
Experimental setup:



Positioning the prism on prism table

Experimental Setup for measuring α





Minimum Deviation Geometry

Observation tables: Least Count of Spectrometer:

30 MSD coincides with 29 MSD Each MSD is 0.5°

$\Rightarrow$ $1\,VSD = \frac{29}{30}\,MSD$ $\Rightarrow$ Vernier Constant $= 1\,MSD - 1\,VSD$

$= \frac{1}{30}\,MSD = \frac{1}{30} \times 0.5^\circ$ degree

$= \frac{1}{60}$ degree $= 1$ min

Hence $\boxed{\text{Vernier Constant} = 1\text{min}}$

For angle of prism α:

Left Reflected Ray (L)						2α	Right Reflected Ray (R)						2α	Mean	Mean
Vernier A			Vernier B			$L_A - R_A$	Vernier A			Vernier B			$L_B - R_B$	2α	α
MSR	VSR	Total	MSR	VSR	Total		MSR	VSR	Total	MSR	VSR	Total			
123	12	123° 12'	303	12	303°12'	120°6'	243	18	243°18'	63(423)	18	423°18'	120°6'		
107	3	107° 3'	287	3	287°3'	120°14'	227	17	227°17'	47(407)	17	407°17'	120°14'	120°52'	60°26'
103	12	103° 12'	283	12	283°12'	120°6'	223	18	223°18'	43(403)	18	403°18'	120°6'		

Readings for deviation Angle (δ_m):

Vernier A							Vernier B							
Normal (c)			Deviation (d)			$c-d = \delta_m$	Normal			Deviation			$c-d = \delta_m$	Mean
MSR	VSR	Total	MSR	VSR	Total		MSR	VSR	Total	MSR	VSR	Total		
196.5	2	196°32'	157.5	23	157°53'	38°39'	17(377)	12	377°12'	337.5	21	337°51'	39°21'	
146.5	13	146°43'	107	18	107°18'	39°25'	326.5	14	326°44'	287	17	287°17'	39°27'	39°16'
133	3	133° 3'	172.5	16	172°46'	39°16'	313	19	313°19'	352.5	15	352°45'	39°26'	

(2) $v = c \dfrac{\sin\frac{\alpha}{2}}{\sin\left(\frac{\alpha+\delta_m}{2}\right)}$

$\Rightarrow \ln v = \ln c + \ln \sin\frac{\alpha}{2} - \ln \sin\left(\frac{\alpha+\delta_m}{2}\right)$

Partial Differentiate on both sides w.r.t δ_m

$$\Rightarrow \frac{dv}{d\delta_m} = v\left[-\frac{1}{\sin\left(\frac{\alpha+\delta_m}{2}\right)} \times \cos\left(\frac{\alpha+\delta_m}{2}\right) \times \frac{1}{2}\right]$$

$$= -\frac{v}{2}\left[\cot\left(\frac{\alpha+\delta_m}{2}\right)\right]$$

$$= -\frac{v}{2}(0.844)$$

$$\Rightarrow \frac{dv}{d\delta_m} = -v(0.422) \quad \text{—— (2)}$$

(1) + (2) $\Rightarrow dv = v(0.437) - v(0.422)$

$$\Rightarrow \boxed{\frac{dv}{v} = 0.015}$$

$\Rightarrow$ Maximum possible Error = 1.5%

Result :

Speed of light in glass comes out to be $1.974 \times 10^8 \, ms^{-1}$

with a maximum possible error of 1.5%

$$\boxed{V = 1.974 \times 10^8 \pm 1.5\%}$$

(P.T.O)

Calculation:

$$V = c \frac{\sin\left(\frac{\alpha}{2}\right)}{\sin\left(\frac{\alpha+\delta_m}{2}\right)}$$

$$= 2.998 \times 10^8 \times \frac{\sin\left(\frac{60^\circ 26'}{2}\right)}{\sin\left(\frac{60^\circ 26' + 39^\circ 16'}{2}\right)}$$

$$= 2.998 \times 10^8 \times \frac{\sin(30^\circ 13')}{\sin(49^\circ 51')}$$

$$\boxed{V = 1.974 \times 10^8 \ m/s}$$

Maximum Possible Error:

(1) $$V = c \frac{\sin\left(\frac{\alpha}{2}\right)}{\sin\left(\frac{\alpha+\delta_m}{2}\right)}$$

$$\Rightarrow \ln V = \ln c + \ln \sin\frac{\alpha}{2} - \ln\left\{\sin\left(\frac{\alpha+\delta_m}{2}\right)\right\}$$

Partial Differentiate on both sides w.r.t α

$$\frac{\partial V}{\partial \alpha} = V\left[\frac{1}{\sin\frac{\alpha}{2}} \times \cos\frac{\alpha}{2} \times \frac{1}{2} - \frac{1}{\sin\left(\frac{\alpha+\delta_m}{2}\right)} \times \cos\left(\frac{\alpha+\delta_m}{2}\right) \times \frac{1}{2}\right]$$

$$= \frac{V}{2}\left[\cot\frac{\alpha}{2} - \cot\left(\frac{\alpha+\delta_m}{2}\right)\right]$$

$$= \frac{V}{2}\left[\cot(30^\circ 13') - \cot(49^\circ 51')\right]$$

$$\frac{dV}{d\alpha} = V(0.437) \quad \text{—— (1)}$$

Precautions:

1. Hold the prism only on the opaque face.
2. Avoid parallax error, look at vernier scale perpendicularly.
3. Before the start of the experiment, focus the telescope
4. Don't touch the experimental setup while taking readings

Source of Error ?

PH110 : PHYSICS LABORATORY

Experiment No.: 5

Name of Experiment:

Determination of 'g' by a Compound Pendulum

25/40

Name	M. Maheeth Reddy
Roll No.	1801CS31
Lab Group	LG5
Date.	16-8-2018

jective :

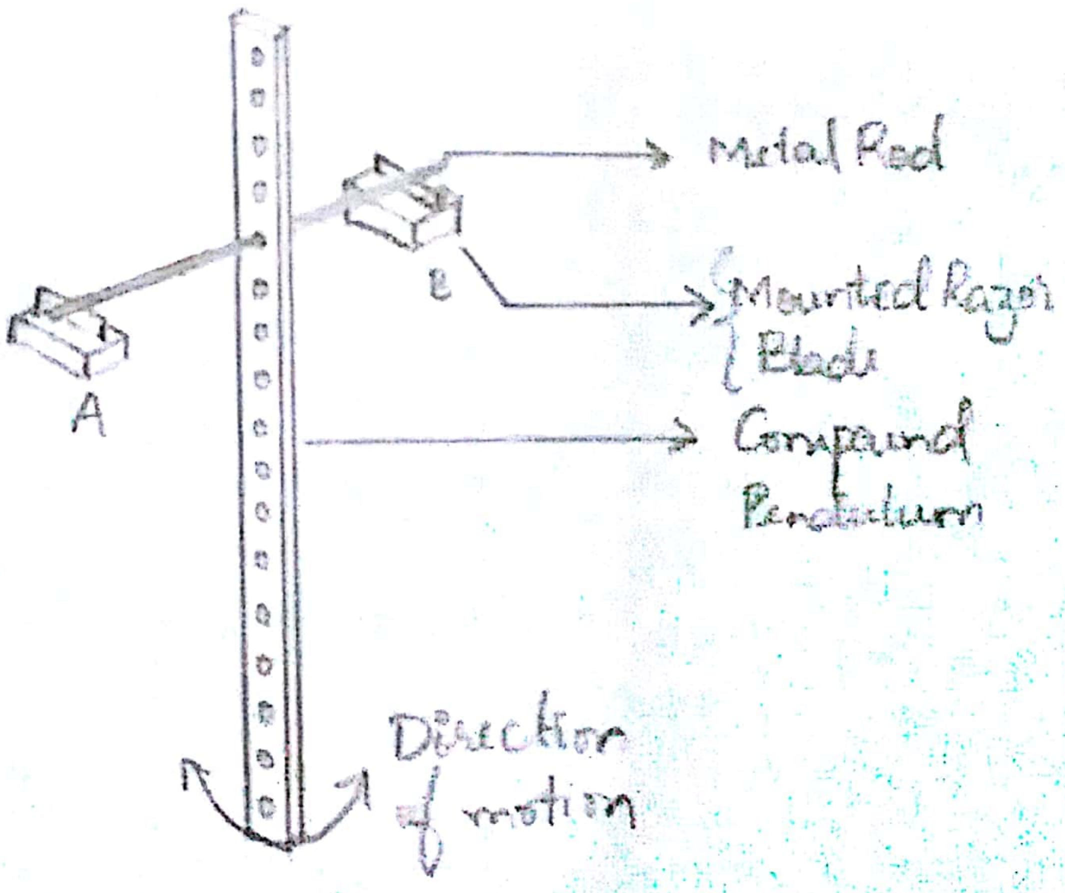
To determine the value of acceleration due to gravity by a compound pendulum.

Apparatus required:

① Long rectangular bar, with series of holes drilled at regular intervals

② Screw type knife-edge

DIAGRAM



Working Formula :

Time period of oscillation of the ~~a~~ rod ~~body~~ constrained to rotate about a horizontal axis (for small amplitudes) is

$$\boxed{T = 2\pi\sqrt{\frac{I}{mgd}}}$$

No derivation?

Here,

$m \rightarrow$ mass of rod

$d \rightarrow$ distance between centre of gravity (CG) and axis of oscillations.

$I \rightarrow$ moment of inertia about axis of oscillations

~~Derivation~~:

If the moments of inertia about an axis parallel to axis of oscillations and passing through centre of ~~mass~~ gravity is I_0. then by parallel-axis theorem,

$$I = I_0 + md^2$$

If $I_0 = mK^2$ (K is radius of gyration)

$$\Rightarrow \boxed{I = m(K^2+d^2)}$$

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After substituting I, rearranging terms for value of g, we get

$$T^2 d = \left(\frac{4\pi^2}{g}\right)(K^2 + d^2)$$

$$\boxed{g = \frac{4\pi^2}{T^2 d}(K^2 + d^2)}$$

Here, $K^2 = \frac{l^2 + b^2}{12}$

where l is length of the bar

b is breadth of the bar

<u>Observation Table:</u>

- Least count of meter scale = 0.1 cm = 1 mm
- Least count of stopwatch = 0.01 s
- Length of bar = 1 m
- Breadth of bar = 4.2 cm
- Mass of bar = 3.4 kg

(P.T.O) for table

S No.	Time period for 20 oscillations t_1(s)	t_2(s)	t_3(s)	t_{mean} (s)	$T = \frac{t_{mean}}{20}$ (s)	d (cm)	d^2 (cm^2)	$T^2 d$ ($cm\,s^2$)
1	31.75	31.57	31.63	31.65	1.5825	45	2025	112.693
2.	31.15	31.07	30.71	30.98	1.5488	40	1600	95.951
3	31.04	31.56	30.89	31.16	1.5582	35	1225	84.979
4	31.79	30.41	30.56	30.92	1.546	30	900	71.703
5	30.84	30.72	30.58	30.71	1.5357	25	625	58.959
6	30.33	31.31	31.34	30.99	1.5497	20	400	48.031 TA[illegible] 16
7	32.28	33.75	33.88	33.30	1.6651	15	225	41.588
8	39.25	39.19	39.15	39.19	1.9598	10	100	38.408
9.	53.65	52.97	53.88	53.5	2.675	05	25	35.778

Result:

Value of 'g' obtained is $\simeq 13.4\ ms^{-2}$

K obtained is $\simeq 0.38m$

Maximum possible error:

$$\frac{dg}{g} = 2\frac{dT}{T} + \frac{2d(d)}{d} + \frac{2d \times d(d)}{k^2+d^2}$$

$$= \frac{2 \times 0.01}{1.96} + \frac{2 \times 0.1}{10} + \frac{2 \times 10 \times 0.1}{100.1444}$$

$$= \frac{1}{98} + \frac{1}{50} + 0.02$$

$$\boxed{\frac{dg}{g} = 0.05} \Rightarrow \boxed{dg = 0.67}$$

Precautions:

① Amplitude should be less than 4°.

② Oscillation should take place about knife edge only

Sources of error:

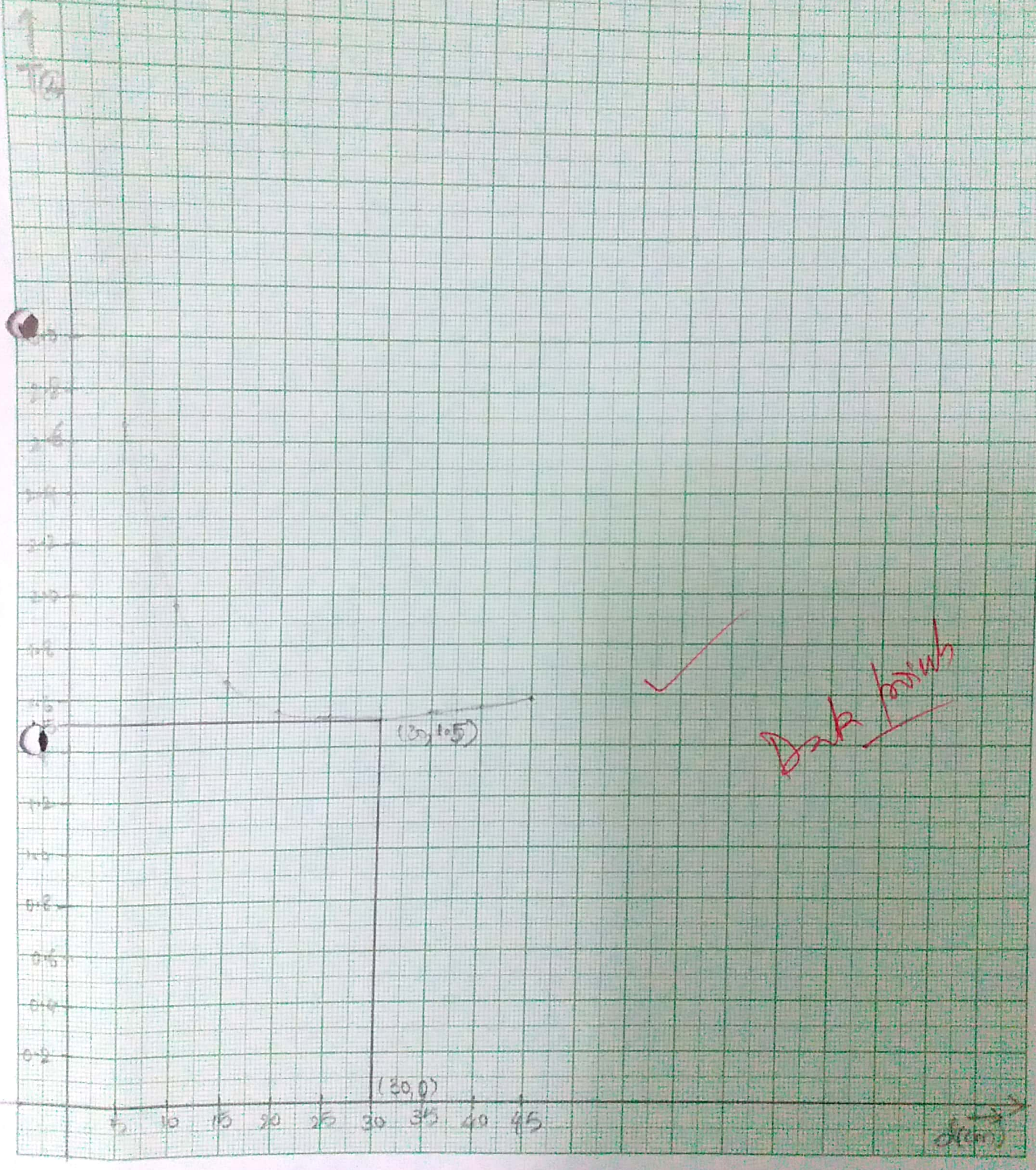
① Oscillation count

② Pausing stopwatch

Result

mination of g T vs d

Scale
x-axis 1 unit = 5cm
y-axis 1 unit = 0.2 s



...mination of g

T^2d vs d^2 graph