Roll No. 47 CLASS. D1AD

VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY

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CERTIFICATE

Certified that Mr./~~Miss~~ YASH SARANG of FE(Sem I) Branch AI - DS has satisfactorily completed a course of the necessary experiments in Engineering Physics Sem I/~~II~~ under my supervision in the Institute of Technology in the year 2020-2021.

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VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY
Department of Humanities and Applied Sciences

(FEC102) Engineering Physics – I

Outcomes: Learner will be able to...

1) Illustrate the fundamentals of quantum mechanics and its applications.
2) Illustrate the knowledge of crystal planes,X-ray diffraction and its application
3) Illustrate the knowledge of Fermi level in semiconductors and applications of semiconductors in electronic devices.
4) Illustrate the knowledge of interference in thin films and its various applications.
5) Illustrate the basic knowledge of superconductors and supercapacitors.
6) Illustrate the knowledge of engineering materials and applications.

INDEX

Sr. No	Name of Experiment	Date of preparation	Date of Submission	Co mapping	Grade	Signature
1	Determination of interplanar distances of different crystal planes.	23/3/2021	08/04/2021	Co2		
2	Determination of Planck's Constant "h" using Photocell.	23/03/2021	08/04/2021	Co1		
3	Determination of radius of curvature of a lens using Newton's Ring Setup.	23/3/2021	08/04/2021	Co4		
4	Determination of Hall-coefficient of a given crystal.	23/3/2021	08/04/2021	Co3		
5	Study of Charging and Discharging characteristics of supercapacitor.	23/3/2021	08/04/2021	Co5		

CLASS : DIAD

ROLL NO : 47

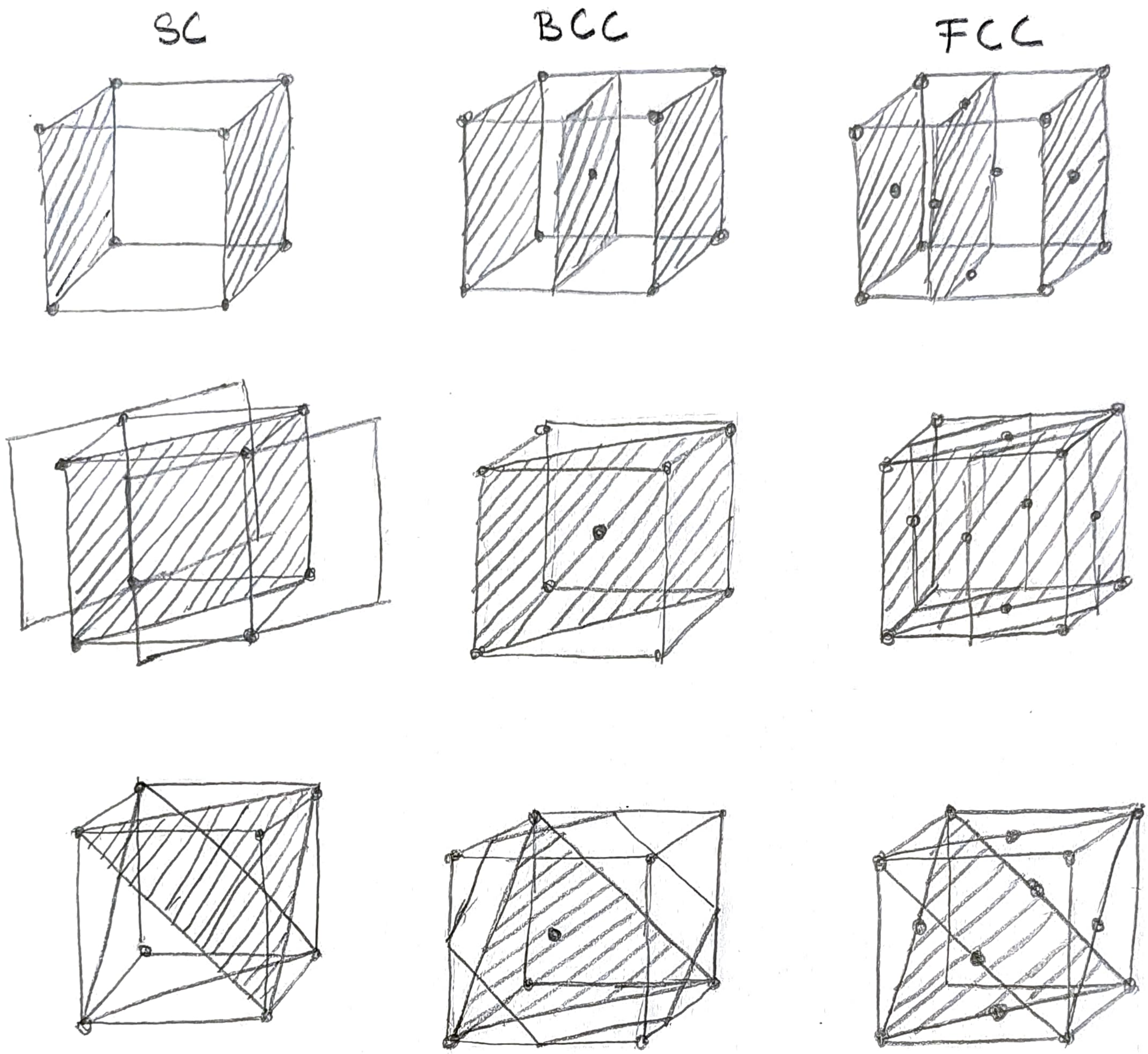
EXPERIMENT NO : 1

EXPERIMENT TOPIC : MILLER INDICES & DIFFERENT INTERPLANAR DISTANCES FOR DIFFERENT CUBIC SYSTEMS.

DOP : 23/03/2021

DOS : 08/04/2021

SIGNATURE OF TEACHER :



MILLER INDICES FOR CUBIC
CRYSTAL PLANE

EXPERIMENT: Miller Indices & Different Interplanar Distances for Different Cubic Systems

AIM: To study Miller Indices for cubic crystal system, verify the interplanar distances and establish the ratio $d_{100} : d_{110} : d_{111}$ for SC, BCC and FCC lattices.

APPARATUS: Given models for SC, BCC, FCC crystal structures with three types of crystallographic planes present.

THEROY: The interplanar distance between any two adjacent planes of a family of planes (hkl) for a cubic lattice is given by

$$d_{hkl} = \frac{a}{\sqrt{h^2+k^2+l^2}}$$

where a = lattice parameter or cube edge of a unit cell,

(hkl) = Miller Indices for the plane under consideration

OBSERVATIONS AND CALCULATIONS: Size of unit cell = 9.2 cm

(hkl)	SC Interplanar distance d_{hkl}	BCC Interplanar distance d_{hkl}	FCC Interplanar distance d_{hkl}			
	Theoretical In units of	Observed (in cm)	Theoretical In units of a	Observed (in cm)	Theoretical In units of a	Observed (in cm)
(100)	a	9.2	a/2	4.6	a/2	4.6
(110)	$a/\sqrt{2}$	6.5	$a/\sqrt{2}$	6.5	$\sqrt{2}a/4$	3.25
(111)	$a/\sqrt{3}$	5.3	$\sqrt{3}a/6$	2.65	$a/\sqrt{3}$	5.3

RESULT AND CONCLUSION: The interplanar distance ratio for (100), (110), (111) is verified to be as follows.

$d_{100} : d_{110} : d_{111}$

Simple Cubic (SC)	$1 : 1/\sqrt{2} : 1/\sqrt{3}$	1: 0.707 : 0.577
Body Centered Cubic (BCC)	$1 : \sqrt{2} : 1/\sqrt{3}$	1: 1.414 : 0.577
Face Centered Cubic (FCC)	$1 : 1/\sqrt{2} : 2/\sqrt{3}$	1: 0.707 : 1.154

CLASS : DIAD

ROLL NO : 47

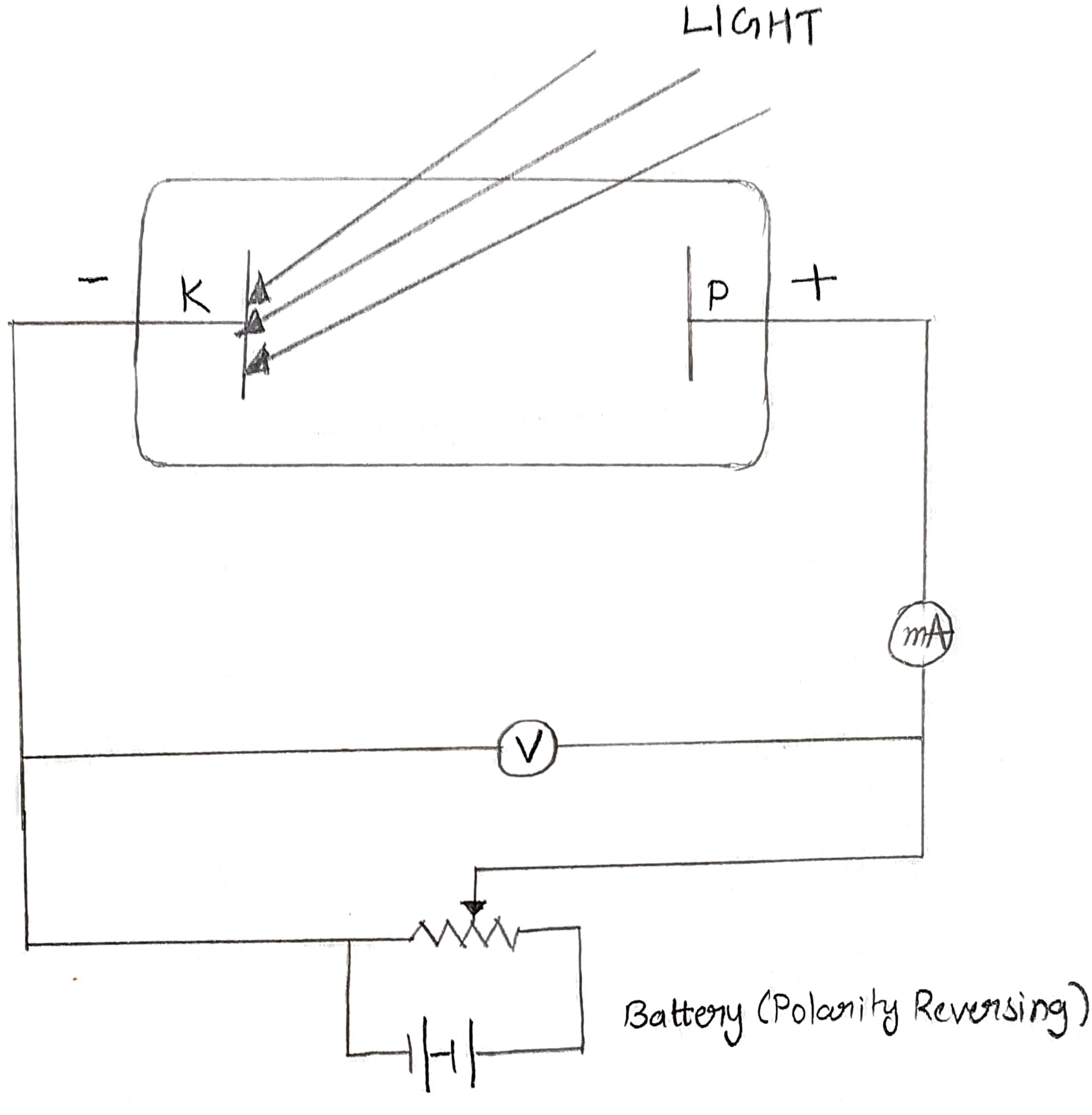
EXPERIMENT NO: 2

EXPERIMENT TOPIC : TO DETERMINE THE PLANCK'S CONSTANT USING A PHOTOCELL.

DOP: 23/03/2021

DOS: 08/03/2021

SIGNATURE OF TEACHER :



Schematic Diagram for Planck's Constant Setup

AIM: To determine Planck's constant using a Photocell

APPARATUS: Photocell, Mercury lamp & different colour filters.

THEORY: The photoelectric equations corresponding to colour filters of frequency ν_1 and ν_2 are

$$h\,\nu_1 = h\,\nu_0 + eV_1$$

$$h\,\nu_2 = h\,\nu_0 + eV_2$$

where ν_0 is the threshold frequency of the photosensitive material used in the photocell, e is the charge of an electron V_1 & V_2 are the stopping potentials corresponding to the colour filters of frequency ν_1 & ν_2. Combining the above two equations Planck's constant is given by

$$h = \frac{e\,(V1 - V2)}{(\nu1 - \nu2)}$$

If V be the voltage applied in the photocell & I be the photo current produced in the circuit then the negative voltage required to produce zero photo current is the stopping potential & this can be obtained from the graph for I-V characteristics.

OBSERVATION TABLE: I-V characteristics (For at least four different frequencies)

Frequency υ1 (4600A) 6.52x10 ^{14}		Frequency υ2 (5400A) 5.55x10 ^{14}		Frequency υ3 (6350A) 4.72x10 ^{14}		Frequency υ4 (5700A) 5.26x10 ^{14}	
Voltage V (volt)	Photocurrent i (μA)	Voltage V (volt)	Photocurrent i (μA)	Voltage V (volt)	Photocurrent i (μA)	Voltage V (volt)	Photocurrent i (μA)
4.91	32.9	4.91	30.3	4.9	10.9	4.92	23.4
3.0	23.8	3.0	21.9	3.0	7.8	3.0	17
1.0	11.3	1.0	10.3	1.0	3.3	1.0	8.1
0	3.3	0	2.5	0.5	2.1	0.5	5.1
-0.5	0.6	-0.3	0.6	0.2	1.1	0	1.6
-0.65	0.3	-0.35	0.5	0	0.4	-0.2	0.6
-0.7	0.2	-0.4	0.4	-0.03	0.3	-0.3	0.2
-0.75	0.2	-0.45	0.2	-0.05	0.2	-0.4	0.1
-0.8	0.1	-0.5	0.1	-0.1	0.1	-0.42	0.1
-0.88	0.1	-0.55	0.1	-0.15	0.1	-0.43	0
-0.89	0	-0.59	0	-0.17	0		

CALCULATIONS:

Frequency of colour filter ν (Hz)	Stopping potential V (volt)	Planck's constant h (J-sec)	Mean h (J-sec)
(6.52×10^{14}) & (5.55×10^{14})	-0.89 -0.59	4.95×10^{-34}	
(6.52×10^{14}) & (4.72×10^{14})	-0.89 0.17	4.8×10^{-34}	
(6.52×10^{14}) & (5.26×10^{14})	-0.89 -0.43	5.84×10^{-34}	5.97×10^{-34}
(5.55×10^{14}) & (4.72×10^{14})	-0.59 -0.17	3.67×10^{-34}	
(5.55×10^{14}) & (5.26×10^{14})	-0.59 -0.43	8.84×10^{-34}	
(5.26×10^{14}) & (4.72×10^{14})	-0.43 -0.17	7.71×10^{-34}	

RESULTS:

Calculated h : 5.97×10^{-34}.

Standard value of h: 6.63×10^{-34}.

Percentage Error: 9.92 %.

CLASS : DIAD

ROLL NO : 47

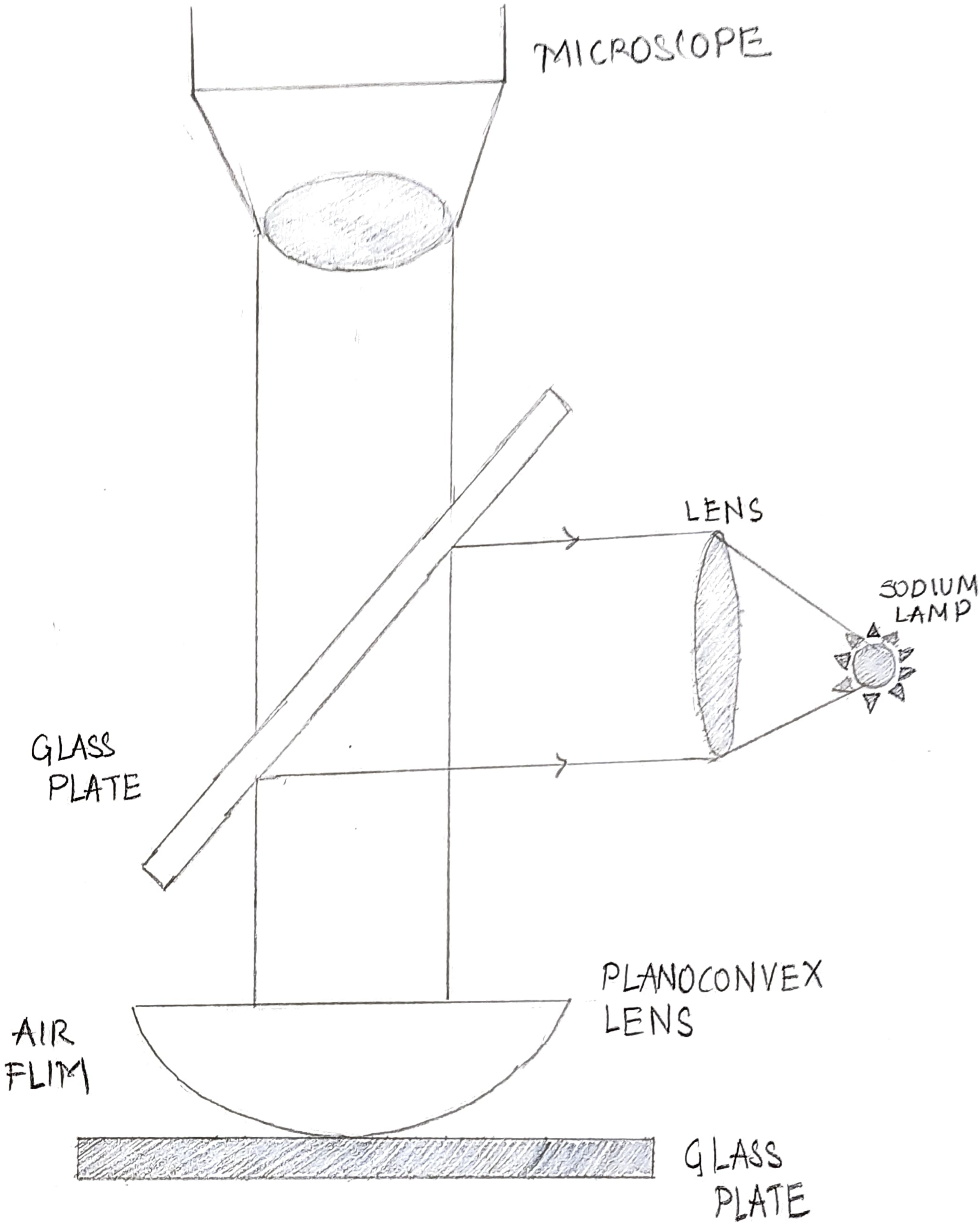
EXPERIMENT NO : 3

EXPERIMENT TOPIC : TO DETERMINE THE RADIUS OF CURVATURE OF A GIVEN LENS USING NEWTON'S RING EXPERIMENTAL SETUP.

DOP : 23/03/2021

DOS : 08/04/2021

SIGNATURE OF TEACHER :



Schematic diagram for Newton's Ring setup

AIM: To determine the radius of curvature of a given lens using Newton's Ring experimental set up.

APPARTUS: Lens, flat glass plate, Sodium light, travelling microscope, reading lens.

THEORY: When a thin film enclosed between a flat glass and a Plano-convex lens is illuminated with a monochromatic source of light. Newton's Rings are observed on the surface of the thin film. These rings represent loci of constant thickness of air film. The radii of these rings deuend on the wavelength and the radius of curvature of the plano-convex lens used in forming the air film. The diameters (D_m & D_{m+p}) of any two dark rings of order m and m+p are given by

$$D^2_m = 4\,mR\lambda \text{ ....} (1)$$

$$D^2_{m+p} = 4\,(m+p)\,R\lambda \text{ ....} (2)$$

Where, R is the radius of curvature of the lens and λ is the wavelength of light used.

Combining the two equations,

$$D^2_{m+p} - D^2_m = 4pR\lambda \text{ ....} (3)$$

The Radius of Curvature is given as

$$R = \{D^2_{m+p} - D^2_m\}/\,4p\lambda \text{ ....} (4)$$

Equation (4) can also be expressed in terms of slope of a plot between D^2_m and m,

$$R = \text{slope}/\,(4\lambda) \text{ ....} (5)$$

OBSERVATION TABLE: (Wavelength of sodium light:5893 Å

Order of Ring	Travelling microscope reading (L.H.S.)cm	Travelling microscope reading (R.H.S.) cm	Diameter D_m= a~b (cm)	D^2_m (cm^2)	D^2_{m+p} - D^2_m (cm^2) for p=4	Avg (D^2_{m+p} D^2_m) (cm^2)
10	8.452	8.106	0.347	0.120408	0.040900	
8	8.451	8.151	0.300	0.09		
6	8.441	8.159	0.282	0.0795	0.0508	0.0517
4	8.403	8.205	0.198	0.0392		
2	8.379	8.252	0.127	0.0169	0.0634	

CALCULATIONS Analytical : $R=[D^2_{m+p}-D^2_m]_{avg}/ 4p\lambda$

$= 0.0517 / 4 \times 4 \times 5.893 \times 10^{-5} = 54.83$ cm

Graphical: $R=slope/4p\lambda$

$= 0.0115 / 4 \times 4 \times 5.893 \times 10^{-5}$

$= 48.78$ cm

RESULT:

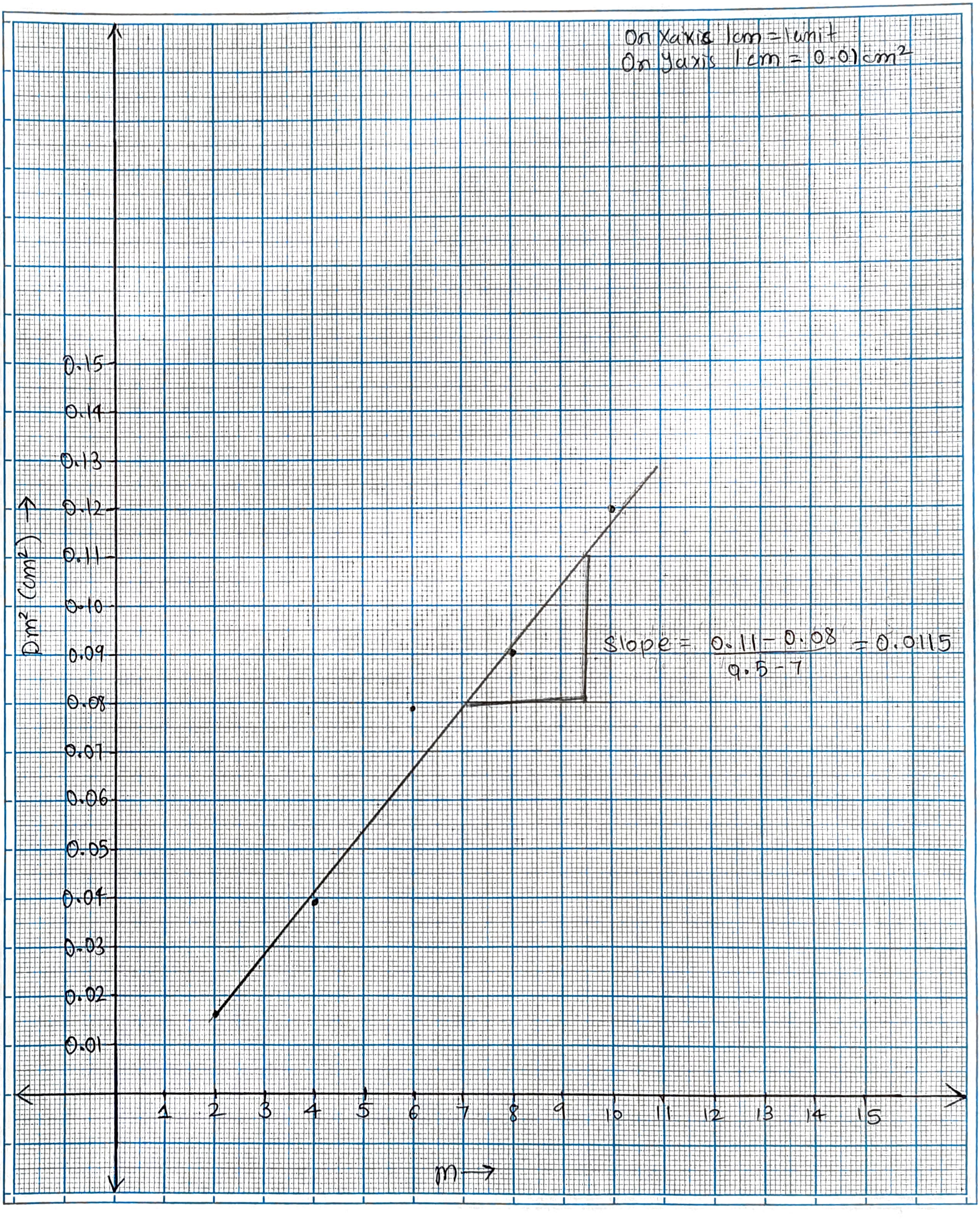
Standard value of the Radius of Curvature = 50 cm

Calculated value of the Radius of curvature = 54.83 cm (Analytical)

Calculated value of the Radius of curvature = 48.78 cm (Graphical)

Average value of Analytical and Graphical R= 51.805 cm

Percentage Error = 3.6%



On X axis 1cm = 1 unit
On Y axis 1cm = 0.01 cm²
Dm² (cm²)
m
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12
0.13
0.14
0.15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Slope = (0.11 − 0.08)/(9.5 − 7) = 0.0115

CLASS : DIAD

ROLL NO : 47

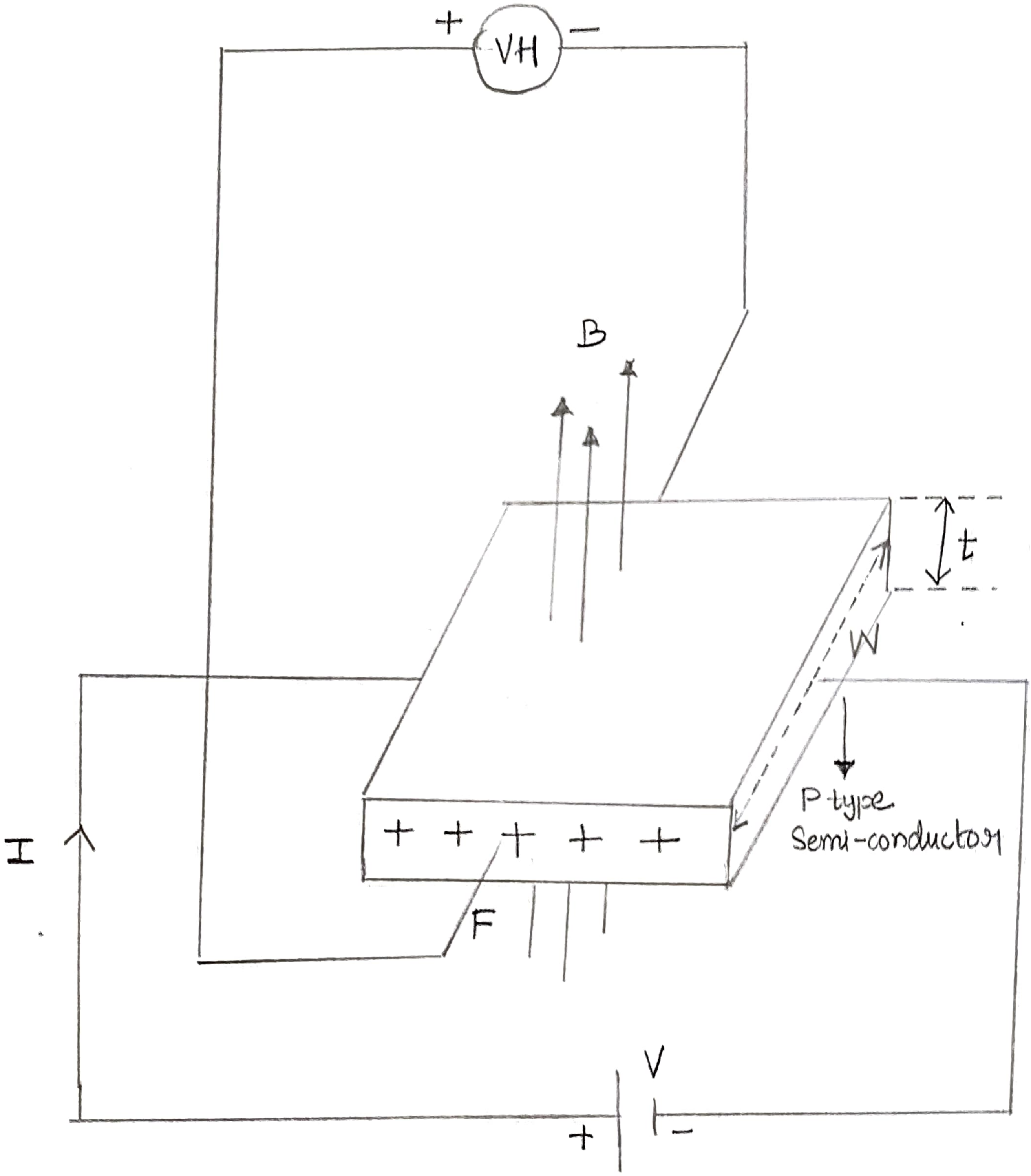
EXPERIMENT NO : 4

EXPERIMENT TOPIC : HALL COEFFICIENT OF A SEMICONDUCTOR CRYSTAL.

DOP: 23/03/2021.

DOS: 08/04/2021

SIGNATURE OF TEACHER :



Schematic diagram for measurement of Hall Coefficient of crystal

Hall-coefficient of a semiconductor

AIM: Determination of the Hall-coefficient of a semiconductor crystal.

OBJECTIVE : To measure the Hall-coefficient of a semiconductor crystal.

THEORY: The Hall effect can be described as the appearance of EMF across the width of a conductor when a current flows along its length & simultaneously a magnetic field is applied along its height i.e. perpendicular to the plane of the conductor. If a current I is passed along the length of the conductor of thickness t and placed in a magnetic field B perpendicular to the plane of the conductor i.e. along t, a potential difference V_H is developed across the width of the conductor and is represented by

$$V_H = ((R_H \times B \times I))/t$$

Where, R_H is Hall-coefficient of a semiconductor crystal in cc/ Coulomb and B is expressed in Gauss & Current (I) in Amp.

For a given plate R_H & t are constant. So for constant I the above relation can be expressed as

$$V_H = K B$$

$$\text{Where } K = (R_H \times I)/t$$

From the slope of V_H vs B graph for a constant I, the value of R_H can be calculated.

KIT- I

OBSERVATION TABLE: Pole gap = 10mm Thickness of given crystal is t = 0.014cm

	Probe current I = 70mA				Probe current I = 100mA			
Magnet current I_m in mA	Magnetic Field B in Gauss for increasing (I_m)	Hall Voltage V_H in mV	Magnetic Field B in Gauss for decreasing (I_m)	Hall Voltage V_H in mV	Magnetic Field B in Gauss for increasing (I_m)	Hall Voltage V_H in mV	Magnetic Field B in Gauss for decreasing (I_m)	Hall Voltage V_H in mV
50	240	1.44	310	1.70	240	1.93	310	2.29
100	420	2.40	530	2.78	420	3.32	530	3.83
150	640	3.45	750	3.85	640	4.84	750	5.41
200	850	4.51	970	4.91	850	6.35	970	6.88
250	1050	5.55	1170	6.03	1050	7.83	1170	8.43

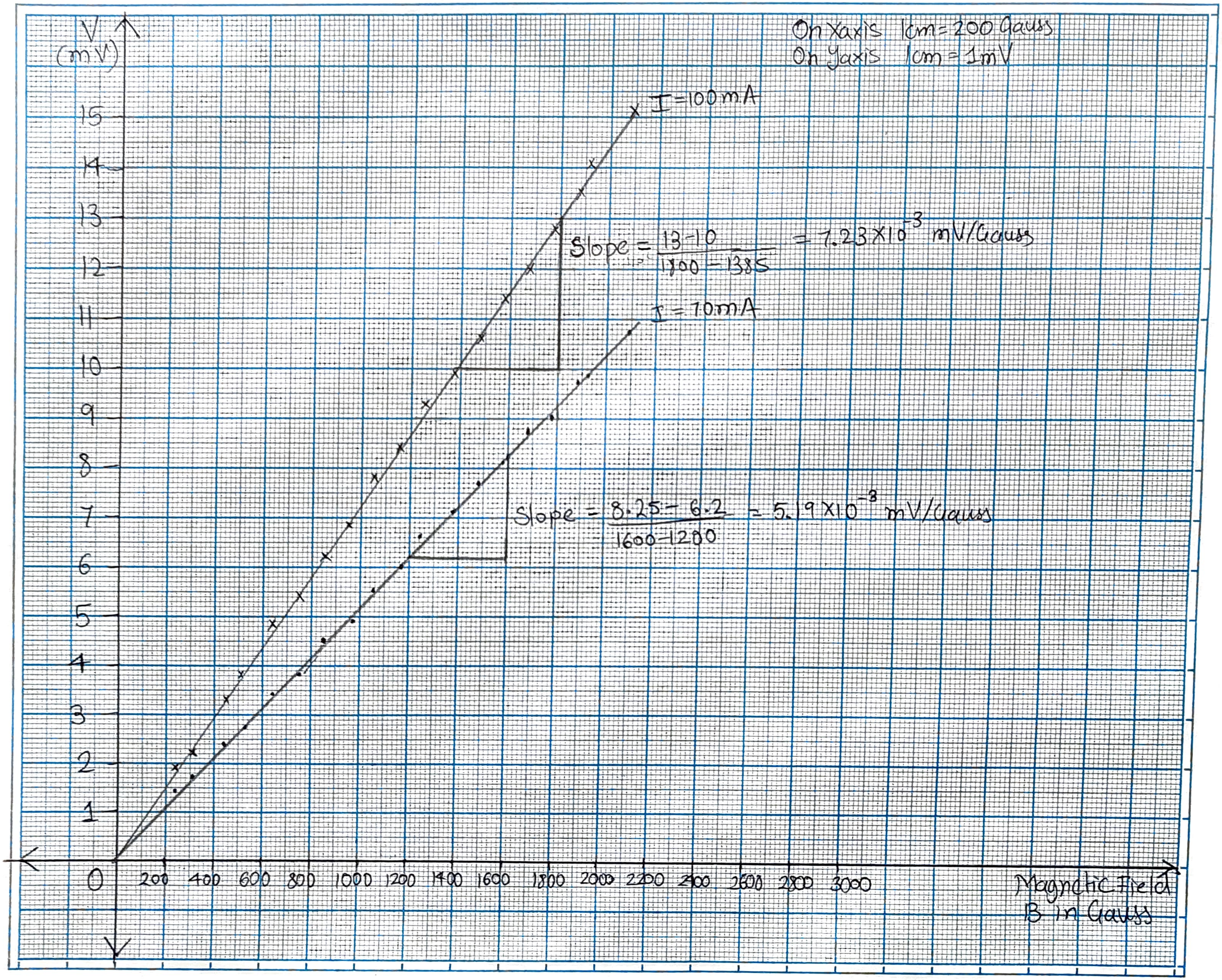
300	126		1380		126		1380	
350	1480		1580		1480		1580	
400	1680		1780		1680		1780	
450	1880		1920		1880		1920	
500	2090		2090		2090		2090	

CACULATIONS:

KIT - 1

Probe current I=70 mA		Probe current I=100 mA		Mean R_H cc/Coulomb
K from graph	$R_{H\ in}$ cc/Coulomb	K from graph	$R_{H\ in}$ cc/Coulomb	
5.19×10^{-3}	103.8	7.23×10^{-3}	101.22	102.51

RESULT: Hall-coefficient of the given crystal is 102.51 cc/Coulomb.



On X axis 1cm = 200 Gauss
On Y axis 1cm = 1mV
V (mV)
I = 100mA
I = 70mA
Slope = (13-10)/(1800-1385) = 7.23×10^-3 mV/Gauss
Slope = (8.25-6.2)/(1600-1200) = 5.19×10^-3 mV/Gauss
Magnetic Field B in Gauss
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

CLASS : D1AD

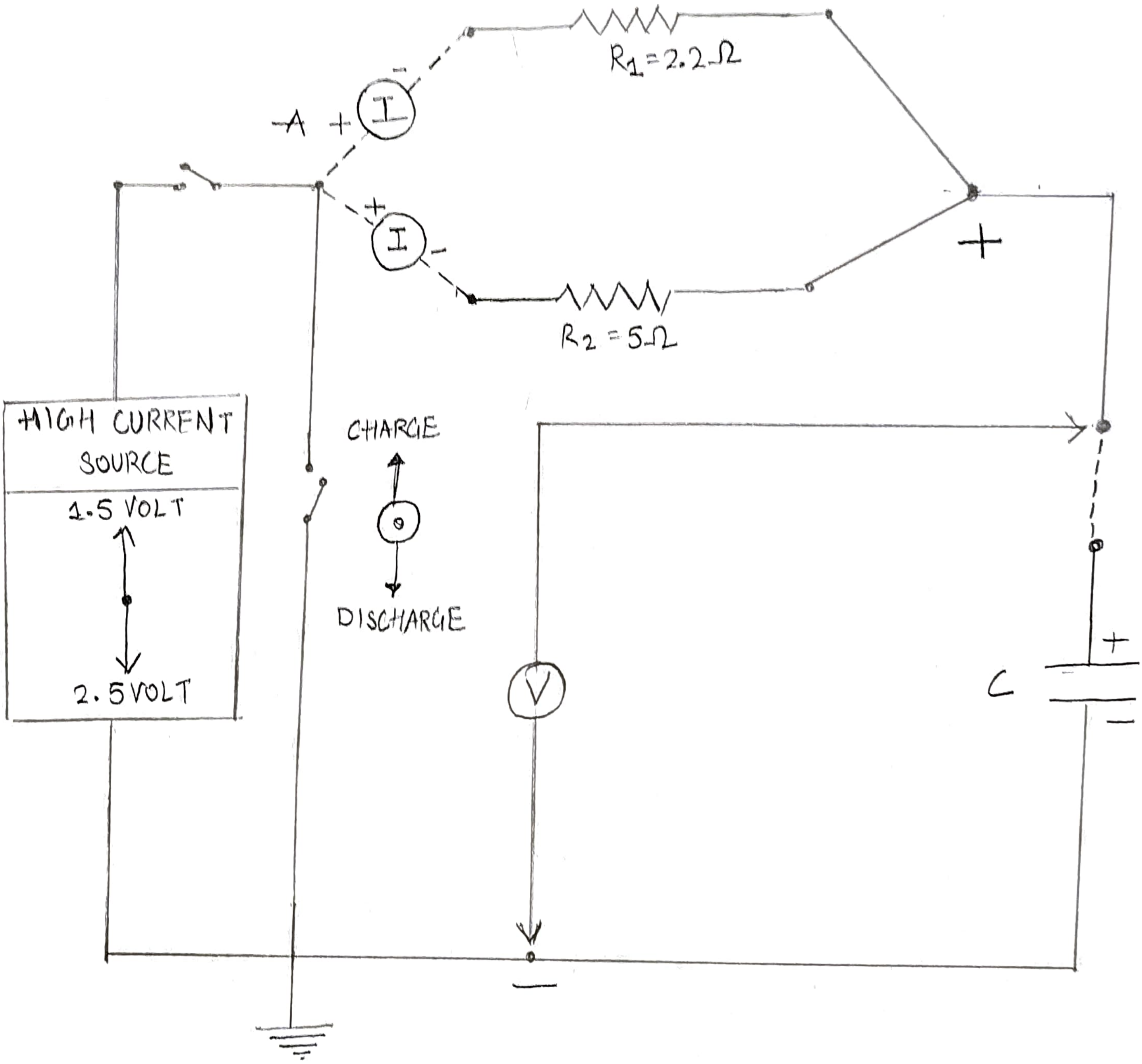
ROLL NO: 47

EXPERIMENT NO: 5

EXPERIMENT TOPIC : To Determine The Time Constant Of A Supercapacitor From The Charging And Discharging Characteristics Of A Super Capacitor.

DOP: 23/03/2021

DOS: 08/04/2021.



R1=2.2Ω
A
I
I
R2=5Ω
HIGH CURRENT SOURCE
1.5 VOLT
2.5 VOLT
CHARGE
DISCHARGE
V
C

CHARGING AND DISCHARGING OF SUPERCAPACITOR

AIM:

To find out the time constant of a supercapacitor from the charging and discharging characteristics of a supercapacitor.

APPARATUS:

Commercial set-up with following components: Supercapacitor (100F), Resistors 3Ω and 5.8 Ω, Regulated power supply V_s (1.5 V & 2.5V) with Ammeter and Voltmeter and stopwatch.

THEORY:

The charging of capacitor is represented by the relation

$$V = V_s(1 - e^{-t/RC}) \quad \text{............ (1)}$$

Where V is the charge on the plate at time t and V_s is the supply voltage

The discharging of capacitor is represented by the relation

$$V = V_0 e^{-t/RC} \quad \text{-----(2)}$$

Where V is the charge on the plate at time t and V_0 is the initial maximum voltage while discharging.

OBSERVATIONS: R=2.2 Ω

Sr.No.	Charging			Discharging		
	Time (sec)	Voltage (volts)	Current (Amp)	Time (sec)	Voltage (volts)	Current (Amp)
1	0	0.3	0.00	0	2	-0.625
2	30	0.65	0.643	30	1.73	-0.550
3	60	0.84	0.591	60	1.59	-0.492
4	90	0.99	0.525	90	1.44	-0.434
5	120	1.2	0.420	120	1.32	-0.343
6	180	1.36	0.378	180	1.11	-0.270
7	240	1.5	0.309	240	0.99	-0.214

RESULT:

Theoretical value of time constant : 300 sec

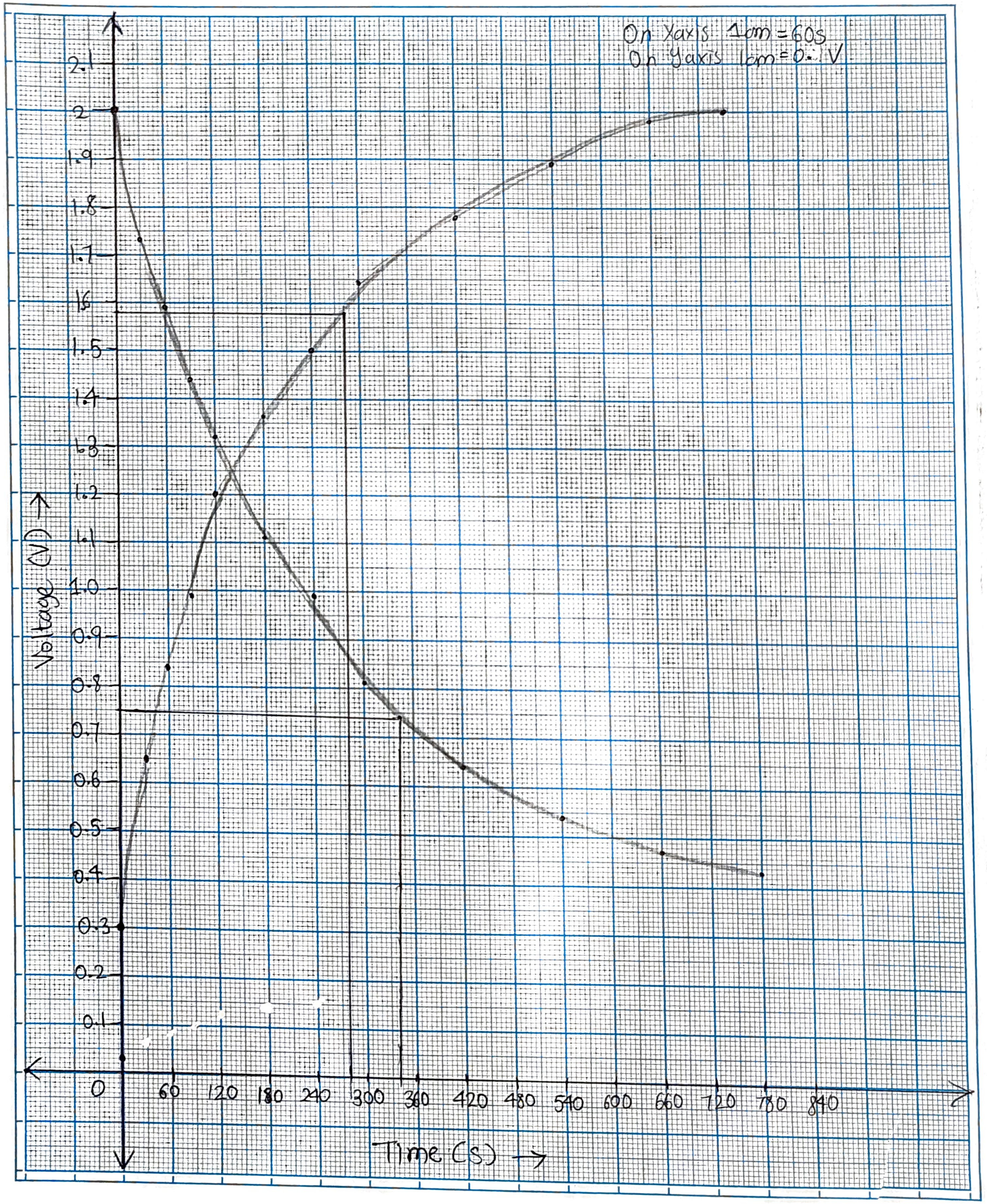
Graphical value of time constant

From charging characteristics (V against Time) : 282 sec

From discharging characteristics (V against Time) : 392 sec

Mean graphical value of time constant : 312 sec

Percentage error : 4%



On X axis 1cm = 60s
On Y axis 1cm = 0.1 V
Voltage (V)
Time (s)
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
60
120
180
240
300
360
420
480
540
600
660
720
780
840