I

Name _____

Roll No. _____ Year 20____ -20____

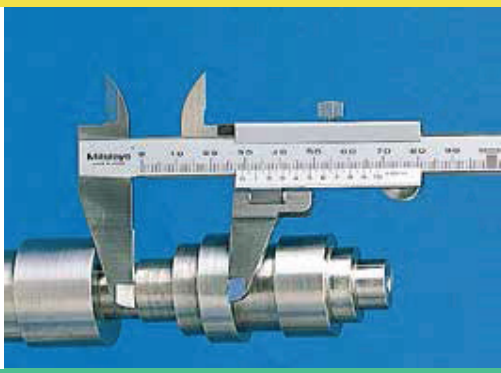
Exam. Seat No. _____

ALL PROGRAMMES | SEMESTER - I | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

BASIC SCIENCE (PHYSICS) (22102)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

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- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

for

Basic Science – Physics

(22102)

Semester-I

Diploma in Engineering and Technology

(All Programme)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO : 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
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(Printed on June, 2017)

MAHARASHTRA STATE

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This is to certify that Mr. / Ms. ……..… Roll No. ……., of First Semester of Diploma in……..…… of Institute ……..……. …… (Code: ……...) has completed the term work satisfactorily in course **Basic Science-Physics (22102)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

The need and importance of fundamental or basic sciences have been established in all walks of technology and everyone has experience that the most important component of basic science are physics and chemistry. The role of physics and chemistry are well accepted in the development of future technology. Therefore it has become essential for every diploma student irrespective of their core discipline to acquire basic knowledge and skills to develop insight not only into its potential and application but also to utilize technology effectively.

Focus in writing this manual has been on developing highly readable experiments that will provide learner with a successful learning experience. Method for developing laboratories begins with identifying concepts that are for particular interest or challenge to students and which would benefit from clarification through laboratory work. From this, experimental learning outcomes are developed and which serve as a key focus point for aspects of given experiment. The pedagogical approach of the laboratory is then chosen to make the most of the topics are trying to be learned. For example, some laboratories benefits from a discovery type approach while others are based taught following a more traditional expository approach.

In particular through this course the students acquire knowledge and skills related to basic physics and chemistry that equip them with the ability to measure, observe keenly, analyze critically, creates the documents for various purpose. The laboratory manual provides detailed guidance to preform the practicals in the right way with necessary resources required to achieve desired outcome.

This lab manual is designed in a way that it is helpful to both the instructors and the students. The manual provides guidelines to help instructors effectively facilitate student-centered activities to be carried out in the lab though practical thus arranging and managing necessary resources, practical outcomes, skills to be achieved through given practical and let students follow the procedures and precautions ensuring the achievement of outcomes and assessing the performance of students.

For students it gives complete guidance regarding minimum theoretical background required to undertake the practical, skills they achieve through the given practical, procedure and necessary precautions to be followed by them. Students can use the acquired knowledge and skills achieved through hands on to solve real-world problems in their professional life. To do this, student must first understand the topic and acquire sufficient background knowledge and implications and limitations of this knowledge.

Programme Outcomes (POs) to be achieved through Practicals

PO 1. ***Basic knowledge:*** *Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Automobile engineering problems.*

PO 2. ***Discipline knowledge:*** *Apply automobile engineering knowledge to solve broad-based Automobile engineering related problems.*

PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve broad-based Automobile engineering problems.*

PO 4. ***Engineering tools:*** *Apply relevant Automobile technologies and tools with an understanding of the limitations*

PO 5. ***The engineer and society:*** *Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Automobile engineering.*

PO 6. ***Environment and sustainability:*** *Apply Automobile engineering solutions also for sustainable development practices in societal and environmental contexts.*

PO 7. ***Ethics:*** *Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Automobile engineering.*

PO 8. ***Individual and team work:*** *Function effectively as a leader and team member in diverse/ multidisciplinary teams.*

PO 9. ***Communication:*** *Communicate effectively in oral and written form.*

PO 10. ***Life-long learning:*** *Engage in independent and life-long learning activities in the context of technological changes also in the Automobile engineering and allied industry.*

Practical- Course Outcome matrix

Course Outcomes (COs)

a) Estimate errors in measurement of physical quantities

b) Apply the principles of electricity and magnetism to solve engineering problems.

c) Use the basic principles of heat and optics in related engineering applications.

S. No.	Title of the Practical	CO a.	CO b.	CO c.
1.	Vernier Calliper	√		
2.	Micrometer Screw gauge	√		
3.	Spherometer	√		
4.	Ohm's Law		√	
5.	Specific resistance of a wire	√	√	
6.	Law of resistances in Series		√	
7.	Law of resistances in Parallel		√	
8.	Magnetic Lines of forces of magnet		√	
9.	Magnetic compass to determine the neutral points		√	
10.	P-n Junction Diode		√	
11.	Forbidden energy band gap		√	
12.	Boyle's Law			√
13.	Joule's Constant by calorimeter	√	√	√
14.	Coefficient of thermal conductivity			√
15.	Refractive index of a prism.			√
16.	Total Internal reflection			√

Brief Guidelines to Teachers

1. For incidental writing on the day of each practical session every student should maintain a dated log book for the whole semester, apart from this laboratory manual which s/he has to submit for assessment to the teacher in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.

Instructions to Students

1. Students should listen carefully the procedure of practical, method of assessment, tentative plan of work in laboratory and total amount of work to be completed in the whole semester.
2. Students should be well prepared while submitting the practical work and submit it for assessment to the teacher in the next practical session, which will develop continuity in the studies.

Content Page

List of Practicals and Progressive Assessment Sheet

* To be transferred to Proforma of CIAAN-2017 .

Experiment No. 1: Vernier Caliper

I Practical Significance

In industries measurement of inner diameter, outer diameter, height and depth of objects with utmost accuracy and precision is a prime requirement. For the measurement of the objects having dimensions less than 1mm or to measure the dimensions of curved surfaces, normal scales cannot be used. Such kind of measurements are possible using measuring instruments like Vernier caliper, micrometer screw gauge etc. In this lab experiment we use Vernier caliper to measure the dimensions of objects in centimeters up to two significant figures.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice

III Relevant Course Outcomes

(a) Estimate errors in measurement of physical quantities.

IV Practical Learning Outcome

Use Vernier caliper to:
(i) Measure dimensions of given objects.
(ii) Measure the dimensions of objects of known dimensions.
(iii) Estimate the errors in measurement.

V Practical Skills

a. Measurement skills
b. Error estimation skills

VI Relevant Affective domain related Outcomes

a. Handle tools and equipment carefully.
b. Select proper instrument.

VII Minimum Theoretical Background

Vernier Caliper is an instrument used to measure dimensions such as inner diameter, outer diameter, height, depth, thickness of an object. Least count (L.C) of instrument is the smallest measurement that can be taken by using an instrument. Range of Vernier caliper is the maximum measurement that can be taken by using the instrument. There are two separate scales on Vernier caliper namely Main Scale and Vernier scale. Least count of Vernier Caliper is given by

$$LC\ of\ vernier\ caliper = \frac{Value\ of\ Smallest\ division\ on\ main\ scale\ (m)}{Total\ no.\ of\ divisions\ on\ vernier\ scale\ (n)}$$

Zero error occurs in an instrument due to non coincidence of zero of main scale with zero of vernier scale when the jaws are closed.

VIII Circuit diagram / Experimental set-up / Work Situation:

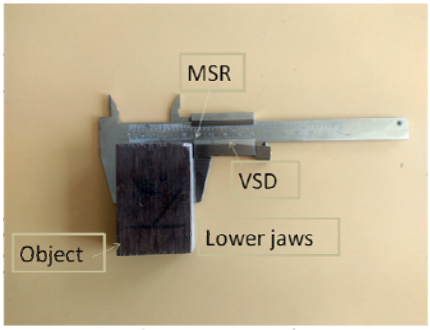

Figure 1A

Outer dimensions of the object

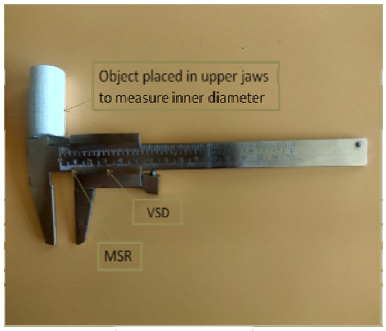

Figure 1 B

Inner diameter of hollow cylinder

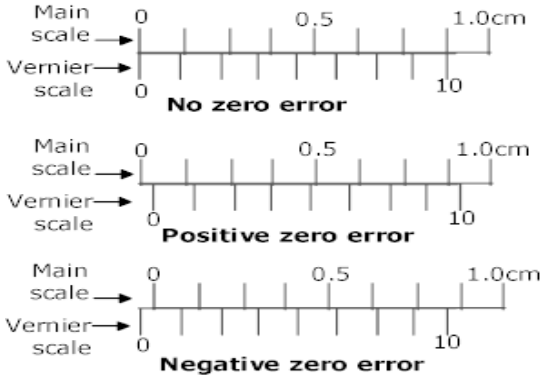

Figure 2

IX Resources required

Sr. No.	Instrument /Object	Specification	Quantity	Remarks
1.	Vernier Caliper	L.C.=0.002cm Range=0-15cm	1 No.	whichever is available
2.	Hollow Cylindrical Pipe	Any dimensions	1 No.	Available dimensions
3.	Rectangular wooden block	Any dimensions	1 No.	Available dimensions
4.	Hollow pipe	16 gauge thickness	1 No.	whichever is available

X Procedure

Part I

1. Identify each part of the instrument.
2. Find the least count of given Vernier calipers using the formula given in the theoretical background.
3. Find the zero error (z) of given Vernier caliper as given in Fig.02.
4. Hold the given object in the appropriate jaws depending upon the parameter to be measured.
5. Observe the zero of the Vernier scale and take main scale reading (MSR).

6. Check the division of Vernier scale coinciding with the main scale and note it down as (VSD).
7. Find the vernier scale reading; VSR = (VSD x L.C.)
8. Calculate the total reading using the formula: Total reading (TR) = MSR+VSR.
9. Calculate the corrected reading CR = TR ± z

XI Precautions

1. The jaws of Vernier caliper should not be pressed hard while taking the readings.
2. The division of Vernier scale exactly coinciding with the main scale should be noted down accurately.
3. Parallax should be removed.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations:

(1) Value of smallest division on main scale = m = ……..……. cm.

(2) Total no of divisions on Vernier scale = n = ……..….

(3) Least count (LC) of Vernier caliper = $\frac{m}{n}$=……..……..cm.

(4) Zero error = (coinciding Vernier division with main scale x LC) = ..…..cm.

(5) Zero error correction (z) = +…….…. cm **or** -…….. cm or No error.

Table 1: Measurement of diameter and height

Object	Dimension		MSR cm	Coinciding VSD	VSR = VSD X LC cm	TR = MSR + VSR cm	CR = TR ± (z) cm	Average cm
Hollow cylinder	Inner Diameter (D_1)	1						
		2						
		3						
Hollow cylinder	Outer Diameter (D_2)	1						
		2						
		3						
Hollow cylinder	Height (h)	1						
		2						
		3						

XVI. Results

1. Average inner diameter of hollow cylinder $D_{1=}$ …….cm
2. Average outer diameter of hollow cylinder = D_2 = ..… cm
3. Average height Hollow cylinder = h = ……..…cm

XVII. Interpretation of results

Error in the measurement= [Known (standard) value- Experimental value]

XVIII. Conclusions and Recommendations

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XIX. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the value of smallest division on main scale and the total no. of divisions on Vernier scale of the instrument used in experiment.
2. Write the range of the Vernier caliper used in the experiment.
3. Give reasons for using upper jaws of the Vernier Calipers to find the inner diameter of cylindrical pipe.
4. Determine the least count (L.C.) of Vernier caliper if smallest division on main scale is 1mm and the number of divisions on Vernier scale is 50.
5. A student has used a Vernier caliper with LC 0.01cm, to measure the length of his pencil. He found that the main scale showed a reading of 8.3 cm and Vernier scale coincides with 5^{th} position to the main scale. Give the correct measurement of the length of the pencil neglecting zero error.

XX. References / Suggestions for further Reading

a. amrita.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=1
b. https://www.youtube.com/watch?v=zqCkb80o_wY
c. mptbc.nic.in/experiments-py-11.pdf

XXI. Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Handling of the instrument	10
2.	Determination of Least Count(L.C.) of instrument	10
3.	Determination of zero error of instrument	10
4.	Fixing of object	10
5.	Proper measurement	10
6.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Error estimation	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

Experiment No. 02: Micrometer screw gauge

I Practical Significance

In industries, many times there is a need to measure the thickness, diameter of objects with utmost precision. Scale is used for the measurement of parameters like length, breadth and height of plane surfaces. Micrometer screw gauge is used to measure dimensions of objects less than 0.1 mm, that cannot be measured by other instruments.

II Relevant Program Outcomes (POs)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

III Relevant Course Outcomes

(a) Estimate errors in measurement of physical quantities.

IV Practical Learning Outcome

Use micrometer screw gauge to:

(i) Measure dimensions of given objects.
(ii) Measure the dimensions of objects of known dimensions.
(iii) Estimate the errors in measurement.

V Practical Skills

a. Measurement Skill
b. Error estimation Skill

VI Relevant Affective domain related

a. Handling tools carefully.
b. Select proper instrument.

VII Minimum Theoretical Background

Micrometer screw gauge: It was invented by William Gascoigne. It is an instrument which consists of two scales i.e. main scale and circular scale.

1. **Pitch** (p): It is the distance between two consecutive threads of the screw. The screw moves forward or backward through a distance equal to its pitch when one complete rotation is given to it. Therefore to find out pitch of the screw, give one rotation to it and find out through how much distance it moves.
2. **Least count (LC)**
   Least count is the smallest measurement that can be done accurately by any measuring instrument. Thus least count indicates the degree of accuracy of measurement by that instrument.

Least count (LC) of micrometer screw gauge

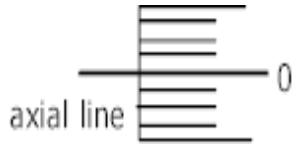
It is ratio of pitch of the screw (p) to the total no of division on circular scale (n).

$$L.C. = \frac{\text{Pitch of the screw (p)}}{\text{Number of divisions on circular scale (n)}} \quad \ldots\ldots\ldots\ldots \textbf{(1)}$$

3. **Zero error**
The zero error is the error caused by non coincidence of zero of circular scale with axial line on main scale when the jaws are closed. Students should refer following diagrams to determine zero error in the instrument used in this lab experience.

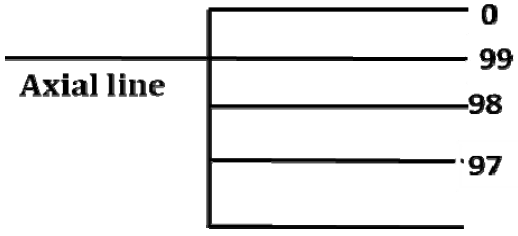
4. **Zero error correction (z)**
Zero error correction (z) is obtained by adding or subtracting zero error.
a) When zero error obtained is positive zero error correction (z) is negative.
b) When zero error obtained is negative zero error correction (z) is positive.

(i) No zero error: When zero of circular scale is coinciding with axial line.



Zero error = No error

(ii) Negative zero error: Zero of circular scale is above the axial line

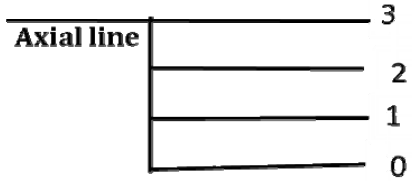


Zero error = Negative error

Zero error = - [(n-99) X LC]

Zero correction (z) = + [(n-99) X L.C.

(iii) Positive zero error: Zero of circular scale is below the axial line



Zero error = Positive error

Zero error = + (3X LC)

Zero correction (z) = - (3 X L.C.)

5. Total reading (TR) of measurement
(i) Total reading (TR) is an addition of main scale reading (MSR) and circular scale reading (CSR).
(ii) Circular scale reading is the multiplication of circular scale division (CSD) and least count (LC)

6. Corrected reading (CR) of measurement
Corrected reading is the addition of total reading (TR) and the zero error correction (z).
TR = MSR + CSR
TR = MSR + (CSD X LC)
and CR = TR ± Zero error correction (z)

VIII Experimental set-up

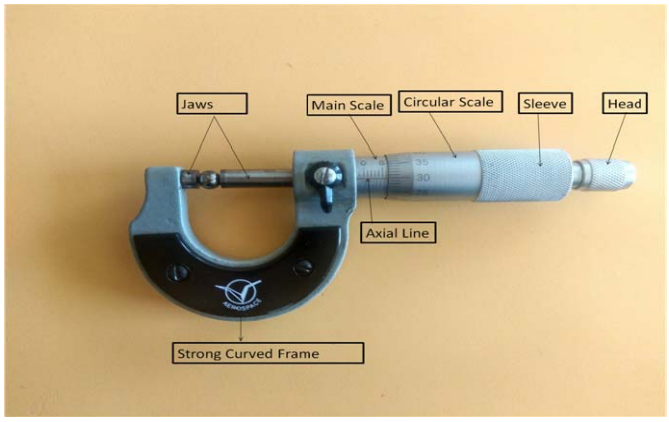


Fig.01

IX Resources required

S. No.	Particulars	Specification	Quantity	Remark
1	Micrometer Screw Gauge	L.C=0.001cm, Range=0 to 2.5cm	01 for each student	
2	Metallic Sphere	Unknown Diameter	01	
3	Plate	Unknown thickness	01	
4	Thin metal wire	Diameter- 16/18/20 gauge	01	

X Procedure

1. Hold the micrometer screw gauge carefully.
2. Identify the main scale and circular scale.
3. Determine the pitch of the screw.
4. Count the number of divisions on circular scale.
5. Calculate L.C. of micrometer screw gauge using equation (1).
6. Identify coinciding division from axial line and calculate zero error (refer zero error diagram.
7. Hold the object in the jaws of micrometer screw gauge. (The jaws should perfectly touch the surface of object).
8. Note main scale reading (MSR) with respect to edge of the rotating drum.
9. Note the circular scale division (CSD) coinciding with the axial line.
10. Determine the circular scale reading (CSR) using the formula CSR= coinciding circular division(CSD) x L.C.
11. Calculate Total Reading T.R. = M.S.R.+ C.S.R.
12. Calculate zero error correction z (refer error diagrams)
13. Calculate corrected Reading.

Corrected Reading = T.R.± Zero error correction (z)

XI Precautions (if any)

1. Only screw head should be rotated and the sleeve should not be rotated to avoid excess pressure.
2. The screw should be always rotated in one direction to avoid backslash error.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

Observations

1. Pitch of the screw = Distance travelled by the screw on main scale in one rotation =
   p = ……..cm.
2. Total number of divisions on circular scale = n = ……..
3. Least count of micrometer screw gauge = p/n=…. cm
4. Zero error = ……. cm
5. Zero error correction, z = Coinciding circular division with axial line (C.S.D.) x L.C.
   = + …….. cm / - ……cm / No zero error

Table 1: Measurement of diameter and thickness

Object	Dimension		MSR cm	CSD	CSR = (CSD X LC) cm	TR = (MSR + CSR) cm	CR = TR ± (z) cm	Average reading cm
Metallic Sphere	Diameter (D_s)	1						
		2						
		3						
Block	Thickness (t)	1						
		2						
		3						
Thin metallic wire	Diameter (D_w)	1						
		2						
		3						

XVI Results

1. Average diameter of metallic sphere = D_s = …… cm.
2. Average thickness of block = t =……...…cm
3. Average diameter of thin metallic wire = D_w = …… cm

XVII Conclusions and Recommendations (if any)

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Is the micrometer screw gauge used for measurement of inner diameter of tube?
2. Name two main parts of a screw-gauge?
3. Write the steps taken to avoid backlash error.
4. State the range of given micrometer screw gauge used in experiment.
5. The circular scale of a screw gauge contains 100 divisions and its pitch is 1 mm. Give the least count of the screw gauge.
6. In ten rotations of the screw, distance travelled on main scale is 20 mm. If number of divisions on circular scale are 50. Find L.C. of micrometer screw gauge.
7. A micrometer screw gauge of pitch 0.5 mm and 50 circular scale divisions is used to measure the thickness of a glass plate. The diagram below shows part of the micrometer gauge. What is the thickness of the glass plate if the micrometer is in the position shown below with the plate in between its jaws?

8. Name the part of the screw gauge, which prevents it from undue tightening?
9. Out of the following instrument which gives maximum accuracy in measurement Give reasons for your answer
   A) Steel ruler. B) Vernier caliper. C) Micrometer screw gauge.

XIX References / Suggestions for further Reading

a. http://amrita.olabs.edu.in/?sub=1&brch=5&sim=156&cnt=470.
b. https://www.youtube.com/watch?v=qCcZebTB7wk.
c. www.phy.uct.ac.za/courses/phylab1.

XX Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Handling of the instrument	10
2.	Determination of Least Count(L.C.) of instrument	10
3.	Determination of zero error of instrument	10
4.	Fixing of object	10
5.	Proper measurement	10
6.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Error estimation	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

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Experiment No.3: Spherometer

I Practical Significance

In oil industry and mechanical industry, inspection of metal surface flatness and roundness of pipe before being shipped to drilling sites helps to remove weakened drill pipe. In civil engineering also equivalent measurements is required for a cylinder or lens in surveying. A Spherometer is the instrument used for precise measurement of the radius of curvature of a sphere, cylinder and lens. The Spherometer is a type of micrometer, it can be employed for purposes other than measuring the curvature of a spherical surface. In this experiment Spherometer is used to determine the radius of curvature of curved surfaces.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge.
PO2- Discipline knowledge.
PO3- Experiments and practice.

III Relevant Course Outcomes

(a) Estimate errors in measurement of physical quantities.

IV Practical Learning Outcome

i. Use Spherometer to measure radius of curvature of any curved surface.
ii. Use Spherometer to determine flatness of a surface.

V Practical Skills

a. Measurement skills
b. Error Analysis

VI Relevant Affective domain related Outcomes

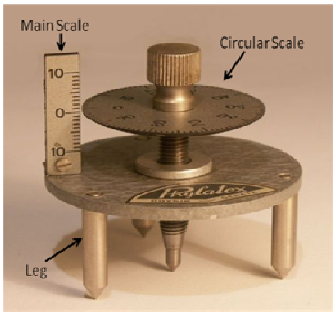
a. Handling the instrument carefully.
b. Demonstrate working as a leader/a team member.

VII Minimum Theoretical Background

1) Spherometer:

A Spherometer works on the principle of the micrometer screw gauge. It is used to measure either very small thickness of flat materials like glass or the radius of curvature of a spherical surface thus getting its name.

2) Parts of a Spherometer



A Spherometer consists of a metallic tripod framework supported on three fixed legs of equal lengths. A screw passes through the centre of the tripod frame, parallel to the three legs. A large circular disc graduated with 100 equal parts is attached to the top of the screw. A small vertical scale known as the Pitch scale (P) with the scale reading divided into millimeters is fixed at one end of the tripod frame.

3) Least count (LC) of Spherometer

It is a pitch of the screw divided by total number of divisions on circular scale.

Least count of Spherometer $LC = \frac{P}{N}$ cm

4) Mean distance between the legs of Spherometer:

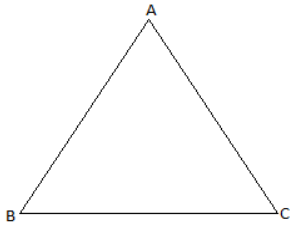


Fig.02

Mean distance,

$$d = \frac{(AB + BC + CA)}{3}$$

5) Concave and Convex surfaces

Concave surface is the surface that curves inward, or is thinner in the middle than on the edges. Convex surface is similar to the exterior of a circle or sphere.

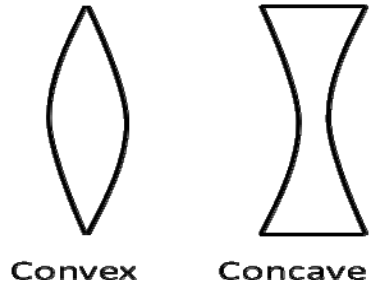


Fig.03

In ordinary usage, *concave* and *convex* are typically used when referring to glass surfaces, like the lenses of optical viewing equipment.

6) Radius of curvature:

The radius of the circle formed with the curved part of the lens is known as radius of curvature. We draw a circle with the help of the curved part of the lens, and locate its centre, by measuring the radius of the circle from the centre we get radius of curvature.

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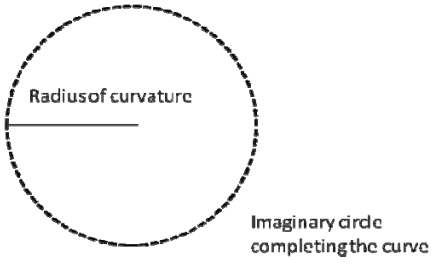
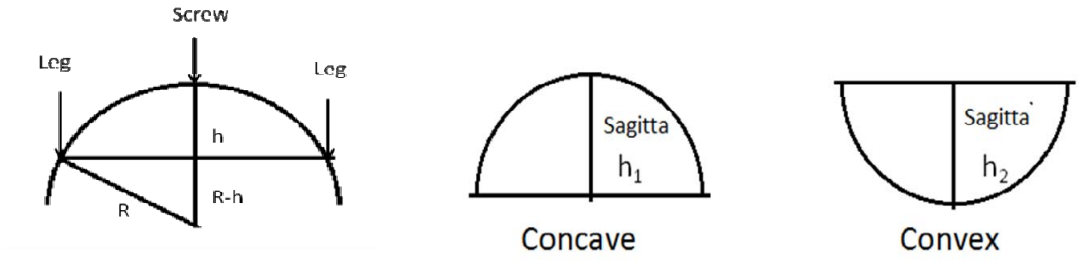


Fig. 4

7) Sagitta:



(a) (b) (c)

Fig.05

The **sagitta** of a circular arc is the distance from the center of the arc to the center of its base. In optics it is used to find the depth of a spherical mirror or lens. The name comes directly from Latin *sagitta*, meaning an arrow.

Sagitta of concave surface h_1 cm

Sagitta of convex surface h_2 cm

Where X= Mean observation for flat plain surface

Y= Mean observation for concave surface

Z= Mean observation for convex surface

Radius of Concave surface is given by $R_1 = \left(\frac{d^2}{6h_1} + \frac{h_1}{2}\right)$ cm

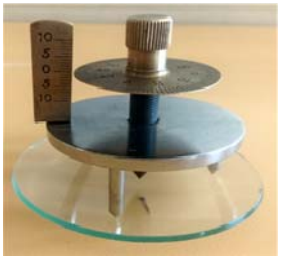
Radius of Convex surface is given by $R_2 = \left(\frac{d^2}{6h_2} + \frac{h_2}{2}\right)$ cm

Where 'd' is the mean distance between the legs of spherometer.

VIII Circuit diagram / Experimental set-up / Work Situation

Convex surface

Fig.06



Concave surface

IX Resources required

S. No.	Name of Instrument	Specifications	Quantity	Remarks
1	Spherometer	L.C.=0.01 mm (0.001cm) Range=0-20 mm or whichever is available		
2	Plane glass plate			Available dimensions.
3	concave surface			Available focal length
4	convex surface			
5	Plain paper	A4		

X Procedure

Part 1: Least Count

1 Find value of smallest division on the main scale.
2 Keep zero of the circular scales coinciding with any division of the main scale.
3 Give one complete rotation to circular scale
4 Note the distance travelled on the main scale.
5 Record it as pitch of the screw (p)
6 Record number of divisions on circular scale as (n)
7 Determine the Least count (L.C.) of the Spherometer using formula.

Part 2: Plane glass surface

1. Place Spherometer on the plane glass surface
2. Turn the screw till it just touches the surface
3. Note main scale reading as (MSR)
4. Note circular scale division readings as (CSD)
5. Calculate the total reading (TR) using formula.
6. Take three independent reading
7. Find the mean reading (X).

Part 3: Concave surface

1 Place the concave surfaces on the plane glass plate
2 Keeps the Spherometer with its legs resting on the concave surface.
3 Turn the screw till it just touches the concave surfaces.
4 Note the main scale reading as (MSR)
5 Note circular scale divisions as (CSD)
6 Find total reading (TR) as (Y) using formula.
7 Find the mean reading (Y) using formula.
8 Note the difference between the readings X and Y as sagitta (h_1) for the concave surface.

Part 4: Convex Surface

1. Place the convex surface on the plane glass plate
2. Raise the screw sufficiently
3. Place the Spherometer with its legs resting on the convex surface.
4. Turn the screw till it touches the convex surface.
5. Note the main scale reading as (MSR)
6. Note circular scale divisions as (CSD)
7. Find total reading (TR) as (Z)using formula.
8. Find the mean reading (Z) using formula.
9. Take three independent observations
10. Find the mean reading (Z)
11. Note the difference between the readings X and Z as sagitta (h_2) for the convex surface.

Part 5: Mean distance

1. Place the Spherometer on a plain paper
2. Press it gently so that the pointed ends A, B and C of the three legs are marked on the paper.
3. Measure the distances AB , BC, and AC
4. Find the mean distance (d)

XI Precautions

1 The screw should move freely without friction.
2 The screw should be moved in same direction to avoid back-lash error of the screw.
3 Excess rotation should be avoided.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

1. Pitch of the screw (P)= ……..cm.
2. Total number of divisions on circular scale = N = …….
3. Least count of Spherometer $LC = \frac{P}{N} = \frac{.....}{.....} = ...$ cm

Table

Surface	Obs. No.	MSR cm	CSD	CSR =CSD x LC cm	Total Reading T.R.=MSR + CSR cm	Average cm
Plane surface	1					X= ……..
	2					
	3					
Concave surface	1					Y= ……..
	2					
	3					
Convex surface	1					Z= ……..
	2					
	3					

1. Sagitta of concave surface $h_1 = X - Y =$ ……cm
2. Sagitta of convex surface $h_2 = Z - X =$ …….cm
3. Reading for distance between legs:
   AB = ……cm , BC = ……cm , CA = ……cm
4. Mean distance, $d = \frac{(AB + BC + CA)}{3}$ = …….cm
5. $R_1 = \left(\frac{d^2}{6h_1} + \frac{h_1}{2}\right)$……cm
6. $R_2 = \left(\frac{d^2}{6h_2} + \frac{h_2}{2}\right)$=……cm

XVI Results

1. Radius of curvature of the given concave surface R_1 = …….cm
2. Radius of curvature of the given convex surface R_2 = ……cm

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Sample Practical Related Questions.

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write steps performed to ensure that the tip of the screw is just touching the plane glass plate.
2. Can the radius of curvature of wrist-watch glass measured by using a Spherometer?
3. Write the effect of changing the pitch from 1mm to 2mm on accuracy of measurement.
4. Write the effect of changing the number of circular divisions from 100 to 50 on least count.
5. Give reasons for main scale marked on both sides of zero.
6. Give reasons for three legs of Spherometer.
7. Name the material and make of Spherometer.

XX References / Suggestions for further Reading

a. amrita.olabs.edu.in/?sub=1&brch=5&sim=168&cnt=2
b. www.learncbse.in
c. http://www.youtube.com/watch?v=SCNZHSgzRYs
d. http://www.youtube.com/watch?v=950xl3MEKM8&feature=related

XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the instrument	10
2.	Determination of Least Count(L.C.) of instrument and mean distance of Spherometer	10
3.	Determination of X, Y, Z carefully	30
4.	Taking care of backlash error	10
Product related: 10 Marks		**40%**
1.	Timely submission of reports	10
2.	Neatness	10
3.	Calculations of R_1 and R_2	10
4.	Interpretation of result	10
5.	Conclusions & Recommendations	
6.	Practical related questions	

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

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Experiment No. 4: Ohm's Law

I Practical Significance

The precise measurement of electric current, voltage, resistance is required in electrical, mechanical industries. It is imperative to have a method by which we can measure all these electrical parameters. Resistance, current and voltage can all be determined by way of the formula which is needed for designing circuits. Ohm's law is used to find out the desired amount of resistance, voltage and / or current levels to make sure that we are able to design circuits. It is applicable to decide the ratings of home and electrical appliances.

II Relevant Program Outcomes (POs)

PO1-Basic Knowledge
PO3-Experiments and practice

III Relevant Course Outcomes

(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Use Ohm's law to solve circuit problems.

V Practical Skills

a. Circuit connections Skills.
b. Measurement Skills.

VI Relevant Affective domain related Outcomes

a. Use Ohm's law to solve circuit problems.
b. Handle tools and equipments carefully.
c. Application of multimeter

VII Minimum Theoretical Background

Ammeter is used to measure electric current (I) & voltmeter is used to measure potential difference (voltage) (V).

Ohm's law: It states that "provided the physical state of the conductor (length, area, temperature) remaining the same in the closed circuit, the current (I) flowing through the conductor is directly proportional to the potential difference (voltage) (V) between the two points of the conductor".

$$I \alpha V$$
$$V \alpha I$$
$$V = IR$$
$$R = \frac{V}{I}$$

Where R is the resistance of the conductor.

Nicrome wire: Nichrome is the form of resistance heating alloy. A common Nichrome alloy is 80% nickel and 20% chromium, by mass, but there are many other combinations of metals for various applications. Nichrome is silvery-grey in colour, is corrosion-resistant, and has a high melting point of about 1,400 °C (2,550 °F). Nichrome is widely used in electric heating elements such as in hair dryers and heat guns.

Eureka wire: Constantan or Eureka is a Cupronic alloy usually consisting of few metals and chemicals melted together at a very high temperature and pressure to form alloy. Its main feature is its resistivity which is constant over a wide range of temperature. Due to its powerful property of constant resistivity up to a wide range of temperature it is widely used in Electrical instruments like current controlling devices, Rheostats, Potentiometers, Thermocouples, Compensating Cables, Load Banks, Electrical speed controllers, Switches, Electric Meters and so on.

VIII Circuit diagram / Experimental set-up / Work Situation

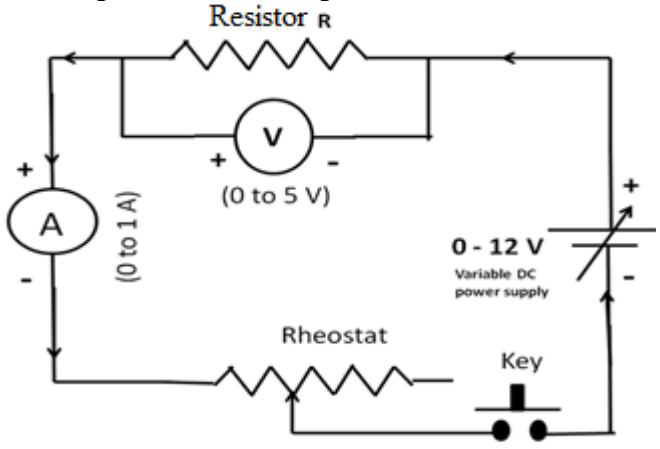

Fig. 01

IX Resources required

S. No.	Instrument/Object	Specifications	Quantity	Remark
1	Power supply	Range- 0 to 12V Range-500 mA	01	Whichever is available
2	Ammeter	Range- 0 to 5A	01	
3	Voltmeter	Range- 0 to 10V	01	
4	Rheostat	Range- 0 to 500Ω	01	whichever is available
5	Key		01	
6	Resistance Wire	1m, Nichrome/Eureka	01	whichever is available
7	Multimeter	Range-0 to 20 M Ω Range-0 to 5 A Range-0 to 10 V	01	

X Procedure

Part I

1. Make connection as per circuit diagram (Fig. 01)
2. Note the LC of Ammeter and range
3. Note the LC of Ammeter and range.
4. Check connection with the help of teacher.
5. Switch on power supply.
6. Close key in circuit.
7. Keep the position of rheostat at maximum resistance.

8. Ensure that the position of ammeter and voltmeter pointer at minimum.
9. Note the reading of ammeter and voltmeter
10. Change the position of sliding arm/ variable arm of rheostat gradually.
11. Note the corresponding change reading in ammeter and voltmeter.
12. Calculate the resistance of wire using the formula: $R = \frac{V}{I}$
13. Repeat the step from 10 to 12 five times
14. Plot the graph with electric current (I) along X- axis and voltage (V) along Y- axis.
15. Find slope of the graph.
16. Determine the resistance by graph .

Part II

1. Make connection as per circuit diagram.
2. Connect multimeter instead of ammeter.
3. Connect multimeter instead of voltmeter.
4. Repeat the steps 4 to 16 given in Part I of procedure

XI Precautions

1. All electrical Connections should be neat and tight.
2. The pointer of ammeter/voltmeter should coincide with zero mark.
3. Check the power supply before connection.
4. Check connection with the help of teacher.
5. Connect Ammeter in series.
6. Connect Voltmeter in parallel.
7. The key should be inserted only while taking readings.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV. Observations and Calculations

1. Using Voltmeter & ammeter
   Least count of ammeter =---------
   Range of ammeter =---------
   Least count of voltmeter =---------
   Range of voltmeter =---------

Table 1 (Using ammeter/ voltmeter)

Sr. No.	Electric current I (Ampere)	Potential difference V(volt)	Resistance $R = \frac{V}{I}$ Ω (ohm)	Mean Resistance R Ω(ohm)
1				
2				
3				
4				
5				

2. Using Multimeter for the measurement
   Range of multimeter as ammeter =---------
   Range of multimeter as voltmeter =---------
   Range of multimeter as ohm meter =---------

Table 2 (Using multimeter)

Sr. No.	Electric current I (Ampere)	Potential difference V(volt)	Resistance $R = \frac{V}{I}$ Ω (ohm)	Mean Resistance R Ω(ohm)
1				
2				
3				
4				
5				

XVI. Results

Resistance of given wire	From observation Ω	From graph Ω
By using voltmeter and ammeter		
By using multimeter		

XVII. Interpretation of results

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XVIII. Conclusions and Recommendations

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the function of rheostat in this lab experiment.
2. A potential difference of 10V appears across the ends of a resistor when 5A of current flows through it. Find resistance of the resistor?
3. If the voltage across a fixed value of resistance is increased five times, what will be the variation in current?

XX. References / Suggestions for further Reading

a. Engineering Physics By Gupta
b. amrita.olabs.edu.in/?sub=1&brch=6&sim=22&cnt=2
c. cdac.olabs.edu.in/?sub=74&brch=9&sim=75&cnt=2

XXI. Assessment Scheme

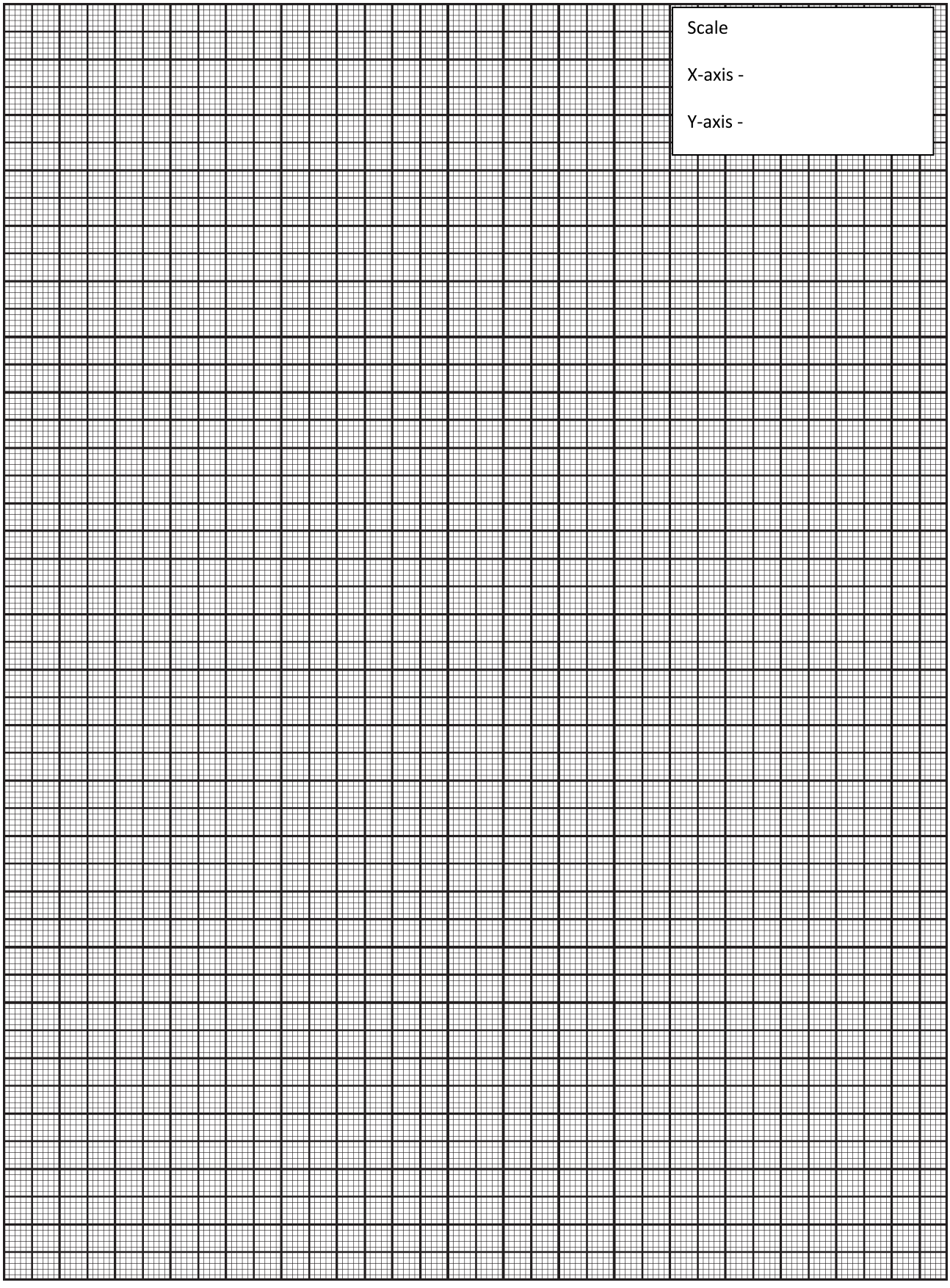
Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Handling of the instrument	10
2.	Determination of Least Count(L.C.) of instrument	10
3.	Identification of instrument	10
4.	Making of electrical connection	10
5.	Proper measurement of voltage and electric current	10
6.		10
Product related: 10 Marks		**40%**
1.	Identification of instruments	10
2.	Resistance of wire	10
3.	Conclusions and Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]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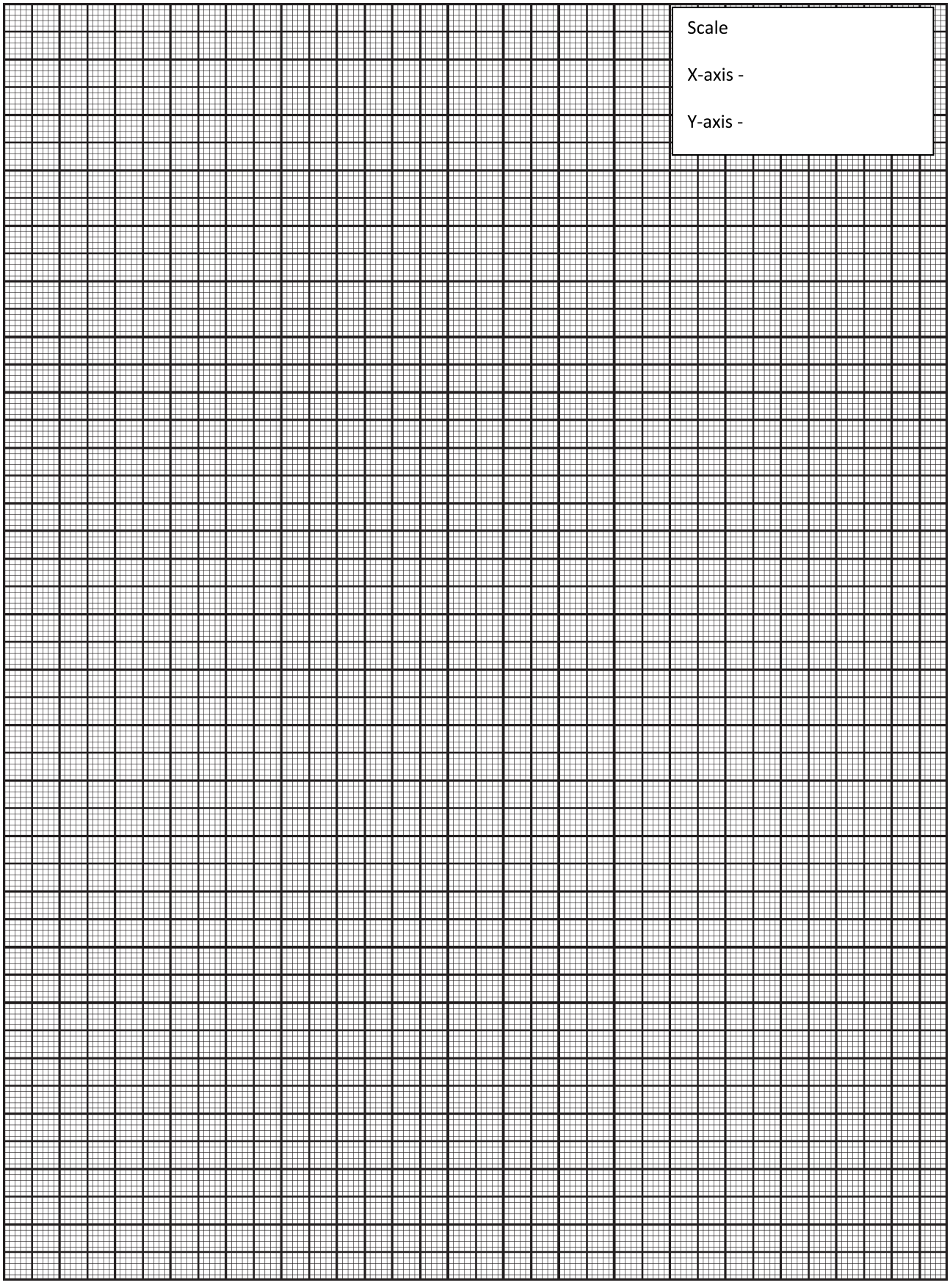
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Experiment No.05: Specific Resistance

I Practical Significance

In industries, components like resistors, inductors and chokes all have to verify that their product meets the requirements of specific resistance, tolerance, and quality control testing. Resistivity or specific resistance (ρ) is a measure of the resistance offered to the electrical conduction for a given size of material. To remove the effect of size from resistance, specific resistance is used. This is a material property which does not depend on size.

II Relevant Program Outcomes (POs) and PSOs

PO 2- Discipline knowledge
PO 3- Experiments and practice

III Relevant Course Outcomes

(a) Estimate errors in the measurement of physical quantities.
(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Determine the specific resistance of given wire.

V Practical Skills

a. Measurement Skill.
b. Electrical circuit connections.
c. Error estimation skill.

VI Relevant Affective domain related Outcomes

a. Follow safety practices.
b. Practice good housekeeping.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Ohm's Law: It states that "Provided the physical conditions of a conductor remaining the same(length, area, temperature of the conductor), in a closed circuit the amount of current (I) flowing through the conductor is directly proportional to the potential difference (V) between two ends of the conductor."

$V \alpha I$

$V = IR$ Where R is resistance of conductor.

Factors affecting resistance of a conductor At constant temperature, resistance(R) of the conductor is directly proportional to the length of the conductor and inversely proportional to its cross sectional area.

$$R \alpha L$$

$$R \alpha \frac{1}{a}$$

$R = \rho \frac{L}{a}$ where **ρ** is specific resistance or resistivity of material.

Specific resistance *:* It is defined as the resistance of a material per unit length per unit cross sectional area when temperature of conductor is constant.

$$\rho = \frac{Ra}{L}$$

VIII Circuit Diagram

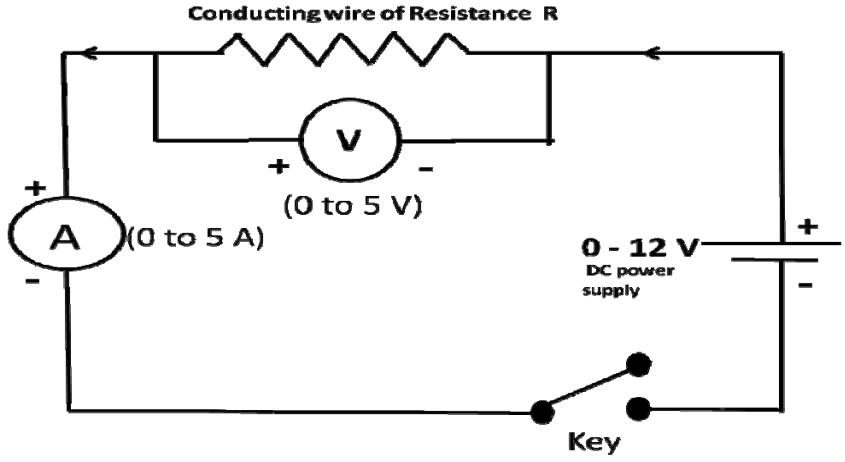

Fig. 01

IX Resources required

S. No.	Particulars	Specification	Quantity	Remark
1	Voltmeter	0-5V	01	
2	Ammeter	0-1A	01	
3	Battery	0-12V	01	
4	metal wire	20cm,30cm,40cm.50cm,60cm,70cm,80cm, 90cm or as available	01 each	As per the available
5	Resistance box	0-1000Ω	01	

X Procedure

1. Measure the radius 'r' of wire using micrometer screw gauge.
2. Determine the area 'a' of the wire using the formula.
3. Find L.C. and range of the given ammeter and voltmeter.
4. Take conducting wire of known length (L).
5. Connect the circuit as per circuit diagram.
6. Now put in the plug key.
7. Switch on the circuit.
8. For a constant supply voltage (V), note down the current (I) using the ammeter.
9. By keeping the voltage constant, note the current (I) for wires of different length.
10. Calculate the resistance (R) of the wire using the formula, $R = \frac{V}{I}$.
11. Calculate the value of specific resistance using the formula , $\rho = Ra/L$.
12. Plot the graph of resistance(R) Vs length (L) of the wire.
13. Find the slope of the graph.

14. From the value of slope, determine the specific resistance of the given wire using the formula ρ=Slope X Area (a).
15. Compare the experimental and graphical value of the specific resistance of the given wire.

XI Precautions

1. Handle all the equipments with care.
2. Make connections according to circuit diagram.
3. The plug key should be open while connecting the circuit
4. Get the connections checked by the teacher.
5. Before switching on the supply, the knob of the DC supply should be strictly kept at 0V(minimum)
6. Take the readings carefully & the connections should be tight.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

To determine the radius and hence area of the given wire:

Dimension		MSR cm	CSD	CSR = (CSD X L.C.) cm	TR = (MSR + CSR) cm	CR = TR ± (z) cm	Average reading d cm	Radius of wire r=d/2 cm	Area of Cross-section $a= \pi r^2$ cm^2
Diameter (d) of wire	1								
	2								
	3								

Observation Table:

1. Least count of ammeter = …….. ….A.
2. Range of ammeter =……A.
3. Least count of voltmeter.=…….V
4. Range of voltmeter = ……V

To determine the specific resistance (ρ) of the wire

Obs. No.	Length of wire(L) in cm	Current (I) in ampere	Potential difference (V)in volt	Resistance of wire $R = \frac{V}{I}$ Ω	Specific resistance ρ =Ra/L $\Omega - cm$
1	20				
2	30				
3	40				
4	50				
5	60				
6	70				
7	80				
8	90				

Mean Specific Resistance (ρ) = …… $\Omega - cm$

Calculations:

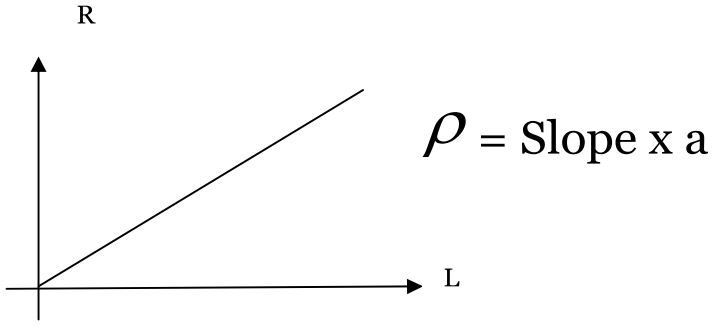
Specific resistance $\rho = \frac{Ra}{L}$

$$\rho = \frac{.....}{.....}$$

$$\rho = ...\Omega.cm$$

1. Specific resistance of the material of the given wire by graph, ρ_{graph}=… Ω.cm.

Graph:



XVI Results

Mean Resistance for wire of length of wire = …….Ω
Specific resistance of the material of given wire by experiment = …….Ω.cm.
Specific resistance of the material of given wire by graph=…… Ω.cm

XVII Interpretation of results

Error in the value of specific resistance=Experimental value- Standard value

XVIII Conclusions and Recommendations (if any)

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XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the factors on which specific resistance of the wire depends in your experiment.
2. For two wires of same length and different radii, does the resistance of wire change? Give reasons.
3. Name the different methods of finding unknown resistance.
4. Calculate the resistance of a copper wire 20 meter long and diameter of 0.05 cm. (specific resistance of copper =1.678 $\times 10^{-6}$ Ω-cm.)
5. If the radius wire is doubled, will the specific resistance change? Explain.

XVII References / Suggestions for further Reading

a. youtube.com: Videos of Practical demonstration of Ohm's law.
b. vimeo.com: Videos of Practical demonstration of Ohm's law.
c. www.authorstream.com/.../aSGuest60357-468668-**ohm**-s-**law**/*OHM'S LAW Ppt* Presentation.
d. http://amrita.olabs.edu.in/?sub=1&brch=4&sim=99&cnt=199

XVIII Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Selection of the instrument	10
2.	Arrangement of the instrument	10
3.	Connection of circuit diagram	10
4.	Handling of instruments	10
5.	Proper measurement	10
6.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Accuracy of Measurement	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

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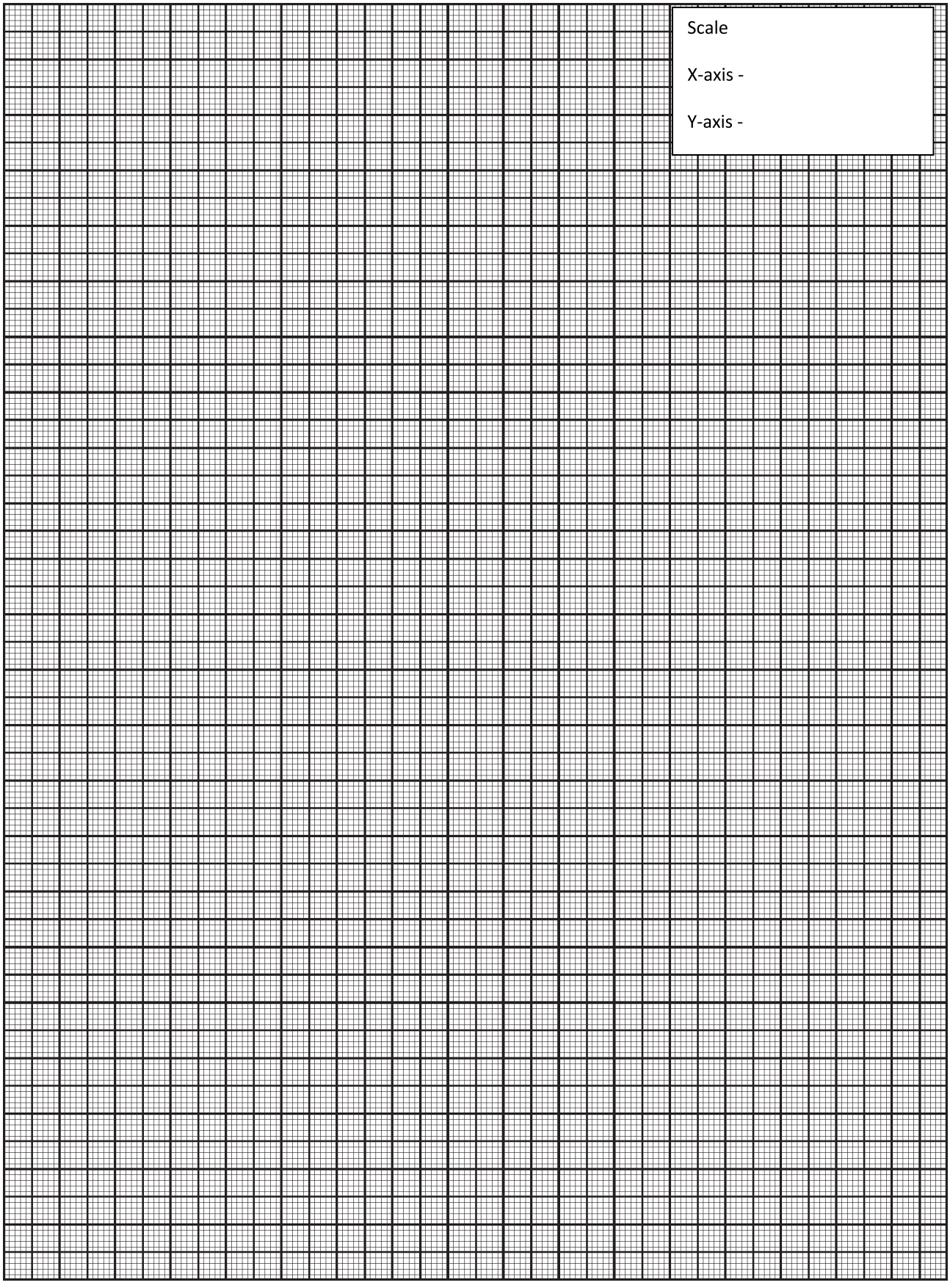
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Experiment No. 6: Law of resistances in series

I Practical Significance

Series circuit connections are common and greatly employed in electrical equipments. Current controlling devices, Fuses , automatic house-heating equipment electromagnetic coils and safety cut-outs connected in series with a voltage source . The application of series and parallel circuit connection can be evidently seen in our homes and industry. In this experiment, resistive wires are connected in series and equivalent resistance of circuit is determined using ohm's law, helps students to analyze series circuits.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO2- Discipline knowledge
PO3- Experiments and practice

III Relevant Course Outcomes

(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Use the principle of series resistance in solving electrical engineering problems.

V Practical Skills

Measurement skills

VI Relevant Affective domain related Outcomes

a. Easiness and appropriateness in connecting the circuit.
b. Confidence while performing the experiment with a good team spirit.

VII Minimum Theoretical Background

1) Ohm's Law

It states that, physical conditions of a conductor such as length, area of cross section, temperature, resistivity remaining the same, in a closed circuit amount of current (I) flowing through the conductor is directly proportional to the potential difference (V) between two ends of the conductor.

$I \propto V$

$I = \frac{V}{R}$ Where R is resistance of conductor

2) Series circuit

A series circuit is a circuit in which resistors or loads are connected end to end so that the circuit will have only one path through which electric current flows. Thus, when a number of resistors are connected in series, the effective resistance (total resistance in the circuit) is obtained by adding the individual resistance algebraically. That is to say, if we have resistors with resistance R1, R2, R3 …Rn connected in series, then;

$R_{eff} = R_T = R_1 + R_2 + R_3 + \ldots R_n$.

In series connections, the same current flows across all the branches of the circuits, but different voltage across it thus making the resistors to have different voltage across them. Each resistor or load will experience a voltage drop. The applied voltage is equal to the sum of the voltage drop across the different parts of the circuit. Voltage drop is proportional to the resistance current being the same throughout the circuit.

When loads are connected in series, the loads will tend to have a common switch. This kind of connection is employed in halls, street lights.

3) Law of resistances in series

It states that equivalent resistance of the resistances connected in series is sum of individual resistances

$$R_s = R_1+R_2+R_3\ldots\ldots\ldots R_n$$

VIII Circuit diagram / Experimental set-up / Work Situation

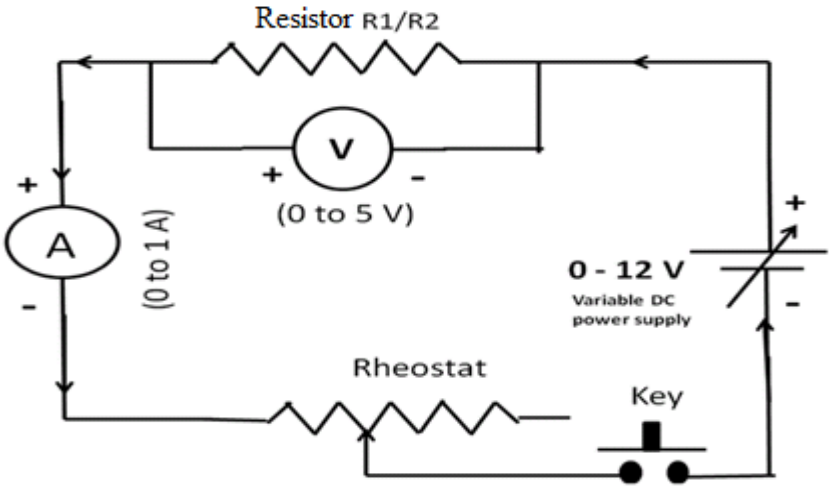
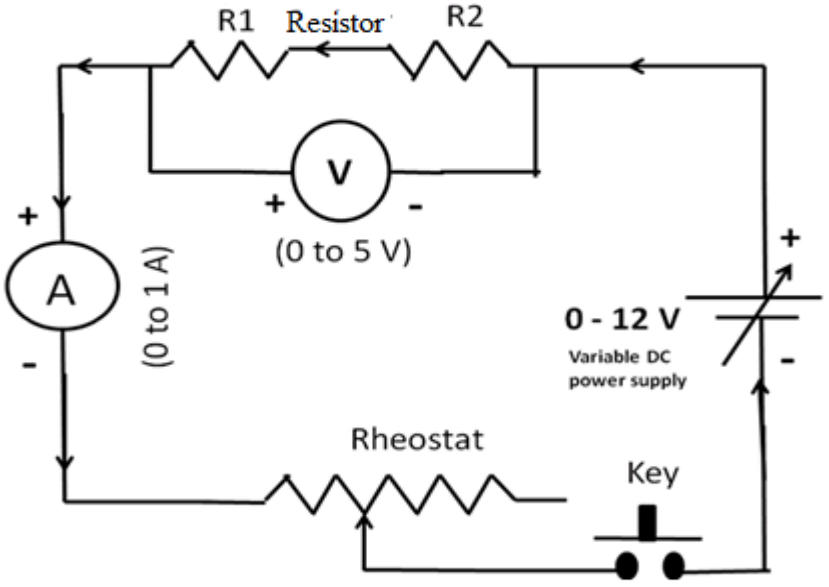


Fig.01



IX Resources required

S. No	Name of Instrument	Specifications	Quantity	Remarks
1	Eureka wire	1m, 2m	1 each	Quantity for 1set
2	Copper wire	Multi-strand	1 bundle	
3	Voltmeter	0-5V	1	
4	Ammeter	0-1A	1	
5	Rheostat	50-110Ω	1	
6	Battery eliminator	0-6V	1	

X Procedure

1. Connect the circuit according to the circuit diagram (Fig. 01).
2. Connect unknown resistance R_1 in the circuit.
3. Vary current in the circuit using rheostat.
4. Record the observations from voltmeter and ammeter in equal intervals.
5. Take five observations.
6. Calculate the resistance of given wire by ohm's law as per the formula.
7. Find mean resistance R_1
8. Repeat the steps 2 to 7 to calculate unknown resistance R_2.
9. Connect the two resistances R_1 and R_2 in series combination as per the circuit diagram (Fig. 02).
10. Repeat the steps 2 to 7 to calculate equivalent resistance R_s by experiment.
11. Calculate equivalent resistance R_s by theory using formula.
12. Show sample calculation.
13. Note down the results.
14. Write interpretation and conclusion.

XI Precautions

1. Connections should be clean and tight.
2. Thick copper wires should be used for connection after removing the insulations near the ends.
3. While changing the voltage, rheostat must be move in one direction only.
4. Voltmeters and ammeters should be of proper range.
5. A low resistance rheostat should be used.
6. The key should be inserted only while taking the observations to avoid excessive heating of resistors.
7. Do not pass a large current through the resistance.
8. While measuring the voltage and current the needle of meters should not move out of the scale.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

1. Range of Voltmeter =_____ V
2. Range of Ammeter =_____ A
3. Least count of voltmeter = _____ V
4. Least count of ammeter = _____ A
5. e.m.f of the Battery = _____V

Table 1: For wire 1 (Fig.01)

S. No.	Voltage Volt(V)	Current Ampere (A)	Resistance $R_1 = \frac{V}{I}$ Ω	Mean Resistance R_1 Ω
01				
02				
03				
04				
05				

Table 2: For wire 2 (Fig.01)

S. No.	Voltage Volt(V)	Current Ampere (A)	Resistance $R_2 = \frac{V}{I}$ Ω	Mean Resistance $R2$ Ω
01				
02				
03				
04				
05				

Table 3: For wire 1 in series with wire 2 (Fig. 02)

S. No.	Voltage Volt(V)	Current Ampere (A)	Resistance $R_s = \frac{V}{I}$ Ω	Mean Resistance R_s Ω
01				
02				
03				
04				
05				

Calculations

1. Sample calculation of resistance of wire,

(Students should consider any one observation from table 1/table 2 and show the sample calculation)

$R = \frac{V}{I}$ Ω (By using Ohm's law)

2. Calculation of equivalent resistance in series combination

By theory,

(Students should consider mean values R_1 and R_2 observation from table 1& table 2 and show the sample calculation)

$R_s = R_1 + R_2$

XVI Results

Value of resistance of wire 1 (R_1)	Value of resistance of wire 2 (R_2)	Equivalent resistance of series combination of resistances (R_S)	
By experiment	By experiment	By Theory	By experiment
…… Ω	……..Ω	……Ω	……..Ω

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Sample Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the function of rheostat in the circuit used.
2. Calculate the potential difference required to pass a current of 5A through a metallic rod of resistance 10Ω.
3. Three resistors of resistances 25Ω, 50Ω, and 75Ω respectively are connected in series in a circuit. What is the effective resistance of the combination of the three resistors?
4. If the voltage across a fixed value of resistance is increased five times, what will be the variation in current?

XX References / Suggestions for further Reading

a. amrita.olabs.edu.in/?sub=1&brch=5&sim=168&cnt=2
b. www.learncbse.in

XXI Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Connection of the circuit	20
2.	Determination of values of voltage and current	20
3.	Team spirit	10
4.	Ability to relate with theory	10
Product related: 10 Marks		**40%**
1.	Timely submission and neatness	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

Experiment No. 7: Parallel law of resistances

I Practical Significance

In industry, parallel circuits are one of the main building blocks used in the infrastructure that supplies power to large populations. By making use of parallel circuits, engineers have been able to create power grids that are more secure and more efficient. Parallel circuits also make it easier to provide an equal power supply to different sectors.

Parallel circuits are used inside many electrical devices and appliances. Using parallel circuits, a device takes an equal amount of power from different sources and combines it on the same line. The most familiar use of parallel circuits is found in lighting fixtures. If one bulb burns out, the other bulbs in the fixture continue to operate. Other uses include an electronic OR gate, where two switches are in a parallel circuit: one of the switches must be closed for the circuit to function. If both sides are closed, the circuit will not function. Household wiring is a series of parallel circuits. In this lab experience, equivalent resistance is found using parallel combination of resistors.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO2-Discipline knowledge
PO3- Experiments and practice

III Relevant Course Outcomes

(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Use the principle of parallel resistance in solving electrical engineering problems.

V Practical Skills

a. Connections
b. Measurement skills

VI Relevant Affective domain related Outcomes

a. House Keeping
b. Taking care of Aesthetics
c. Follow safety measure
d. Team work

VII Minimum Theoretical Background

1) Ohm's Law

It states that, physical conditions of a conductor such as length, area of cross section, temperature, resistivity remaining the same, in a closed circuit amount of current (I) flowing through the conductor is directly proportional to the potential difference (V) between two ends of the conductor.

$I \propto V$

$I = \frac{V}{R}$ Where R is resistance of conductor

2) Law of resistances in parallel

The law states that the effective resistance in parallel combination is the sum of reciprocal of all resistance which are connected in parallel combination.

Hence the equation is

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_p = \frac{R_1 \times R_2}{(R_1 + R_2)}$$

VIII Circuit diagram / Experimental set-up / Work Situation

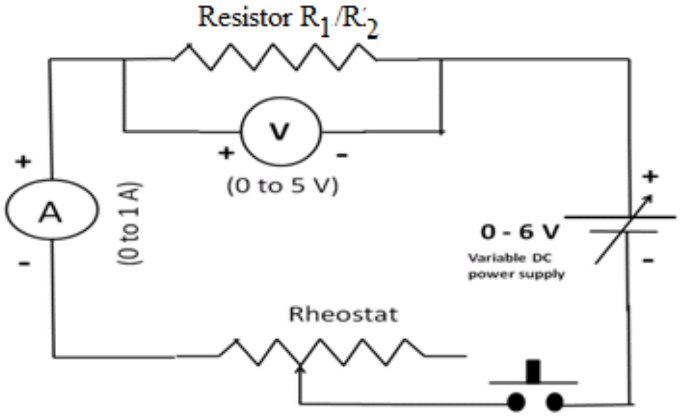

Fig.01

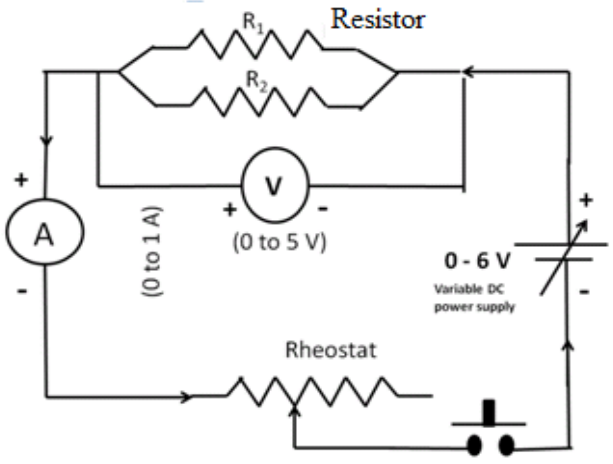

Fig. 02

IX Resources required

S. No	Name of Instrument	Specifications	Quantity	Remarks
1	Eureka wire (Cupper – Nickel alloy)	1m and 2m	3No.	
2	Copper wire	multistrand	3No.	
3	Voltmeter	0-5V	1No.	As per availability
4	Ammeter	0-5A	1No.	As per availability

S. No	Name of Instrument	Specifications	Quantity	Remarks
5	Rheostat	0-300 Ω	1No.	As per availability
6	Power Supply	0-12V, 0-5A	1No.	

X Procedure (Step wise)

1. Connect the circuit as shown in circuit diagram 1.(Fig 1)
2. Connect unknown resistance R_1 in the circuit.
3. Vary current in the circuit using rheostat.
4. Record the observations from voltmeter and ammeter in equal intervals.
5. Take five observations.
6. Calculate the resistance of given wire by ohm's law as per the formula.
7. Find mean resistance R_1
8. Repeat the steps 2 to 7 to calculate unknown resistance R_2.
9. Connect the two resistances R_1 and R_2 in parallel combination as per the circuit diagram.
10. Repeat the steps 2 to 7 to calculate equivalent resistance R_p by experiment.
11. Calculate equivalent resistance R_p by theory using formula.

XI Precautions (if any)

1. Connections should be clean and tight.
2. Thick copper wires should be used for connection after removing the insulations near the ends.
3. While changing the voltage, rheostat must be moving in one direction only.
4. Voltmeters and ammeters should be of proper range.
5. A low resistance rheostat should be used.
6. The key should be inserted only while taking the observations to avoid excessive heating of resistors.
7. Pass a current through the resistance as per power rating.
8. While measuring the voltage and current the needle of meters should not move out of the scale.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XII Observations and Calculations

1. Range of Voltmeter =_____ V
2. Range of Ammeter =_____ A
3. Least count of voltmeter = _____ V
4. Least count of ammeter = _____ A
5. e. m. f of the Battery = _____V

Table 1: For wire 1

S. No.	**Voltage Volt(V)**	**Current Ampere (A)**	**Resistance** $R_1 = \frac{V}{I}$ Ω	**Mean Resistance** R_1 Ω
1				
2				
3				
4				
5				

Table 2: For wire 2

S. No.	**Voltage Volt(V)**	**Current Ampere (A)**	**Resistance** $R_2 = \frac{V}{I}$ Ω	**Mean Resistance** $R2$ Ω
1				
2				
3				
4				
5				

Table 3: For wire 1 in parallel with wire 2

Sr. No.	Voltage Volt(V)	Current (I) Ampere (A)	Resistance $Rp = \frac{V}{I}$ Ω	Mean Resistance Rp Ω
1				
2				
3				
4				
5				

Calculations :

R_p by theory

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_p = \frac{R_1 \times R_2}{(R_1 + R_2)}$$

XIII Results

Value of resistance of wire 1 (R_1)	Value of resistance of wire 2 (R_2)	Equivalent resistance of parallel combination of resistances (R_p)	
By experiment	By experiment	By experiment	By Theory
…… Ω	…… Ω	……Ω	……Ω

XIV Interpretation of results

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XV Conclusions and Recommendations

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XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the range of the ammeter used in experiment.
2. Write the range of the voltmeter used in experiment.
3. Write the application of rheostat used in experiments.

XVII References / Suggestions for further Reading

a. www.youtube.com/watch?v=BbYtMQ8EYBg ,
b. www.youtube.com/watch?v=g8MajsGfhO0
c. www.youtube.com/watch?v=PZ1ioqAAW7M
d. amrita.olabs.edu.in/?sub=1&brch=4&sim=41&cnt=70

XVIII Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Connection of the circuit	20
2.	Determination of the values of voltage and current	20
3.	Team spirit	10
4.	Ability to relate with theory	10
Product related: 10 Marks		**40%**
1.	Timely submission and neatness	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

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Experiment No. 08: Magnetic lines of forces of magnet

I Practical Significance

Magnetism plays an important role in electrical and electronic engineering because without it components such as relays, solenoids, inductors, chokes, coils, loudspeakers, motors, generators, transformers, and electricity meters etc, would not work.

II Relevant Program Outcomes (POs)

PO 1- Basic knowledge
PO 2- Discipline knowledge.

III Relevant Course Outcomes

b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Use magnetic compass to draw the magnetic lines of forces of magnet of different shapes.

V Practical Skills

Sketching Skill

VI Relevant Affective domain related Outcomes

Practice good housekeeping.

VII Minimum Theoretical Background

Magnets

Substances that possess the property of attracting iron are called magnets. The two ends of a magnet are called magnetic poles. All magnets have two poles, namely, the north pole and the south pole. In order to identify the poles, the north pole is usually painted in red colour. The other end of the magnet will, therefore, be the south pole.

Magnetic Compass

A magnetic compass is an instrument which is used by sailors and navigators to find the direction in which their ship is sailing. It has a thin magnetic needle supported from a pivot so that it can rotate freely. The needle is placed over a dial with the directions marked. The entire assembly is placed inside an airtight box. **The north pole of the magnetic needle is painted red**. The magnetic needle in the compass points in the north-south direction. By aligning the dial properly, the directions can be found. In the ancient days, an old pointing device called the south-pointing fish was used to know the directions, in which the head of the fish pointed towards the south.

Properties of Magnets

- Attractive property: A magnet attracts magnetic materials towards itself.
- Directive property: A freely suspended bar magnet always aligns in the north-south direction.
- Unlike poles (N-S) attract each other and like poles(N-N and S-S) repel each other.
- A magnet with a single pole does not exist. If a magnet is cut into two pieces, each piece will behave like an independent magnet, with a north pole and a south pole.

- When a bar magnet is rubbed over an iron bar, it changes the iron bar into a magnet.
- If a magnet is heated, hammered or dropped from a height, it loses its magnetism.
- Repulsion is the surest test of magnetism.
- Magnets can damage objects like CDs, DVDs, debit cards, credit cards, audio and video cassettes, and mobile phones which contain magnetic material.

Magnetic Field and Magnetic Lines of Force

The space surrounding the magnet where attraction or repulsion can be experienced is called the **magnetic field**. The magnetic field is filled with magnetic lines of force. A magnetic line of force is a closed continuous curve in a magnetic field along which always points from north pole to south pole outside the magnet and from south to north pole inside the magnet.

Properties of Magnetic Lines of Force

- Magnetic lines of force are closed continuous curves.
- They travel from north to south outside the magnet and from south to north inside the magnet.
- They never intersect each other because if they intersect, there would be two directions of the magnetic field at that point, which is not possible.
- They are crowded near the poles of the magnet where the magnetic field is strong and are separated near the middle of the magnet and far from the magnet, where the magnetic field is weak.
- They behave like the stretched elastic rubber strings.They contract laterally, i.e., they bend along the length of the magnet.

VIII Experimental set-up.

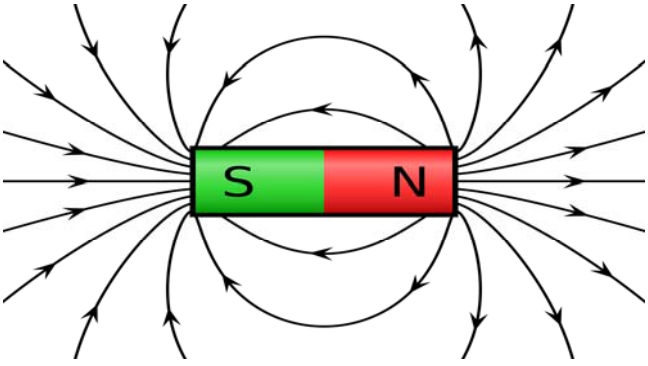

Fig.01

IX Resources required

S. No.	Particulars	Specification	Quantity	Remark
1	Bar Magnet	Magnetic length, d= 5 cm	01	as per availability
2	White Paper	A4 size	01	
3	Magnetic Compass		01	As per the availability

X Procedure (Step wise)

1. Fix an A4 size white paper on a drawing board with brass pins.
2. Place the bar magnet at the centre of the paper.
3. Draw its boundary.
4. Place the compass needle at the north pole of the bar magnet.
5. Mark the positions of the N and S poles of the compass needle by pencil dots.
6. Move the compass until the end of the compass is over the second dot.
7. Mark the new position of the other with a third dot.
8. Repeat the steps from point no. 02 to 05 till the compass needle reaches the other end of the bar magnet.
9. Join all the points to get a continuous smooth curve, which represents a magnetic field line.

XI Precautions (if any)

1. Keep away other magnetic materials from the board.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

Attached A4 size paper used for this lab experience.

XVI Results

The magnetic lines of forces of bar magnet are as shown on the paper

XVII Interpretation of results

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XVIII Conclusions and Recommendations (if any)

NA

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Name the material of magnets used.
2. Write the permeability of the given magnet.
3. Is the compass needle a unipolar magnet?

XX References / Suggestions for further Reading

a. https://www.youtube.com/watch?v=JUZC679CwKs.
b. https://www.youtube.com/watch?v=DMO373nDp8M.
c. http://cdac.olabs.edu.in/?sub=74&brch=9&sim=74&cnt=4.

XXI Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Arrangement of instrument	20
2.	Handling of instruments	20
3.	Drawing of magnetic lines of force	20
Product related: 10 Marks		**40%**
1.	Error estimation	10
2.	Interpretation of result	20
3.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

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Experiment No. 9: Magnetic compass to determine Neutral points

I Practical Significance

All the navigation devices used in radars, airplane, ships, surveying and mountaineering used earth's magnetic field to determine geographical directions. Magnets are used in electric motors, transformers and generators. Magnetic field produced by magnets depends upon the shape, size and material of magnets. In this experiment a student will determine the nature of magnetic field produced by bar magnet and null point formed due to combination of horizontal component of earth's magnetic field and magnetic field of bar magnet.

II Relevant Program Outcomes (POs)

PO 1- Basic knowledge
PO 2-Discipline knowledge

III Relevant Course Outcomes

(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Use magnetic compass to determine the neutral points when
(i) North pole of bar magnets points towards the north pole of earth.
(ii) South pole of bar magnets points towards the north pole of earth.

V Practical Skills

a. Analysis skill
b. Drawing Skill and Observation Skill

VI Relevant Affective domain related Outcomes

a. Practice good housekeeping.
b. Demonstrate working as a leader/a team member.
c. Handling the instrument carefully

VII Minimum Theoretical Background

1) Neutral Points in a Magnetic Field

At a particular point, if the compass needle does not point in any particular direction, then there is no net magnetic field at the point. Such a point is called Neutral point or the Null point. A neutral point is a point where the resultant magnetic field is zero.

1. North pole of bar magnets points towards the north pole of earth.

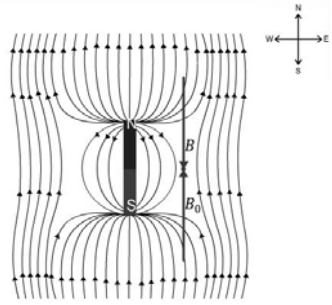

Fig. 01

The two points on either side of the bar magnet at equal distances from its centre, where the compass needle does not show any specific direction. At these points, the magnetic field

induction B due to the bar magnet and the horizontal component of the earth's magnetic field induction, B_0 are equal in magnitude and opposite in direction. The resultant magnetic field is zero. These points represent the neutral points denoted by N_1 and N_2. These two points fall on the equatorial line of the bar magnet.

Thus, when the north pole of a bar magnet points towards the geographical north pole of the earth, the two neutral points lie on the equatorial line of the bar magnet such that they are equidistant from the centre of the bar magnet.

2. North Pole of bar magnets points towards the north pole of earth.

The two points along the axis and at equal distances from the centre of the magnet where the compass needle does not show any particular direction. At these points, the magnetic field induction B due to the bar magnet and the horizontal component of the earth's magnetic field induction, B0 are equal in magnitude and opposite in direction. The resultant magnetic field is zero. These points represent the neutral points, denoted by N1 and N2. These two points lie on the axial line of the bar magnet.

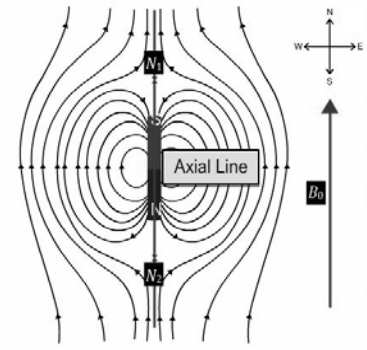

Fig.02

Thus, when the south pole of a bar magnet points towards the geographical north pole of the earth, the two neutral points lie on the axial line of the bar magnet such that they are equidistant from the centre of the bar magnet. By locating the neutral points for a given bar magnet in the two cases, we can calculate its magnetic moment and pole strength.

VIII Circuit diagram / Experimental set-up / Work Situation.

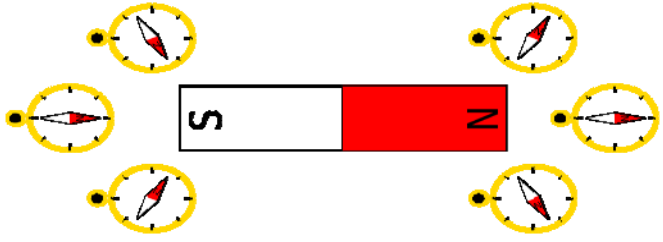

Fig. 03

IX Resources required

Sr.	Particulars	Specification	Quantity	Remark
1	Bar Magnet	5 cm or as per available	01	
2	White Paper	A4 size	01	
3	Magnetic Compass		01	As available

X Procedure

Part (i): When the north pole of a bar magnet points towards the north pole of the earth.

1. Fix a sheet of white paper on a drawing board with brass pins.
2. Take a compass needle, place it at the centre of the paper.
3. Mark the north and south directions.
4. Draw a straight line along the paper connecting the two points.
5. Represent the magnetic meridian of the earth.
6. Represent the geographical directions at the corner of the paper.
7. Draw an arrow from the geographical south to the geographical north on the right side of the paper.
8. Indicate the direction of the horizontal component of the earth's magnetic field, B_0.
9. Take a bar magnet and place it at the centre of the paper such that the north pole of the bar magnet points towards the North Pole of the earth.
10. Draw outline of bar magnet.
11. Now place the compass needle at the north pole of the bar magnet.
12. Mark a point at north-pole of the compass needle.
13. Shift the compass such that the south pole of the compass needle is at the point marked.
14. Mark another point at the north of the compass needle, and then shift the compass, as done in step 13.
15. Repeat the procedure till the compass needle reaches the other end of the bar magnet.
16. Join all the points to get a continuous smooth curve, which represents a magnetic field line.
17. Repeat the procedure from the north pole of the magnet, but from different points, and draw the magnetic field lines.

Part (ii): When the south pole of the bar magnet points towards north pole of the earth.

1. Take a new paper and repeat the steps 1 to 8 of part (i)
2. Take a bar magnet and place it at the centre of the paper such that the south pole of the bar magnet points towards the North Pole of the earth.
3. Draw outline of bar magnet
4. Repeat the steps 11 to 17 of part (i)

XI Precautions (if any)

1. All the point must be traced very accurately and neatly using a compass.
2. A sharp pencil must be used to draw all the magnetic lines of forces.
3. Distance of neutral points must be measured from the centre of Bar Magnet.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

Observing Natures of magnetic lines of force and locate the neutral points of bar magnets

Length of bar magnet = …. cm. = …….m.

Distance between the neutral points from center of bar magnets

(i) North Pole of bar magnets points towards the north pole of earth =….. ….cm
=…….m

(ii) South Pole of bar magnets points towards the north pole of earth = …. …cm
=…….m

XVI Results

The neutral points are determined for the following cases

1) The nature magnetic lines of forces of bar magnet is as per sheet attached.
2) North Pole of bar magnets points towards the north pole of earth =….. …..m.
3) South Pole of bar magnets points towards the north pole of earth =…… m

XVII Interpretation of results

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.....
.....
.....

XVIII Conclusions and Recommendations (if any)

NA

XIX Sample Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write reason for deflection in compass needle ,when brought near bar magnet.
2. Give the number of neutral points obtained if we place a bar magnet in east west direction.
3. Write material and length of given bar magnet.
4. Give the position of the neutral point ,when a bar magnet is placed with its South Pole pointing towards geographic north.

XX References / Suggestions for further Reading

a. Physics text book of class xii(NCERT)
b. Fundamental of physics by wiley -india lastly,
c. https://en.wikipedia.org/
d. www.physicsprojects.org
e. https://www.youtube.com/watch?v=JUZC679CwKs.
f. https://www.youtube.com/watch?v=DMO373nDp8M.
g. http://cdac.olabs.edu.in/?sub=74&brch=9&sim=74&cnt=4.
h. https://www.nextgurukul.in/.../Mapping-of-Magnetic-Lines-of-Force-due-to-a-Bar-M

XXI Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Neatness of work	10
2.	Handling of instruments	10
3.	Drawing of magnetic lines of force	40
Product related: 10 Marks		**40%**
1.	Sketch ready for submission	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

Experiment No. 10: p-n junction diode

I Practical Significance

In industry, p-n junction diode has wide range of applications. Diode is used in clipping and wave shaping circuits in computers, radios and radar. It is used as switch in digital logic designs. Detector and demodulator circuits use diodes in TV receiver circuits Voltage multipliers and rectifiers circuits used in house hold appliances consists diodes. In this lab experience, students will determine the forward and reverse bias characteristics, static and dynamic resistance of p-n junction diode which helps in designing the circuits as per the required.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice

III Relevant Course Outcomes

(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Use p-n junction diode to draw forward bias and reverse bias I-V characteristics.

V Practical Skills

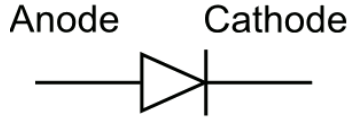
a. Circuit connection skills
b. Measurement skills
c. Graph plotting skills
d. Analytical skills

VI Relevant Affective domain related Outcomes

a. Handle tools and equipments carefully.
b. Select instruments of required least count and range.
c. Following safety measure.

VII Minimum Theoretical Background

Symbol of p-n junction diode



1. Formation of p-n junction: In p-type semiconductor, holes are the majority carriers and electrons are the minority carriers whereas in n-type semiconductor, electrons are the majority carriers and holes are the minority carriers. When p-type and n-type semiconductors are intimately joined together, p-n junction diode is formed. The boundary region of p type and n type semiconductors is called **p-n junction**. When a p-n junction is formed, some electrons from the n- region cross over the junction and move into the p-type. Here they recombine with the holes and the holes from the p-region cross over the junction and move into the n-region and recombine with the electrons. But the immobile charges (i.e. negative ions in p-region and positive ions in the n-region) cannot cross over

the junction. Thus there is a region formed on either side of the junction which contains immobile charges only. This region is called '**depletion region**.'

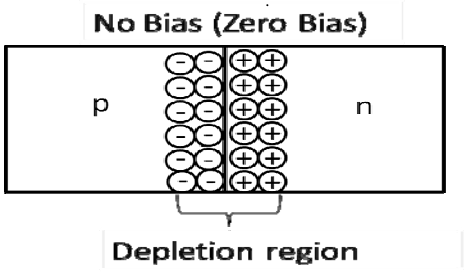


Fig.01

2. Forward bias: When p-type semiconductor is connected to positive terminal of battery and n-type semiconductor is connected to the negative terminal of the battery, the junction is said to be **forward biased**. The forward voltage(V_f) at which the diode starts to conduct current is called knee voltage or cut-in voltage.

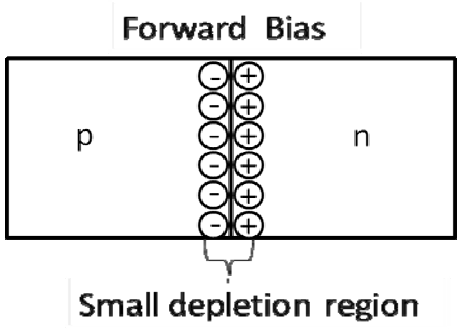


Fig.02

3. Reverse bias:

When p-type semiconductor is connected to negative terminal of battery and n-type semiconductor is connected to the positive terminal of the battery, the junction is said to be reverse **biased**. The reverse voltage (V_R) at which the reverse current (I_R) becomes maximum is called **breakdown voltage**.

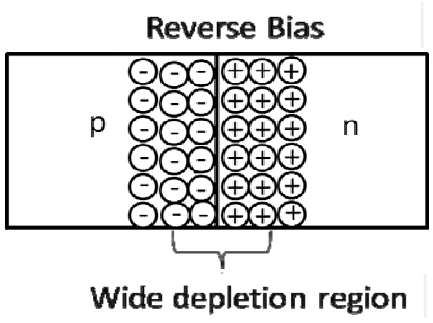


Fig.03

VIII Circuit diagram / Experimental set-up / Work Situation:

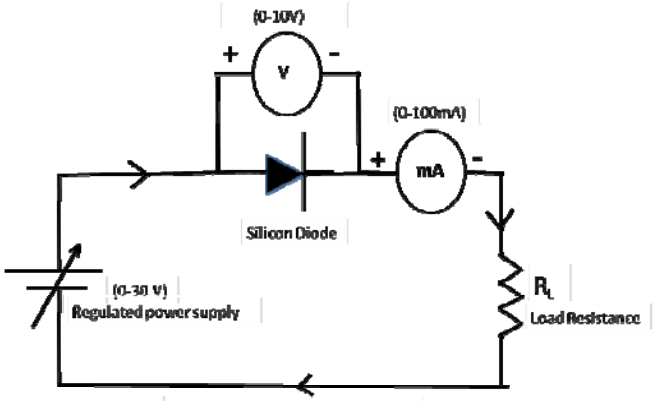


Fig .04: Forward bias

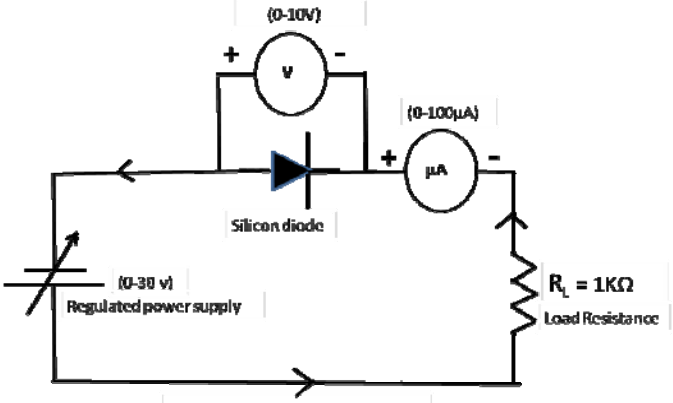


Fig.05: Reverse bias

IX Resources required

S. No	Instrument	Specification	Quantity	Remarks
1	Voltmeter	(0-1V),(0-30V)	1 No	
2	Ammeter	(0-50milliamps) (0-500μA)	1 No	
3	Bread board			
3	Resistor	1k□	1	
4	DC power supply	0-30 V	1	
5	p-n junction diode	IN4001,IN4007	1	Whichever is available and compatible
6	Connecting wires	Hook up wire		

X Procedure (Step wise):

Part I : p-n junction diode in forward biased

1. Connect the p-n Junction diode in forward bias (Fig.04)
2. Connect the p-terminal (Anode) of the diode to positive terminal of the regulated power supply
3. Connect n-terminal (cathode) to the negative terminal of the regulated power supply.

4. Vary the supply voltage (V_f) in steps of 0.1V using the regulated power supply.
5. Record the corresponding values of forward current (I_f).
6. Plot a graph of forward current (I_f) Vs forward voltage (V_f)
   (i) Find its slope at a point where the the forward current (I_f) increases rapidly.
   (ii) Find the point of intersection on X-axis to obtain the knee voltage of the diode.
   (iv) Calculate reciprocal of the slope .This reciprocal gives the value of dynamic resistance of the diode.
   (vi) Locate the co-ordinates on the curve.
   (vii) Find the static resistance at that point using the formula Static resistance= $\frac{V_f}{I_f}$

Part II: p-n junction diode in reverse biased

1. Connect the p-n Junction diode in reverse bias. (Fig.05)
2. Connect the p-terminal (Anode) of the diode to negative terminal of the regulated power supply
3. Connect n-terminal (cathode) to the positive terminal of the regulated power supply.
4. Vary the supply voltage (V_R) in steps of using the regulated power supply till the current becomes maximum.
5. Record the corresponding values of reverse saturation current (I_R).
6. Note down this reverse breakdown voltage of the diode.

XI Precautions

1. The current in the circuit should not exceed the current ratings of the diode.
2. Connect voltmeter and Ammeter in correct polarities.
3. Show the connections to concerned teacher and then switch ON the power supply

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations:

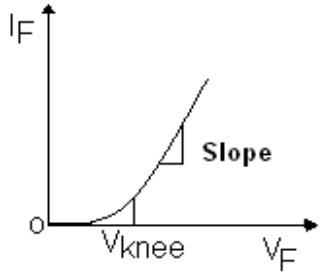
Table1:Forward Bias

Least count of voltmeter =…..V

Least count of milliammeter =…. .mA

Sr. No.	Forward voltage(V_f) (volts)	Forward Current(I_f) (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Graph of current (in mA) Vs voltage (in volts)



Observations from graph:

1. ΔV =……..V
2. ΔI =…….. mA
3. V_f =…… V
4. I_f =……mA

Calculations from the graph

Dynamic resistance = $\frac{\Delta V}{\Delta I}$ = **…….Ω**

Static resistance= $\frac{V_f}{I_f}$ **=……Ω**

Table 2: Reverse Bias

Least count of voltmeter =…..V
Least count of micro-ammeter =…… μA

Sr. No.	Reverse Voltage(V_R) (in volts)	Reverse Current(I_R) (in μA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

XVI Results

(i) The static resistance of the given diode at a particular point =……

(ii) The dynamic resistance of the given diode =…

XVII Interpretation of results

(i) Error in value of knee voltage = standard value - experimental value obtained from graph

XVIII Conclusions and Recommendations

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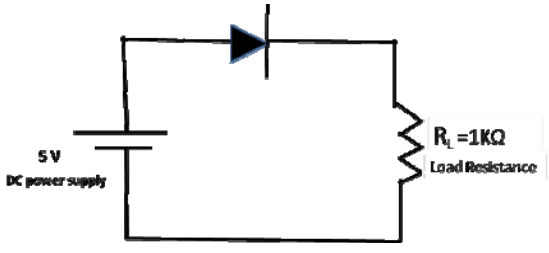
XIX Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the ideal value of knee voltage for the diode used.
2. Write the steps to identify the p and n terminals of diode using multimeter.
3. Give reasons for using micro ammeter in a reverse bias mode.
4. State the specifications of diode used in this lab experience.
5. Calculate the current in the given circuit.



XX References / Suggestions for further Reading:

a. https://www.youtube.com/watch
b. www.electronics-tutorials.ws

XXI Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Choosing equipments and components of required resolution	5
2.	Determination of least count of voltmeter and ammeter	5
3.	Proper connection of electrical circuit	20
4.	Taking proper readings	10
5.	Plotting of graph	20
Product related: 10 Marks		**40%**
1.	Determination of static and dynamic resistance from graph	10
2.	Conclusion & Recommendations	10
3.	Interpretation of result	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

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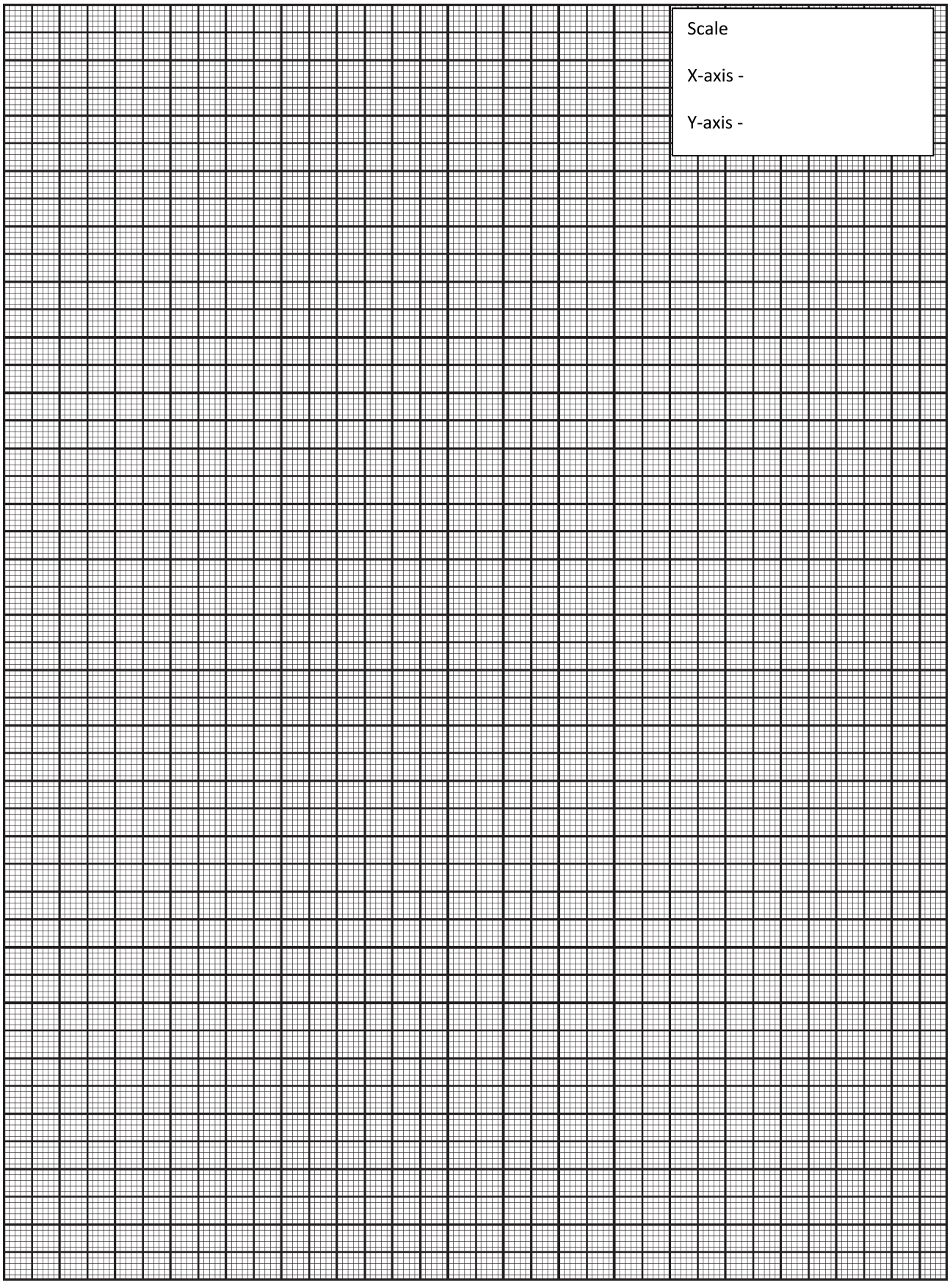
Scale
X-axis -
Y-axis -

Experiment No. 11: Forbidden energy band gap

I Practical Significance

Band gap is basically the factor used for determining the conductivity of any metal. Energy band gap differentiates the metals into conductor, insulator, and semiconductor. The electronics industry has seen paradigm shift from the use of triodes, pentodes, and valves to diodes, transistors, semiconductors. The semiconductors are the foundation of modern day electronics such as radio, computers and mobile phones. Semiconductor material is used in the manufacturing of electronic components and used in electronic devices such as transistors and diodes.

II Relevant Program Outcomes

PO 2- Discipline knowledge
PO 3- Experiments and practice

III Relevant Course Outcomes

(b) Apply the principles of electricity and magnetism to solve engineering problems.

IV Practical Learning Outcome

Determine forbidden energy band gap in semiconductors.

V Practical Skills

a. Measurement Skill
b. Electrical circuit connections.
c. Error estimation Skill.

VI Relevant Affective domain related Outcomes

a. Follow safety practices.
b. Practice good housekeeping.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Solids can be broadly classified into three groups conductor, semiconductor, insulator. on the basis of their ability to conduct heat and electricity.

Forbidden energy gap(E_g) ;Forbidden energy gap is the energy gap between conduction band and valence band, where no electron is present.In case of conductors, the forbidden energy gap is absent, in case of semiconductors it is of the order of 1eV and in case of insulators, the forbidden energy gap is very large of the order of 6electron volt.

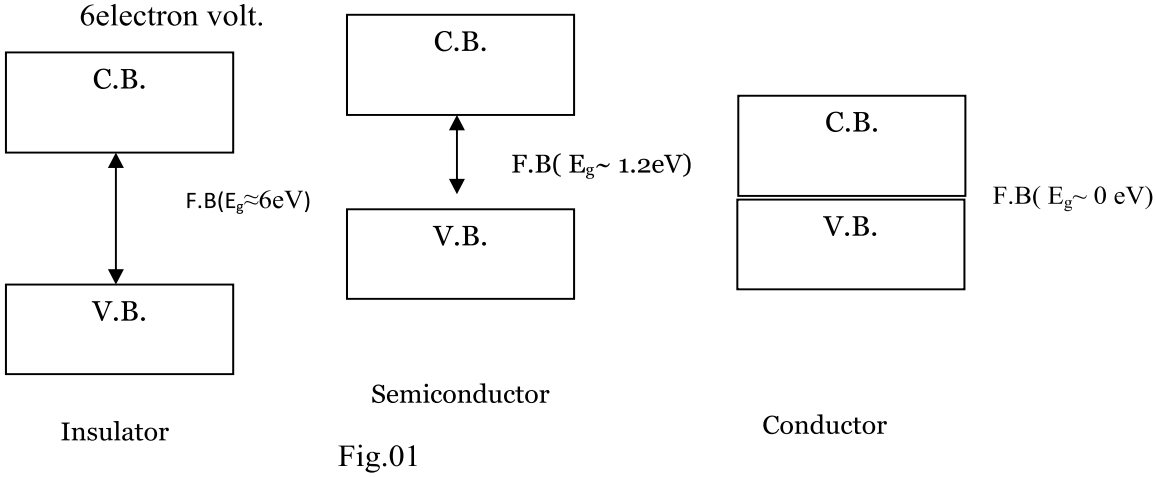

Fig.01

Forbidden Energy Gap is the minimum energy required by electron in valence band to jump into conduction band. Electron in conductor band is free to conduct electricity.

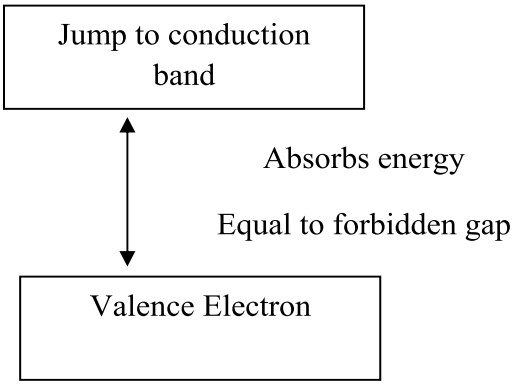

Fig.02

VIII Circuit diagram

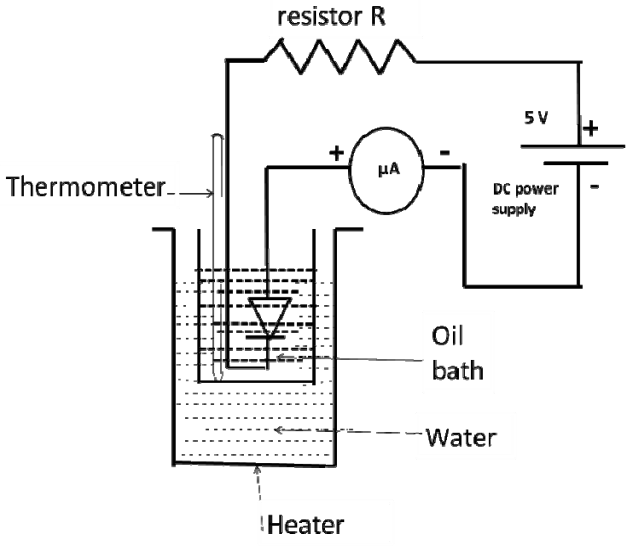

Fig.03

IX Resources required

S. No.	Particulars	Specification	Quantity	Remark
1	Beaker	Volume capacity=250 ml	01	
2	Test tube	--	01	
3	Thermometer	0 to 100 ^{o}C	01	
4	Diode	Ge and Si	01	
5	Paraffin Oil	--	200 ml	
6	Oil lamp for heating	As available	01	
7	Power Supply	0 to 12 V	01	

X Procedure (Step wise)

1. Connect the circuit as per circuit diagram.
2. Take the oil in the test tube.
3. Put diode and thermometer in test tube.
4. Fill water in the beaker.
5. Arrange the test tube in beaker.
6. Adjust the voltage till the constant saturation current flows through the diode.
7. Heat the water till the temperature reaches to about $70°C$.
8. Record the readings of temperatures while cooling at the interval of $5°C$.
9. Note corresponding current.
10. Plot a graph of $\log_e I_S$ (on Y-axis) against 1/T (on X-axis)
11. Calculate the slope of graph.
12. Calculate forbidden energy gap in joule.
13. Convert it into electron volt (eV).

XI Precautions

1. Handle all the equipments with care.
2. Make connections according to circuit diagram.
3. Get the connections checked by the teacher.
4. Take the readings carefully & the connections should be tight.
5. The maximum temperature should not exceed 95^0C
6. Bulb of the thermometer should be inserted well in the oil bath.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

Table1:To find absolute temperature and reverse saturation current

Obs. No.	Temp. of Oil bath t $(°C)$	Diode reverse Saturation current I_S µA	Absolute Temperature $T = (t + 273)$ $°K$	$\frac{1}{T}$ Per $°K$	$\log_e(I_S)$
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Calculation:

Diode reverse current is due to the flow of minority carriers. This reverse saturation current (Is) depends on temperature of semiconductor diode and increases with rise in temperature.

Saturation current is,

$$I_s = CT^3 e^{-Eg/KT}$$

$$\text{Log}_e I_s = \log_e CT^3 - Eg \times 1/K \times T$$

$$\text{Log}_e I_s = \left(-\frac{Eg}{K}\right) \times \frac{1}{T} + \log_e CT^3$$

Where, T = Absolute temperature of diode.

K= Boltzmann constant=1.38×10^{-23} J/K

E_g= Forbidden energy gap.

C = constant.

Slope and intercept of line are related as

Y = mx + C

Y intercept = $\log_e CT^3$

Forbidden energy Gap = Eg = slope x K

Eg = slope x 1.38×10^{-23} Joule

or $Eg = \frac{\text{slope} \times 1.37 \times 10^{-23}}{1.6 \times 10^{-19}}$ eV

XVI Results

1. Forbidden Energy gap for (silicon/ germanium) diode = …… Joule.
2. Forbidden Energy gap for (silicon/ germanium) diode = …….. eV.

XVII Interpretation of results

1. Error in measurement of forbidden energy gap for (silicon/ germanium) diode
   = Experimental value-Standard value =……eV
   Standard value

XVIII Conclusions and Recommendations (if any)

.....
.....
.....
.....
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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. The forbidden energy gap for silicon is 1.1eV and for germanium is 0.7eV.Which of the above material will have more conductivity? Give reasons.
2. Give reasons for diode immersed in an oil bath.
3. Is resistivity of solid depends upon width of forbidden energy gap ?. Give reasons
4. Is reverse saturation current dependent upon the change in temperature? Explain.

XX References / Suggestions for further Reading

a. https://www.youtube.com/watch?v=RElSMr65IZ0
b. https://www.youtube.com/watch?v=harhtPOxPFc
c. https://www.youtube.com/watch?v=CM0C7gWMcyw

XXI Assessment Scheme

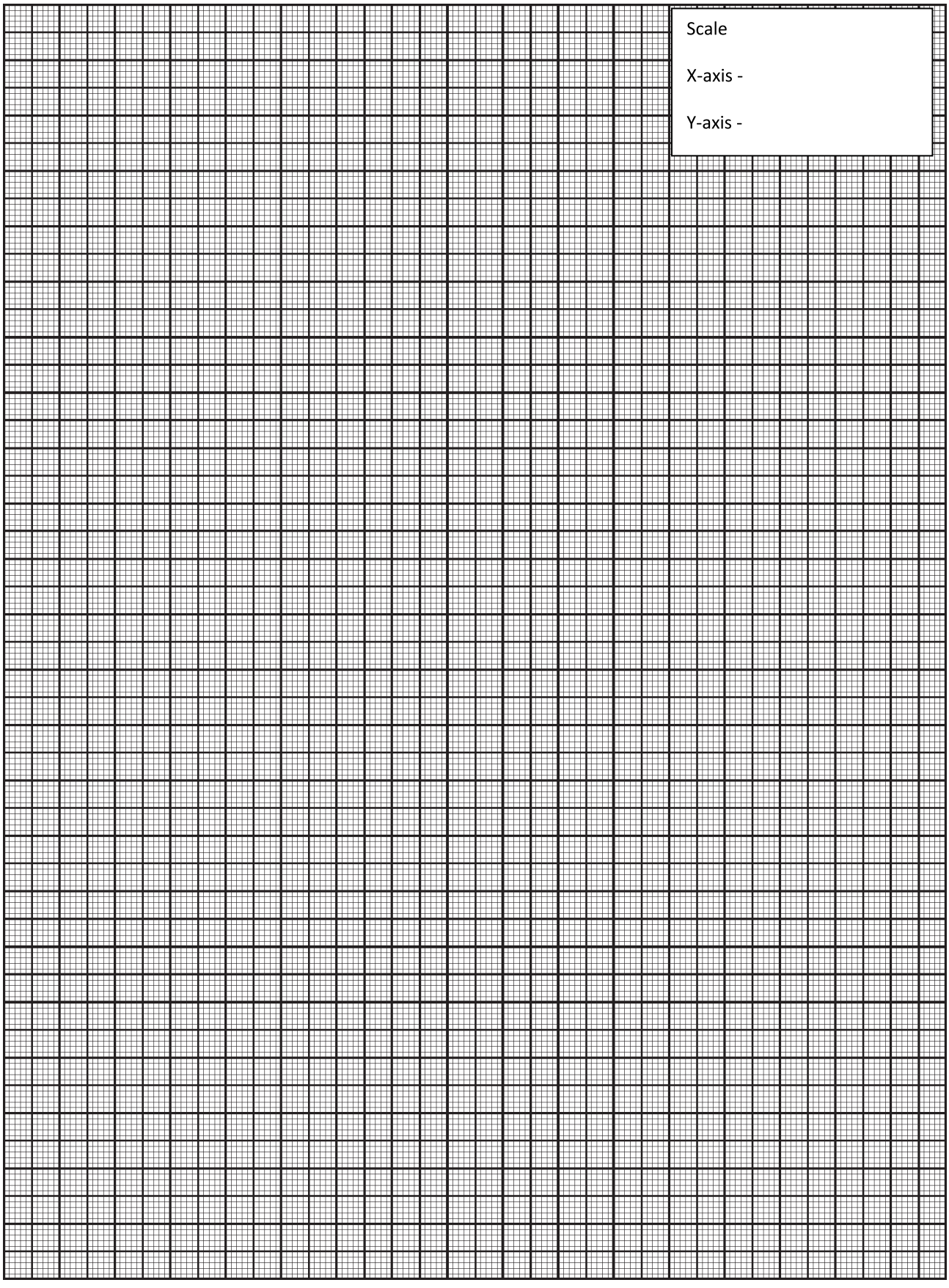
Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Selection of the instrument	10
2.	Arrangement of the instrument	10
3.	Connection of circuit diagram	10
4.	Handling of instruments	10
5.	Proper measurement	10
6.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Accuracy of measurement	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]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X-axis -
Y-axis -

Experiment No. 12: Boyle's Law

I Practical Significance

Various engineering applications such as vehicle tyres , aerosols cans, steam engines and combustion engines works on the principle of Boyle's law of Gases. Many fuel gases are stored under high pressure to occupy smaller volume. In this experiment student determines the relation between the change in pressure and volume of gas.

II Relevant Program Outcomes (POs) and PSOs

PO1: Basic knowledge
PO2: Discipline knowledge
PO3: Experiments and practice

III Relevant Course Outcomes

(c) Use the basic principles of heat and optics for related engineering applications.

IV Practical Learning Outcome

Determine the pressure-volume relation using Boyle's law.

V Practical Skills

Measurement skills

VI Relevant Affective domain related Outcomes

a. Handling instrument carefully.
b. Practice good housekeeping.
c. Demonstrate working as a team member.

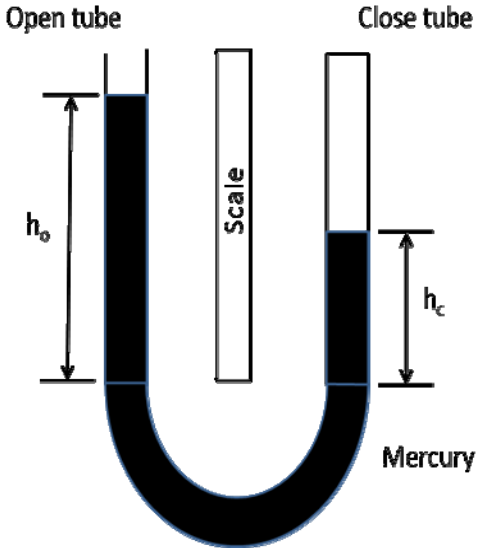
VII Minimum Theoretical Background

Gas is a state of matter that has no fixed shape and no fixed volume. Gases have lower density than other states of matter, such as solids and liquids. When more gas particles enter a container, there is less space for the particles to spread out, and they become compressed. The particles exert more force on the interior volume of the container. This force is called pressure. Temperature, pressure, and volume of a gas are interdependent, and many scientists have developed laws to describe the relationships among them.These variables of gases are related with each other and magnitude of these variables or properties will determine the state of gas.

According to ***Boyle's law***, at constant temperature and for a fixed mass of gas, absolute pressure of the gas is inversely proportional to volume of gas. If absolute pressure of the gas is P and volume of the gas is V, at constant temperature and for a fixed mass of gas, we will have following relationship between absolute pressure P and volume V It could also be defined as product of pressure and volume will be constant for a gas of fixed mass and constant temperature.

$P \propto \frac{1}{V}$ at constant temperature or $P \times V = constant$

VIII Circuit diagram / Experimental set-up / Work Situation



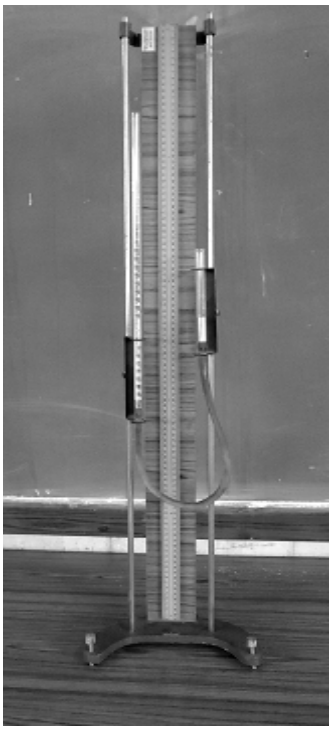


Fig.01

IX Resources required

S. No.	Particulars	Specifications	Quantity	Remark
1	Barometer	Simple mercury barometer	01	
2	Boyle's law apparatus	--	01	As per availability
3	Spirit level	Standard	01	
4	Mercury	--	1.25kg	
5	Thermometer	0 to 100 ^oC	01	

X Procedure

1. Find atmospheric pressure using Barometer.
2. Set up the Boyle's Law experiment apparatus by using sprit level.
3. Adjust the height of mercury in open and closed tube at the same level.
4. Note down,
   a. Volume of air in closed tube V.
   b. Height of Hg in closed tube h_c.
   c. Height of Hg in open tube h_0.
   d. Find $h = h_0 - h_c$
5. Keep close tube at constant height.
6. Change the height of open tube in upward direction.
7. Note down,
   a. Volume of air in closed tube V.

b. Height of Hg in closed tube h_c.
c. Height of Hg in open tube h_0.
d. Find $h = h_0 - h_c$

8. Repeat step 06 and 07 for two times.
9. Repeat step 06 and 07 for downward direction.
10. Calculate pressure P for each reading.
11. Calculate P x V for each reading.
12. Calculate mean value of P x V.
13. Plot a graph of P against $\frac{1}{V}$.
14. Calculate the slope of graph.

XI Precautions

1. Keep eye position in the level with the Mercury Meniscus while taking observations.
2. Handle the apparatus carefully as mercury is poisonous.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

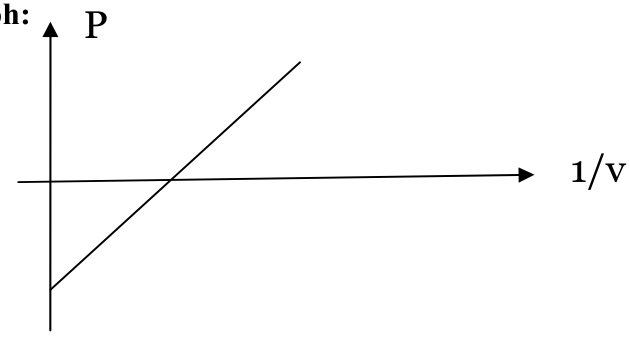
1) Atmospheric pressure (H) = ….. ..cm of Hg
2) Room temperature = ……^{0}C

Sr. No.	Volume of enclosed air V cm^3	1/ V cm^3	Height of Hg		h = h_o - h_c cm	P = H + h cm of Hg	P xV
			in closed tube h_c cm	in open tube h_o cm			
1							
2							
3							
4							
5							
6							
7							
						Mean (P x V)	

Sample calculation.

1. V_1 = ...……c.c.
2. $\frac{1}{V_1}$ = ……per c.c.
3. h_c = ……cm of Hg
4. h_o = ……cm of Hg
5. $h=h_o - h_c$ = …… cm of Hg
6. $P_1=H + h$ = …… cm of Hg
7. P_1V_1 =…….

Graph:



XVI Result:

1. P x V = ---------- By calculation.
2. P x V= ---------- By graph.

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Practical Related Questions.

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State new volume of the gas if the pressure on 350 cm^3 of oxygen at 720 mm Hg is decreased to 600 mm Hg?
2. Can we measure the atmospheric pressure using Boyle's law apparatus?
3. Give the name of gas enclosed in closed tube.

XX References / Suggestions for further Reading

a. http://www.hkdivedi.com/2016/02/boyles-law.html#sthash.jhSSJixA.dpuf
b. http://amrita.olabs.edu.in/?sub=1&brch=5&sim=226&cnt=1
c. http://www.chemistryexplained.com/Fe-Ge/Gases.html

XXI Assessment Scheme:

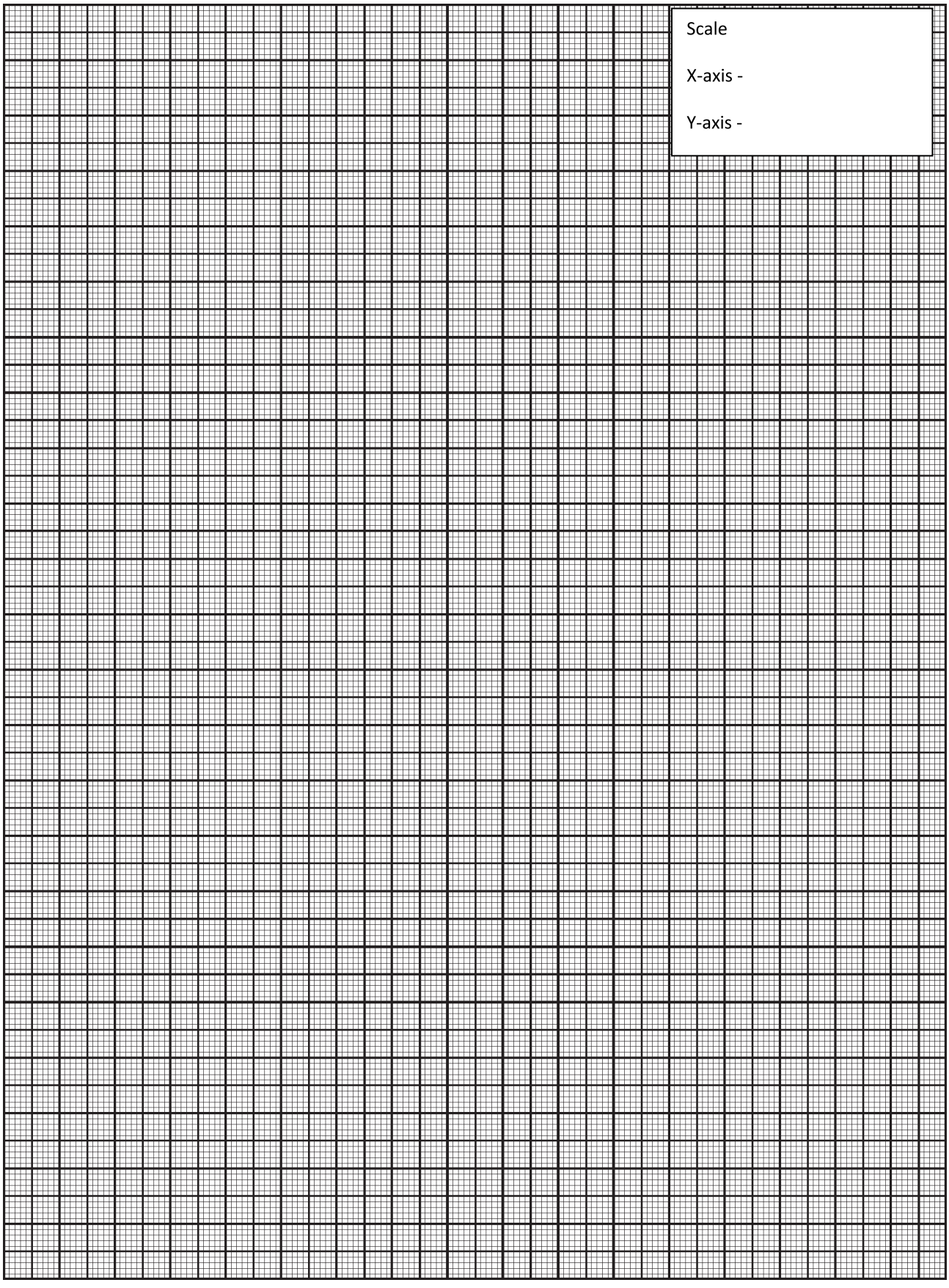
Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Arrangement of apparatus	20
2.	Measurement of heights	20
3.	Calculations	10
4.	Involvement in experiment	10
Product related: 10 Marks		**40%**
1.	Accuracy of measurement	10
2.	Interpretation from graph	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]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X-axis -
Y-axis -

Experiment No. 13: Determination of Joule's constant by calorimeter

I Practical Significance

Turbines used for generation of electricity involve conversion of mechanical energy into electrical energy. Similarly in heat (steam) engine, heat energy is converted into mechanical energy and in electric geysers and heaters, electrical energy is converted into heat energy. The study of conversion of energy from one form into another is vital from engineering point of view. Therefore in this experiment student will analyze one such conversion i.e. conversion of electrical in to heat energy and determine the electrical equivalent of heat energy.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice

III Relevant Course Outcomes

(a) Estimate errors in measurement of physical quantities.
(b) Apply the principles of electricity and magnetism to solve engineering problems.
(c) Use the basic principles of heat and optics in related engineering applications.

IV Practical Learning Outcome

Use Joule's calorimeter to determine Joule's electrical equivalent of heat.

V Practical Skills

a. Circuit connections skills
b. Measurement skills:
c. Graph plotting skills

VI Relevant Affective domain related Outcomes

a. Handle tools and equipments carefully.
b. Follow the safety measures.

VII Minimum Theoretical Background

Heat is form of energy which flows from higher temperature to lower temperature. When mechanical work and/ electrical work is done, heat is produced. The mechanical energy and / electrical energy is related to heat energy by means of proportionality constant. This constant is called "Joule's constant".

When electric current is passed through a metal coil, equal amount of heat is generated. In this experiment, the coil is placed in the water in the calorimeter. So as the current passes through the coil, the water in contact with the coil also gets heated. The time for which the current is passed increases, the heat generated also increases.

The electric power is calculated using the formula

$$P=VI,$$

Where, I is the current flowing in the circuit and V is the voltage developed. The relation between work done (W) and electric power (P) is

$$P=W/t.$$

Hence, the work done is calculated using the formula

$$W= VIt.$$

The heat generated in the process is calculated using the formula

$$H = (McSc+MwSw)(\theta_2- \theta_1)$$

Where,
M_c - Mass of copper calorimeter
M_w - Mass of water in calorimeter
S_c - Specific heat of copper calorimeter==0.1 Kcal/Kg ^{0}C
S_w - Specific heat of water==1 Kcal/Kg ^{0}C
θ_1 -Initial temperature of water
θ_2- Final temperature of water

and Work done (W) is directly proportional to the heat produced(H).

$$W \alpha H$$

W=JH where J is electrical equivalent of heat.

$$J=W/H$$

VIII Circuit diagram / Experimental set-up / Work Situation

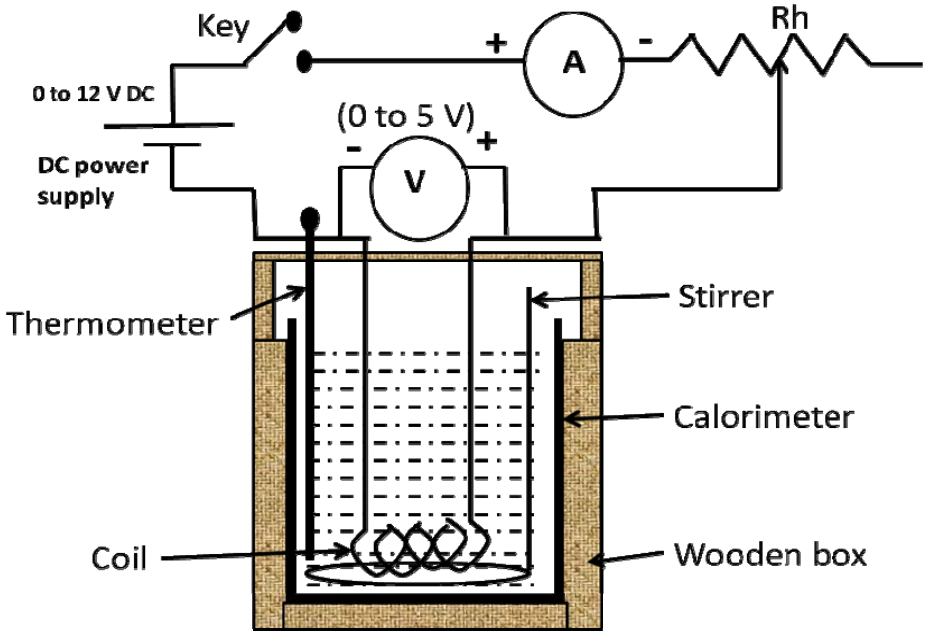


Fig.01

IX Resources required

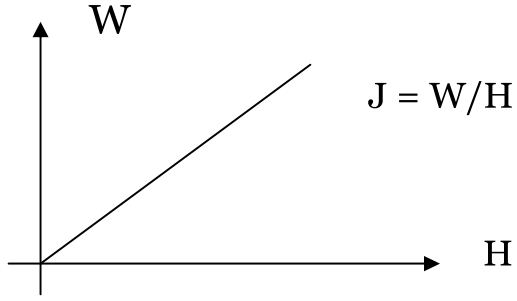
S. No	Instrument	Specification	Quantity	Remarks
1	Voltmeter	(0-5V);L.C.=0.1V	1 No	Whichever is available
2	Ammeter	(0-5A); L.C.=0.1A	1 No	Whichever is available
3	Plug key		1No	
4	Rheostat	Range=300 □	1No	Whichever is available and compatible

S. No	Instrument	Specification	Quantity	Remarks
5	DC power supply	0-12 V,1Amp	1No	
6	Joule's calorimeter with stirrer encased in wooden box		1No	
7	Thermometer	Least count=0.5^0c	1No	
8	Connecting wires			

X Procedure

1. Record the least count and range of ammeter, voltmeter and thermometer .
2. Weigh the calorimeter.
3. Take required amount of water in the calorimeter.
4. Connect the circuit as shown in Fig.01.
5. Note down the initial temperature (θ_1) of water.
6. Switch on the DC supply.
7. Adjust the current (I) to a desired value (say I=1.5A) using rheostat.
8. Note down the corresponding voltage (V).
9. Switch off the DC supply.
10. Switch on the DC supply and stop watch simultaneously.
11. Note the temperature (θ_2) of water at regular interval of 300 second.
12. In order to have uniform distribution of heat, stir the water continuously throughout the experiment.
13. Calculate the work done W=VIt in Joules.
14. Calculate heat generated H==$(M_cS_c+M_wS_w)(\theta_2-\theta_1)$ in Kcal.
15. Find Joule's constant(electrical equivalent of heat) J= $\frac{W}{H}$
16. Plot the graph of W Vs H.
17. Find the slope of this graph.
18. Calculate the value of Joule's constant by slope of the graph.

Graph:



XI Precautions (if any)

1. Connections should be tight.
2. Weigh the calorimeter and water taken accurately.
3. Continuously stir the water throughout the experiment.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

i. Least count of ammeter =
ii. Range of ammeter=
iii. Least count of voltmeter=
iv. Range of voltmeter=
v. Least count of thermometer=
vi. Mass of copper calorimeter=M_c
vii. Mass of water in calorimeter=M_w=
viii. Specific heat of copper calorimeter=S_c=0.1 Kcal/Kg ^{0}C
ix. Specific heat of water=S_w=1 Kcal/Kg ^{0}C
x. Initial temperature of water= θ_1=
xi. Current flowing in the circuit=I=
xii. Voltage developed= V=

Sr. No.	Time for which current is passed(t sec)	Temperature of water (θ_2 ^{0}C)	Work done W=VIt (J)	Heat generated $H=(M_cS_c+M_wS_w)(\theta_2-\theta_1)$ (Kcal)	Joule's constant $J=\frac{W}{H}$ (J/Kcal)
1	300				
2	600				
3	900				
4	1200				
5	1500				
6	1800				
Mean					J=

XVI Results

Value of J by experiment (in J/Kcal)	Value of J by graph (in J/Kcal)	Theoretical value of J under ideal conditions(in J/Kcal)
		4186

XVII Interpretation of results

Error in the experimental value of J= Theoretical value of J under ideal conditions - Value of J by experiment

XVIII Conclusions and Recommendations (if any)

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XIX Practical Related Questions.

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Will there be any change in amount of heat produced, if direction of current is changed. Give reasons for your answer.
2. The work done 5000 J is equivalent to how many kcal?
3. If amount of current passed through coil is doubled, determine the corresponding change in the heat produced.
4. Is there any change in amount of heat produced if heating element of coil is replaced by Copper (keeping the current constant). Give reasons.

XX References / Suggestions for further Reading

a. https://www.youtube.com/watch?v=i7VTx8fqkwk.
b. https://www.youtube.com/watch?v=XKs2XbUruL0.
c. http://www.simulatedlab.in/Laboratory/Physics/Joules-constant/Joules-constant.php

XXI Assessment Scheme

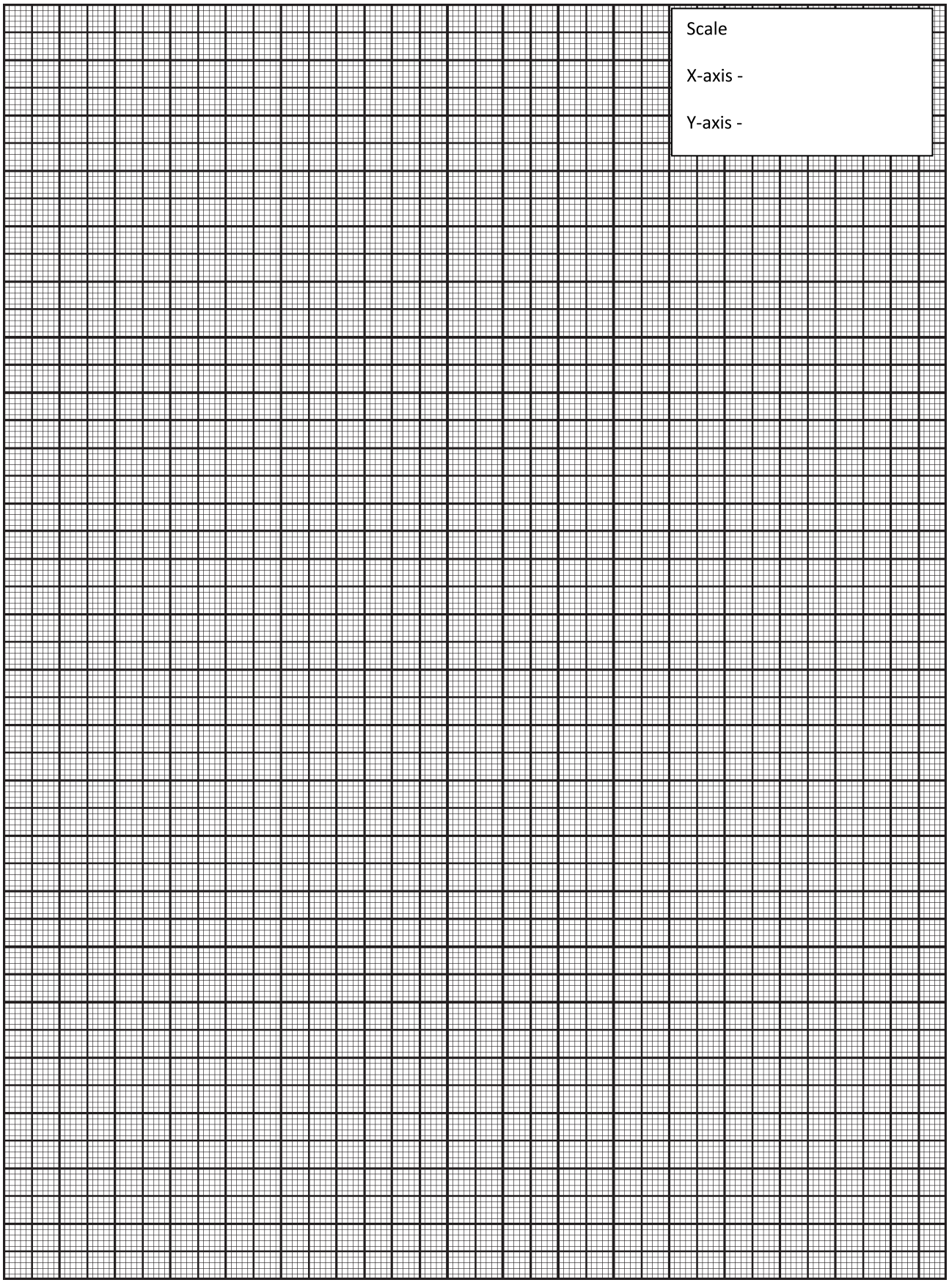
Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Selection of the instrument	10
2.	Arrangement of the instrument	10
3.	Connection of circuit diagram	10
4.	Handling of instruments	10
5.	Proper measurement	10
6.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Accuracy of measurement	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]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Y-axis -

Experiment No. 14: Thermal Conductivity

I Practical Significance

Materials of high thermal conductivity are widely used in heat sink applications and materials of low thermal conductivity are used as thermal insulation. In this experiment student will measure the thermal conductivity of a material by using Searle's apparatus.

II Relevant Program Outcomes (POs)

PO 1-Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

III Relevant Course Outcomes

(C)Use the basic principles of heat and optics in related engineering applications.

IV Practical Learning Outcome

Use Searle's thermal conductivity apparatus to find co-efficient of thermal conductivity of a given material.

V Practical Skills

Measurement skill

VI Relevant Affective domain related Outcomes

a. Follow safety practices.
b. Practice good housekeeping.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Steady state of temperature is a state where the amount of heat in a slab is constant. ***Temperature gradient*** is defined as the change in temperature per unit change in distance. Its SI unit is ^{0}K/m.

Coefficient of thermal conductivity (K) is defined as the quantity of heat which flows in one second through a slab of given material of unit thickness and unit area of cross-section when its opposite faces are maintained at a temperature difference of 1^{o}C.

Formula used:

$$K = \frac{m \times s \times (\theta 3 - \theta 4) \times d}{A \times (\theta_1 - \theta_2) \times t}$$

'm' is the mass of water, *'s' i*s specific heat of water, '*t*' is the time of flow of water in steady state, '*A*' is the area of cross section of copper rod, '*d*' is the distance between the thermometer T_1 and T_2 and θ_1, θ_2, θ_3, θ_4 are the temperatures of thermometer T_1 , T_2 ,, T_3 and T*4* respectively (Fig.01).

VIII Experimental set-up

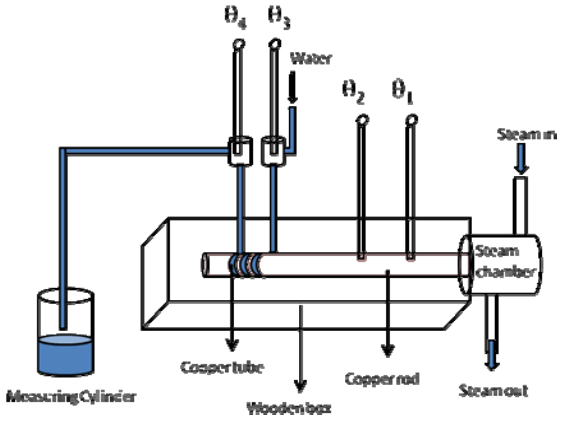

Fig.01

IX Resources required

S. No.	Particulars	Specification	Quantity	Remark
1	Searle's apparatus	length of rod 50cm	01	As available
2	Steam chamber	-----	01	As available
3	Measuring cylinder	500ml	01	As available
4	Stop watch	LC 0.1sec	01	As available
5	Electric heater	750watt	01	As available

X Procedure (Step wise)

1. Measure the radius of the metallic rod using a Vernier caliper and hence determine the area of the rod.
2. Measure the distance between thermometers T_1 and T_2 mounted on rod using meter scale.
3. Mount the thermometers T_3 and T_4 as shown in Fig.01.
4. Pass steam through the steam chamber.
5. Connect copper tubing wound round on the right end of metal rod to constant pressure head.
6. Adjust the top and punch cock such that water flows at steady rate.
7. Collect the water leaving the copper tube for known time (5 minutes).
8. Measures the volume of water collected with the help of measuring cylinder
9. Finds the mass of water collected.
10. Record the steady state temperatures θ_1, θ_2, θ_3 and θ_4 from the thermometers T_1, T_2, T_3 and T_4 respectively.
11. Calculate the coefficient of thermal conductivity (K) of given material of rod using given formula.

XI Precautions

1. Temperature should be noted at steady state temperature.
2. Insulation jacket must be efficient to reduce loss of heat due to radiation
3. Flow of water circulated through tube should be slow and uniform.
4. The gas cylinder burner is keep in off mode when the experiment is completed
5. Be sure that the steady state is reached before taking the final reading.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

Observations

1. Material of rod = ……..
2. Length of the rod= …… cm
3. Area of cross section of the rod = ……. cm^2 = …….. m^2

Diameter (D) at different points	**MSR cm**	**CSD**	**CSR = CSD X LC cm**	**TR = MSR + CSR cm**	**CR = TR ± (z) cm**	**Average reading D cm**	**Radius of rod (D/2) cm**	**Area of Cross-section A= π r^2 cm^2**
1								
2								
3								

4. Distance between thermometers T_1 and T_2= d =…… cm = …….. m
5. At steady state,
   θ_1 = ……. °C
   θ_2 = ……. °C

θ_3 = ……. °C
θ_4 = ……. °C

6. Time for which water is collected (t) = 5 min = …… s.
7. Mass of water = m =…… gm =……kg.
8. Specific heat of water=s = 1 kcal /kg °C (Given)

Calculations:

$$K = \frac{m \times s \times (\theta 3 - \theta 4) \times d}{A \times (\theta_1 - \theta_2) \times t}$$

$$K = \frac{\text{.....}}{\text{.....}}$$

K =……

K =…… kcal / m °C s.

XVI Results

Coefficient of thermal conductivity (K) of given material of rod K=……kcal / m °C s (MKS unit)

XVII Interpretation of results

1. Coefficient of thermal conductivity (K) of given material of rod K=…… kcal / m °C s.
2. Standard value of coefficient of thermal conductivity (K) of given material of rod K=…… kcal / m °C s.
3. Error in measurement of K = Standard value – experimental value
   =(……..) - (……..)
   =…….. Kcal / m °C s

XVIII Conclusions and Recommendations

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.....
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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give reasons for covering copper rod by insulating material.
2. Under steady state the temperature of a body –
   a) Increases with time
   b) Decreases with time
   c) Does not change with time and it remain same at all points of the body.
3. Give reasons for the temperatures θ_1, θ_2, θ_3 and θ_4 remains steady even if heating of rod is continued?
4. State the effect of heat conducted if area of rod is doubled?
5. Is this method is suitable for bad conductor? Give reasons.

6. State the importance of maintaining steady flow during the experiment?
7. Name the mode of heat transfer observed in this experiment.
8. If a constant pressure head is not maintained through the spiral tube, what will be the expected change in the experimental observations?
9. Will temperature of outgoing water remain same if the rate of flow of water is changed?

XX References / Suggestions for further Reading

a. http://hyperphysics.phy-astr.gsu.edu/hbase/permot2.html
b. https://www.youtube.com/watch?v=F44nP5SwsKk
c. https://www.youtube.com/watch?v=Pam7SUKzyMQ
d. https://www.youtube.com/watch?v=MGbvoQTAcFk

XVIII Assessment Scheme

Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Selection of the instrument	10
2.	Arrangement of the instrument	10
3.	Connection of circuit diagram	10
4.	Handling of instruments	10
5.	Proper measurement	10
6.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Accuracy of measurement	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

[Space to Write Answers]

Experiment No. 15: Refractive index of prism

I Practical Significance

In optics, the refractive index of a material is a dimensionless number that describes how light propagates through that medium. The refractive index of water is 1.333. Light travels 1.333 times faster in a vacuum than it does in water. Refractive Index is commonly used for calculating the concentration of dissolved substances in water. Refractive Index measurement is often the simplest, most convenient, and most rapid procedure for evaluating the composition of a binary liquid or a gaseous mixture. In this experiment students determine the refractive index of glass with respect to air.

II Relevant Program Outcomes (POs)

PO 1-Basic knowledge.
PO 2-Discipline knowledge:
PO 3-Experiments and practice:

III Relevant Course Outcomes

(c)Use the basic principles of heat and optics for related engineering applications.

IV Practical Learning Outcome

Use pin method to determine refractive index of prism.

V Practical Skills

Measurement skills

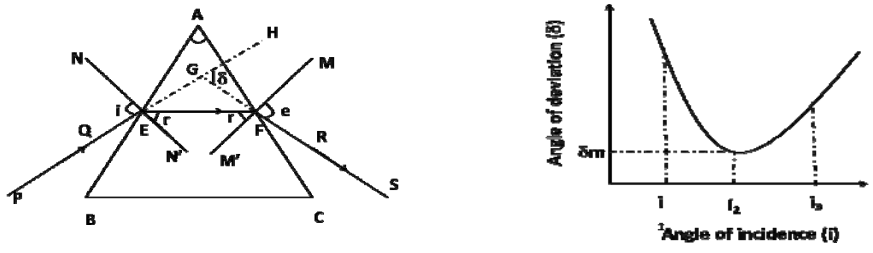
VI Relevant Affective domain related Outcomes

a. Follow safe practices
b. Practice good housekeeping.

VII Minimum Theoretical Background

When light travels from one medium to another medium, it is refracted and enters the new medium at a different angle. The degree of bending of the light's path depends on the angle that the incident beam of light makes with the surface of the prism, and on the ratio between the refractive indices of the two media. For any two media, the ratio of sine angle of incidence to sine angle of refraction is constant and is known as ***Snell's Law***. The constant of proportionality is called as refractive index(n) of second medium with respect to first medium.

A prism is an optical element. It has polished flat surfaces that refract light. The traditional geometric shape of a prism has a triangular base and two rectangular sides. It is called triangular prism. A prism can be made from materials like glass, plastic and fluorite. It can be used to split light into its components.



(a) (b)

Fig.01

PE- Incident ray ∠ i- Angle of incidence
FS- Emergent ray ∠e- Angle of emergence
EF- Refracted ray ∠δ- Angle of deviation
NN', MM'- Normal ∠ r – Angle of refraction

The angle A between the two refracting surfaces AB and AC is called the angle of prism.
A ray of light suffers two refractions on passing through a prism. If PQ be a monochromatic light falling on the side AB, it is refracted and travels along EF. It once again suffers refraction at F and emerges out along RS. The angle through which the emergent ray deviates from the direction of incident ray is called angle of deviation 'δ'(Fig.01 a). As the angle of incidence is increased, angle of deviation 'δ' decreases and reaches minimum value. If the angle of incidence is further increased, the angle of deviation is increased (Fig.01 b). The relation between Refractive Index (n), Angle of Prism (A) and Angle of minimum deviation (δ_m) is given by,

$$n = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

VIII Circuit diagram / Experimental set-up / Work Situation

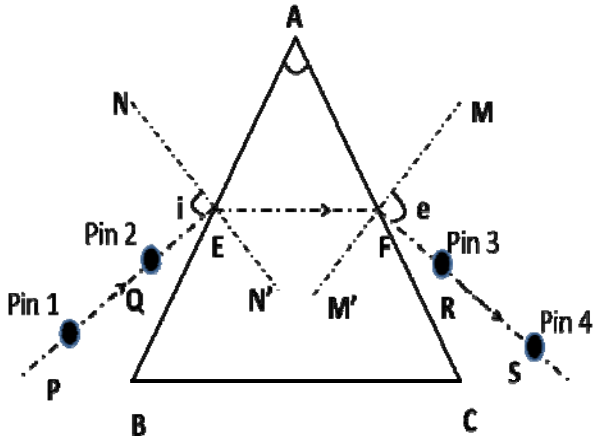


Fig.02

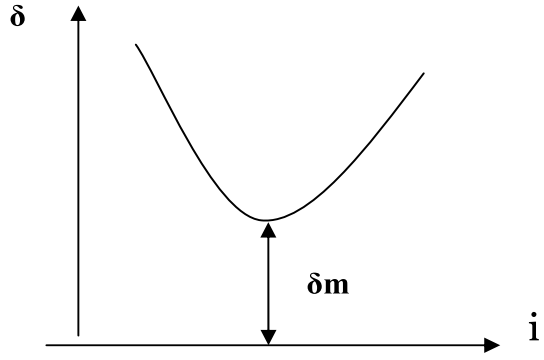
IX Resources required

S. No.	Name of Item	Specification	Quantity	Remark
1	Prism	Glass, A=60 ^{0}	01	
2	Drawing board	A3	01	
3	Paper pins	--	15	
5	Protractor	0 to 90 ^{0}	01	
6	Scale	1 to 30 cm	01	

X Procedure

1. Place A4 size white paper on the drawing board.
2. Place the given glass prism on the center of the paper.
3. Mark the outline ABC of the prism on the paper using the pencil.
4. Remove the prism from board.
5. Draw normal to refracting surface AB and AC.
6. Use protractor and measure an angle 30° from the normal.
7. Draw line a PQ at E making the angle 30° (angle of incidence i) with the normal.
8. Fix two pins R1 and R2 on this line.
9. Replace the prism on the outline ABC.
10. View the pins from the face AC of the prism, two other pins R3 and R4 are fixed so that R1, R2, R3 and R4 are in a line.
11. Remove the pins.
12. A line RS is drawn to meet on the face AC through the marks of R3 and R4.
13. Join The line EF .
14. Extend the line RS and PQ both two lines meet at G (Fig.01).
15. Use protractor to measure the angle HGF (Fig.01). This is the angle of deviation δ.
16. Repeat the steps 05 to 15 for different values of angle of incidence (i).
17. Measure the values of angle of deviation.
18. Draw a graph with angle of incidence (i) along the X-axis and angle of deviation (δ) along the Y – axis.
19. Note the angle of deviation corresponds to the lowest bend of the curve i.e. the angle of minimum deviation (δ_m).
20. Measure the angle of the prism A is from the outline of the prism using the protractor.
21. Calculate the refractive index of the material of the prism using the formula.

Graph:



XI Precautions

1. Handle prism carefully.
2. Eyesight should be parallel to pins.
3. Pins should be straight.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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.....

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XIV Precautions followed

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.....

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XV Observations and Calculations

Sr. No.	Angle of incidence (i) (in degrees)	Angle of deviation (δ) (in degrees)
1	30	
2	35	
3	40	
4	45	
5	50	
6	55	
7	60	

Calculations: Angle of prism (A) =

From graph, angle of minimum deviation **δm** = ----------

Refractive index of the material of the prism,

$$n = \frac{\sin\left(\frac{A + \delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

XVI Results

A graph showing the variation of angle of deviation with the angle of incidence is plotted.

Angle of minimum deviation (**δm**) = --------°

Refractive index of material of the prism, n = ----------

XVII Interpretation of results

1. Calculated value of refractive index of glass =
2. Standard value of refractive index of glass =
3. Error in measurement =

XVIII Conclusions and Recommendations

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XIX Practical Related Questions.

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the factors on which the angle of deviation depend in your experiment.
2. Give the number of refractions occur when a ray of light passes through a triangular prism in your experiment.
3. In case ,If the angle of a prism is 60° and the angle of minimum deviation is 37.2°, the refractive index of the prism will be …….

XX References / Suggestions for further Reading

a. A manual of Practical Physics for Higher Secondary classes by Prof. E.V. Thomas.
b. Lab manual for class XII by NCERT.
c. Comprehensive Practical Physics for Class XII by J. N. Jaiswal and Dr. Rajendra Singh.
d. http://www.physicsclassroom.com/class/refrn/Lesson-4/Dispersion-of-Light-by-Prisms
e. http://gradestack.com/CBSE-Class-10th-Course/Human-Eye-and-Colourful/Refraction-of-Light/15033-2998-4728-study-wtw
f. http://xamidea.in/learning/Physics/20/Reflection,-Refraction-and-Dispersion-of-Light-/94/Newton%60s-formula-and-Refraction-through-a-Prism/title/10000674.

XXI Assessment Scheme

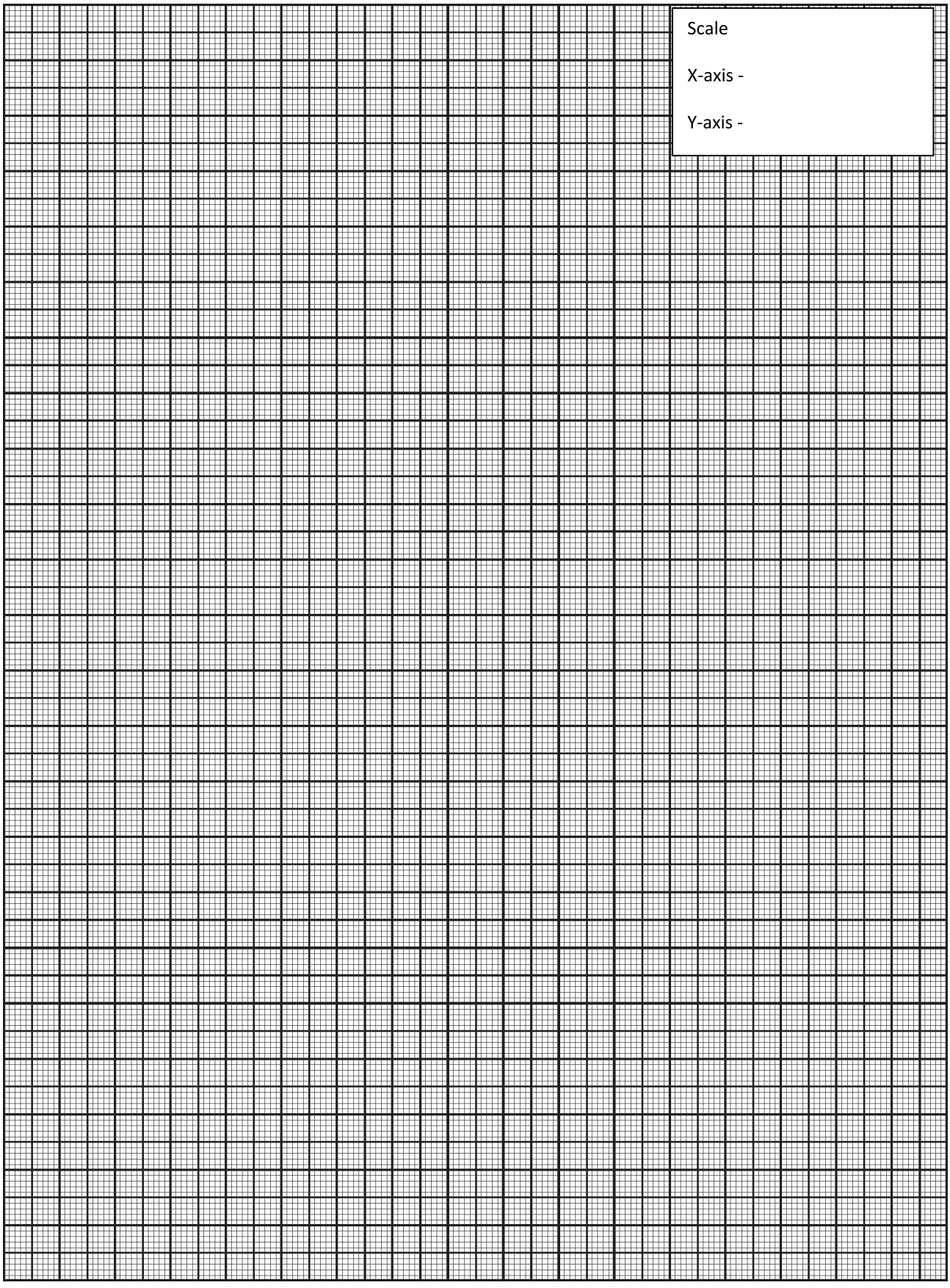
Performance indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Handling of instruments	10
2.	Arrangement of the instrument	10
3.	Measurement of angle (i, δ, δm)	30
4.	Calculation of parameters concerned	10
Product related: 10 Marks		**40%**
1.	Accuracy of measurement	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

[Space to Write Answers]


Scale
X-axis -
Y-axis -

Experiment No.16: Total Internal Reflection

I Practical Significance

Optical fibers has numbers of industrial and house hold applications , such as guiding medium for sending communication signals, fiber optic sensor for leveling of bridges, pressure sensor, stress sensor, Endoscopes and decorative purposes. Optical fiber works on the principle of total internal reflection (TIR). Mirage is an optical illusion, is also an illustration of TIR. In this lab experience student will analyze the phenomenon of TIR and determine the refractive index of glass by measuring the critical angle.

II Relevant Program Outcomes (POs)

PO-1 Basic knowledge
PO-2 Discipline knowledge
PO-3 Experiments and practice

III Relevant Course Outcomes

(c) Use the basic principles of heat and optics in related engineering applications

IV Practical Learning Outcome

Determine the refractive index of glass slab using TIR phenomenon.

V Practical Skills

a. Measurement skills.
b. Drawing skills

VI Relevant Affective domain related Outcomes

a. House Keeping

VII Minimum Theoretical Background

Refractive index: It is a measure of bending of light while entering the medium. It is a dimensionless quantity. It is denoted as " μ". ***Snell's law*** is defined as "The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, for the light of a given colour and for the given pair of media".

$$\mu = \frac{Sini}{Sinr}$$

Critical angle: The critical angle of incidence is defined as that angle of incidence from denser medium for which the angle of refraction in rarer medium is 90^o.

Total internal reflection: When a ray of light passes from a denser to a rarer medium, some part of it gets refracted into the rarer medium such that it bends away from the normal. Some part of it gets reflected back into the denser medium. The light reflected back into the denser medium is said to be internally reflected. In case of refraction from a denser to a rarer medium, the angle of refraction 'r' is greater than the angle of incidence 'i'. If the angle of incidence of the light ray is gradually increased, then at a certain angle of incidence, the angle of refraction in the rarer medium becomes 90^o.

The refracted light grazes the interface of the two media. This angle of incidence in the denser medium is called the critical angle, C, for the pair of media under consideration. When angle of incidence i = C, angle of refraction r = 90^o.The refractive index of the denser medium with respect to the rarer medium is given by

$$\mu = \frac{1}{Sin\, C}$$

For total internal reflection, the conditions that must be satisfied are:

- Light must pass from a denser medium to a rarer medium.
- The angle of incidence in the denser medium must be greater than the critical angle for that pair of media.

VIII Circuit diagram / Experimental set-up / Work Situation

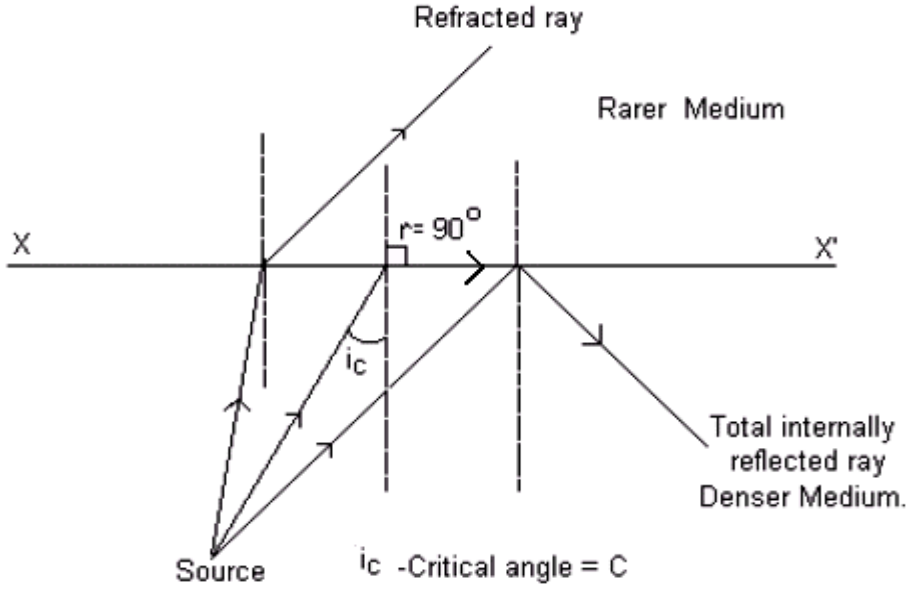


Fig.01

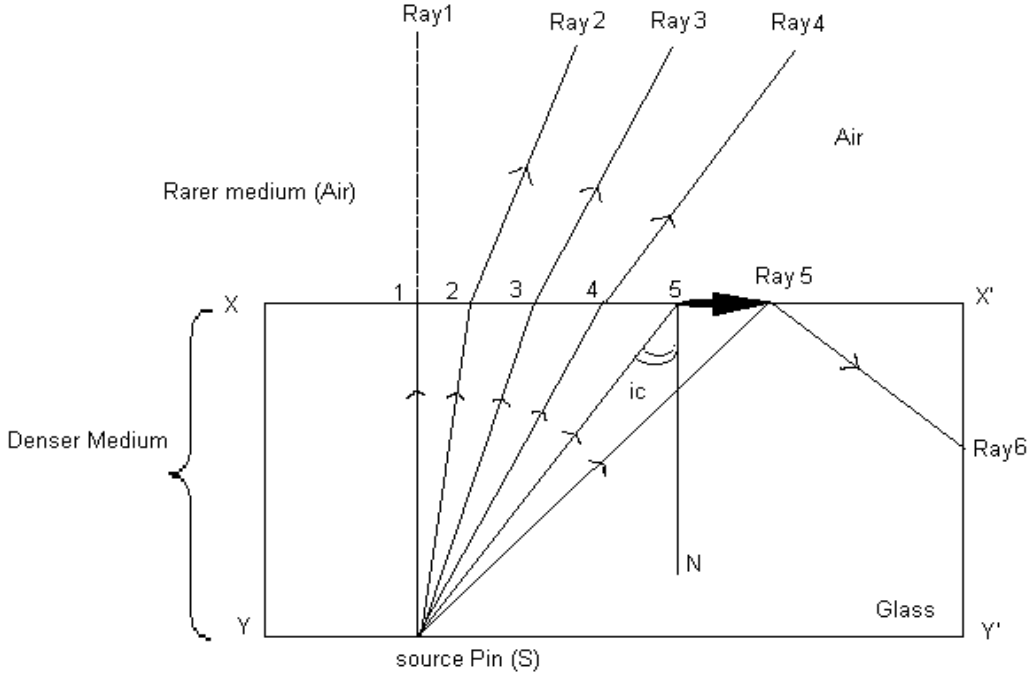


Fig.02

IX Resources required

S. No	Name of Instrument	Specifications	Quantity	Remarks
1	Standard glass slab	Variable size, Different thickness	01No.	
2	Drawing paper	A 4 size	01No.	
3	Drawing pins		01No.	As per availability
4	Drawing board	Base wood	01No.	As per availability
5	Protractor, scale, HB/B pencil		01 No. each	As per availability

X Procedure

1. Place A_4 size drawing paper on a drawing board properly.
2. Fix the paper using drawing pins .
3. Take the glass slab.
4. Clean glass slab with a white cotton cloth.
5. Place glass slab at the center of the drawing paper.
6. Mark the position outline with pencil , label it as XX' and YY' as given in Fig. 02
7. Place a pin near left corner 'Y' as source pin S.
8. Look at the source pin from other side through glass slab.
9. Locate point 1 on XX', with the help of another pin.
10. Mark point 2, 3 and 4 on plane XX' till refraction is observed.
11. Now select point number 5 such that the source gets just disappeared.
12. Join source point and 5 with straight line after removing glass slab.
13. Draw normal (N) to plane XX' through point 5.
14. Locate point 6 as shown in Fig.02.
15. Measure the critical angle of incidence i_c=C.
16. Calculate refractive index of material of glass slab.

XI Precautions

1. Make sure that there is adequate ventilation (Sufficient Light).
2. Clean drawing board before beginning work.

XII Actual procedure followed

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XIII Resources used (with major specifications)

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XIV Precautions followed

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XV Observations and Calculations

1 Material of glass slab ……..

2 Critical angle of incidence = i_c = C = ……..

Calculations:

Refractive index of material of prism (μ)

$$\mu = \frac{1}{Sin\,C}$$

μ = ...

XVI Results

1. Critical angle of incidence for glass is ……..
2. Refractive index of material of glass is ……..

XVII Interpretation of results

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XVIII Conclusions and Recommendations

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XIX Related Practical Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give reasons for an observing pin at point 6.
2. If crown glass slab is replaced with flint glass slab in your experiment the critical angle will increase or decrease?

XX References / Suggestions for further Reading

a. https://www.nextgurukul.in/wiki/concept/ICSE/X/.../Total-Internal-Reflection.htm
b. www.physicsclassroom.com › Physics Tutorial › Refraction and the Ray model of light
c. https://www.merospark.com › HSEB Notes
d. https://www.youtube.com/watch?v=ZXw1_5I_H_E

XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Experimental set-up	10
2.	Handling of apparatus	20
3.	Correctness of reading	10
4.	Measurement of angles	20
Product related: 10 Marks		**40%**
1.	Timely submission and neatness	10
2.	Interpretation of result	10
3.	Conclusions & Recommendations	10
4.	Practical related questions	10

List of student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

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List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
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4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
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8	Automobile Engines	22308
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10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
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15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
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1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
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14	Microcontroller & Applications	22426
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17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
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3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
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15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

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1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
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12	System Programing	17634
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14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
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25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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