SCHEME : K

Name : _____

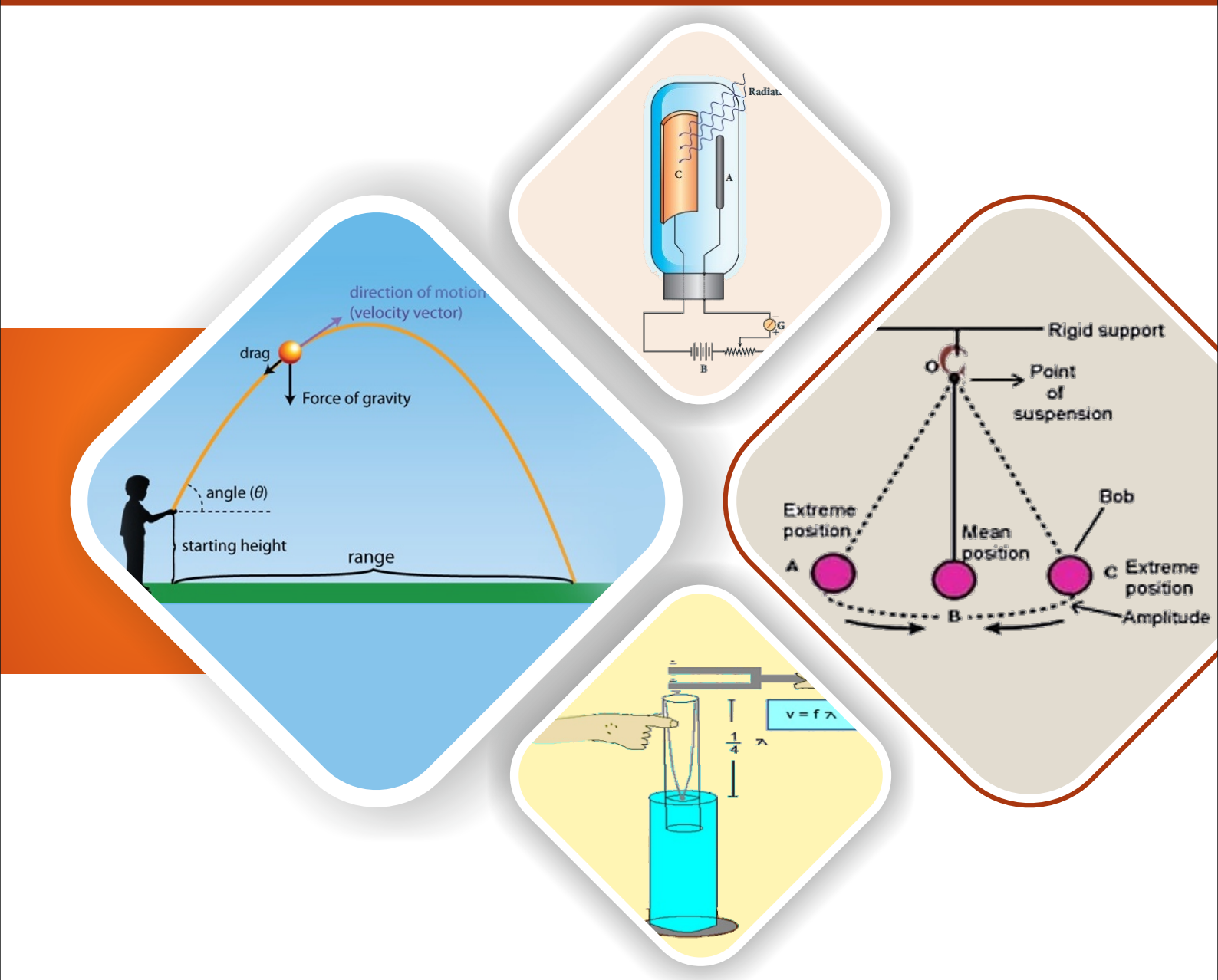
Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

APPLIED SCIENCE (PHYSICS)

(312308)



FIRST YEAR ENGINEERING

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

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

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

A Laboratory Manual for

Applied Science-Physics

(312308)

Semester-II

(AE/AL/AO/CE/CR/CS/EE/EP/IC/IS/LE/ME/MK/PG)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous)(ISO9001:2015)(1SO/IEC27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO9001:2015) (ISO/IEC27001:2013)
4thFloor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on December, 2023)

MAHARASHTRA STATE
BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms……..
Roll No……of Second Semester of Diploma in .....
..... .of Institute, ...
..... (Code:.....) has completed the term work satisfactorily in Course **Applied Science- Physics (312308)** for the academic year 20.....to 20……as prescribed in the curriculum.

Place:..... Enrollment No:.....

Date:…… Exam Seat No:.....

Course Coordinator **Head of the Department** **Principal**

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Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much-needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'K' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher, instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes,*** rather than the traditional age-old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Diploma engineers have to deal with various materials and machines. The study of concepts and principles of science like elasticity, motion, photo- sensors, LASERs, X-Rays will help the student to select and use relevant materials and methods which will be economical and eco-friendly.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practicals

PO1. Basic and Discipline Specific Knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems

PO2. Problem Analysis: Identify and analyse well-defined engineering problems using codified standard methods.

PO3. Design/Development of Solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO4. Engineering Tools, Experimentation and Testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO5. Engineering practices for Society, Sustainability and Environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO7. Life-Long learning: Ability to analyse individual needs and engage in updating in the context of technological changes.

Practical- Course Outcome matrix

Course Outcomes (COs)

1. Select relevant material in industries by analyzing its physical properties.
2. Apply the concept of simple harmonic motion, resonance and ultrasonic sound for various engineering applications.
3. Apply the concept of modern Physics (X-rays, , LASER, Photo sensors and Nanotechnology) for various engineering applications.

Sr. No.	Title of the Practical	CO 1	CO 2	CO 3
1	Determination of Young's modulus of given wire.	✓		
2	Comparison of Young's modulus of given materials of wires.	✓		
3	Determination of relationship between angle of inclination and downward force using inclined plane.	✓		
4	Determination of range of projectile	✓		
5	Determination of force constant using helical spring		✓	
6	Determination of velocity of sound using resonance tube method		✓	
7	Determination of acceleration due to gravity by using simple pendulum		✓	
8	Determination of distance of object using ultrasonometer.		✓	
9	Determination of velocity of ultrasonic sound waves in different liquids using ultrasonic interferometer.		✓	
10	Determination of the dependence of the stopping potential on the frequency of given light source. (Virtual Lab)			✓
11	Determination of I-V characteristics of photoelectric cell.			✓
12	Determination of I-V characteristics of LDR.			✓
13	Determination of the divergence of laser beam.			✓
14	Determination of refractive index of glass plate using laser beam. (Virtual Lab)			✓
15	Determination of wavelength of helium neon laser (Virtual Lab)			✓

Guidelines to Teachers

Hints regarding strategies to be used

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 for Students

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. Students should read the precaution carefully before start of experiment

Content Page

List of Practicals and Progressive Assessment Sheet

Sr. No.	Practical outcomes	Page No.	Date of performance	Date of submission	Assessment marks (25)	Dated sign. of Teacher	Remarks (if any)
1	* Use Searle's method to determine the Young's modulus of given wire	1-9					
2	Compare Young's modulus of different materials of wires.	10-17					
3	* Use of inclined plane to find the downward force.	18-25					
4	*Use projectile motion to find the range from initial launch speed and angle	26-32					
5	*Use helical spring to find force constant.	33-40					
6	*Use resonance tube method to determine velocity of sound	41-48					
7	*Use Simple pendulum to find acceleration due to gravity	49-54					
8	Use ultrasonic distance – meter to measure distance of object	55-60					
9	Use ultrasonic interferometer to determine velocity of sound	61-66					
10	Use photo electric cell to find dependence of the stopping potential on the frequency of given light source.	67-74					
11	*Determine I-V characteristics of the given photo electric cell.	75-82					
12	*Determine I-V characteristics of given light dependent resistor.	83-90					
13	Find divergence of given laser	91-97					
14	Use LASER beam to find the refractive index of glass plate	98-103					
15	Find the wavelength of given laser	104-109					
Total Marks							

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No. 1: Determination of Young's modulus of given wire

I. Practical Significance

- In industries mechanical properties like strength, stiffness (Rigidity), ductility, malleability and brittleness have to be carefully studied to select a material for a particular job. The metallic parts of machines should not be subjected to stress beyond the elastic limit otherwise they will be deformed. In civil engineering, beams are the simplest and most common parts of large structures. In an arched stone bridge, the stone is compressed and this makes the stone weak. Hence, steel arch is used as it is stronger than the stone arched bridge. The thickness of the metallic rope needed to lift a given load is decided using the knowledge of elastic limit of the material of the rope and the factor of safety.
- Young's modulus (Y) is a measure of the ability of a material to withstand changes in length when force is applied on it. Material either elongates or gets compressed depending on a type of force applied on it. Young's modulus of elasticity predicts how much a material sample extends under tension or shortens under compression.
- In this experiment, we use Searle's apparatus to determine Young's modulus of elasticity of given steel wire.

II. Industry / Employer Expected Outcome

The aim of this course is to attain industry/ employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcomes (COS)

Use relevant material in industry by analyzing its physical properties.

IV. Laboratory Learning Outcome (LLO)

Use Searle's method to:

i. Determine the Young's modulus of given wire.

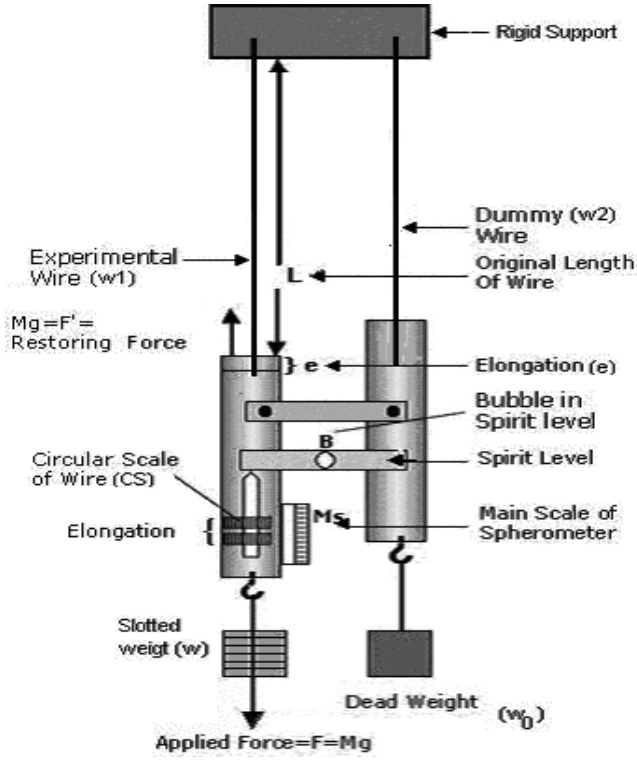
V. Relevant Affective domain related Outcomes

a. Follow safe practices.
b. Practice good housekeeping.
c. Function as a team member.

VI. Relative Theoretical Background

1) Searle's apparatus: Searle's apparatus consists of two metal frames Fl and F2. Each frame has a torsion head at the upper side and a hook at the lower side. These frames are suspended from two wires AB and CD of same material, length and cross-section. The upper ends of the wires are screwed tightly in two torsion heads fixed in the same rigid support. A spirit level rests horizontally with one end hinged in the frame F2. The other end of the spirit level rests on the tip of a spherometer screw, fitted in the frame F1. The spherometer screw can be rotated up and down along a vertical pitch scale marked in millimeters. The two frames are kept together by cross bars El and E2.

VII. Actual Circuit diagram/Experimental setup used in laboratory with equipment specification



VIII. Resources required

Sr. No	Instrument /Object	Specification	Quantity	Remarks
1	Searle's apparatus	Conventional	1 No.	whichever is available
2	Two long steel wires of same length and diameter	Length: 2-meter Diameter: 0.1-0.15 mm	1 No.	Available dimensions
3	A set of slotted weights	1/2 Kg each	1 No.	Available dimensions
4	weight hanger	1 Kg	1 No.	whichever is available
5	Dead load	1 Kg	1 No.	whichever is available
6	Meter scale	1 meter	1 No.	whichever is available

IX. Precautions

1. Micrometer screw should be rotated in same direction while taking reading.
2. The load added should be within elastic limit.
3. Micrometer screw should be rotated in same direction while taking reading.
4. The load added should be within elastic limit.
5. The experiment should be carried out using a common support, as any sagging will have no effect the measurement of the extension.
6. The wire under test should be uniform and free from kinks.
7. The area is measured by taking repeated readings of the diameter of the wire from different sections.
8. Repeated readings for extensions should be taken as this reduces margin of error.
9. After every instance that a load is added and removed the proper amount of waiting time should be given to avoid personal error.
10. After every instance that a load is added and removed the original length of the wire should always be obtained as this ensures that the elastic limit would not have been exceeded

X. Procedure

Part I: To find area of cross section of experimental wire

1. Find out Least count of micrometer screw gauge.
2. Determine zero error correction (z) of the micrometer screw gauge.
3. Take observations for diameter of wire at three different places.
4. Calculate radius "r" of wire.
5. Calculate area of cross section of wire, using $A = \pi r^2$
6. Record the observations in Table No. 1

Part II: Find elongation of wire after application of weight.

1. Find L.C. of spherometer.
2. Load both the wires with same loads of about 1 Kg. (Dead load Wo)
3. Adjust the bubble in the spirit level at center with the help of spherometer screw.

4. Record the reading of spherometer in loading column against Wo in the observation Table No2.
5. Increase load on experimental wire by 0.5 Kg.
6. Observe the movement of bubble for 2,3 minutes so that wire elongates.
7. Take the reading when bubble is stationary.
8. Bring the bubble of spirit level in the center with the help spherometer screw
9. Record the spherometer reading against weight 0.5 Kg.
10. Repeat the procedure from step 5 to 8 up till the load becomes (Wo + 2.5) Kg.
11. Record the last spherometer reading for (Wo + 2.5) Kg in both the columns of loading and unloading
12. Decrease the load gradually in steps of 0.5 Kg.
13. Observe the movement of bubble for 2,3 minutes so that wire contracts.
14. Take the reading when bubble is stationary.
15. Bring the bubble of spirit level in the center with the help spherometer screw.
16. Record the spherometer reading against weight (Wo + 2.0) Kg.
17. Repeat the procedure from step 12 to 15 till the load becomes (Wo) Kg.
18. Calculate mean spherometer reading for each load attached to the experimental wire.
19. Calculate elongation (e) in given wire (refer observation table 2)
20. Calculate Tensile(longitudinal) stress using formula $\sigma = \underline{Mg/A}$
21. Calculate Tensile(longitudinal) strain using formula $E = e/L$
22. Calculate Young's modulus of elasticity using formula. $Y = \sigma / E$
23. Determine mean value of Young's modulus of elasticity "Y"
24. Plot a graph of stress (cr) against stain (E), calculate Slope.

XI. Observations and Calculations:

Part I: To find area of cross section (A) of experimental wire

a) To find Zero Correction (Z)

Least count of Micrometer	……cm
Zero error correction (z)	……cm

b) To find area of cross section of experimental wire

Sr. No	MSR cm.	CSR cm.	T.R.= (MSR+ CSR) cm	Corrected diameter TR±Z (cm)	Average Corrected Diameter (m)	Radius of wire r (m)	Area of wire $A = \pi r^2$ (m^2)
1							
2							
3							

Part II: Find elongation of wire after application of

weight. Original length of wire (L) = ...m. (Given)
Gravitational acceleration g = 9.81 m/s^2

Sr. No	Load M Kg.	Weight Mg Kg.	Spherometer Reading			Elongation (e) m	Stress = Mg/A N/m^2	Strain E=e/L	Y= σ/E N/m^2
			Load cm.	Unload cm.	Mean cm.				
1	Wo=				Xo				
2	Wo+0.5=				X1	X1-Xo			
3	Wo+l.0=				X2	X2-Xo			
4	Wo+l.5=				X3	X3-Xo			
5	Wo+2.0=				X4	X4-Xo			
6	Wo+2.5=				*Xs*	Xs-Xo			
Mean "Y"									

XII. Result:

Standard value of Young's modulus of given metallic wire	Young's modulus by Experiment	Young's modulus by Graph

XIII. Interpretation of results:

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

……

……

……

XIV. Conclusions and Recommendations:

……

……

XV. 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. "It is necessary to wait for some time after each loading or unloading" Give reason.
2. Explain the role of dummy wire in Searle's apparatus.
3. "Dead load is attached to wires initially" Give reason
4. Explain the graph developed using readings from Searle's apparatus.
5. A & B are wires of different materials having equal length and equal cross-sectional area. If they extend by amounts e & e^1 due to same force F applied to them, Identify the wire of material having larger value of Y. Give reason.
6. A cable that can support a load W is cut into two equal parts. Find maximum load that can be supported by either part of wire?
7. From the values of Young's modulus "Y" for some materials shown below, predict material that will be more elastic when equal force is applied.

Material	y
A	3×10^{11} N/m^2
B	2×10^{11}N/m^2
C	1×10^{11} N/m^2

Space for Answers

XVI. References / Suggestions for further Reading

https://amrita.olabs.edu.in/?sub=1&brch=5&sim=155&cnt=4
https://youtu.be/xASsYJo3zrM?si=n61dF23C5XV33rht

XVII. Suggested Assessment Scheme

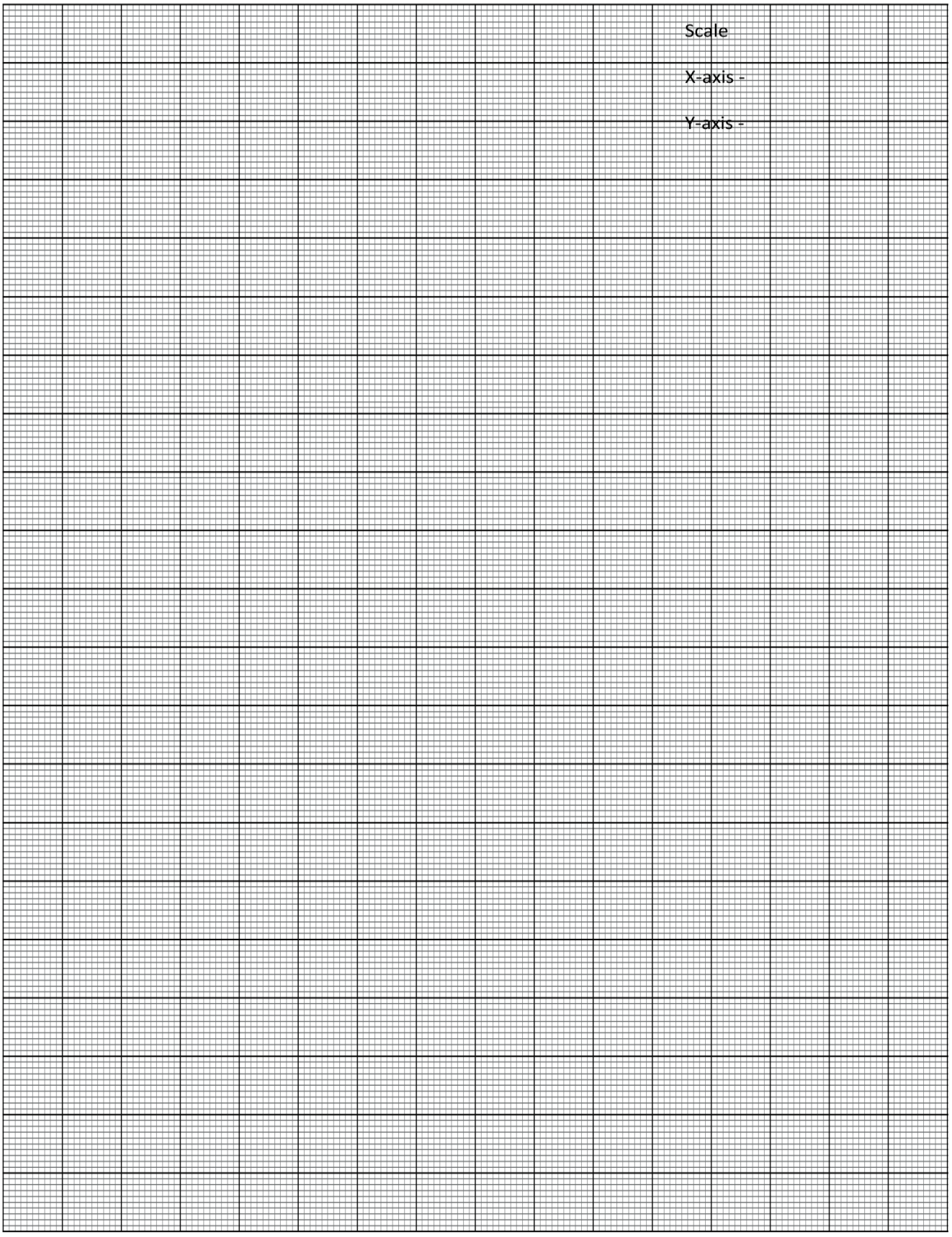
The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related: 15 Marks		**60%**
1	Handling of the instrument	5
2	Determination of Least Count (L.C.) of instrument	5
3	Determination of Area of cross section of wire	10
4	Determination of Young's modulus of wire	20
5	Plotting graph	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
Total (25 Marks)		**100%**

Name of student Team Members:

1. .....
2. .....
3. .....
4. .....

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

Practical No. 2: Comparison of Young's Moduli of the given materials of wires.

I. Practical Significance

The Young's modulus directly Measures the stiffness of the Solid material. It defines the relationship between stress (force per unit area) and strain (proportional deformation) in a material. Young's modulus (E) is a measure of the ability of a material to withstand changes in length when under length wise tension or compression. It predicts how much a material sample extends under tension or shortens under compression. Young's modulus is also used in order to predict the deflection that will occur in a statically determinate beam when a load is applied at a point in between the beam's supports. Young's modulus or Modulus of Elasticity which is material Constant Value. Thus, modulus of elasticity always seems to be an important parameter in any field of engineering.

II. Industry / Employer Expected Outcome

The aim of this course is to attain industry / employer expected outcome through various teaching learning experiences.

III. Level Learning Outcomes (COS)

Use relevant material in industries by analyzing its physical properties.
Select relevant material in industry by analyzing its physical properties.

IV. Laboratory Learning Outcome (LLO)

Compare young's modulii of different materials of wires .

V. Relevant Affective domain related Outcomes

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

VI. Relevant Theoretical Background

Elasticity is a property of a material which allows it to return to its original shape or length after being distorted. Some materials are not at all elastic - they are brittle and will snap before they bend or stretch. Others, like rubber, for example, will stretch a long way without significant warping or cracking. This is because the materials contain long chain molecules that are wrapped up in a bundle and can straighten out when stretched. Hooke's Law states that within the limit of elasticity, stress applied is directly proportional to the strain produced.

i.e. **Stress α Strain**

$$\frac{Stress}{Strain} = \textbf{Constant}$$

Constant The constant is called as modulus of elasticity.

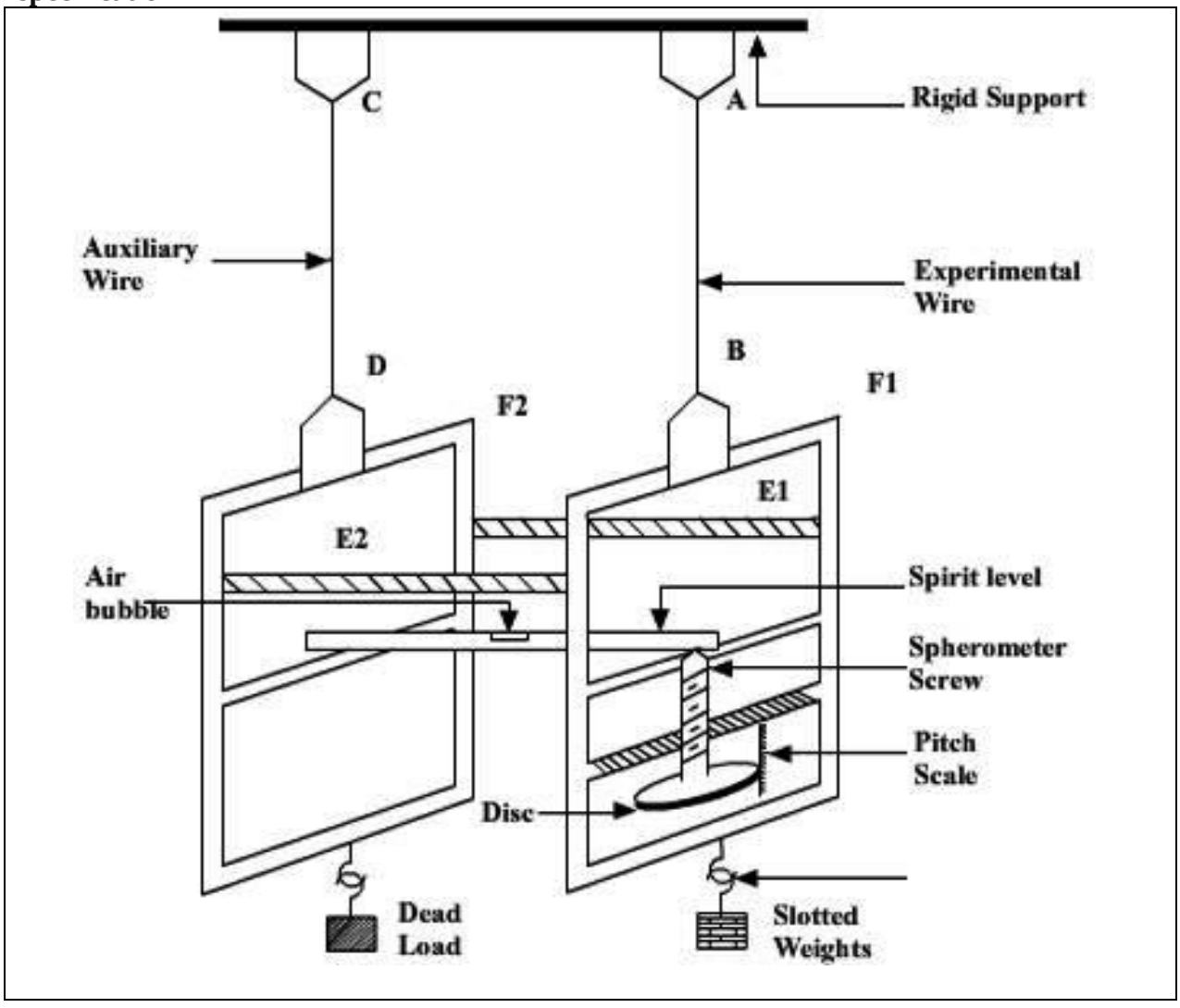
Young's modulus is defined as the ratio of tensile stress to the tensile strain.

Y = (F L) / (A ΔL)

Where Y= Young's modulus
F= M X g
F= Force
M = Mass attached to the wire.
g = Gravitational acceleration = 9.81 m/s^2
A = Area of Cross section of wire
L = Original length
ΔL = Change in length

VII. Actual circuit diagram/ Experimental Setup used in laboratory with equipment specification

Actual circuit diagram/ Experimental Setup used in laboratory with equipment specification



VIII. Resources required

Sr. No.	Instrument/Object	Specification	Quantity
1	Searl's apparatus		
2	Slotted weight	0.5 Kg	
3	Meter scale	1 Meter	

IX. Precautions

1. Loading and unloading of weight must be done gently.
2. Avoid backslash error.
3. Loading should not be beyond elastic limit.

X. Procedure

1. Attach dead load to dummy wire as well as experimental wire so that kinks present in the wire can be removed.
2. Adjust the bubble in the spirit level at its center using spherometer screw.
3. Observe main scale reading (MSR) shown by spherometer.
4. Observe circular scale division (CSD) shown by spherometer.
5. Calculate circular scale reading (CSR). CSR = CSD X LC
6. Calculate total reading (TR) = MSR + CSR
7. Now gradually increase load by 0.5 kg each.
8. Wait for 2-3 minutes till bubble in spirit level shift from centre.
9. Repeat steps from 3 to 8 till weight becomes W0 + 2.5kg
10. Now gradually decrease a load by 0.5kg each.
11. Repeat the steps 3 to 6 for getting TR.
12. Repeat the steps till weight becomes W0.
13. Calculate elongation as shown in observation table.
14. Calculate stress as shown in the table.
15. Calculate Young's modulus Y using the formula.
16. Calculate mean value of Young's modulus.
17. Repeat the steps from 1 to 16 for next wire.

XI. Observations and Calculations:

Table 1:

Given: 1) Material of wire =

2) Area of the wire = ……...m^2

3) LC of spherometer = ……...cm.

4) Length of wire=…….cm

To find area of crosssection of experimental wire

Sr. No.	MSR cm	CSR cm	TR=MSR+CSR	Tr±Z	Average Diameter	Radius	Area of Wire
1							
2							
3							

Table 2:

Given: 1) Material of wire=

2) Area of the wire=…….m^2

3) LC of spherometer=…….cm

4) Length of wire=…….cm

Sr. No	Load (M) Kg	Mg	Spherometer reading							Elongation (l) X 10^{-2} m	Stress = Mg/ A N/m^2	Strain = l/L	Y =Stress/Strain
			Load			Unload			Mean TR				
			MSR	CSR	TR	MSR	CSR	TR					
1													
2													
3													
4													
5													
6													
Mean of Young's Modulus (Y) =													

XII. Result

Standard value of Young's modulus of given metallic wire	Young's modulus by Experiment	Young's modulus by Graph

XIII. Interpretation of results

……

……

……

XIV. Conclusions and Recommendations

……

……

……

XV. 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 Hooke's law?
2. If Area of the wire is increases, then what will be the effect on Young's modulus?
3. If mass attached to the wire is made 2 times heavier, then what will be the effect on young's modulus?
4. Why do we have to wait for some time after adding or removing of weight to the wire?
5. If material of wire change, then young's modulus of wire change or not. give reason.

Space to write answers

XVI. References / Suggestions for further Reading

1. https://amrita.olabs.edu.in/?sub=1&brch=5&sim=155&cnt=4
2. https://youtu.be/xASsYJo3zrM?si=n61dF23C5XV33rht

XVII. Suggested Assessment Scheme

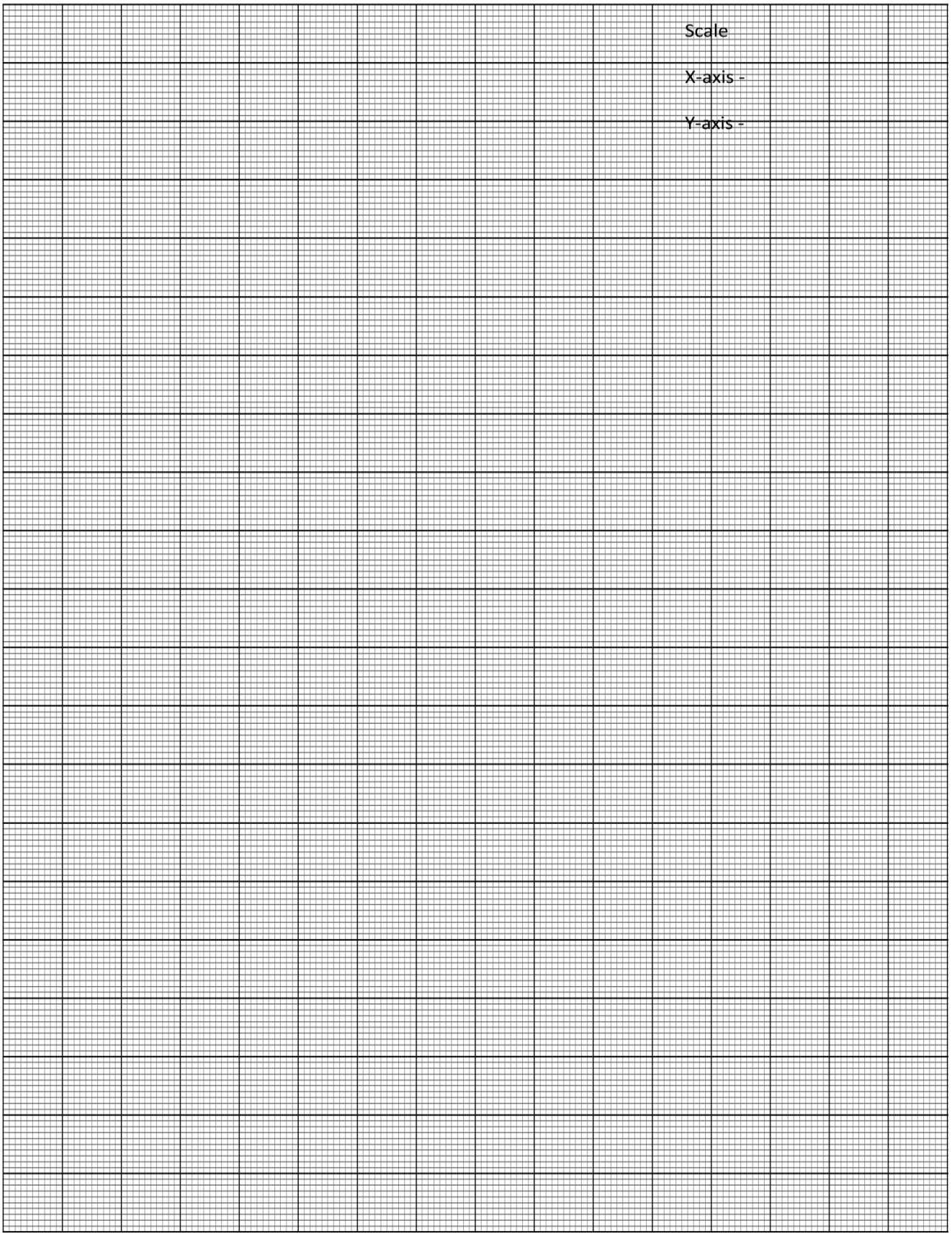
The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related: 15 Marks		**60%**
1	Handling of the instrument	5
2	Determination of Least Count (L.C.) of instrument	5
3	Determination of Area of cross section of wire	10
4	Determination of Young's modulus of wire	20
5	Plotting graph	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
Total (25 Marks)		**100%**

Name of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 3: Determination of relationship between angle of Inclination and download force using inclined plane

I. Practical Significance

The force laws, the force laws, together with the laws of motion, are the foundations of classical mechanics. They are based on experimental observations and were formulated more than three centuries ago by Isaac Newton (l642-l 727).

An inclined plane, also known as a ramp, is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. The inclined plane is one of the six classical simple machines defined by Renaissance scientists. Inclined planes are widely used to move heavy loads over vertical obstacles; examples vary from a ramp used to load goods into a truck, to a person walking up a pedestrian ramp, to an automobile or railroad train climbing a grade.

Moving an object up an inclined plane requires less force than lifting it straight up, at a cost of an increase in the distance moved. The mechanical advantage of an inclined plane, the factor by which the force is reduced, is equal to the ratio of the length of the sloped surface to the height it spans. Due to conservation of energy, the same amount of mechanical energy (work) is required to lift a given object by a given vertical distance, disregarding losses from friction, but the inclined plane allows the same work to be done with a smaller force exerted over a greater distance

II. Industry / Employer Expected outcome(s)

The aim of this course is to attain industry/ employer expected outcome through various teaching learning experiences.

III. Course Level Learning outcome(s)

Select relevant material in industry by analyzing its physical properties.

IV. Laboratory Learning Outcome

Use of inclined plane to find the downward force.

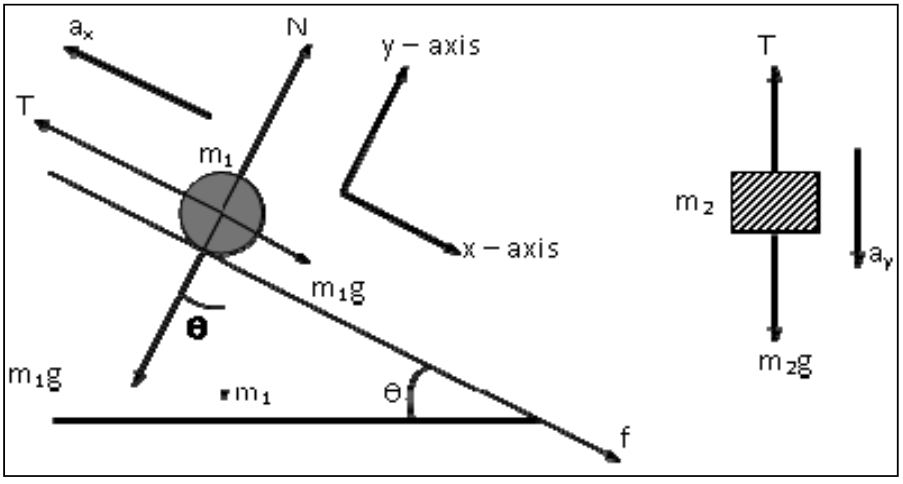
V. Relevant Affective domain related Outcome(s)

a. Follow safe practices.

b. Demonstrate working as a leader/a team member.

c. Follow ethical practices

VI. Relevant Theoretical Background



If total weight W_1 - m_1g moves the body up and total weight W_2 - m_2g makes the body move down, then downwards force acting on the body along the inclined plane is

$$W = \frac{W_1 + W_2}{2} = \frac{(M_1 + M_2)}{2} g$$

This force must be equal to mg sinθ

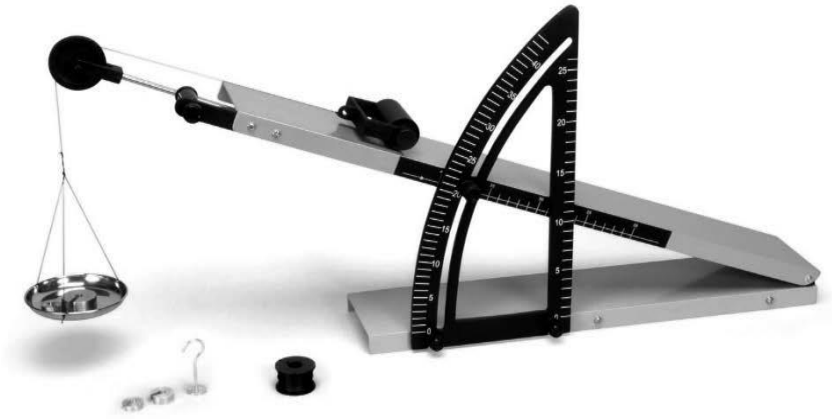
1.e $W = mg \sin\theta$

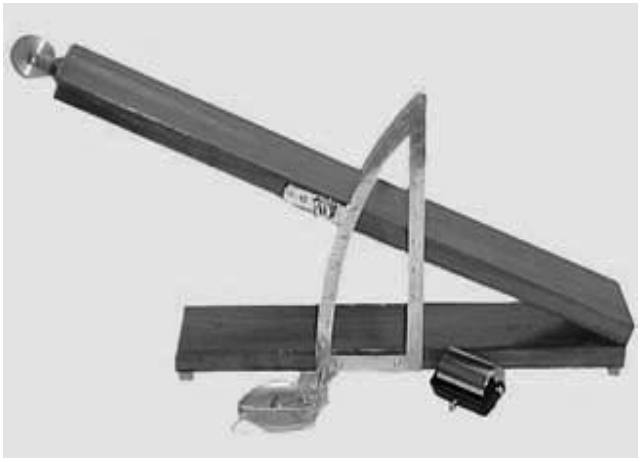
For the same body m is a constant.

So $W \alpha \sin\theta$

If a graph is plotted between W (along Y axis) and sinθ (along X axis).then it is a straight line.

VII. Actual Circuit diagram/ Experimental setup used in Laboratory with equipment specifications:





VIII. Required Resources/ apparatus/equipment with specifications:

An inclined plane, A trolley or roller, pan, weight box, spring balance spirit level, strong thread, half meter scale

IX. Precautions

1. Pulley should be friction less.
2. Base should be stable and horizontal.
3. Thread should not touch the board or table.
4. Inclined surface should be clean, dry and smooth (use glass top).
5. Weights in pan should be increased or decreased in small steps.
6. Weights should be noted only when the roller just starts moving up or moving down.

X. Procedure

1. Test the pulley of the inclined plane and see that is free from friction. Oil it, if necessary.
2. Keep the apparatus on the table with the slot portion of the base beyond the edge of the table.
3. Make the base of inclined plane horizontal (test by spirit level) and make it stable (by putting paper pieces if necessary).
4. Bring the inclined plane to horizontal position (touching the base). The angle of inclination is now zero (as indicated by protractor).
5. Find the weight of the roller by a spring balance and place it on the inclined plane in the middle.
6. Tie one end of a thread to the roller placed on the inclined plane and pass it over the pulley.

7. Pass the thread through the slot in base.
8. Find the weight of the pan by the spring balance and tie it to free end of thread, keeping the thread free from board.
9. Raise the inclined plane and fix it at an angle of 30°· The roller may start rolling down with acceleration.
10. Put weights on pan and increase them till the roller just starts moving upward with uniform velocity only on tapping. Note the total weights in pan.
11. Remove some small weights from weights in the pan till the roller just starts moving downward with uniform speed only on tapping. Note the total weights in pan.
12. Increase the angle of inclination in steps of 5° each, making it 35°, 40°, 45°, 50°, 55°
and 60° and repeat steps 10 and 11.

XI. Observations and Observation Table

1. Least count of spring balance=……g wt.
2. Zero error of spring balance (e) =……g wt.

3. Zero correction of spring balance (c) = (±e) =……g wt.
4. Observed weight of the roller (w0) =……g wt
5. Corrected weight of the roller (w=mg) = (w0+ c) =……g wt.
6. Observed weight of the pan (po)=……g wt.
7. Corrected weight of the pan (p)= (po+ c) =……..g wt

Tables for angle of inclination and weights in pan

Sr. No	Angle of inclination (θ) {degree)	sinθ	w sinθ = mg sinθ	Weight in pan when roller moves		Total weight when roller moves		Force acting on roller downward	Error
				Upward Wt (gwt)	Downward W2 (g wt)	Upward W1= W1+p (gwt)	Downward W2= W2+p (gwt)	W= (W1+W2)/2	W- mg sinθ
1	**30**								
2	**35**								
3	**40**								
4	**45**								
5	**50**								
6	**55**								

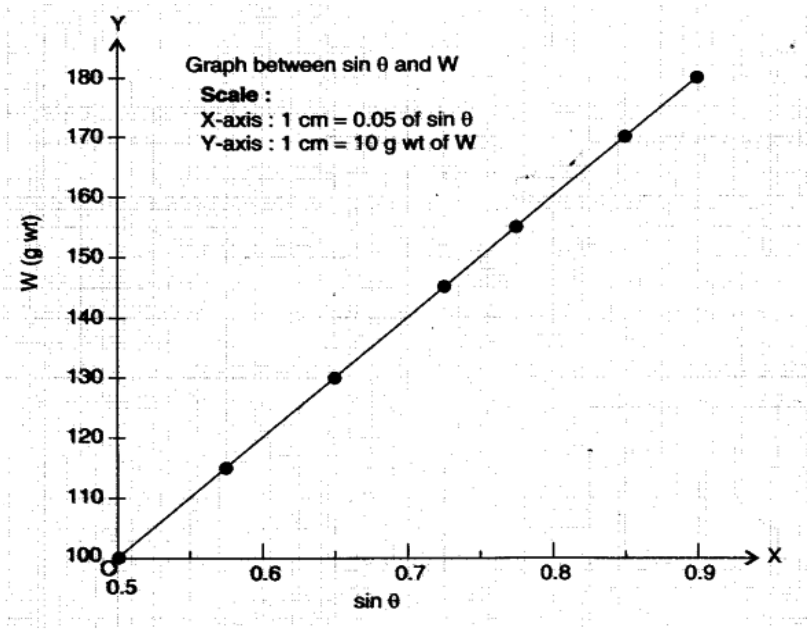


Fig. Graph between sin θ and *W*. It is a straight line.

XII. Result

Downwards force on the body of weight W = mg on an inclined plane is mg sinθ
The graph between Wand sinθ is a straight line, i.e. W a sinθ

XIII. Interpretation of Results.

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XIV. Conclusion and Recommendations

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XV. Practical Related Questions.

1. What is inclined plane?
2. What is the relation between downward force and angle of inclination of the plane?
3. What is the normal reaction on the inclined plane?
4. Why is the glass plate fixed on an inclined plane?


Scale
X-axis -
Y-axis -

Space to write answers:

XVI. References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=WZTbz-fL6bM
2. https://youtu.be/Axv5m7E0hkc?si=eL_S9INRiE7cGnDT

XVIII. Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1.	Arrangement of inclined plane in horizontal position	10
2.	Least count and zero error of spring balance and measurement of weights	10
3.	Accuracy in measurement of W_1 and W_2	10
4.	Measurement of □ and calculation of sin□	10
5.	Team spirit	20
Product Related : 10 Marks		**40 %**
1.	Timely submission and neatness	10
2.	Interpretation of result	10
3.	Conclusions and Recommendations	10
4.	Practical related questions	10
Total (25 Marks)		**100 %**

Name of Student Team Members

1. .....
2. .....
3. .....
4. .....

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

Practical No. 4: Determination of range of Projectile

I. Practical Significance

A particle moving under the combined effect of vertical and horizontal forces is called a projectile. A projectile is any object that is given an initial velocity and then follows a path determined entirely by gravitational acceleration. Regardless of whether you're launching a balloon, a baseball, or an arrow, all projectiles follow a very predictable path, making them a great tool for studying kinematics.

II. Industry / Employer Expected outcome(s)

The aim of this course is to attain industry/ employer expected outcome through various
teaching learning experiences.

III. Course Level Outcomes

Select relevant material in industry by analyzing its physical properties

IV. Laboratory Learning Outcome(s)

Use projectile motion to find the range from initial launch speed and angle

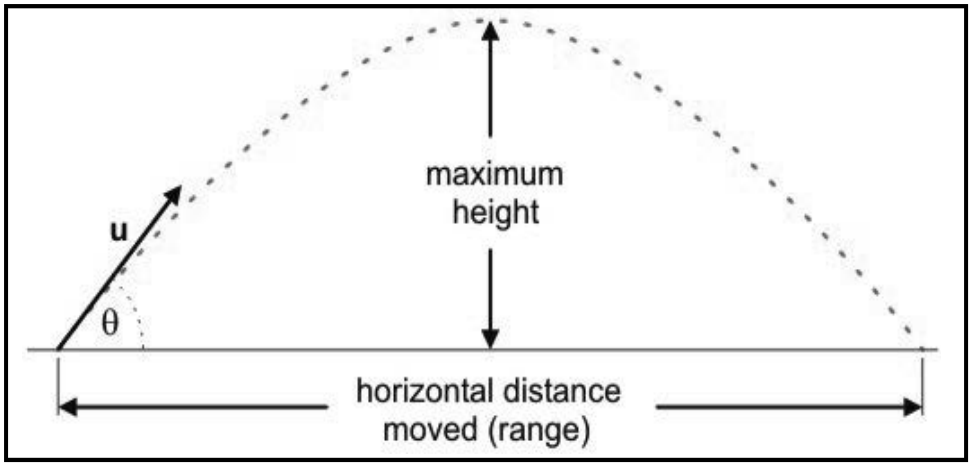
V. Relevant Affective Domain Related Outcomes

a) Follow safe practices
b) Demonstrate working as a leader/ a team member
c) Follow ethical practices

VI. Relevant Theoretical Background

Projectile motion is a predictable path travelled by an object that is influenced only by the initial launch speed, launch angle, and the acceleration due to gravity.

The following terms are commonly used in projectiles:



1. Trajectory. It is the path traced by a projectile in the space.

2. Velocity of projection. It is the velocity with which a projectile is projected.
3. Angle of projection. It is the angle with the horizontal at which the projectile is Projects.
4. Range. It is the distance between the point of projection and the point where the projectile strikes the ground.
5. Time of Flight

$$T = \frac{2V \sin\theta}{g}$$

6. Maximum height reached,

$$H = \frac{V^2 sin^2\theta}{2g}$$

7. Horizontal Range,

$$R = \frac{V^2 \sin 2\theta}{g}$$

Where

the initial velocity is v

- the component of v along
- the y-axis is v sinθ the
- component of v along the
- x-axis is v cosθ

VII. Actual Circuit diagram/Experimental setup used in Laboratory with equipment specifications:

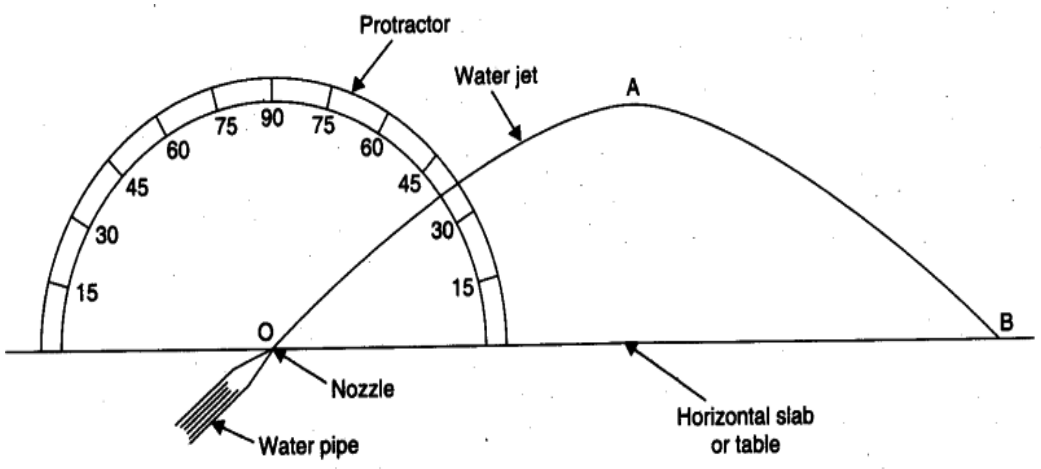


Fig. Range of a water jet.

VIII. Resources required

A ply board, protractor with radius of about 30cm and mark 0° - 90° with an interval of 15° each, a 10 m long measuring tape. A constant level reservoir under pressure (a tap connected to a tank or water supply line), a water pipe with a metallic nozzle (narrow opening).

IX. Precautions

1. Throughout the experimental procedure don't change the setting of the water jet.
2. Jet should be thin in order to give fine point of fall.

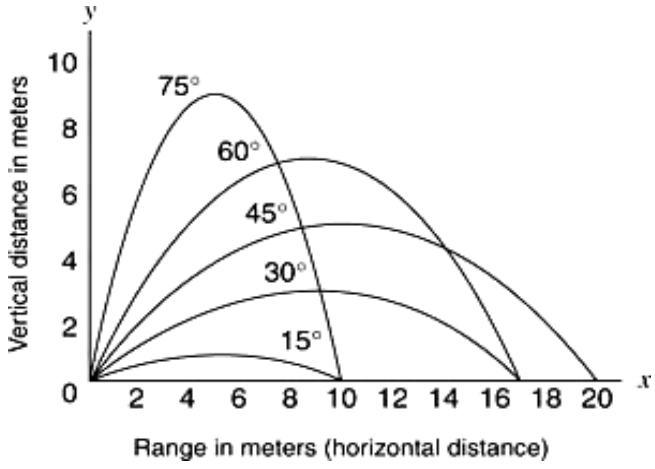
X. Procedure

1. Arrange a constant level of water reservoir at one end of a horizontal slab of the laboratory.
2. Connect a water pipe with the outlet of the reservoir and insert a metallic nozzle in th other end of the pipe held in hand.
3. Open the water tap and check that there is no leakage of water (remove if it is there).
4. Fix the protractor in a slot in a horizontal base to make its plane vertical and graduated surface vertical towards yourself.
5. Place the nozzle at the center O of the protractor and falls back on the slab at some distance.
6. The jet moves along a parabola and falls back on the slab at some distance.
7. Set the water tap such that the distance is few meters.
8. Ask your laboratory bearer to make a mark Bl on the slab where the jet falls.
9. Change the angle to 15°, 30°, 45°, 60° and 75° and repeat Step 8 to get marks B_2, B_3, B_4 and B_5 (Do not change the setting of water tap otherwise it will change the velocity of jet).
10. Measure distances OB1, OB2, OB3, OB4 and OB_5 by the measuring tape. These distances give range R for different angles (and same velocity).
11. Record your observations in the table as given below.

XI. Observations and Calculations:

a) Table for Range and Angle of Projection:

Sr. No.	Angle of Projection of water jet (in degree)	Range of water jet (m)
1		OB1
2		OB2
3		OB3
4		OB4
5		OB5



XII. Result

a. Range is maximum/minimum for the angle of projection of 45°

XIII. Interpretation of Result:

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XIV. Conclusions and Recommendations:

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XV. Practical Related Questions

1. What is Projectile Motion?
2. What is the velocity of projection
3. What is range of projection and how it changes with the angle of projection??
4. A body is projected with a velocity of 40 *mis* at an angle of 45° with horizontal surface, what will be the range of projection?


Scale
X-axis -
Y-axis -

[Space to write answers]

XVI. References/suggestions for further reading

https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_all.html

XVII. Suggested Assessment scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Arrangement of Water reservoir with jet pipe	20
2	Water reservoir Velocity adjustment	20
3	Team spirit	20
Product Related : 10 Marks		**40 %**
1	Timely submission and neatness	10
2	Interpretation of result	10
3	Conclusions and Recommendations	10
4	Practical related questions	10
Total (25 Marks)		**100 %**

Name of Students Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 5: Determination of force constant using Helical Spring

I. Practical significance

Hooke's Law states that the force needed to compress or extend a spring is directly proportional to the distance you stretch it. As an equation, Hooke's Law can be represented as F = kx, where F is the force we apply, k is the spring constant, in Newton's per meter (N/m) and x is the displacement of the spring from its equilibrium position. The spring constant, k, is representative of how stiff the spring is. Stiffer (more difficult to stretch) springs have higher spring constants

II. Industry / Employer Expected Outcome

The aim of this course is to attain industry/ employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcome(s)

Apply the concept of simple harmonic motion , resonance and ultrasonic sound for various engineering applications.

IV. Laboratory Learning Outcome(s)

Use helical spring to find force constant .

V. Relevant Affective Domain Related Outcomes

a. Handle tools and equipment carefully

b. Practice energy conservation.

c. Function as a team leader / a team member

VI. Relevant Theoretical Background

Elasticity is a property of a material which allows it to return to its original shape or length after being distorted. Some materials are not at all elastic - they are brittle and will snap before they bend or stretch. Others, like rubber, for example, will stretch a long way without significant warping or cracking. This is because the materials contain long chain molecules that are wrapped up in a bundle and can straighten out when stretched. The spring constant is a number that represents how much force it takes to stretch a material --

materials with larger spring constants are stiffer. The helical spring, is the most commonly used mechanical spring in which a wire is wrapped in a coil that resembles a screw thread. It can be designed to carry, pull, or push loads. Twisted helical (torsion) springs are used in engine starters and hinges. Helical spring works on the principle of Hooke's Law. Hooke's Law states that within the limit of elasticity, stress applied is directly proportional to the strain produced.

i.e. **Stress α Strain**

$$\frac{Stress}{Strain} = Constant$$

When a load 'F' is attached to the free end of a spring, then the spring elongates through a distance 'l'. Here 'l' is known as the extension produced. According to Hooke's Law, extension is directly proportional to the load.

This can be represented as

F α l

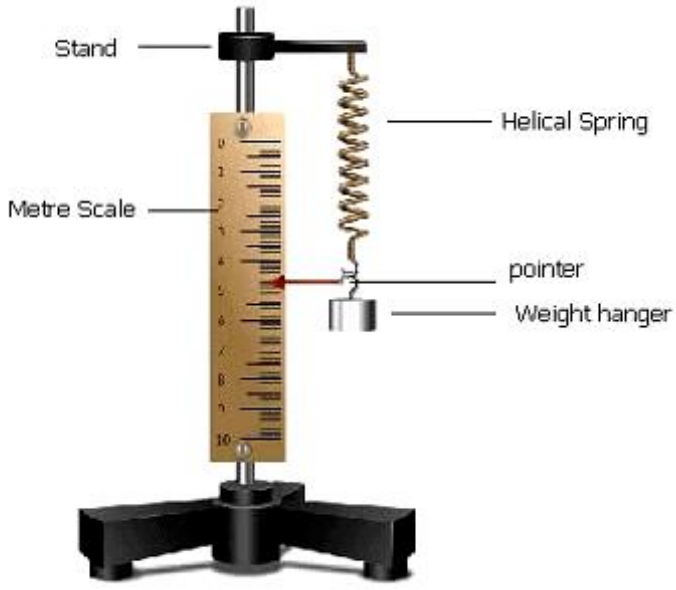
F = kl

Where 'k' is constant of proportionality. It is called the force constant or the spring constant of the spring. A graph is drawn with load M in kg wt along X axis and extension, l in metre along the Y axis. The graph is a straight line whose slope will give the value of spring constant, k

Formula to find the Force constant is; $T = 2\pi \sqrt{M/K}$; i.e.

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

VII. Circuit diagram/ Experiment set-up /Work Situation:



VIII. Resources Required

Sr. No.	Instrument/Object	Specification	Quantity
1	Meter Scale		1
2	Weight Hanger		1
3	50g to 500g slotted weights		1 each
4	Fine Pointer		1

IX. Precautions

1. Loading and unloading of weight must be done gently.
2. Reading should be noted only when tip of pointer comes to rest.
3. Pointer tip should not touch the scale surface.
4. Loading should not be beyond elastic limit.

X. Procedure

1. Suspend the spring form a rigid support. Attach a pointer and a hook form its lower fee end (as shown in the diagram above).
2. Attach a load of M gm at end hook of the helical spring.
3. Set the vertical wooden scale such that the tip of the pointer comes over the divisions on the scale but does not touch the scale.
4. Note the reading of the position of the tip of the pointer on the scale.

5. Wait for few minutes till the pointer tip comes to rest
6. Now gently move the spring so that it starts oscillating.
7. Note the time taken (T1) for 20 oscillations.
8. Repeat the same procedure to note time taken as T2.
9. Find the mean Time period (T sec) and hence calculate the value of T2 sec2.
10. Calculate the value of Force Constant K.
11. Repeat the same procedure by adding 50 gm weights and complete the observation table.
12. Find the value of Mean K.
13. Plot a graph of Mass suspended M kg verses Time period T2 sec2
14. Calculate the slope and hence calculate the value of the Force constant K.
15. Compare the value of Force constant by experiment and from graph.

XI. Observation table/Calculations

Sr.No.	Load in the hanger = Applied Force F = Mass suspended M (Kg)	Position of the Pointer tip (Extension) (cm)	Time for 20 Oscillations		Mean Time Period T (sec)	Time Period T^2 (sec2)	Force constant $K= 4\Pi^2M/ T^2$
			t_1 (sec)	t_2 (sec)			
Mean force constant (K) =……..N/m							

XII. Result:

Value of force constant K by experiment =…….. N/m

Value of force constant K by grapht =…… N/m

XIII. Interpretation of Results

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XIV. Conclusions and Recommendations

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XV. 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. Define Hooke'law?
2. State the formula and unit of force constant?
3. If mass attached to the spring is made 2 times heavier. How many times the period of oscillation changes?
4. Why do we have to wait for some time after adding or removing of weight to the spring?
5. Which law is used in the movement of a helical spring?

a) Pascal's law b) Gravitational Law c) Newton's Law d) Hooke's Law

Space to write answers

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XVI. References/suggestions for further reading

https://youtu.be/bTrWGt7X6bM?si=XtEnk5Xgu7onLGJf

XVII. Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	10
4	Plotting graphs	10
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Students Team Members

1. ……
2. ……
3. ……
4. ……

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


Scale
X-axis -
Y-axis -

Practical No. 6: Determination of Velocity of sound using Resonance Tube Method

I. Practical Significance

In industry, phenomenon of resonance is used in variety of applications such as manufacturing musical instruments, Constructing big halls or auditorium, in ultra sonography in silencer of a vehicle in automobile industry, Resonating circuits, filters, loud speakers etc. in electronic industry .Resonance phenomena occur with all types of vibrations or waves such as mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) Resonant systems can be used to generate vibrations of a specific frequency (e.g., musical instruments), or pick out specific frequencies from a complex vibration containing many frequencies (e.g., filters). Resonance occurs widely in nature in many manmade devices. Sound waves are produced by the compression of a substance by vibrations caused by objects such as vocal cords, guitar strings, organ pipe, loud speaker etc. A resonance frequency exists when a system is driven by its natural frequency. Pendulums and swings demonstrate only one natural frequency. In this experiment the principle of resonance is utilized to determine the velocity of a sound wave in air using resonance tube method.

II. Industry / Employer Expected Outcome

The aim of this course is to attain industry/ employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcome

Apply the concept of simple harmonic motion , resonance and ultrasonic sound for various engineering applications.

IV. Laboratory Learning Outcome

Use resonance tube method to determine velocity of sound.

V. Relevant Affective domain related Outcomes

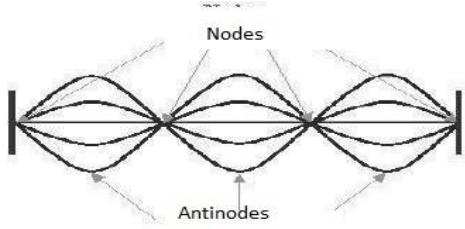
a. Handle tools and equipments carefully.

b. Practice energy conservation.

c. Function as a team member.

VI. Relevant Theoretical Background.

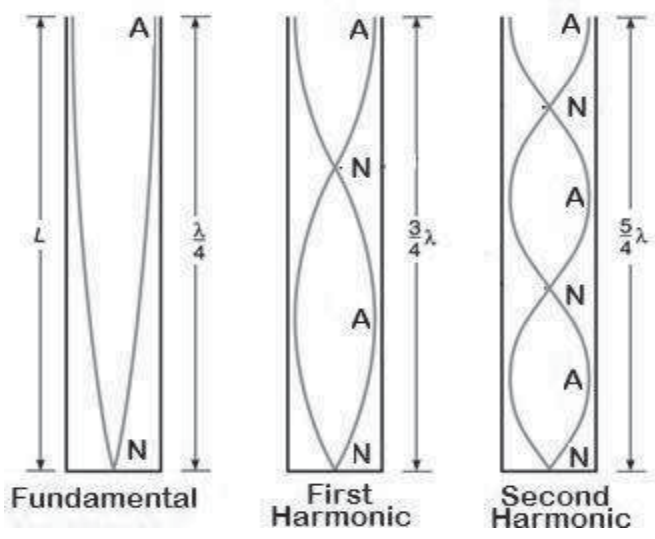
2.Stationary waves



Stationary waves are produced by the superposition of two waves of same frequency and amplitude travelling with same velocity in opposite directions. Due to the constructive interference, these waves produce certain fixed points along the medium which undergo zero displacement. These points of no displacement are known as nodes. Midway between every nodes are regions of maximum displacement. These points are called antinode.

1. Reflection of sound at the end of closed tube

When a tube enclosing a column of air is excited by resonant vibrations produced by a tunning fork placed over the mouth of the tube, a stationary wave system is set up formed due to the superposition of direct waves and the reflected waves at the end of the tube. The node is formed at the lower fixed end and the antinode is just above the open end of the tube. This distance is considered as end correction (e) in the resonating length of air column



Production of longitudinal stationary waves in air column

Standing waves can be formed in a tube of air due to the interference of longitudinal sound waves travelling in opposite directions. In a pipe closed at one end, the closed end is a displacement node and the open end is a displacement antinode.

2. Resonance

It is a phenomenon in which the natural frequency of a body becomes equal to the frequency of externally applied force (force frequency) and the body starts vibrating with maximum amplitude

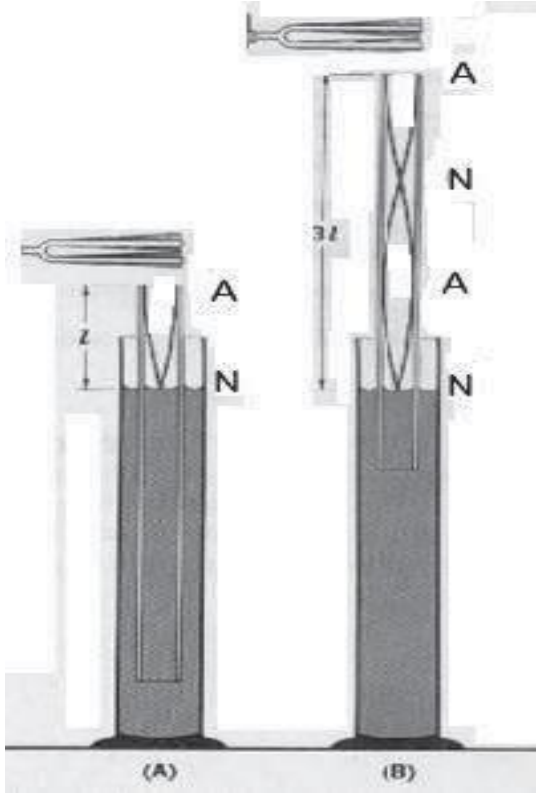
3. About Resonance column apparatus

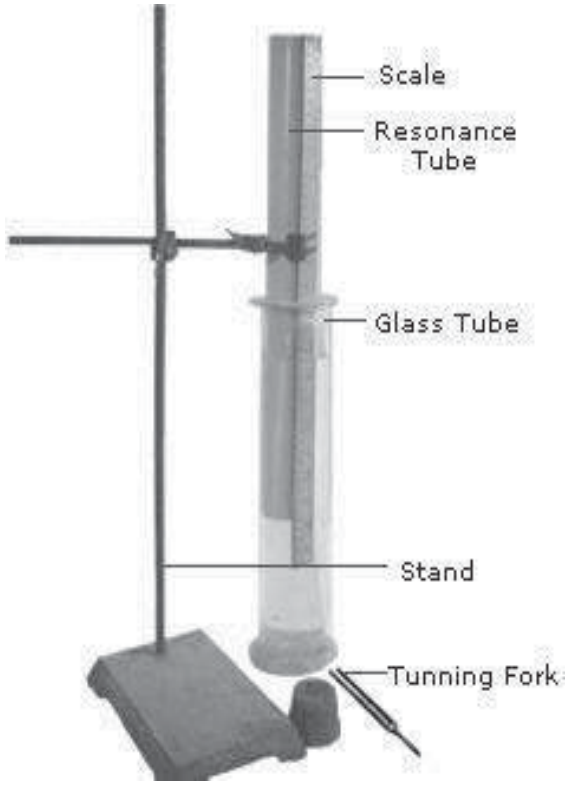
Vibration of air column can be set up in a resonance column apparatus. It consists of along metal tube held vertically in a tall jar containing the water. The tube can be fixed in vertical position. The length of the air column can be varied by raising or lowering the tube.

Here, the surface of water will act as the closed end. When a vibrated tuning fork is held above the open end, longitudinal waves are sent down the air column. These waves are reflected at the water surface and thus produce standing waves. Nodes are produced at the water surface and antinodes are produced at the open end.

When the frequency of waves in the air column becomes equal to the natural frequency of tuning fork, a loud sound is produced in the air column. It is the condition for resonance. It occurs only when the length of air column is proportional to one- fourth of the wavelength of sound waves having frequency equal to frequency of tuning fork.

VII. Actual diagram used in Laboratory with equipment specifications





VIII. Resources required

Sr. No.	Instrument/Object	Specifications	Quantity
1	Resonance column apparatus		**1**
2	Tuning forks of known frequency		5
3	Rubber hammer		**1**

IX. Precautions

Sources of error for this experiment may consist of mistaking overtones as resonance and therefore including overtones in the data. Another source of error could include missing points of resonance and therefore not including resonance points into the data. Furthermore, the length of the air column could have been incorrectly interpreted when holding the tuning fork above the air column and adjusting the length of the air column.

X. Procedure

1. Measure the inner diameter of the resonance tube using a Vernier caliper.
2. Calculate the end correction 'e'.
3. Take the tuning fork of a particular frequency; note the frequency in the observation table.
4. Hit the tuning fork on the rubber pad so that it produces forced frequency.
5. Place the vibrating tuning fork on top of the resonance tube, so that the air molecules vibrate and produce the natural frequency.
6. Move the resonance tube up and down and find the position of the resonance, the position where the natural frequency is equal to forced frequency.
7. Resonance is the position where we hear a loud sound.
8. Note the vibrating length from the surface of the water till the end of the tube as 'l'.
9. Calculate the corrected length as L = **1** + e
10. Repeat the same procedure for three times so as to reduce the error.
11. Now repeat the same procedure for five different frequencies of tuning fork
12. Complete the observation table and calculate the Velocity of sound usmg the formula.
13. Plot the graph of n Vs 1/L and find the velocity of sound by graph.
14. Compare the result from observation and graph.

XI. Observations and Calculations (Part 1)

i. Least count of Vernier caliper L.C. =---------- cm

ii. Calculate Diameter (d) of resonance tube

iii. End Correction e= 0.3d =---------- cm

iv. Calculate velocity of sound:

Obs. No.	MSR cm	VSD	VSR=VSD x L.C cm	TR = MSR + VSR cm	Diameter cm	Average diameter of resonance tube cm
1						
2						
3						

Part (2)

Obs. No.	**Frequency Of tuning fork (n) Hz**	**Length of air column**			**Mean *l* cm**	**Resonating Length L=*l*+e (cm)**	1 / L	**Velocity V = 4nL (cm/s)**
		***l*1 cm**	***l*2 cm**	***l*3 cm**				
1								
2								
3								
4								
5								

Calculations

Velocity of sound in air at room temperature

V= _____cm/s =_____ m/s

Graph: plot graph of frequency (n) against 1/L

XII. Results

1) Velocity of sound in air at room temperature= ----------m/s by experiment.
2) Velocity of sound in air at room temperature =----------m/s by graph.

XIII. Interpretation of results

……

……

XIV. Conclusions and Recommendations

……

……

XV. 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 type of vibrations produced in the air column in resonance tube.
2. State the purpose of obtaining resonating length in the experiment.
3. State the effect of increase in frequency on resonating length of air column.
4. Explain the effect on resonating position if water is replaced by kerosene oil in this experiment.
5. The velocity of sound in air at 30°C is 351.45 mis. Calculate the velocity of sound in air at O degree Celsius.

Space to write answers

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XV. References / Suggestions for further Reading

1. https://youtu.be/lEq-ShFTAbY?si=5iEejEbEX9IxG_RM

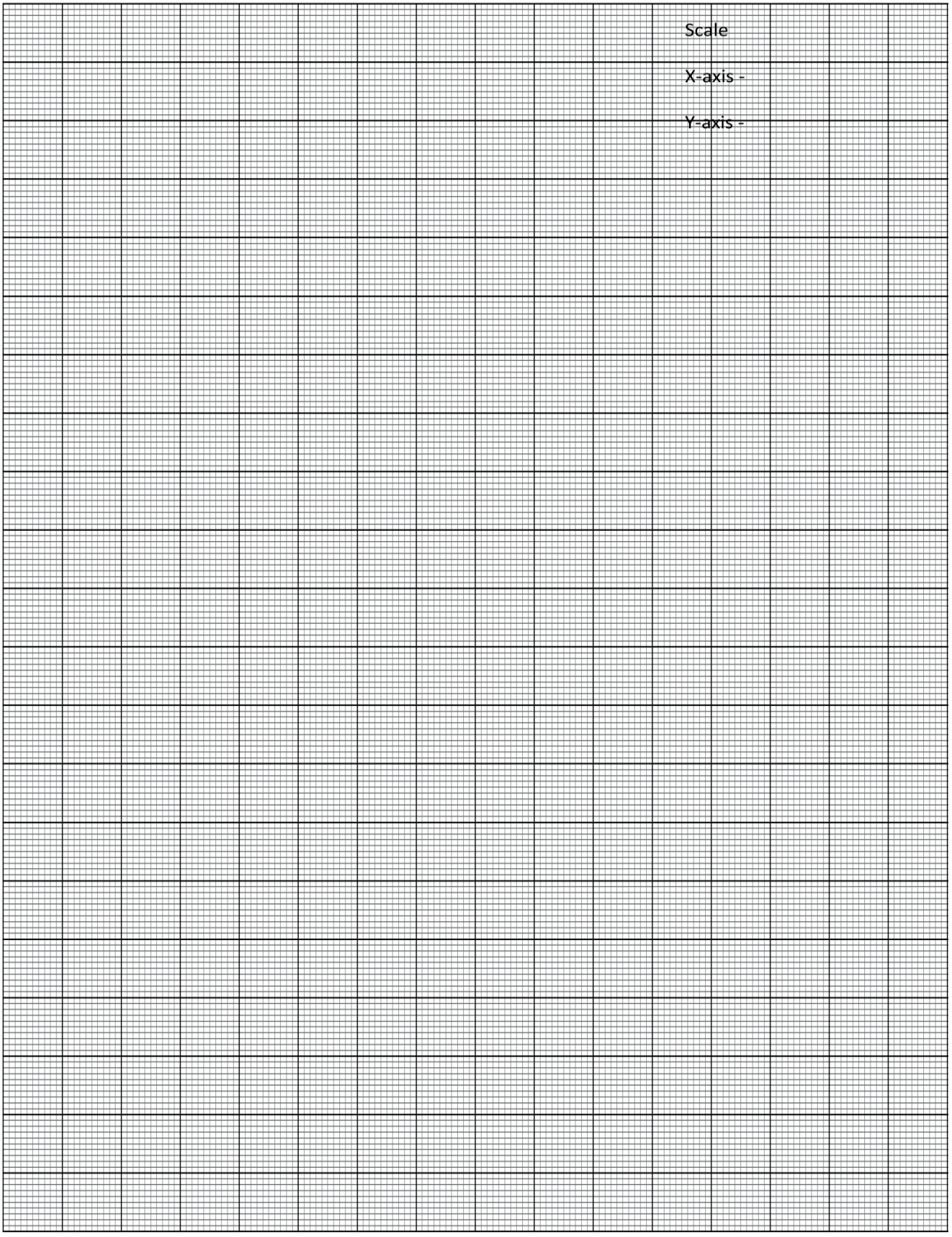
XVI. Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instrument	10
2	Performing Part I	20
3	Performing Part II	20
4	Plotting Graphs	10
Product related: 10 Marks		**40%**
5	Timely submission and Neatness	20
6	Conclusions & Recommendations	10
7	Practical related questions	10
	Total (25 Marks)	

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

Name of Student Team Members

1. **……**
2. ……
3. ……..
4. ……


Scale
X-axis -
Y-axis -

Practical No:- 07 Determination of acceleration due to gravity by using simple pendulum

I. Practical Significance :

The simple pendulum consist of small sphere of mass, which is attached or concentrated at the end of the string. If the sphere is then pulled back from its equilibrium position and then released, it will exhibit Simple Harmonic Motion. (S.H.M.). If the force acting on an oscillating object is always directed towards the equilibrium position, the oscillation is called simple harmonic motion. In this experiment you will study the relation between the period of a pendulum and its length. Also you will determine acceleration due to gravity using the simple pendulum.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME:

The aim of this course is to attain industry/ employer expected outcome through various teaching learning experiences.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Apply the concept of simple harmonic motion, resonance and ultrasonic sound for various engineering applications.

IV. Laboratory Learning Outcome (LLO)

Use simple pendulum to find acceleration due to gravity.

V. Relevant Affective domain related Outcomes:

a. Handle tools and equipment carefully
b. Practice energy conservation.
c. Function as a team leader / a team member

VI. Relevant Theoretical Background :

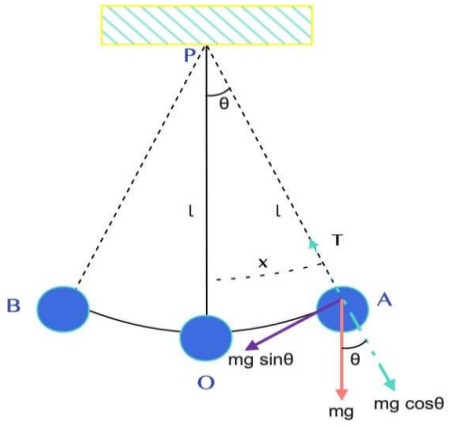
A pendulum is a device made of a weight suspended from a pivot so that it can swing freely. When a pendulum is displaced sideways from its resting, equilibrium position, it is subject to a restoring force due to gravity that will accelerate it back toward the equilibrium position. When released, the restoring force acting on the pendulum's mass causes it to oscillate about the equilibrium position, swinging back and forth. The time for one complete cycle, a left swing and a right swing, is called the period. The period depends on the length of the pendulum and also to a slight degree on the amplitude, the width of the pendulum's swing.

The period of swing of a simple gravity pendulum depends on its length, the local strength of gravity, and to a small extent on the maximum angle that the pendulum swings away from vertical, θ_0, called the amplitude. It is independent of the mass of the bob. If the amplitude is limited to small swings the period T of a simple pendulum, the time taken for a complete cycle, is

$$T \approx 2\pi \sqrt{\frac{L}{g}}$$

Where L is the length of the pendulum and is the acceleration due of gravity.

VII. Experimental Setup



VIII. Resources required :

Sr. No.	Instrument/Object	Specification	Quantity
1	A Clamp With Stand		1
2	Cotton thread		1
3	Metalic bob with hook		1
4	Stopwatch/stopclock		1
5	Meter scale		1

IX. Precautions:

a) Thread should be very light and strong.
b) The point of suspension should be reasonably rigid.
c) Determination of time for 20 or more oscillations should be carefully taken and repeated for at least three times.

X. Procedure :

1. Take the thread for the experiment.
2. Take a metallic bob.
3. Calculate weight of the bob.
4. Attach the bob to the thread.
5. Distance between rigid support and the bob is 30 cm.
6. Move the bob from equilibrium position i.e. at certain distance from the position equilibrium. It will oscillates.
7. Take the readings of time for 20 oscillations.
8. Increase the length by 10 cm of the thread and take more readings with different lengths..
9. Calculate the time period for each length of the thread.
10. Calculate the value of T^2.
11. Finally calculate the l/T^2 of each reading.
12. Values of the l/T^2 is nearly same.
13. Plot the graph of l vs T^2 on the graph paper.

XI. Observations and Calculations:

Sr. No.	Length of the pendulum (*l*) cm	Time for 20 Oscillations			Time period $T = \frac{X}{20}$ sec	T^2 sec.	$g = 4\pi^2 L/T^2$
		I	II	Mean time (X)			

XII. Result:

1. Acceleration due to gravity g (by calculation) =
2. Acceleration due to gravity g (by graph) =

XIII. Interpretation of results:

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XIV. Conclusions and Recommendations

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XV. 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) Define Simple pendulum.
2) State the applications of simple pendulum.
3) State the various precautions while doing practical.

Space for Answers

XVI. References/suggestions for further reading

https://phet.colorado.edu/sims/html/pendulum-lab/latest/pendulum-lab_all.html

XVII. Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	10
4	Plotting graphs	10
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

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

Name of Students Team Members

1. ……
2. ……
3. ……
4. ……

Scale

X-axis -

Y-axis -

Practical No. 8: Determination of distance of object using ultrasonometer.

I. Practical Significance

Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz Ultrasound is used in many different fields. Ultrasonic devices are used to detect objects and measure distances. Ultrasound imaging or sonography is often used in medicine. In the non-destructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning, mixing, and to accelerate chemical processes Scientists are also studying ultrasound using graphene diaphragms as a method of communication.

II. Industry / Employer Expected Outcome(s)

The aim of this course is to attain following industry/employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcome(s)

Apply the concept of simple harmonic motion, resonance and ultrasonic sound for various engineering applications.

IV. Laboratory Learning Outcomes

Use ultrasonic distance-meter to measure distance of object.

V. Relevant Affective Domain Related Outcomes

a. Handle tools and equipment's carefully.
b. Function as a team member.

VI. Relevant Theoretical Background

Ultrasonic sound refers to sound with a frequency greater than the human audible range (20Hz to 20KHz). Ultrasonic can be produced by different methods. The most common methods include mechanical method in this, ultrasonic frequencies up to 100 KHz are produced. But this method is rarely used due to its limited frequency range.

1. **Piezoelectric generator** -In this is the most common method used for the production of ultrasound. When mechanical pressure is applied to opposite faces of certain crystals which are cut suitably, electric fields are produced. Similarly, when subjected to an electric field, these crystals contract or expand, depending on the direction of the field. Thus, a properly oriented rapid alternating electric field causes a piezoelectric crystal to vibrate mechanically. This vibration, largest when the crystal is at resonance, is used to produce a longitudinal wave, i.e., a sound wave.
2. **Magnetostriction generator**: In this method, the magnetostriction method is used for the production of ultrasonic. Frequencies ranging from 8000 Hz to 20,000Hz can be produced by this method. An Ultrasonic sensor is a device that can measure the

distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object

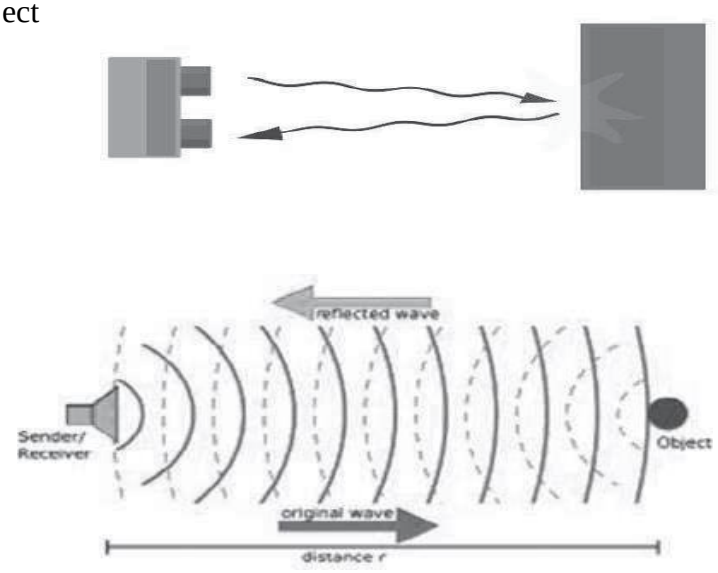
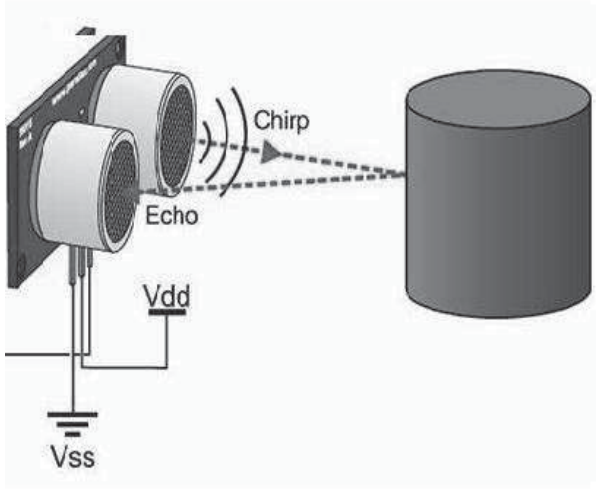


Diagram of the basic ultrasonic sensor operation

Since it is known that sound travels through air at about 340 mis, you can take the time for the sound wave to return and multiply it by 340 meters to find the total round-trip distance of the sound wave. Round-trip means that the sound wave traveled 2 times the distance to the object before it was detected by the sensor; it includes the the sound wave bounced off the object). To find the distance to the object, simply divide the round-trip distance in half.

Distance = (speed of sound × time taken)/ 2

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



VIII. Required Resources/apparats/equipment with specifications

Sr. No.	Instrument/ Object	Specification	Quantity
1	Ultrasonic distance (meter)		1
2	Meter Scale		1

IX. Precautions to be followed

a. Handle the equipment carefully.
b. Do not obstruct the path of the ultrasonic waves.

X. Procedure

1. Connect the mains cord to the Trainer.
2. Switch the power supply.
3. Now select Clock Generator for frequency of 40 kHz at mode
4. Select second switch at “Distance Measurement” mode.
5. Adjust the Threshold Voltage such that the display shows exact reading of distance.
6. Take the reflector plate from the accessories box and hold it with the hands in the ultrasonic range.
7. Move the reflector plat up and down parallel to the ultrasonic sensors (Transmitter and Receiver)
8. Observe the display as it shows the distance (in cm) between the ultrasonic sensors and the object.
9. Note the reading of distance and compare it by taking a meter scale
10. Change the distance of the object from ultrasonic distance meter and note down readings.

XI. Observations and Calculations

Sr.No	Distance measured on ultrasonic distance meter (d1) cm	Distance measured on ultrasonic distance meter(d2) cm	Error = d2 - d1 cm
1			
2			
3			
4			
5			

XII. Result

Distance of object measured by ultrasonometer distance meter = …….. cm

XIII. Interpretation of result

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XIV. Conclusions and Recommendations

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XV. 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. Define ultrasonic waves
2. State properties of ultrasonic wave
3. State four application of ultrasonic waves
4. What is piezoelectric effect?

Space to write answers

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XVI. References/suggestions for further reading

https://youtu.be/3omt4SLVOyM?si=hNSykMplzKpoOwyp

XVII. Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	20
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Student Team Members

1. …….....

2. …….....

3. …….....

4. …….....

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

Parctical No.:-09 Determination of Velocity of Ultrasonic Sound Waves in Different Liquids using Ultrasonic Interferometer

I. Practical Significance

An Ultrasonic Interferometer is a simple and direct device to determine the ultrasonic velocity in. liquids with a high degree of accuracy. The principle used in the measurement of velocity (V) is based on. the accurate determination of the wavelength (λ) in the medium..

II. Industry / Employer Expected Outcome(s)

The aim of this course is to attain following industry/employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcome(s)

Apply the concept of simple harmonic motion, resonance and ultrasonic sound for various engineering applications.

IV. Lboratory Learning Outcomes

Use ultrasonic interferometer to determine velocity of sound.

V. Relevant Affective Domain Related Outcomes

a. Handle tools and equipment's carefully.

b. Practice energy conservation.

c. Function as a team leader / a team member.

VI. Relevant Theoretical Background

In an ultrasonic interferometer, the ultrasonic waves are produced by the piezoelectric method. In a fixed frequency variable path interferometer, the wavelength of the sound in an experimental liquid medium is measured, and from this one can calculate its velocity through that medium. The apparatus consists of an ultrasonic cell, which is a double walled brass cell with chromium plated surfaces having a capacity of 10ml. The double wall allows water circulation around the experimental medium to maintain it at a known constant temperature. The micrometer scale is marked in units of 0.01mm and has an overall length of 25mm. Ultrasonic waves of known frequency are produced by a quartz crystal which is fixed at the bottom of the cell. There is a movable metallic plate parallel to the quartz plate, which reflects the waves. The waves interfere with their reflections, and if the separation between the plates is exactly an integer multiple of half-wavelengths of sound, standing waves are produced in the liquid medium. Under these circumstances, acoustic resonance occurs. The resonant waves are a maximum in amplitude, causing a corresponding maximum in the anode current of the piezoelectric generator. If we increase or decrease the distance by exactly one half of the wavelength ($\lambda/2$) or an integer multiple of one half wavelength, the anode current again becomes maximum. If d is the separation between successive adjacent maxima of anode current, then ,

$$d = \frac{\lambda}{2}$$

We have, the velocity (v) of a wave is related to its wavelength (λ) by the relation,

$v = \lambda f$

, where ***f*** is the frequency of the wave.

Then,

$$v = \lambda f = 2df$$

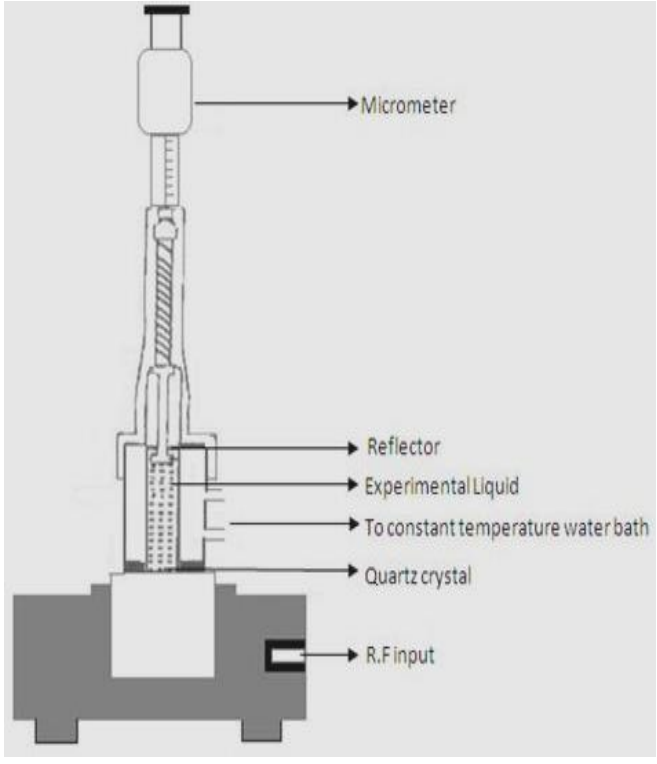
The velocity of ultrasound is determined principally by the compressibility of the material of the medium. For a medium with high compressibility, the velocity will be less. Adiabatic compressibility of a fluid is a measure of the relative volume change of the fluid as a response to a pressure change. Compressibility is the reciprocal of bulk modulus, and is usually denoted by the Greek word beta (β).The adiabatic compressibility of the material of the sample can be calculated using the equation,

$$\beta = \frac{1}{\rho v^2}$$

,

Where ρ is the density of the material of the medium and v is the velocity of the sound wave through that medium.

VII. Experimental Setup:



VIII. Resource required

S.No.	Instrument/object	Specification	Quantity
1.	Ultrasonic inferometer		01
2.	Frequency generator		01
3.	Measuring cell		01
4.	Rectangular cup containing test liquid		01
5.	Piezoelectric crystal		01
6.	Kerosene, water and CCl_4		01

IX. Precautions to be followed

1. Note that not to switch on the generator without filling the experimental liquid in the cell.
2. Note that remove experimental liquid out of cell after use to keep it clean and dry.
3. Note that keep micrometer open at 25mm after use.
4. Note that generator should be given a time of 15 min for warming up before the observation (interferometer).
5. Note that experimental liquid should be removed out of cell after use and keep the cell clean and dry

X. Procedure

1. From the combo box Choose medium, select the desired experimental liquid.
2. Using the slider Frequency of wave, set the frequency of the ultrasonic sound used.
3. A lower frequency will give a longer wavelength, which is easier to measure accurately.
4. Switch ON the frequency generator using the Power on button.
5. Adjust the GAIN and ADJ knobs such that the ADJ value is greater than GAIN value.
6. At this micrometer setting the ammeter will show a maximum. Do not record the micrometer reading at this maximum. It could be inaccurate because the first maximum should be at zero and the micrometer cannot be set to zero.
7. In the simulator, right and left arrows are provided to increase or decrease the micrometer distance.
8. Increase the micrometer setting till the anode current in the ammeter shows a new maximum. (After the first few clicks, if you click and hold the arrow, the micrometer setting will increase continuously. A single click increases it by a small increment.) Note down the micrometer reading at the new maximum. Stop when you have recorded micrometer readings for 10 or more maxima.
9. The distance between the adjacent maxima is calculated. From the equations, one can calculate the velocity of sound waves through the medium and also the adiabatic compressibility of the liquid can be calculated.

XI. Observation table:

For liquid 1

Number of oscillations	PSR (mm)	HSC div	TR (mm)	Distance between two maxima (d) (mm)	$\lambda = 2d$ (m)	V= 2df m/s

For liquid 2

Number of oscillations	PSR (mm)	HSC div	TR (mm)	Distance between two maxima	$\lambda = 2d$ (m)	V= 2df m/s

XII. Result

The velocity of ultrasonic waves for given liquid (1) is ---------- m/s

The velocity of ultrasonic waves for given liquid (2) is ---------- m/s

XIII. Interpretation of result

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XIV. Conclusions and Recommendations

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……

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XV. 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 principle of ultrasonic interferometer
2. Explain the working of ultrasonic interferometer

Space to write answers

XVI. Reference / Suggestions for further Reading

https://youtu.be/sMSvVSRhTfg?si=VtRNnlZ_Q5ffqSWH

XVII. Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	20
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Student Team Members

1. ……
2. ……
3. ……..
4. ……....

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

Practical No: 10 : Determination of the dependence of the stopping potential on the frequency of given light source. (Virtual Lab)

I. Practical Significance

In industry different types of light sensors such as photocell and photo diodes are used in manufacturing and other industrial applications. A light sensor is a device that is used to detect light. Computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen. Barcode scanners used in retailer locations work on light sensor technology. The light sensor enables a robot to detect light. Photocell is used in auto Flash for camera, in industrial process control and headlight dimmer. Photocells are used in television camera to reproduce sound recorded on films, in counting devices, in burglar and fire alarms, to control the temperature in chemical reactions and to determine the Planck's constant.

II. Industry / Employer Expected Outcome(s)

The aim of this course is to attain following industry/employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcome(s)

Apply the concept of modern physics (X-rays, Laser, Photosensors and Nanotechnology) for various engineering applications.

IV. Laboratory Learning Outcomes

Use photo electric cell to find dependence of the stopping potential on the frequency of given light source.

V. Relevant Affective Domain Related Outcomes

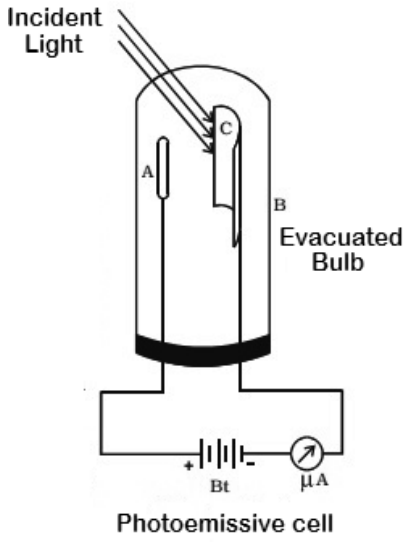
a. Handle tools and equipment's carefully.
b. Practice energy conservation.
c. Function as a team leader / a member.

VI. Relevant Theoretical Background

1) Photocell: The photoelectric cell is a device which converts light energy into electrical energy. The photo electric cells are of three types:

1. Photo emissive cell
2. Photo voltaic cell and
3. Photo conductive cell etc.

It consists of a highly evacuated bulb B made of glass or quartz. A semi cylindrical metal plate C connected to the negative terminal of a battery, acts as cathode. This plate is coated with a low work function material such as cesium oxide, in order to get large number of photo electrons. A thin platinum wire A is connected to the positive terminal of the battery and kept along the axis of the metal plate C and this serves as the anode as shown in Figure above.



When a light of suitable wave length falls on the cathode, photo electrons are emitted, which are attracted by the anode A. The resulting current is measured by a micro ammeter. The current produced by this type of cell is proportional to the intensity of the incident light for a given frequency.

2) **Stopping Potential:** When we apply a positive potential on the plate placed directly opposite to this metal plate, the plate attracts the negative electrons. A force acts on these electrons and thus they get accelerated towards this plate. So, the more positive potential we apply on this (collector) plate, more rapidly will the electrons flow through the circuit. But if we apply a negative potential on this (collector) plate, the electrons will not approach so easily. Only the electrons with sufficient energy and hence, velocity, will be able to surpass this opposing potential called retarding potential of the (collector) plate. If we keep on increasing this negative (retarding) potential, there will be one point when no more electrons reach this plate and thus, no electron flows through the circuit. Thus, current flow through the circuit stops. This potential applied on the (collector) plate is called as the stopping potential.

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

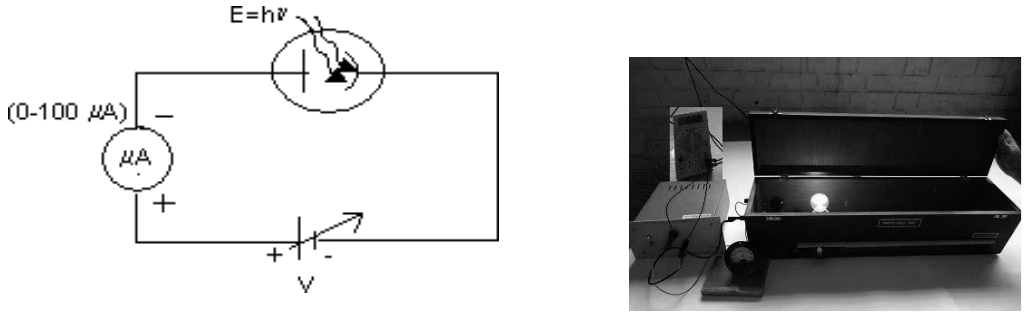


Fig. To determine characteristics of photoelectric cell

VIII. Required Resources/apparats/equipment with specifications

Sr. No.	Instrument/Object	Specifications	Quantity
1	Variable Power supply	Range- 0 to 12V Range-5OO mA	01
2	Micro-ammeter	Range- 0 to 100 µA	01
3	Voltmeter/multi-meter	Range- 0 to 1OV	01
4	Photoelectric cell setup	Photo electric cell and variable light source enclosed in a wooden box	01

Specification of filters

Color	Blue	Green	Yellow	Orange	Red
Wavelength (A^0)	4600	5000	5400	5700	6350
Frequency (Hz) calculate using formula $c = \gamma\lambda$ C = 3 X 10^8 m/s					

IX. Precautions

1. Stray light should be avoided
2. The effect of the reflected light from the bench surface should be minimized.
3. Very sensitive micro ammeter should be used.
4. All electrical Connections should be neat and tight.
5. The pointer of micro ammeter should coincide with zero mark.
6. Check the power supply before connection.
7. Check connection with the help of teacher.

X. Procedure

Part I: **Effect of Frequency on Stopping Potential**

1. Make circuit connections as shown in diagram.
2. Keep applied voltage constant say 2V.
3. Keep light source close to photocell (at constant distance).
4. Calculate the frequency of each color using the formula C=νλ. (Value of 'A is given)
5. To find the stopping potential, give the negative potential and measure the voltage using multi-meter where the current decreases to zero.
6. To find the stopping potential, give the negative potential and measure the voltage using multi-meter where the current decreases to zero
7. Now for various frequencies find the stopping potential (Table **1)**
8. Plot a Graph of stopping potential on (Y-axis) Versus photoelectric frequency on (X-axis)

Part II: Effect of Intensity of light on Stopping Potential

1. Keep intensity of incident light constant. This is done by keeping distance between photocell and light source constant, say d_1 = 10 cm
2. Increase the potential difference across photocell using variable power supply and measure the photoelectric current.
3. Take at least 10 readings.(Table 2)
4. Repeat the same procedure for two more different distances (i.e. d_2 and d_3)
5. Plot a Graph of photoelectric current 'I' on (Y-axis) versus applied voltage 'V' on (X-axis)

XI. Observations and Calculations

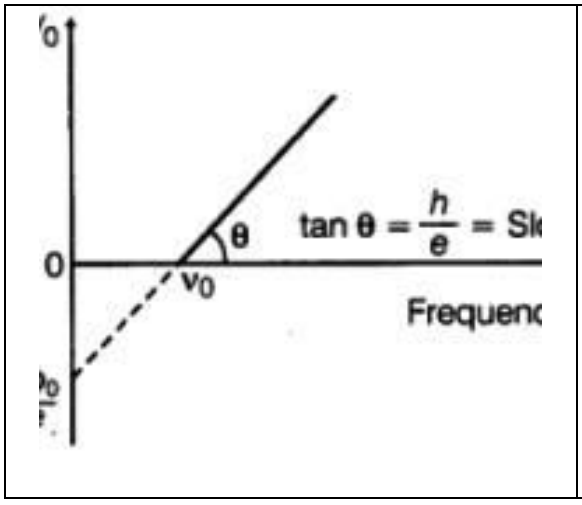
Table 1: Effect of Frequency on Stopping Potential

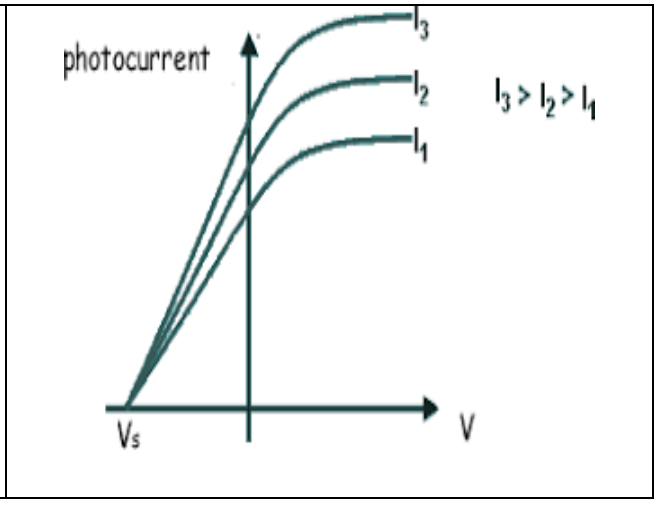
Color	**Blue**	**Green**	**Yellow**	**Orange**	**Red**
Wavelength (A^0)	4600 (Å)	5000 (Å)	5400 (Å)	5700 (Å)	6350 (Å)
Frequency (Hz)					
Stopping Potential (Vs)					

=

Table 2: Effect of Intensity of light on Stopping Potential

Obs. No.	**Distance between Source and Photoelectric cell d_1 = cm**		**Distance between Source and Photoelectric cell** d2 = **cm**		**Distance between Source and Photoelectric cell d_3 = cm**	
	Applied Voltage 'V' (Volt)	**Photoelectric current 'I' (μA)**	**Applied Voltage 'V'** (Volt)	**Photoelectric current** 'I' (μA)	**Applied Voltage 'V' (Volt)**	**Photoelectric current 'I' (μA)**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						





XII. Result

1. The stopping potential ..... (Increases / decreases) when the frequency of light source increases
2. In case of photoelectric cell, the stopping potential at all intensities of light(remains constant *I* varies)

XIII. Interpretation Results

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XIV. Conclusions and Recommendation

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XV. 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 applications of photoelectric effect cell.
2. What is the use of optical bench in this experiment?
3. What happens if the photocell is moved away from the source (bulb)?
4. Define Stopping Potential.

Space to write answer

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XVI. References / Suggestions for further Reading

a) Engineering Physics By Gaur & Gupta
b) https://youtu.be/Zh9fCCnimxA?si=xHIBXE0inFaKo8xK

XVII. Suggested Assessment Scheme

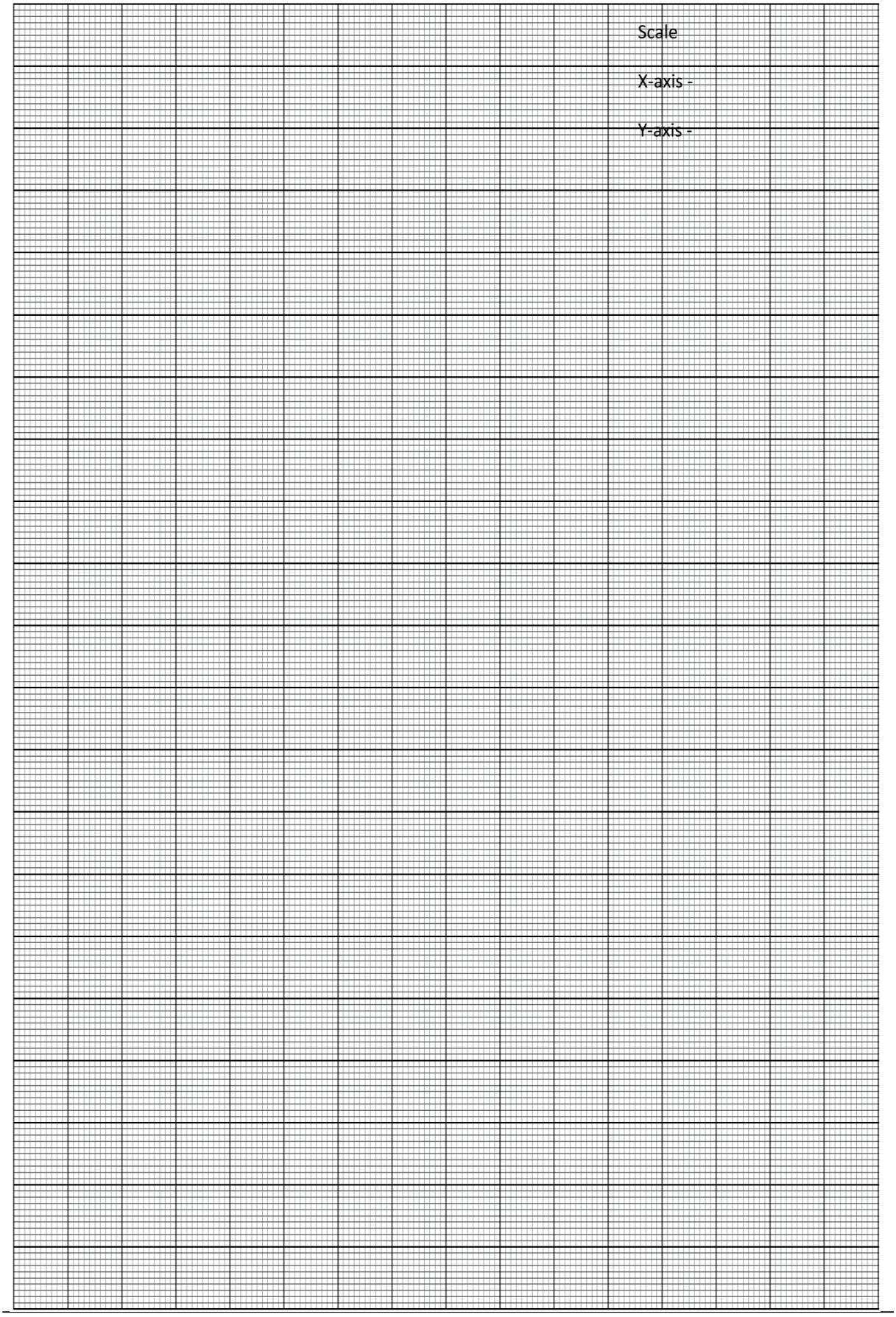
The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	10
4	Plotting graphs	10
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Student Team Members

1. .....
2. .....
3. .....
4. .....

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

Practical No. 11: Determination of I-V Characteristics of Photoelectric Cell

I. Practical Significance

In industry different types of light sensors such as photocell and photo diodes are used in manufacturing and other industrial applications. A light sensor is a device that is used to detect light. Computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen. Barcode scanners used in retailer locations work on light sensor technology. The light sensor enables a robot to detect light. Photocell is used in auto Flash for camera, in industrial process control and headlight dimmer. Photocells are used in television camera to reproduce sound recorded on films, in counting devices, in burglar and fire alarms, to control the temperature in chemical reactions and to determine the Planck's constant.

II. Industry / Employer Expected Outcome(s)

The aim of this course is to attain following industry/employer expected outcome through various teaching learning experiences.

III. Course Level Learning Outcome(s)

Apply the concept of modern physics (X-rays, Laser, Photosensors and Nanotechnology) for various engineering applications.

IV. Laboratory Learning Outcomes

Determine I-V characteristics of the given photo electric cell

V. Relevant Affective Domain Related Outcomes

a) Handle tools and equipment's carefully.

b) Practice energy conservation.

c) Function as a team leader / a member.

VI. Relevant Theoretical Background

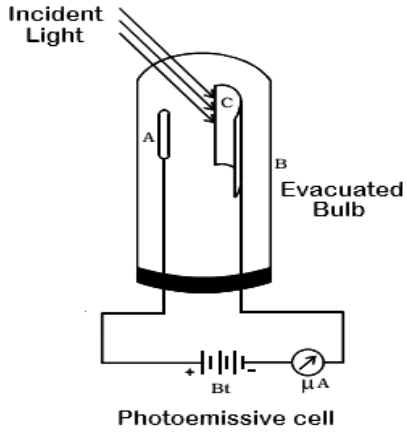
1) Photocell: The photoelectric cell is a device which converts light energy into electrical energy.

The photo electric cells are of three types:

1) Photo emissive cell
2) Photo voltaic cell and
3) Photo conductive cell etc.

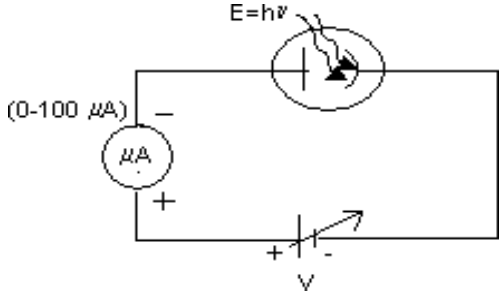
It consists of a highly evacuated bulb B made of glass or quartz. A semi cylindrical metal plate C connected to the negative terminal of a battery, acts as cathode. This plate is coated with a low work function material such as cesium oxide, in order to get large number of photo electrons. A thin platinum wire A is connected to the

positive terminal of the battery and kept along the axis of the metal plate C and this serves as the anode as shown in Figure above.



When a light of suitable wave length falls on the cathode, photo electrons are emitted, which are attracted by the anode A. The resulting current is measured by a micro ammeter. The current produced by this type of cell is proportional to the intensity of the incident light for a given frequency.

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



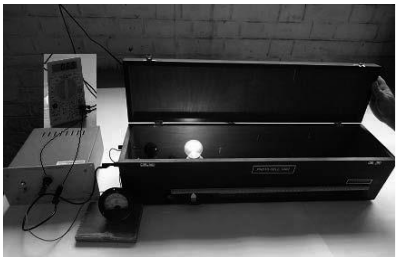


Fig. To determine characteristics of photoelectric cell

VIII. Resources Required

Sr. No.	Instrumentation/ Object	Specification	Quantity	Remark
1	Variable Power supply	Range 0 to 12 V Range 500mA	01	Whichever is available
2	Micrometer	Range 0 to 100μA	01	Whichever is available
3	Voltmeter/multimeter	Range 0 to 10 V	01	Whichever is available
4	Photoelectric cell setup	Photoelectric cell and variable light source enclosed in a wooden box	01	Whichever is available

IX. Precautions

1. Stray light should be avoided.
2. The effect of the reflected light from the bench surface should be minimized.
3. Very sensitive micro ammeter should be used.
4. All electrical Connections should be neat and tight.
5. The pointer of micro ammeter should coincide with zero mark.
6. Check the power supply before connection.
7. Check connection with the help of teacher.

X. Procedure

Part I- Effect of intensity of light on photoelectric current.

1. Make circuit connections as shown in diagram.
2. Keep applied voltage voltage constant say 2V.
3. Keep light source close to photocell.
4. Note value of photoelectric current from microammeter in the observation table.
5. Decrease intensity of incident light by moving light source away from the photocell.This is done by increasing the distance of the light source from the photocell.
6. Record the change in photoelectric current from micro ammeter for equal intervals of the distance.
7. Take at least 10 readings (Table 1)
8. Plot a graph of photoelectric current 'I' on (Y-axis) versus distance 'd' on (X-axis).

Part II-Effect of applied voltage (Plate potential on photoelectric current)

1. Keep intensity of incident light constant. This is done by keeping distance between photocell and light source constant, say 10cm.
2. Increase the potential difference across photocell using variable power supply and measure the photoelectric current.
3. Take at least 10 readings.(Table 2)
4. Plot a graph of photoelectric current 'I' on (Y-axis) versus applied voltage 'V' on (X-axis)

XI. Observations and Calculations

Table 1: Effect of intensity of light on photoelectric current. (When Voltage is kept Constant)

Sr. No	Distance d in cm	Photoelectric current I (Microampere) µA
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 2: Effect of Voltage on photoelectric current. (When Intensity of light is Constant)

Sr. No	Applied Voltage 'V' Volt	Photoelectric current I μA
1		
2		
3		
4		
5		
6		
7		

XII. Result

Nature of graph from observation table 1 is ……..

Nature of graph from observation table 2 is ……..

XIII. Interpretation of Results

a) In case of photoelectric cell, photoelectric current increases with…….(increase / decrease) in intensity of light.

b) In case of photoelectric cell, Photoelectric current ..... (increase/ decrease) with increase in applied voltage.

XIV. Conclusions and Recommendations

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XV. 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. Which of the following instrument makes use of photoelectric effect?
   Television receiver, Television camera, Cathode ray oscilloscope, radar.
2. What is the use of optical bench?
3. What happens if the photocell is moved away from the source (bulb)?

Space to write answers

XVI. References / Suggestions for further Reading

a) Engineering Physics By Gaur & Gupta
b) https://www.youtube.com/watch?v=zYWcPzxytTQ
c) https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=4

XVII. Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

	Performance Indicators	Weightage
	Process Related: 15 Marks	**60%**
1	Handling of the instrument	10
2	Performing Part I	15
3	Performing Part II	15
4	Plotting graphs	20
	Product Related : 10 Marks	**40%**
1	Timely submission of reports	5
2	Neatness	5
3	Interpretation of result from graphs	15
4	Conclusions & Recommendations	5
5	Practical related questions	10
	Total (25 Marks)	**100%**

Name of Student Team Members

1. ……
2. ……
3. ……
4. ……

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


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

Practical No. 12: Determination of I -V characteristics of LDR

I. Practical Significance

In industry different types of light sensors such as photocell/photo resistor and photo diodes are used in manufacturing and other industrial applications. A light sensor is a device that is used to detect light. There are Photo resistor also called as light dependent resistor (LDR). It has a resistor whose resistance decreases with increasing incident light intensity. Computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen. Barcode scanners used in retailer locations work on light sensor technology. Photocell/LDR are widely used in space and robotics for controlled and guided motions of vehicles and robots. The light sensor enables a robot to detect light. Robots can be programmed to have a specific reaction if a certain amount of light is detected. Photocell/LDR are used in auto Flash for camera, in industrial process control and headlight Dimmer.

II. Industry / Employer Expected outcome

The aim of this course is to attain following industry/ employer expected outcome through various teaching learning experiences

III. Course Level Learning Outcomes

Apply the concept of modern Physics (X-rays, LASER, Photosensors and Nanotechnology) for various engineering applications

IV. Laboratory Learning Outcome

Determine I-V characteristics of given light dependent resistor.

V. Relevant Affective domain related Outcomes

a. Handle tools and equipments carefully.
b. Practice energy conservation.
c. Function as a team member.

VI. Relative Theoretical Background

Photoresistor/ LDR: Photo resistor is also called as light dependent resistor (LDR). It has a resistor whose resistance decreases with increasing incident light intensity. It is made of a high resistance semiconductor material, cadmium sulfide (CdS). The resistance of a CdS photo resistor varies inversely to the amount of light incident upon it. Photo resistor follows the principle of photoconductivity which results from the generation of mobile carriers when photons are absorbed by the semiconductor material.

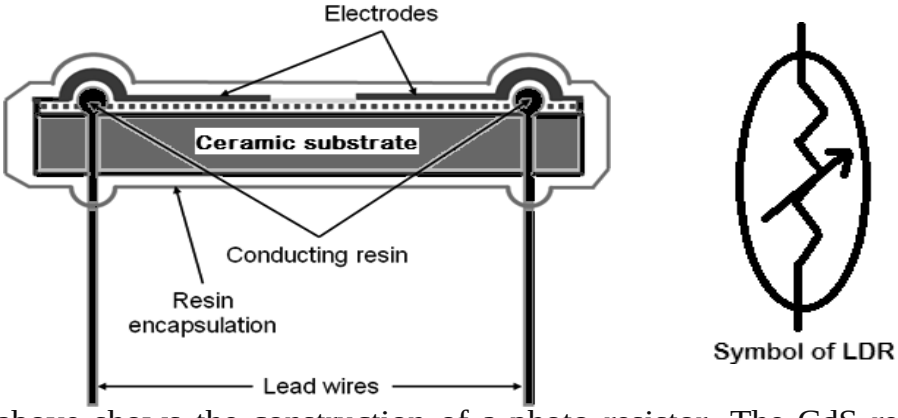


Figure above shows the construction of a photo resistor. The CdS resistor coil is mounted on a ceramic substrate. This assembly is encapsulated by a resin material. The sensitive coil electrodes are connected to the control system though lead wires. On incidence of high intensity light on the electrodes, the resistance of resistor coil decreases which will be used further to generate the appropriate signal by the microprocessor via lead wires. Photo resistors are used in science and in almost any branch of industry for control, safety, amusement, sound reproduction, inspection and measurement.

VII. Actual diagrame used in Laboratory with equipment specifications:

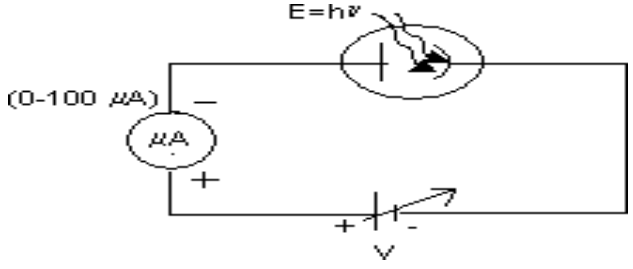


Fig (1) To determine characteristics of photoelectric cell

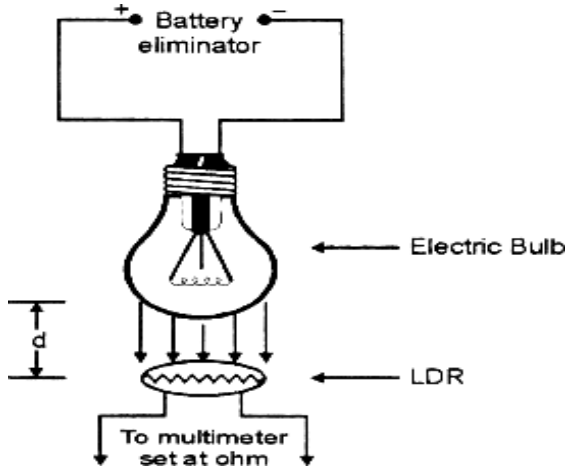


Fig (2) To determine characteristics of LDR

VIII. Resources required

S. No.	Instrument/Object	Specifications	Quantity
1	Variable Power supply	Range- 0 to 12V Range-500 mA	01
2	Microammeter	Range- 0 to 100 μA	01
3	Voltmeter/multimeter	Range- 0 to 10V	01
4	Phoelectric cell setup	Photo electric cell and variable light source enclosed in a wooden box	01
5	Phoresistor cell setup	Photo resistor and variable light source enclosed in a wooden box	01

IX. Precautions

1. Stray light should be avoided.
2. The effect of the reflected light from the bench surface should be minimized.
3. All electrical Connections should be neat and tight.
4. The pointer of micro ammeter should coincide with zero mark.
5. Check the power supply before connection.

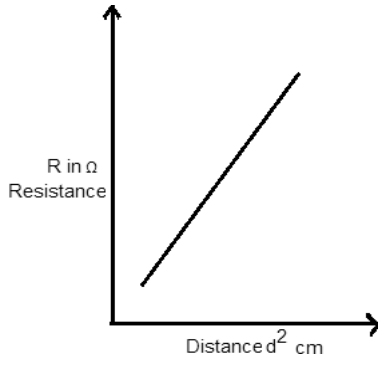
X. Procedure effect of intensity on a Photoresistor/LDR (Light Dependent Resistor)

1. Select the appropriate range of multimeter to measure resistance.
2. Plug the metallic ends of probe at suitable places in multimeter. Adjust zero ohm in multimeter.
3. Keep LDR at distance of 5 or 10 cm from electric bulb.
4. Connect the metallic probes to two metal ends on LDR.
5. Allow light to fall on LDR and read the value of resistance from multimeter.
6. Decrease intensity of incident light by moving light source away from the LDR . This is done by increasing the distance of light source from the LDR.
7. Take 10-12 readings.
8. Plot a graph of R against d^2

XI. Observation table & calculations:

Table : Effect of lntensity of light on resistance of LDR.

Sr. No	Distance of LDR from source of light 'd' in cm	Resistance of LDR 'R' in Ω	Square of distance d^2 in cm
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			



XII. Result

Observation table No	Nature of graph
1	

XIII. Interpretation of results

Resistance of LDR is (directly/Inversely)..... proportional to square of the distance of LDR from the source of light

XIV. Conclusions and Recommendations

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XV. 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. Which of the following instrument makes use of photoelectric effect?
2. Television receiver, television camera, cathode ray oscilloscope, radar.
3. What is the use of optical bench?
4. What happens if the photocell is moved away from the source (bulb)?

Space to write answers

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XVI. References / Suggestions for further Reading

a. Engineering Physics By Gupta
b. https://youtu.be/p0grnUXViNk

XVII. Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related: 15 Marks		**60%**
1	Handling of the instrument	20
2	Making of connection	20
3	Experiment	10
4	Plotting graphs	10
Product Related : 10 Marks		**40%**
1	Timely submission of reports	5
2	Neatness	5
3	Interpretation of result from graphs	15
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Student Team Members

1.……

2.……....

3.……...

4.……

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


Scale
X-axis -
Y-axis -

Practical No. 13: Determination of the Divergence of LASER Beam

I. Practical Significance

Lasers are key tools in manipulating and communicating information (in CD and DVD players, supermarket barcode readers and broadband telecommunications), in measurement (surveying and environmental studies), chemical analysis (of foods, medical specimens and materials) and, increasingly, in transforming.

II. Industry / Employer Expected outcome

The aim of this course is to attain following industry/ employer expected outcome through various teaching learning experiences

III. Course Level Learning outcome

Apply the concept of modern Physics (X-rays, LASER, Photosensors and Nanotechnology) for various engineering applications.

IV. Laboratory Learning Outcomes

Determine the divergence of LASER beam.

V. Relevant Affective Domain Related Outcomes

a. Handle tools and equipment's carefully.
b. Function as a team member.
c. Follow safe practices

VI. Relative Theoretical Background

Laser is an extremely coherent, monochromatic, directional, focusable, polarized and powerful light. These extraordinary features make it greatly applicable in day-to-day life, science and technology. A few notable applications of laser include medical diagnosis and treatments, fibre optic communications, CD- ROMS, CD players, laser printers, defence, cutting, welding, drilling, surveying, aligning etc. Laser is produced due to stimulated radiation; a process where a resonating photon stimulates the de-excitation of an excited atom. This results in to emission of two coherent photons, which are identical in all respects. These photons further stimulate the de-excitation of other excited atoms and this continues to generate an avalanche of coherent photons. For stimulated emission to take over spontaneous emission and stimulated absorption, a few conditions are necessary. These are availability of metastable state (life time ::: 10^{-3} sec), population inversion

(greater number of atoms in metastable state than in lower energy state) and enough number of photons in the cavity (mirrors).

He-Ne laser

He-Ne laser is a low power, continuous gas laser, which is used in supermarket scanners, student laboratories and holography. The active system is neon, which is pumped electronically via helium in a resonant cavity made of discharge tube. The main lasing occurs in neon between the levels E6 (metastable) and E3 which produces an intense coherent beam of red colour (wavelength 6328°). The population of photons necessary for stimulated emission is maintained by mirrors (one is semi-transparent) on both sides. Brewster windows are used to polarize the laser light.

VII. Actual diagram used in Laboratory with equipment specifications:

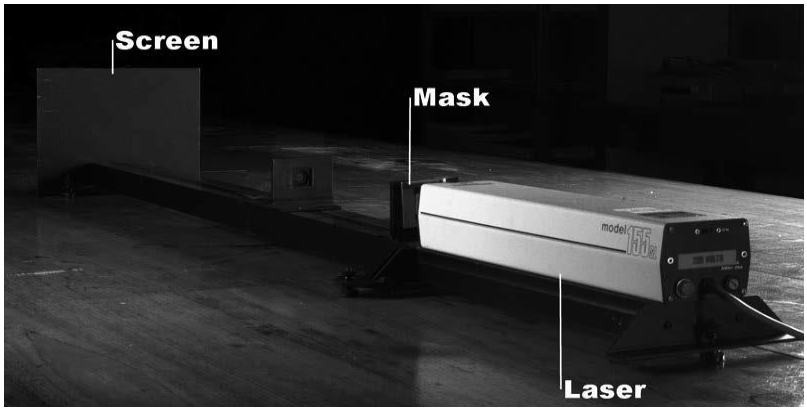


Fig.I. Measurement of Divergence of Laser beam

VIII. Resources Required

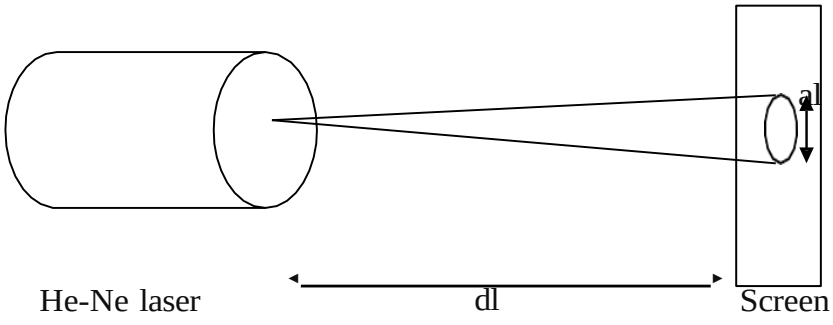
Sr. No.	Instrument/ Object	Specification	Quantity
1	He-Ne kit	Class II	1
2	Card Board (Screen) with white Paper	10 cm × 10 cm	1
3	Meter Scale	1 m	1

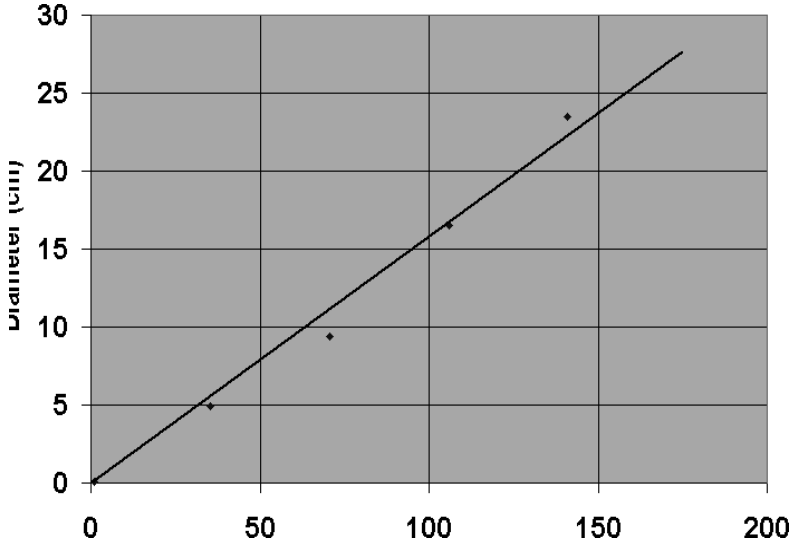
IX. Precautions

1. Handle the equipment carefully.
2. Do not obstruct the path of the LASER beam.

X. Procedure

1. The laser beam from He-Ne is made to fall on the screen which is kept at a distance of dl from the source.
2. Now the position of the screen is altered to a new position d2 from the laser source and again the spot size of the beam is noted by taking horizontal and vertical diameter and their mean is taken as a2.
3. The same procedure is repeated by changing the position of the screen at equal intervals at least 5 times.
4. The readings corresponding to the position of the screen and spot size of the beam is tabulated.
5. From this, the angle of divergence of the laser beam is calculated using the formula <D = (a2-al) / (d2-dl) radian.
6. Plot graph of spot size (a0) vs distance between source and screen (d0).Find slope of the graph.





XI. Observations and Calculations

Sr. No.	Distance between laser beam and screen (d_n) cm	Diameter the spot (Horizontal) cm	Diameter the spot (Vertical) cm	Mean Diameter of the Spot (a_n)	$Ø=(a_n - a_{n-1})/(d_n - d_{n-1})$ radian
1					
2					
3					
4					
5					

Calculations

1. Distance between laser source and the screen (d1) = ...cm
2. Spot size of the laser beam on the screen for distance d1(a1) = ...cm
3. Distance between laser source and the screen (d2) = ...cm
4. Spot size of the laser beam on the screen for distance d2 (a2) = ...cm
5. Angle of divergence of the laser beam, $\phi = (a_2-a_1)/(d_2-d_1)$ radian

XII. Result

1. Angle of divergence of the beam using He-Ne laser by experiment ϕ = ... rad.
2. Angle of divergence of the beam using He-Ne laser by graph (slope) ϕ =..... rad

XIII. Interpretation of result

……

……

XIV. Conclusions and Recommendations

……

……

XV. 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 long form of LASER.
2. State properties of LASER.
3. State four applications LASER.
4. State four types of LASER.

Space to write answers

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XVI. References / Suggestions for further Reading

1. Engineering Physics By Gaur and Gupta.
2. http://vlab.amrita.edu/?sub=1&brch=189&sim=342&cnt=2
3. https://youtu.be/Xaq4YUd6e2E?si=-Ajmjl9aOxnaic2O

XVII. Suggested Assessment Scheme

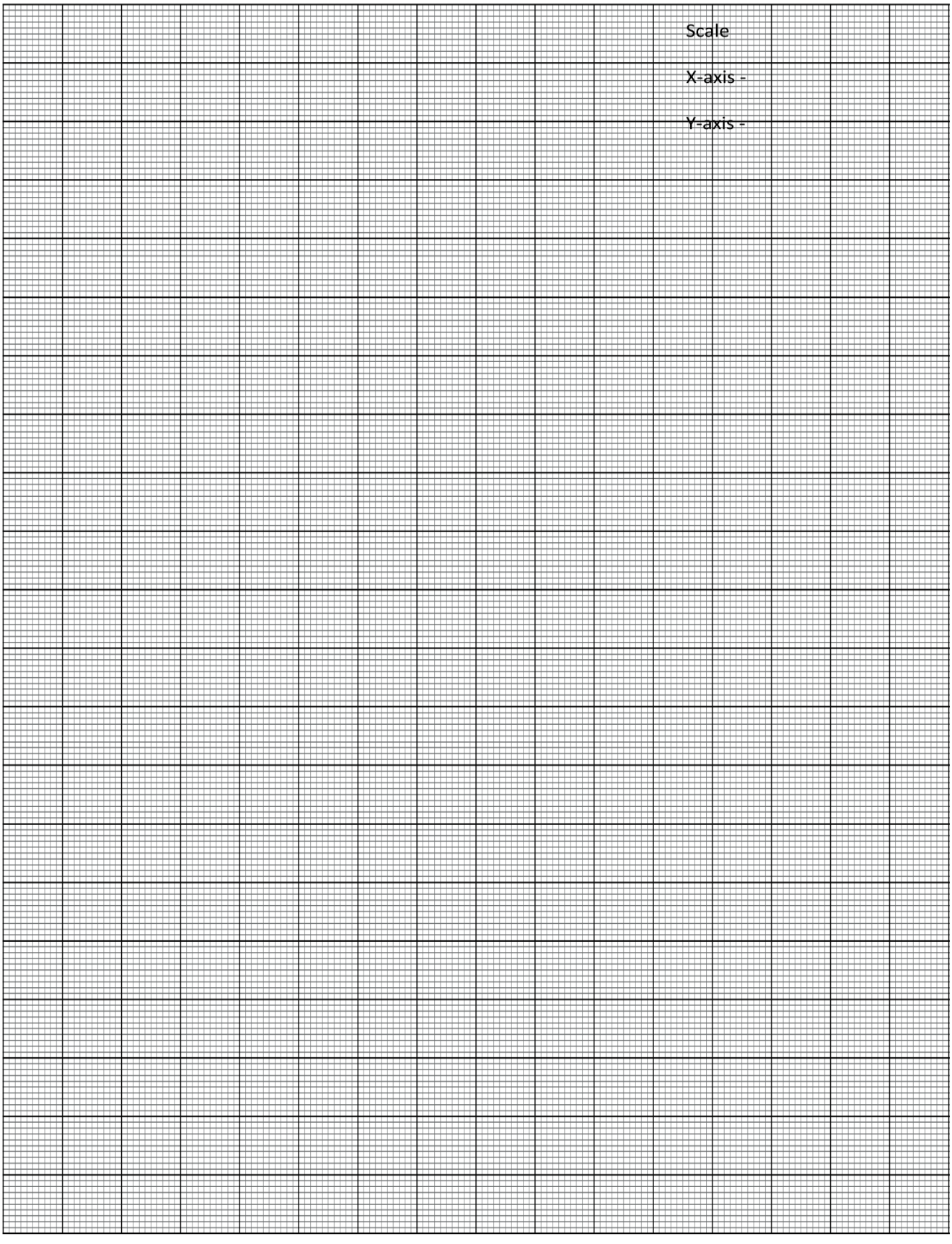
The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	10
4	Plotting graphs	10
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

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

Name of Student Team Members

1. .....
2. .....
3. .....
4. .....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Y-axis -

Practical No. 14 To determine the refractive index of a glass plate using laser beam (Virtual Lab)

I. Practical Significance

When light passes from air into a transparent and denser material such as glass, water or plastic it slows down. If it meets the join between the materials at an angle then it bends – this is called refraction. The light bends towards the normal line so that the angle of refraction is less than the angle of incidence. The amount of bending for a given angle of incidence depends on the material. It is greater for diamond than for glass and greater for glass than it is for water. The mathematics of refraction – Snell's Law. The amount of bending (refraction) depends on a property of the material known as its refractive index. This property connects the angle of incidence (i) with the angle of refraction (r). The law relating these two angles was discovered by Snell in 1621 and is known as Snell's Law.

$$n = \sin i / \sin r$$

The greater the refractive index the more the light refracts. Glass has a refractive index of 1.5, water 1.3 and diamond 2.42. This means that light will bend more when it hits a diamond than it will when it hits a piece of glass of the same shape. It is partly this that makes diamonds sparkle so much.

II. Industry / Employer Expected outcome

The aim of this course is to attain following industry/ employer expected outcome through Various teaching learning experiences.

III. Course Level Learning outcome

Apply the concept of modern Physics (X-rays, LASER, Photosensors and Nanotechnology) for various engineering applications.

IV. Laboratory Learning outcome

Use LASER beam to find the refractive index of glass plate

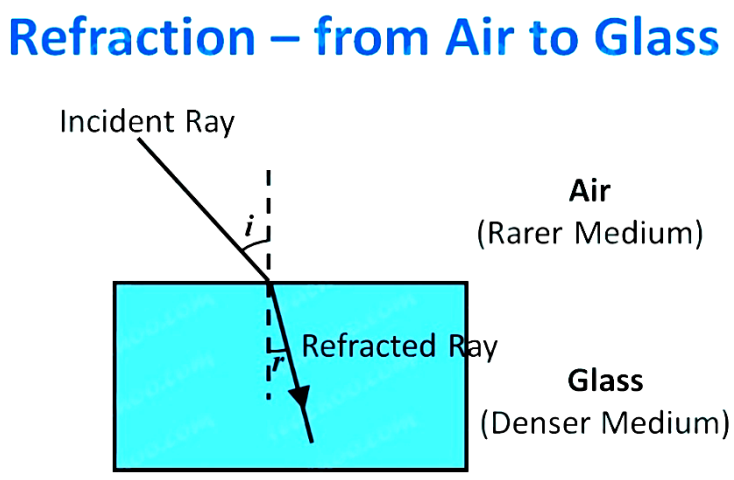
V. Relevant Affective domain related outcomes

a) Handle tools and equipment carefully

b) Function as a team member

VI. Relevant Theoretical background

The index of refraction is a property of transparent substances that has been independently discovered several times, but is attributed to Will board Snellius whose name is associated with the law (you can't make this stuff up). Mathematically, Snell's law describes the relationship between the angle of incidence of a beam of light as it intersects a new transparent medium and the angle of refraction as enters that transparent medium.



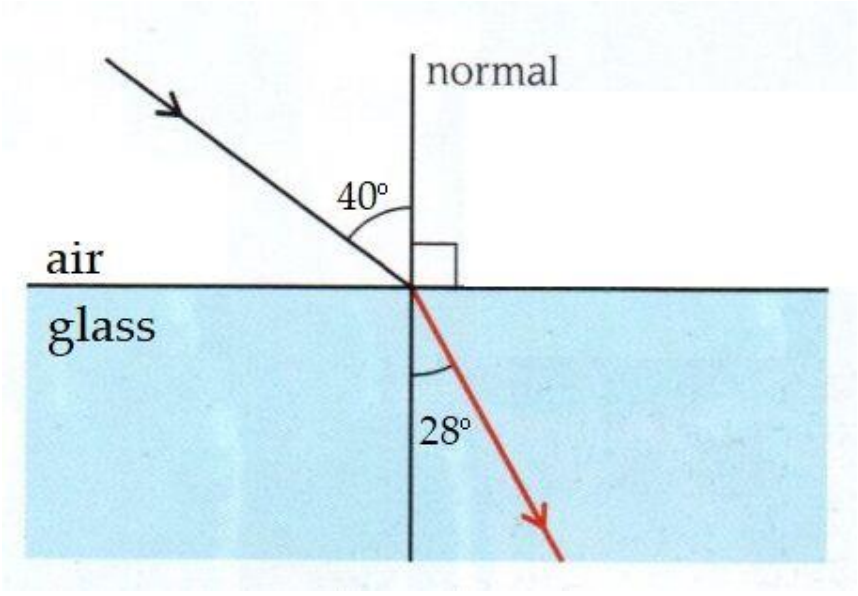
Snell's law quantifies the relationship that is observed in $n1 \cdot \sin \theta 1 = n2 \cdot \sin \theta 2$ where n1 is the index of refraction of medium 1, n2 is the index of refraction medium 2, θ1 is the angle that the light ray makes with respect to the normal in medium 1, θ2 is the angle that the light ray makes with respect to the normal in medium 2. The index of refraction of any medium (ni) is the ratio of the speed of light in vacuum (c) to the speed of light in that medium (vi), as shown in equation

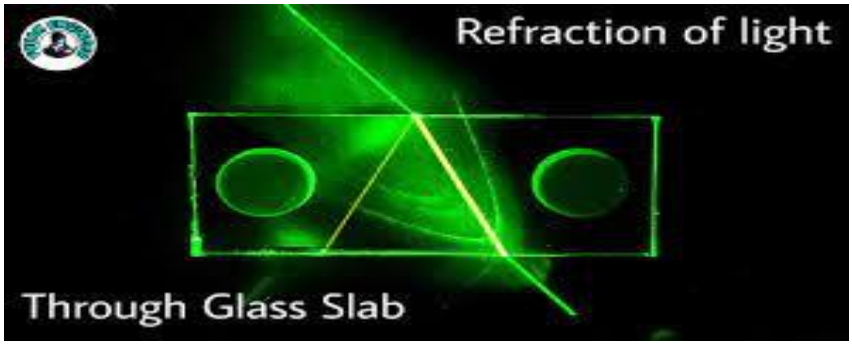
$ni = c\ vi$ where c = 3.00×108m/s (the accepted value for the speed of light in vacuum, a constant

VII. Resourse Required :

Sr. No.	Instrument/Object	Specifications	Quantity
1	White Paper sheet		01
2.	Rectangular glass plate		
3	Ruler/ Scale		**01**
4	Protractor for measuring angles		**01**
5	Laser beam source		**01**

VIII. Actual Experimental set up used in laboratory with equipment specifications





IX. Precautions to be followed

1. Handle the equipment carefully
2. Do not obstruct the path of the LASER .
3. Glass has very sharp edges it can cut your skin very easily .make sure the edges of slab is smooth and polished.
4. Ensure that pins coincide exactly
5. Observe the reading with eye at same level as readings
6. Repeat the experiment six times at different values of incidence.

X. Procedure:

1. Place a rectangular glass plate on the sheet of white paper and draw around a rectangular glass plate of suitable thickness by pencil.
2. At an angle , shine a ray of laser beam through it . trance the incident and emergent ray .
3. Mark the crosses on the paper along the incident and emergent ray by pencil and pin are inserted at each cross so as to determine the laser beam path.
4. Now remove the glass block and use a scale or ruler of 15 cm to mark the incident emergent rays and join the Entry and exit points which are already pinned to show the path beam within the glass plate .

5. Draw the normal at the entry point by pencil
6. Use a protector to measure the angle of incident and angle of refraction
7. Calculate the refractive index using the equation n= sin i/ sin r
8. Repeat the procedure for other required incident angles.

XI. Observation and Calculation :

Sr.No	Angle of incidence (i)	Angle of refraction (r)	Refractive index n = sini/Sinr
1			
2			
3			
4			
5			
6			

XII. Result

1. Refractive index of glass slab using laser beam = ...

XIII. Interpretation of results

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XIV. Conclusions and recommendation

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XV. Practical related questions (Provide space for answers)

1) Define Refractive Index.
2) What will be the refractive index of the medium in which the speed of light is 2.5 $\times 10^8$ m/s?
3) Which among the following is the cause of the twinkling of stars?Give reason

XVI. References/Suggestions for further reading: include websites/links

https://phet.colorado.edu/sims/html/bending-light/latest/bending-light_en.html

Space for answers

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XVII. Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
1	Handling of the instrument	20
2	Proper measurement	20
3	Calculation of parameter concerned	10
4	Plotting graphs	10
Product Related: 10 Marks		**40%**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Student Team Members

1.....

2.....

3.....

4.....

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

Practical No 15: Determination of Wavelength of Helium Neon Laser (Virtual lab)

I. Practical Significance

Laboratory experiment of diffraction grating is used to measure the wavelength of a He-Ne laser. He-Ne laser is preferred because it is more stable (consistent) and more orders may be observed due to its higher wattage. The 633 nm line w is highest gain in the visible spectrum, making this the wavelength of choice for most He-Ne lasers.

He-Ne laser is a gas laser which emits red light having wavelength of **632.8 nm**. It is widely used in scientific research, industrial applications, medical procedures, and communication because of its coherence, stability, and affordability.

II. Industry / Employer Expected Outcome(s):

The aim of this course is to attain following industry/ employer expected outcome through various teaching learning experiences

III. Course Level Learning outcome

Apply the concept of modern Physics (X-rays, LASER, Photosensors and Nanotechnology) for various

engineering applications.

IV. Laboratory Learning outcome

Find the wavelength of given laser.

V. Relevant Affective domain related outcomes

a) Handle tools and equipment carefully

b) Function as a team member

VI. Relevant Theoretical Background

A diffraction grating is an optical element that divides(disperses) light composed of lots of different wavelengths(e.g., white light) into light components by wavelength. The simplest type of grating is one with a large number of evenly spaced parallel slits. It provides angular dispersion, i.e., the ability to separate wavelengths based on the be angle that they emerge from the grating. Gratings can be transmissive, like the multi-slit aperture, but they can also be reflective where the grooved surface is overcoated with a reflectingmaterial such as aluminum.

The formula for diffraction grating**:**

Consider two rays that emerge making the angle θ with the straight through the line. Constructive interference will occur if the difference in their two path lengths is an integral multiple of their wavelength λ i.e.,

Now, $n\lambda = d\sin(\theta)$ where $n = 1, 2, 3, \ldots$ This is known as the DIFFRACTION GRATING EQUATION.

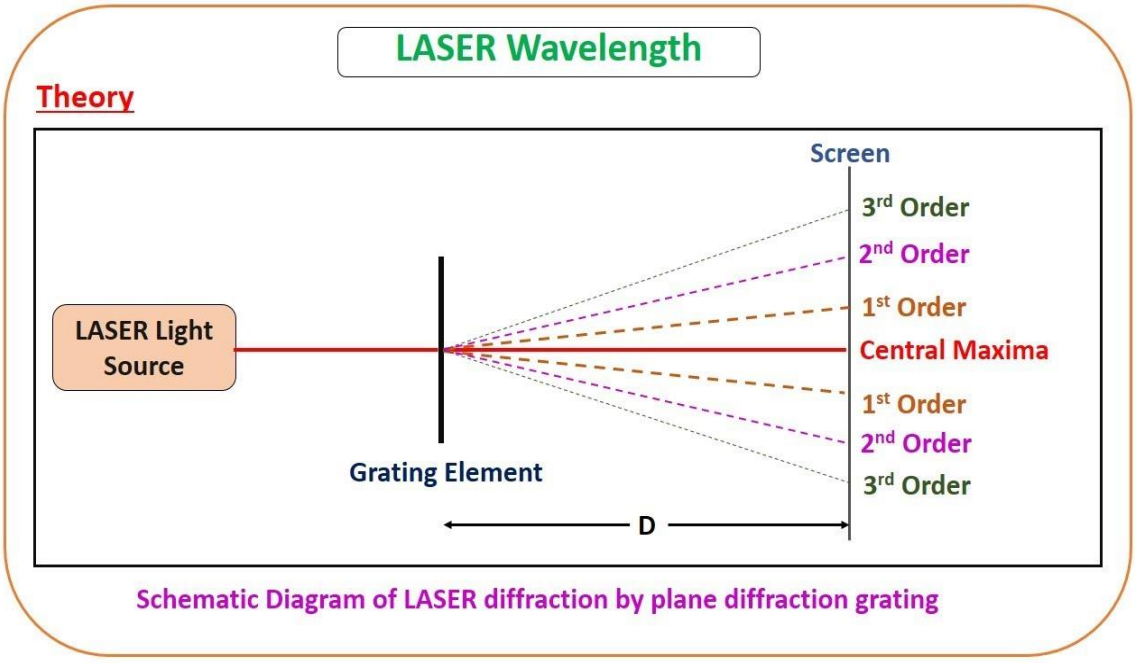
In this formula, θ is the angle of emergence at which a wavelength will be bright. Also, d is the distance between slits.

Obviously, $d = 1N$, where N is the grating constant, and it is the number of lines per unit length.

Also, n is the order of grating, which is a positive integer, representing the repetition of the spectrum.

Furthermore, a complete spectrum could be observed for n = 1 and another complete spectrum for n = 2, etc., but at the larger angles.

VII. Actual Circuit diagram used in laboratory with equipment specifications



Schematic Diagram of LASER diffraction by plane diffraction grating

VIII. Required Resources

Sr. No.	Instrument/Object	Specifications	Quantity
1	Laser source		01
2	Diffraction gratting		01
3	Ruler/ Scale		01

IX. Precautions

1. Handle the equipment carefully.
2. Do not obstruct the path of the LASER..

X. Procedure

1. Take a laser source in front of source attach a grating element. In front of grating element fix a scale in horizontal fashion that acts as a screen.
2. First adjust the distance between creating and screen equal to 70 cm.

3. Switch the laser source. You will get five red spots on the screen.
4. The central spot present on the scale is the reference spot so you consider it at 5 cm.
5. Also you will get the first order and second order spectrum as shown in figure.
6. Measure the distance between first order which is equal to 2x. With the help of this find x ,Also find tan θ
7. Repeat the same procedure by changing the distance between grating and screen as 70 cm, 80 cm and 90 cm
8. Repeat the same thing for second order and find tan θ = X /D
9. Calculate the wave length of laser source using formula.

XI. Observation Table

Obs. No.	**Distance D. cm**	**Order**	**Distance 2x cm**	**Distance x cm**	**Tanθ = x/D**	θ	**Sinθ**
1	70	I II					
2	80	I II					
3	90	I II					

Calculation

Formula:

$$n\lambda = d \sin\theta$$

d = Gratting element

$$= \left(\frac{2.54}{500}\right)\left(\frac{\sin\theta_1 + \sin\theta_2 + \sin\theta_3}{3}\right)$$

For D = 70 cm

D = 80cm

D = 90cm

For 1st order, n=1

$$\lambda_1 = \frac{d\sin\theta}{1}$$

$$= \left(\frac{2.54}{500}\right)\left(\frac{\sin\theta_1 + \sin\theta_2 + \sin\theta_3}{3}\right)$$

$\lambda_1 =$ _____

For 2nd order ,n=2

$$\lambda_2 = \frac{d\sin\theta}{2}$$

$$= \left(\frac{2.54}{500}\right)\left(\frac{\sin\theta_1 + \sin\theta_2 + \sin\theta_3}{3}\right)$$

$\lambda_2 =$ _____

Find λ

Take the average value of wavelength

i.e. $\lambda = \lambda_1 + \lambda_2$

XII. Result

The wave length of He-Ne laser light is _____ A^0.

XIII. Interpretation of results

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XIV. Conclusions and recommendation

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XV. Practical related questions (Provide space for answers)

1) Define Diffraction.
2) Define Diffraction grating.
3) State applications of He-Ne Laser.

XVI. References/Suggestions for further reading: include websites/links

https://youtu.be/ya_v3mgr79I?si=2grCe5v7Zu0d8FSU

Space for answers

XVII. Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60%**
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3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100%**

Name of Student Team Members

1. ……
2. ……
3. ……
4. ……

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