VIJAYAM INSTITUTE OF TECHNOLOGY

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)
Sundararajapuram (V), G.D.Nellore, Opp. Heritage Dairy, Puttur Road,
Chittoor Dist-517125, Andhra Pradesh
Website: www.vijayamit.comContact: 08572-236328

DEPARTMENT OF HUMANITIES & SCIENCES

ENGINEERING PHYSICS

LABORATORY MANUAL FOR I Year B.Tech

(COMMON TO ALL BRANCHES)

PREFACE :

Physics deals with matter and energy. Matter is composed of protons Electrons in the form of atoms and molecules. Energies are of various forms like Mechanical, thermal, optical sound magnetic nuclear etc., it is well established that these energies are inter convertible. The processes of analysis, understanding and applications of the energies lead to different branches in engineering and technology. Physics plays a prominent role in developing different Engineering course. It is obvious that sound knowledge of this information, available in physics, Chemistry and Mathematics, is inevitable for young engineers and technologists. Along with the theoretical skills practical skills in the basic sciences of physics and chemistry are unavoidable to become an eminent Engineer or Technologist. Induction of practical's in physics and chemistry by the university is very much appreciable.

PROGRAM OUTCOMES

A B.Tech –graduate should posses the following program outcomes.

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

INSTRUCTIONS TO STUDENTS

- Before entering the lab the student should carry the following things.
  1. Identity card issued by the college.
  2. Class notes
  3. Lab observation book
  4. Lab Manual
  5. Lab Record
- Student must sign in and sign out in the register provided when attending the lab session without fail.
- Come to the laboratory in time. Students, who are late more than 15 min., will not be allowed to attend the lab.
- Students need to maintain 100% attendance in lab if not a strict action will be taken.
- All students must follow a Dress Code while in the laboratory
- Foods, drinks are NOT allowed.
- All bags must be left at the indicated place.
- The objective of the laboratory is learning. The experiments are designed to illustrate phenomena in different areas of Physics and to expose you to measuring instruments, conduct the experiments with interest and an attitude of learning.
- You need to come well prepared for the experiment.
- Work quietly and carefully
- Be honest in recording and representing your data.
- If a particular reading appears wrong repeat the measurement carefully, to get a better fit for a graph
- All presentations of data, tables and graphs calculations should be neatly and carefully done
- Graphs should be neatly drawn with pencil. Always label graphs and the axes and display units.
- If you finish early, spend the remaining time to complete the calculations and drawing graphs. Come equipped with calculator, scales, pencils etc.
- Do not fiddle with apparatus. Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment. Any damage will be charged.

Preparedby:N HEMA KUMAR

(M.SC., M.PHIL., B.Ed.,)

SYLLABUS

(Common to ALL Branches)

PHYSICS

LABORATORY: EXPERIMENTS

List of Experiments:

1. Determination of radius of curvature of a given Plano-convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Verification of Brewster's law
4. Determination of dielectric constant using charging and discharging method.
5. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
6. Determination of wavelength of Laser light using diffraction grating.
7. Estimation of Planck's constant using photoelectric effect.
8. Determination of the resistivity of semiconductors by four probe methods.
9. Determination of energy gap of a semiconductor using p-n junction diode.
10. Magnetic field along the axis of a current carrying circular coil by Stewart Gee's Method.
11. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall effect.
12. Determination of temperature coefficients of a thermistor.
13. Determination of acceleration due to gravity and radius of Gyration by using a compound pendulum.
14. Determination of magnetic susceptibility by Kundt's tube method.
15. Determination of rigidity modulus of the material of the given wire using Torsional pendulum.
16. Sonometer: Verification of laws of stretched string.
17. Determination of young's modulus for the given material of wooden scale by non uniform bending (or double cantilever) method.
18. Determination of Frequency of electrically maintained tuning fork by Melde's experiment.

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO experiments may be conducted in virtual mode.

References: • **A Textbook of Practical Physics - S. Balasubramanian, M.N. Srinivasan, S. Chand Publishers, 2017.**

Web Resources •www.vlab.co.in• https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

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CONTENT

EXPT-1 **Date:**

NEWTON'SRINGS

Aim: To determine the radius of curvature of the given plano convex lens using Newton's rings.

Apparatus:

1. Plane glass plate,
2. Plano convexl ens,
3. Black sheet,
4. Travelling microscope,
5. Retard stand,
6. Reading lens,
7. Sodium vapour lamp.

Formula:

The radius of curvature of the plano convexlens

$$R = \frac{Dm^2 - D_n^2}{4\lambda(m-n)}$$

Where D_m= Diameter of m^{th} dark ring– cm, D_n=Diameter of n^{th} dark ring λ=wavelength of sodium light=5893 Å m,n = number of ring.

Procedure:

1. A glass plate is kept on a black paper. The given plano convex lens is placed on the plane glass plate. Another glass plate is arranged at 45 ° to the horizontal above the plano convex lens with the help of retord stand.

2. The above unit is kept on the travelling microscope platform and under the microscope.

3. Parallel beam of monochromatic light is incident on the plane glass plate at 45° and hence abeam is incident on the plano convex lens.

4. A path of the incident light is reflected by the plano convex lens and a path of light is transmitted which is reflected from the surface of the plane glass plate. Hence, interference fringes are formed in between the glass plate and the bottom of the plano convex lens which can be observed through the microscope.

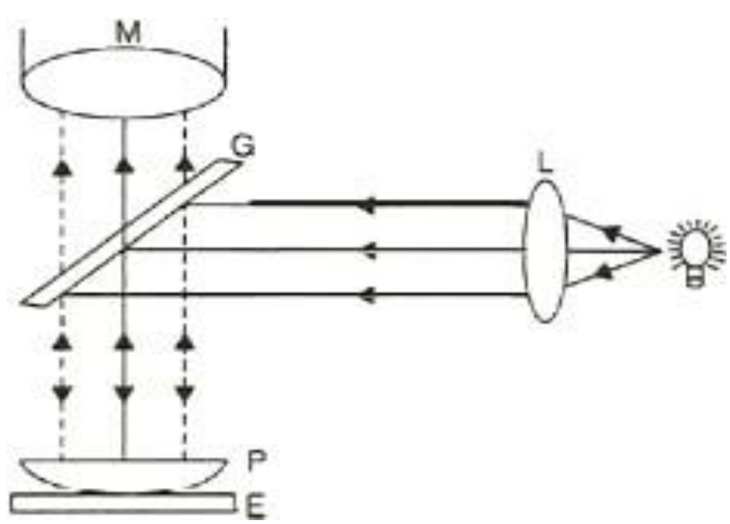
5. The microscope is moved to the one side (say left side) and the vertical cross wire is made tangential to the 18^{th}, 15^{th} etc., up to 3^{rd} ring. The horizontal scale reading of the travelling microscope is noted.

6. The vertical cross wire is made tangential to the other side (say right side) of the rings 3^{rd}, 6^{th} etc., up to 18^{th} ring. The horizontal scale readings are noted in the tabular form.

7. From the tabular form, the value of D_m^2, D_n^2 are calculated.

8. The radius of the curvature of the given plano convex lens is determined using the formula.

Fig.1:Newton's ring apparatus



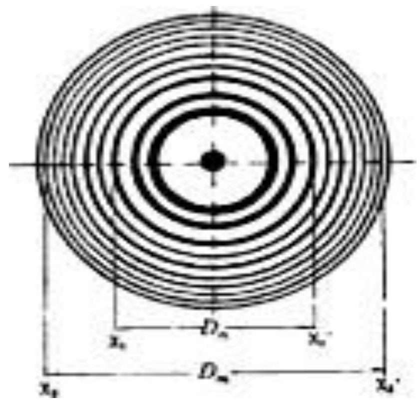
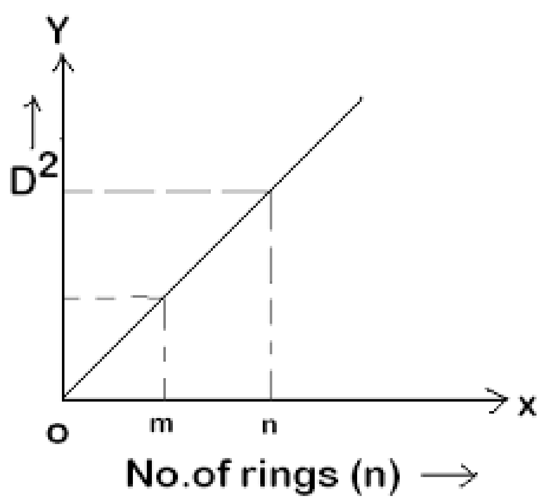


Fig. 2: Newton's Rings

Graph:

A graph is drawn by taking number of rings on x-axis and D^2 value on y-axis. The graph is a straight line passing through the origin. From the graph D_m^2, D_n^2 are calculated then 'R' can be known from the formula.



Precautions:

1. Microscope should be moved only in one direction to avoid backlash error.
2. Slow motion of tangential screw should be used while taking the readings.
3. The readings of central black spot need not be considered.

Table1:CalculationofD²   **LeastCount:0.001cm**

S.No.	Ring no.	TravellingMicroscopereadings								Diameter ofthering D=(x-y) cm	D^2
		Left				Right					
		MSR a(cm)	VC (n)	b=nXLc	Total x=(a+b) cm	MSR a(cm)	VC (n)	b=nXLc	Total y=(a+b) cm		
1.	18										
2.	15										
3.	12										
4.	9										
5.	6										
6.	3										

Table2:

S.No.	Ring No. m^{th}	D^2_m	Ring No. n^{th}	D^2_n	$D^2_m - D^2_n$
1.	18		9		
2.	15		6		
3.	12		3		

Calculations:

Result:

The radius of curvature of the given plano convex lens is

determined From experiment , R= --- cm

Fromgraph, R= ------------------- cm

EXPT-2 **Date:**

NORMAL INCIDENCE METHOD

Aim: To determine the wavelength of mercury spectrum lines using a plane transmission grating in normal incident position.

Apparatus:

1. Spectrometer
2. Plane Transmission Grating
3. Spirit Level
4. Mercury Vapour Lamp

Formula:

$$\lambda = \frac{\sin\theta}{N\,n} \text{ Å}$$

Where λ=wave length of spectral line in Å

θ= angle of diffraction in degree

n= order of the spectrum(1)

N= number of lines per cm on the grating

Procedure:

1. After the preliminary adjustments of the spectrometer are made, the slit is illuminated .with the mercury vapour lamp.

2. The grating is mounted on the prism table with the help of clamps.

3.The telescope is kept exactly opposite to the collimatorare0°and180°, in this position, the vernier table is fixed with screws.

4. Now the telescope is turned to 90° then the grating is adjusted, such that the reflected image of the slit is made to coincide with the vertical cross wire of the telescope. At this position the vernier readings are 90° and270°.

5. Then the prism table is rotated further 45° such that the plane of the grating is far to the collimator.

6. Now the grating is fixed in the normal incidence position. Then the telescope is rotated to the left side to observe the spectrum. Now the vertical cross wire is made to coincide with the red spectral line and thereadings$V_1$and $V_2$are noted.

7. The experiment is repeated for other spectral lines (red to violet) and the readings are tabulated in tabular form.

8. Now the telescope is rotated to the right side and the experiment is repeated as above from violet to red and the readings$V^1_1$and $V^1_2$are noted in tabular form.

9. From the tabular form the wavelength of the spectral lines are calculated by using the formula:

$$\lambda = \frac{\sin\theta}{Nn} \text{ Å}$$

Diagram:

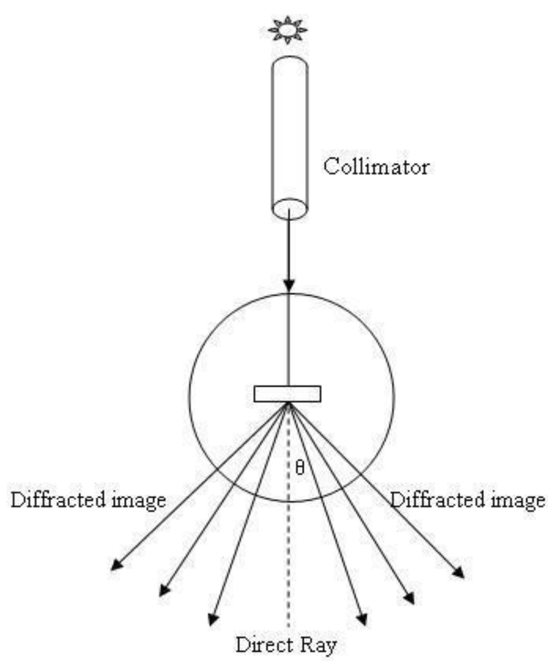


Fig.:Normal incidence method–Diffraction grating

Determination of wavelength of different spectral lines:

Least count (LC) of spectrometer $= \dfrac{\textbf{Value of 1MSD}}{\textbf{NO OF VSD}}$

$= \mathbf{(1/2)^0/30^1}$

$= 1^1$

Table

S. No	**Colour**	**Readings on the spectrometer**				**Difference between vernier readings**			**Angle θ**	$\lambda = \dfrac{\sin\theta}{Nn}$ **(Å)**
		Left		**Right**						
		V_1	V_2	V_1^1	V_2^1	$V_1 \sim V_1^1$	$V_2 \sim V_2^1$	**Mean (2θ)**		
1.	Red									
2.	Yellow									
3.	Green									
4.	Blue									
5.	Violet									

Precautions:

1. The grating should be arranged in normal incidence position.

2. Micrometer screw should be used for fine adjustment of the telescope.

3. Read both the verniers to eliminate any errors due to non-coincidence of the center of the circular scale with the axis of rotation of the telescope.

Calculations:

Result:

The wavelength of the different spectral lines are determined and they are approximately equal to the standard values.

EXPT-3 **Date:**

Laser-Determination of wavelength using diffraction grating Aim: To

determine the wavelength of laser light using diffraction grating.

Apparatus: Laser source, diffraction grating, clamp stand, scale.

Formula:

$$\sin\theta = \frac{d}{\sqrt{D^2+d^2}} \quad \text{and}$$

$$\lambda = \frac{\sin\theta}{N\,n}\ \text{Å}$$

where θ=angle of diffraction

D=distance between grating and the screen

d=distance of diffraction spots from the central spot

n= order of the spot(1,2,3 -------)

N=number of lines per inch on the diffraction grating

λ =wave length of given laser source.

Procedure:

1. Laser source is kept on the table. A grating plate is fixed vertically on a clamp stand such that the grating surface is perpendicular to the table so that the diffraction spots are seen on either side of the central spot at measurable distances.

2. The distance between the screen and the grating "D' is measured with a scale. The distance of the diffracted spots (I order) on either side of the center spot are measured and their average value (d) is calculated.

3. The angle of diffraction 'θ' is calculated using the formula, $\sin\theta = \frac{d}{\sqrt{D^2+d^2}}$.

4. The wavelength of laser source (λ)is calculated by using the formula, $\lambda = \frac{\sin\theta}{Nn}$ Å.

5. Similar calculation is made for the other orders (II and III) and the average value of λ can be calculated.

6. The experiment is repeated by changing the distance between the screen and the grating and wavelength of laser source is calculated.

Precautions:

1. Laser beam should not be seen with the nacked eye directly which may cause blindness.

2. Don’t shine the laser to ward anyone.

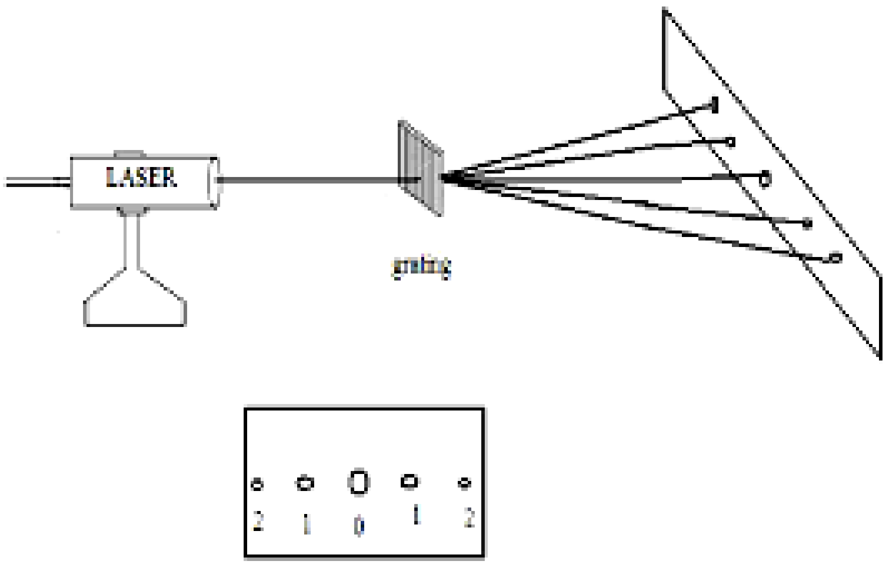


Fig.: Laser-diffraction grating

Table:

S.No.	Distance between the grating and the screen D(cm)	Order of the spot (n)	Distance from the centre spot			$\sin\theta = \frac{d}{\sqrt{D^2+d^2}}$	$\lambda = \frac{\sin\theta}{Nn}$ (Å)
			Left	Right	Average (d)cm		
1.							
2.							
3.							

Calculations:

Result:

The wavelength of Laser light λ=-----------------Ǻ

EXPT-4 **Date:**

STEWART &GEE'SEXPERIMENT

Aim: To study the variation of the intensity of magnetic field along the axis of a current carrying circular coil using Stewart & Gee's type of tangent galvanometer.

Apparatus:

1. Stewart&Gee's tangent galvanometer
2. Magnetic compass
3. Ammeter
4. Commutator
5. Battery eliminator
6. Rheostat
7. Plugkey
8. Connecting wires

Formula:

1. The magnetic field along the axis of a current carrying coil is given by

$$B = \frac{2\Pi n i a^2}{10(d^2+r^2)^{3/2}}$$

Where n=no. of turns of the coil=50

i= current flowing through the coil(Amp)=0.2A

r=Radius of the coil (cm)=10.1 cm

d=distance of magnetic needle from the center of the coil towards east and west

2. At the center of the magnetometer the flux density 'B' due to the current in the coil and the horizontal component of the earth's flux density B_H act at right angles to each other, so that the deflection 'θ' is given by

$$B=B_H \mathrm{Tan}\theta$$

Where B_H=horizontal component of the earth's magnetic field=0.38Gauss

θ =Average angle of deflection of the magnetic needle

CircuitDiagram:

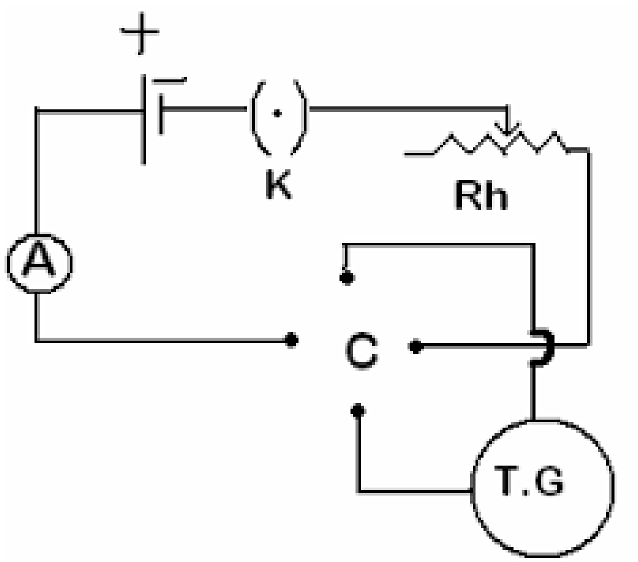
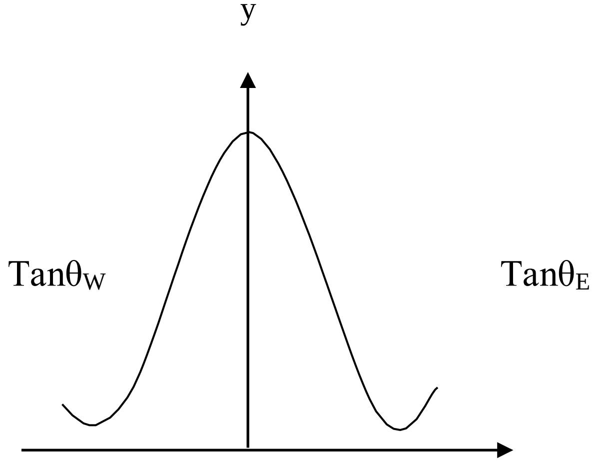


Fig.:CircuitdiagramofStewart&Gee'sexperiment

Graph: A graph is drawn between 'd' along x-axis and Tanθ along y-axis as shown in figure2.It is symmetrical about the center of coil.



Procedure:

1. Orient the apparatus such that the coil is in the north-south plane as shown in the fig.1

2. Adjust the leveling screws to make the base horizontal. Make sure that the compass is moving freely.

3. Connect the circuit as shown in the figure, selecting the number of turns(n) of the coil.

4. Keep the compass at the center of the coil and adjust the apparatus so that the pointersindicate0-0reading.

5. Close the plug keys (k) and commutator (C) (make sure that you are not shorting the power supply) and adjust the current with rheostat (Rh) so that the deflection is between 50to 60 degrees. The current is noted by ammeter (A) and it will be kept fixed at this value for the rest of the experiment.

6. Note down the readings θ_1 and θ_2. Reverse the current by changing the commutator keysandnotedown$\theta_3$andθ_4.

7. Repeat the experiment at intervals of 2 cm along the axis towards East until the value of the field drops to 10 % of its value at the center of the coil.

8. Repeat the experiment on other sides of the coil towards West and note the deflectionsθ_5, θ_6, θ_7 and θ_8.

Precautions:

1. The coil and the magnetic needle are adjusted to be in magnetic meridian.

2. All the magnetic materials and current carrying conductor should be kept away from the apparatus.

3. The apparatus should be kept without any disturbance throughout the experiment.

4. Readings should be taken without parallax error.

Table:

S.No	d(cm)	Deflectionindegrees								Avg. θ	Tanθ	$B=B_H Tan\theta$	
		Leftarm				Right arm							
		θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	θ_7	θ_8				
1.	0												
2.	2												
3.	4												
4.	6												
5.	8												
6.	10												

Calculations:

1. **For d=0**

2. **Ford=2**

3. **Ford=4**

4. **Ford=6**

5. **For d=8**

6. **Ford=10**

Result:

1. The magnetic fields along the axis of a current carrying coil have been computed and compared.

2. The variation of magnetic field along the axis of a current carrying coil have been studied with the help of a graph.

EXPT-5 **Date:**

DETERMINATION OF RIGIDITY MODULUS BY WIRE-DYNAMICMETHOD (Torsionalpendulum)

Aim: To determine the rigidity modulus of the material of the wire.

Apparatus: A circular disc provided with chucknut(Torsionalpendulum),steelwire,stopwatch,screwgauge,vernier calipers.

Formula:

Rigidity Modulus of the material is given by

$$\eta = \frac{8\Pi I l}{a^4 T^2}$$

WhereM = Mass of the disk

R =Radius of the disk

a=Radius of the wire

l=length of the wire

T=Time period of oscillation

I = moment of inertia of the circular disc about the wire as axis of rotation.

$= MR^2/2$ gm.cm^2

Procedure:

The circular metal disc is suspended to a wire of convenient length as shown in figure. A vertical pin (a small mark on the disk when it is in equilibrium) is placed in front of the disc. This will help to note the number of oscillations made by the disc. The disc is set to oscillate through small angles.

When the disc is rotating, the time for 20 oscillations is noted with help of a stopwatch. This is repeated twice and the mean of two trials is taken. The time period (T) for one oscillation is calculated.

This experiment is repeated for different lengths of the pendulum. The radius of the wire (a) is to be found accurately with screw gauge.The radius(R) of the disc is found with vernier calipers. The mass (M) of the disc is obtained by balance. The mean value of the (l/T^2) from the graph and then η is calculated.

Diagram:

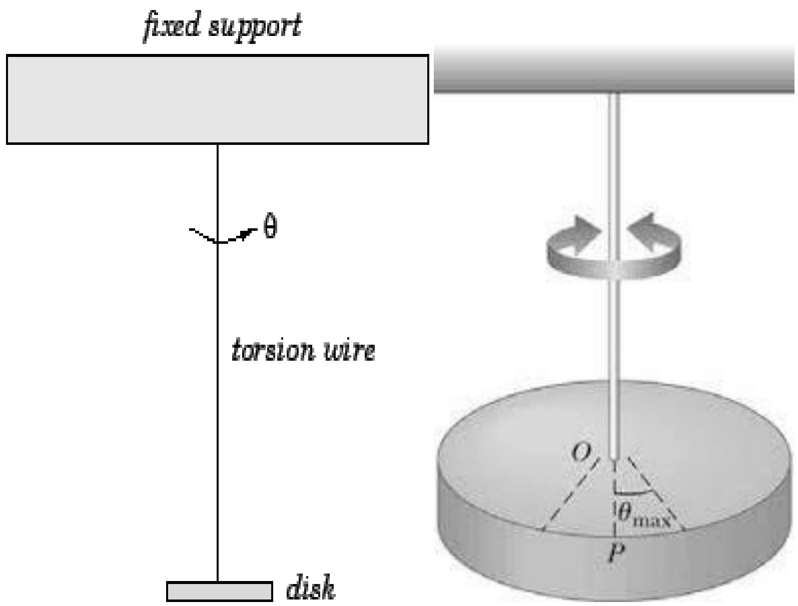
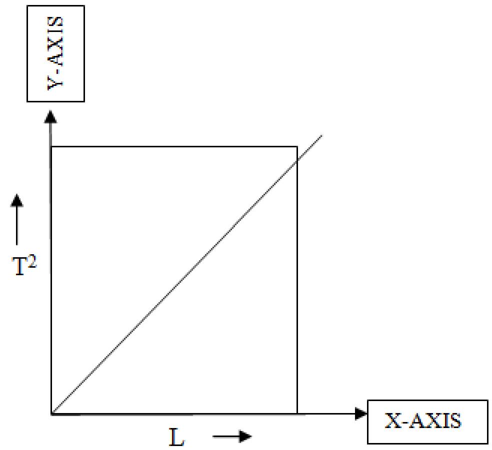


Figure:Torsionalpendulum.

Model graph:A graph is drawn with l on x-axis and T^2 on y-axis. From the equation it should be linear as shown in figure. From the graph the value of T^2 for large l is noted and this value of (l/T^2) is substituted in the equation and found η.


Y-AXIS
T2
L
X-AXIS

Precautions:

1. There should be no kinks in the string.
2. The oscillations must be in a horizontal plane only.
3. The readings should be taken without any parallax error.

Table1:

S.No.	Length ofthewire(l)	Time for 20 oscillations			Timeperiod(T)=t/20	l/T^2
		Trial 1	Trial 2	Mean (t)		

Table2: To measure the radius of the disc with vernier calipers.

S.NO.	Main scale reading (MSR) (a)	Vernier coincidence (VC)	V.CX L.C=b	Diameter d=a+b

Table3:To measure the radius of the wire with screwgauge

Least count=Pitch of the screw/Number of head scale readings.

Zero error=　　　　Zero correction=

S.NO.	Reading of the Pitch scale (P.S.R) (a)	Head scale reading (H.S.R)	Corrected Head scale reading (C.H.S.R)	C.H.R.SXL.C (b)	Diameter of the Wire C=a+b

Calculations:

Result: The Rigidity Modulus of the material is = ____________

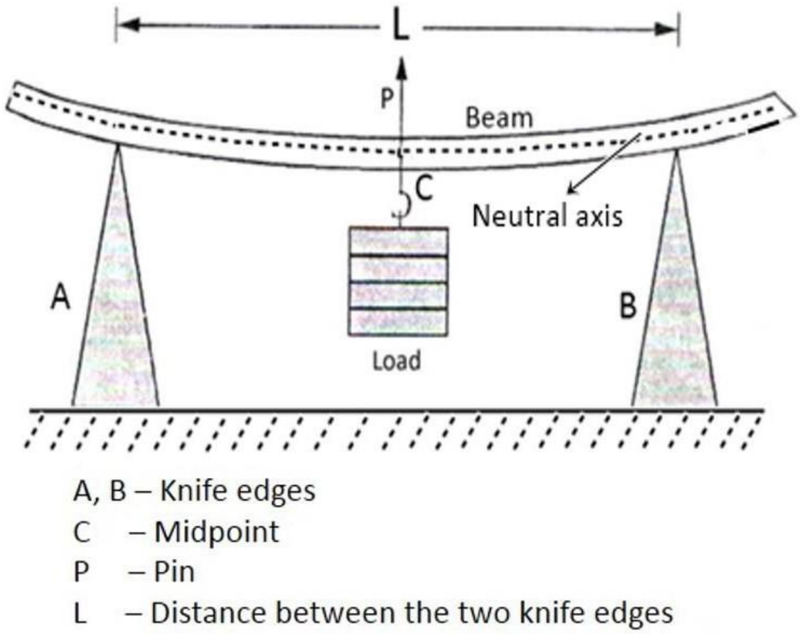


Figure3.1 Young'smodulus-Non-uniformbending

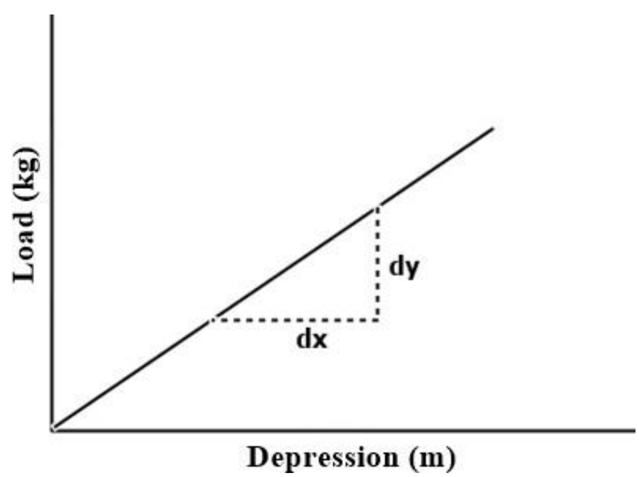


Figure3.2 Model Graph

Young's Modulus-Non-uniform Bending

Expt.No.: 6 Date:

AIM

To find the Young's modulus of the given material of the beam by non-uniform bending.

GENERALOBJECTIVE

To evaluate the elastic behavior of the given wooden beam by pin and microscope experimental method and to find its Young's modulus

SPECIFIC OBJECTIVES

1. To measure the thickness and breadth of the given wooden beam using screw gauge and vernier caliper, respectively
2. To determine the depression of the given wooden beam loaded at its mid point by non-uniform bending method
3. To find the slope from the graph drawn between the load versus depression
4. To calculate theYoung's modulus of the wooden beam from the mean depression and slope obtained from table and graph, respectively
5. To analyze the elastic behavior of the given wooden beam from the results obtained

APPARATUS REQUIRED

- Wooden beam
- Weight hanger with slotted weights
- Knife edges
- Travelling microscope
- Vernier caliper
- Screw gauge
- Metre scale

LEAST COUNT FOR SCREW GAUGE

$$\text{Least Count (LC)} = \frac{\text{Pitch}}{\text{Number of head scale divisions}}$$

$$\text{Pitch} = \frac{\text{Distance moved}}{\text{Number of rotations given}} = \frac{5\text{mm}}{5} = 1\text{mm}$$

$$\text{LC} = \frac{1\text{mm}}{100} = 0.01\text{mm}$$

TABLE-I

To determine the thickness (d) of the beam using screw gauge

Zero Error(ZE):**……….** divisions   Zero Correction(ZC)................mm

S.No.	**Pitch Scale Reading PSR a mm**	**Head Scale Coincidence HSC**		**b=nxLC**	**Total a+b**
		Observed	**Corrected (n)**		
1					
2					
3					
4					

Mean(d) =..............**x10^{-3}m**

[Type text]

FORMULA

Young's modulus of the material of the beam

$$Y = \frac{MgL^3}{4sbd^3} \quad (N/m^2)$$

Symbol	Explanation	Unit
Y	Young's modulus of the material of the beam	N/m^2
M	Load applied	kg
L	Distance between the knife edges	m
g	Acceleration due to gravity	m/s^2
b	Breadth of the beam	m
d	Thickness of the beam	m
s	Depression produced for 'M' kg load	m

Unit	Equivalent Units	
N/m^2	$kgm^{-1}s^{-2}$	1Pa

PRE REQUISITE KNOWLEDGE

1. **Stress**

   Stress is a dimension quantity defined as force per unit area.

2. **Strain**

   Strain is the relative change in shape or size of an object due to externally applied forces. It is dimensionless quantity and has no units.

3. **Young'smodulus**

   Young's modulus is defined as the ratio between linear stress and linear strain.

LEAST COUNT FOR VERNIER CALIPER

Least Count (LC)	=Value of 1Main Scale Division (MSD)/Number of divisions in the vernier
10MSD	= 1 cm
Value of 1 MSD	=1/10cm=0.1cm
Number of divisions in the vernier	= 10
LC	=0.1/10=0.01cm

TABLE-II

To determine the breadth(b)of the beam using vernier caliper

LC=**0.01**cm Zero error(ZE):**……….** Zero Correction(ZC):**……….**

S.No.	**Main Scale Reading MSR (10^{-2}m)**	**Vernier Scale Coincidence VSC (divisions)**	**Observed Reading OR=MSR+(VSC×LC) (10^{-2}m)**	**Correct Reading CR = OR ± ZC (10^{-2}m)**
1				
2				
3				
4				

Mean (b)=**……………. ×10^{-2} m**

4. Uniform and non-uniform bending

In uniform bending, the beam is elevated due to load, and non-uniform bending, the beam is depressed due to load.

In uniform bending, every element of the beam is bent with the same radius of curvature where as in non-uniform bending, the radius of curvature is not the same for all the elements in the beam.

PROCEDURE

1. The given beam is supported on two knife edges separated by a distance 'L'. A pin is fixed vertically at the mid-point. A weight hanger is suspended at the mid- point of the beam. The beam is brought to the elastic mood by loading and unloading it several times.
2. With the dead load 'W', the pin is focused through microscope. The microscope is adjusted so that the horizontal crosswire coincides with the tip of the pin. The microscope reading is taken.
3. The load is changed in steps of 0.05 kg and in each case the microscope reading is taken during load in gand unloading.The readings are tabulated. The depression at the mid-point for 'M' kg is calculated.
4. The distance between the knife edges (L) is measured using a metre scale. The breadth (b) and thickness (d) of the beam are found using vernier caliper and screw gauge, respectively.

LEAST COUNT FOR TRAVELLING MICROSCOPE

Least Count (LC) =Value of 1 Main Scale Division(MSD)/Number of divisions in the vernier

20MSD = 1 cm

Value of 1 MSD =1/20cm=0.05cm

Number of divisions in the vernier = 50

LC =0.05/50=0.001cm

TABLE-III

Tofind depression's'

LC=**0.001cm** *TR=MSR +(VSC □LC)

Load M (10^{-3} kg)	**Microscope reading**							**Depression 's' for M kg (10^{-2}m)**
	Loading			**Unloading**			**Mean (10^{-2}m)**	
	MSR (10^{-2}m)	**VSC (div)**	**TR (10^{-2}m)**	**MSR (10^{-2}m)**	**VSC (div)**	**TR (10^{-2}m)**		
WW								
+50								
W+100								
W+150								
W+ 200								

Mean(s)=................**×10^{-2}m**

*Note:TotalReading(TR)=MainScaleReading(MSR)+(VSC□LC)

[Type text]

RESULT

The Young's modulus of the material of the given beam **Y=................. 10^{10}N/m^2**

APPLICATIONS

AFM probe, wing so fair craft, helicopter rotator, marine fittings, designing of bridges, bicycle frames and wind mill turbine blades.

VIVAVOCEQUESTIONS

1. Define elastic limit.

2. When a beam is loaded at its midpoint, it is then said to be under non-uniform bending. Why?

3. Differentiate between elasticity and plasticity.

4. Give the significance of neutral axis.

OBSERVATION

Mass for the depression	M	=	....	$\times 10^{-3}$kg
Distance between the two knife edges	L	=	....	$\times 10^{-2}$m
Acceleration due to gravity	g	=	....	m/ s^2
Breadth of the beam	b	=	....	$\times 10^{-2}$m
Thickness of the beam	d	=	....	$\times 10^{-3}$m
Depression produced for 'M' kg of load	s	=	....	$\times 10^{-2}$m

CALCULATION

Young's Modulus of the material of the beam

$$Y = \frac{MgL^3}{4sbd^3} \quad (N/m^2)$$

The Energy Band Gap of a Semiconductor

EXPT N0 7 =

Aim: To determine the Energy Band Gap of a Semiconductor by using PN Junction Diode.

Apparatus: Energy band gap kit containing a PN junction diode placed inside the temperature controlled electric oven, micro ammeter, voltmeter and connections brought out at the socket, a mercury thermometer to mount on the front panel to measure the temperature of oven.

Formula :

E_g = slope of the straight line(m)/5.06 eV

Where E_G = energy band gap of the given semiconductor diode

M = slope of the straight line plot obtained for $log_{10}I_s$ and $10^3/T$

I_s = reverse saturation current (µA)

T = absolute temperature (^0K)

Procedure: The experimental setup is shown in fig.1

1. Insert the thermometer in the hole of the oven.
2. Switch ON the instrument using ON/OFF toggle switch provided on the front panel.
3. Keep the temperature control switch to the high side.
4. Adjust the voltage at 1V DC.
5. Switch ON the oven using ON/OFF toggle switch provided on the front panel. Temperature starts increasing and the reading of micro ammeter also starts increasing.
6. When temperature reaches to 90°C or 100°C, switch OFF the oven and note down the reading of micro ammeter (µA).
7. As the temperature starts falling, note down the readings of micro ammeter after every 5°C or 10°C drop in temperature.
8. Repeat the whole procedure for 2V and 3V DC.
9. Plot graph between $log_{10} I_s$ and 10_3 / T for different voltages.

Fig. 1 Reverse biased PN junction Diode

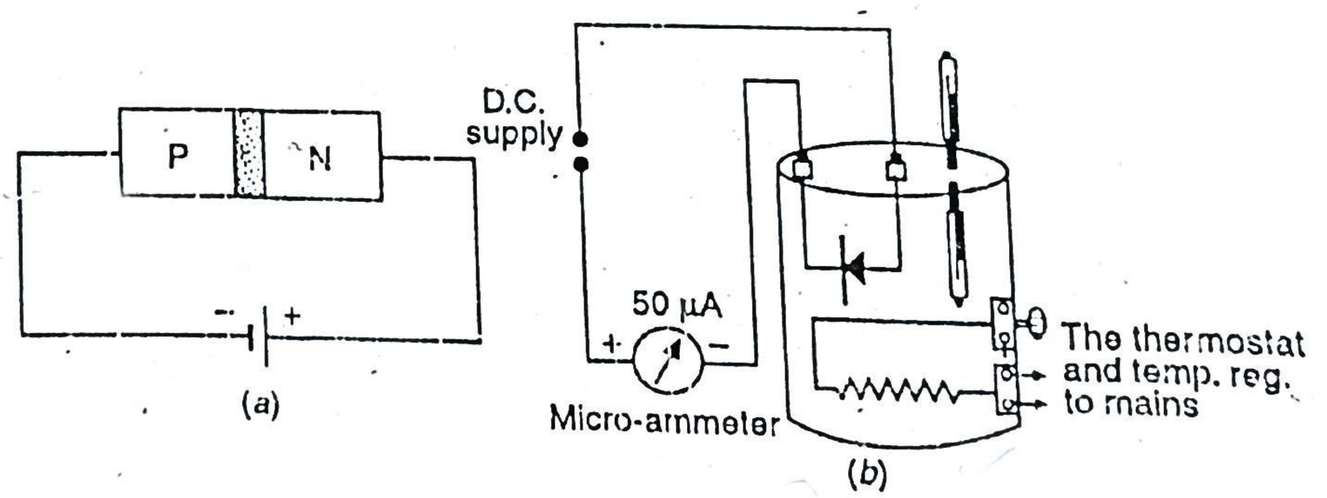


Fig. 1 Reverse biased PN junction Diode

Observations:

S.no	**Temp (oc)**	**Current I_S(µA)**			**TEMP**	**10^3/T**	**Log I_S**	
		V=1 V	**V=2 V**	**V= 3V**				

Calculations:

Taking 10^3 / T along X-axis and $\log_{10} I_s$ along Y-axis, plot a graph between $\log_{10} I_s$ and 10^3 / T for three different voltages. The graph will be a straight line as shown in fig.3. Determine the slope of straight line from this graph and then calculate band gap using formula,

Band gap (E_g) = $Slope/5.036$ = _______ eV.

Take average of three values of band gap

Result:

The band gap (E_g) of the given semiconductor is found to be ______ eV.

Precautions:

The following precautions should be taken while performing the experiment:

1. The diode must be reverse biased.
2. Do not exceed the temperature of the oven above 100°C to avoid over heating of the diode.
3. The voltmeter and ammeter reading should initially be at zero mark.
4. Bulb of the thermometer should be inserted well in the oven.
5. Readings of micro ammeter should be taken when the temperature is decreasing.
6. Readings of current and temperature must be taken simultaneously.

Sample viva voce questions:

1. What is PN junction diode?
2. What do you understand by band gap of a semi-conductor?
3. What do you mean by valence band, conduction band and forbidden band?
4. How many types of semi-conductors are there?
5. What are P-type and N-type semi-conductors?
6. Define doping and dopant.
7. Why P-type (N-type) semi-conductor is called Acceptor (Donor)?
8. What do you mean by Fermi energy level?
9. What is the position of Fermi level in an intrinsic semi-conductor and in a p-type or n-type semi-conductor with respect to the positions of valence and conduction bands?
10. What do you mean by forward biasing and reverse biasing?
11. Why diode is reverse biased in determining the band gap of semi-conductor?
12. What is the shape of graph between $\log_{10} I_s$ and $10^3 / T$? How do you find band gap energy from this graph?
13. Why conductivity of metals decreases with increase in temperature?
14. Why conductivity of a semi-conductor increases with increase in temperature?

AIM : TO verify the laws of transverse vibrations of stretched strings

APPARATUS : Sonometer, tuning fork, weight hanger, simple balance, rubber hammer and strings

FORMULA :

$$n = 1/2l \times \sqrt{T/m}$$

Where n = frequency of the tuning fork - Hz

m = linear density of the string ($\Pi r^2 d$) - gm/cm^2

r = radius of the string - cm

d = density of the material of the wire - gm/cc

T = tension of the string = mg dynes

g = acceleration due to gravity - cm/sec2

l = length of the vibrating string-cm

Laws of transverse vibrations :

First law : n α l or nxl = constant

When T and m are constants

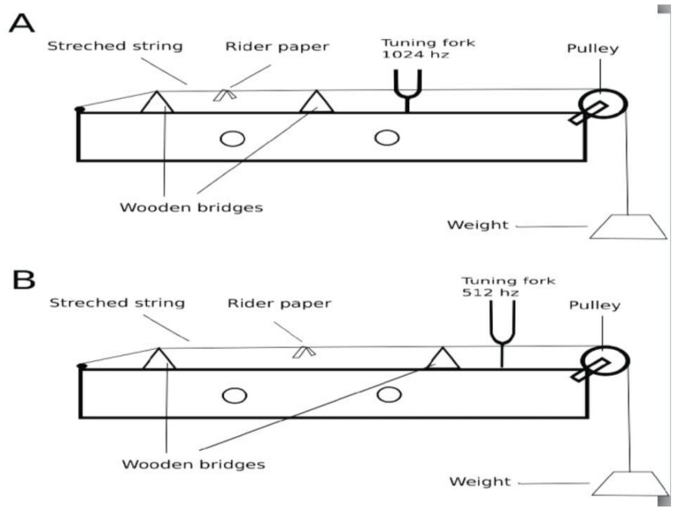
Second law : n α √T

When l and m are constants

Third law : n α √m

When l and T are constants

PROCEDURE :



1. Verification of first law : To verify the first law, the Sonometer is kept under a suitable tension. A tunning fork of known frequency is excited by the rubber hammer and its shank is placed on the base of sounding box. A light paper rider is placed centrally on the string between the fixed bridge and the movable bridge. The length of the wire is adjusted until the paper rider fall down. The length of the vibrating string is measured. Keeping the tension constant and using the same wire the experiment is repeated with different frequencies. The values are tabulated in the tabular form.The first law is verified by showing n x l = constant.

2. Verification of second law : The experiment is done as above keeping the frequency constant and using the same string with different tensions.second law is verified by showing that √T/l is constant

3. Verification of third law : The experiment is done as above keeping the frequency of the tunning fork and tension are constants with different strings that is different linear densities. Third law is verified by showing that l x √m is constant.

OBSERVATIONS :

1. Verification of the first law :

S.No	Freuency n (Hz)	Length of the vibrating string l (cm)			n x l Hz-cm
		Trial 1	Trial II	Mean	

2.Verification of the second law :

Determination of diameter of iron string using screw guage :

$$\text{Pitch of the screw} = \frac{\text{Distance moved by the screw}}{\text{No. Of rotations made by the screw}} = 5/5 = 1\text{mm}$$

$$\text{LC of the screw guage} = \frac{\text{Pitch of the screw}}{\text{No. Of HSD}} = 1\text{MM}/100 = 0.01\text{mm} = 0.001\text{cm}$$

S.No	PSR a (mm)	HSR		Fraction b = n x LC	Total a + b (mm)
		Observed	Corrected(n)		

Average d =

Determination of the diameter of steel wire :

S.No	PSR a(mm)	HSR		Fraction b = n xLC	Total a + b (mm)
		observed	Corrected (n)		

Average d =

Radius of the iron string = mm

Radius of the steel string = mm

Density of the iron (d) = 7.8gm/cc

Density of the steel(d) = 8.2gm/cc

Linear density of the iron string(m) = Πr^2 d gm/cm

Linear density of the steel string(m) = Πr^2 d gm/cm

3. Verification of third law

S.No	Material of the wire	Linear density (m) gm/cm	Length of the vibrating string l (cm)			l x √m gm-cm
			Trial I	Trial II	Mean	

PRECAUTIONS :

1. The pulley should be frictionless
2. Tunning fork is held at the shank only

RESULT : The laws of transverse vibrations are verified.

EXPT NO 9 :TEMPERATURE COEFFICIENT OF THERMISTOR

Aim:-To determine temperature coefficient of resistance of the given thermistor and Also to draw the V-I characteristic curve.

Apparatus:-Postoffice box, thermistor, galvanometer, battery, plug-key, rheostat, thermometer,hotwaterbath,voltmeter,milli-ammeterandconnectingterminals.

Formula :- The temperature coefficient of resistance of the given thermistor

$$\alpha = \frac{S_2 - S_1}{S_1 t_2 - S_2 t_1} \ /^oc$$

Where S_1 and S_2 are the resistances of the thermistor at temperatures t_1°C and t_2°C respectively.

Description:- Thermistor is a heat sensitive resister usually made up of a semi-conducting material, such that its resistance varies appreciably with change in temperature. Thus the thermistor has a large temperature coefficient of resistance. They may have negative or positive temperature coefficient. The high sensitivity to temperature changes makes the thermistor extremely well-suited for the precise temperature measurement, control and compensation. Hence, they are widely used for such purposes, particularly in the lower temperature range of–100°Cto+350°C.

Thermistors are made by sintering mixtures of metallic oxides such as Manganese, Cobalt and Copper etc. Their resistance varies from 0.5 Ω to 100 MΩ. These are chemically stable. These can be connected in series or parallel, depending up on the purpose.

The V-I characteristics is not a straight line. So it is a non-linear of non-ohmic resistor. As current increases, the voltage first increases and then decreases.

Procedure:-**a)Temperature characteristic curve:**

The circuit is connected as shown in the figure-1 using Post office box. In P and Q arms 100Ω and 10Ω resistances are taken (in general) and in S arm the thermistor is connected. If the connections are correct, the galvanometer shows opposite deflections for the resistance (R) values of zero and infinite respectively.

Initially at room temperature the bridge is balanced by adjusting Rand the resistance(S) of the thermistor is calculated using the formula

$$P/Q = R/S$$

Now the thermistor is kept in a water bath and the temperature is increased from 30^{o}Cto90^{o}C,in steps of 5^{0}C. At every temperature the bridge is balanced by adjusting the R-value and the S value is calculated. The experiment is repeated while decreasing the temperature also.

Graph:- A graph is drawn by taking temperature on X- axis and resistance of the thermistor on Y- axis (figure-2). For two close and different values of t_1 and t_2, the corresponding resistances S_1 and S_2 are taken. The values are substituted in the formula given below and obtain the temperature coefficient of resistance of the thermistor.

$$\alpha = \frac{S_2 - S_1}{S_1 t_2 - S_2 t_1} \ /^oc$$

Which is negative.

b)Voltage- current characteristic :-The circuit is connected as shown in the figure-3. The current is varied in the circuit by adjusting the jockey position of the rheostat and the potential across the thermistor is measured for each value of current. The current and the potential differences values are noted in table 2.The voltage first raises and then falls with increase in current.

Graph:- A graph is drawn by taking current on X- axis and voltage on Y-axis, as shown in the figure- 4 and studied how the voltage varies with increase of current.

Precautions:-1.The resistances P and Q should be maintained at constant values.

2.Much current should not be sent through the thermistor.

3.First we have to observe whether the galvanometer shows opposite deflections or not for the resistance (R) values of zero and infinite respectively.

Results:-

Table-1

P =100Ω Q =10Ω

S.No	Temperature 0c	Resistance (R) Ω	Thermistor resistance S = R/P x Q Ω

Table -2

S.No	Current (mA)	Voltage (V)

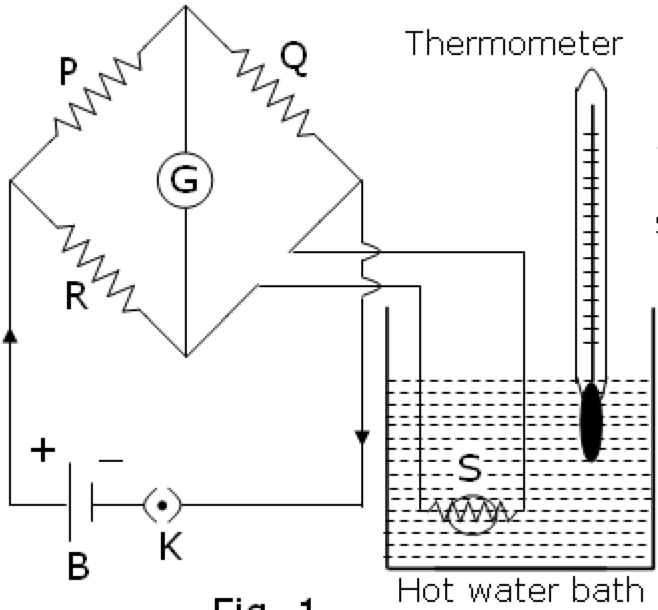


Fig. 1

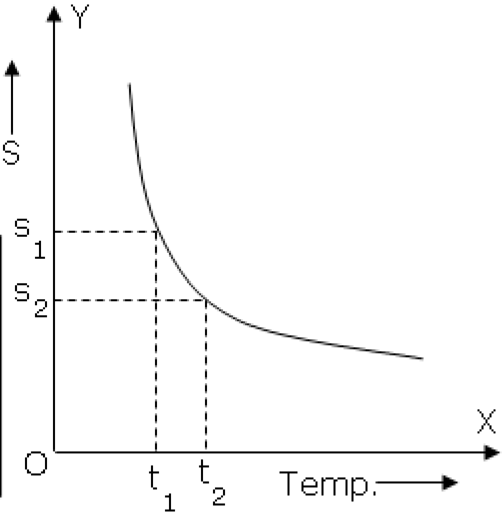


Fig. 2

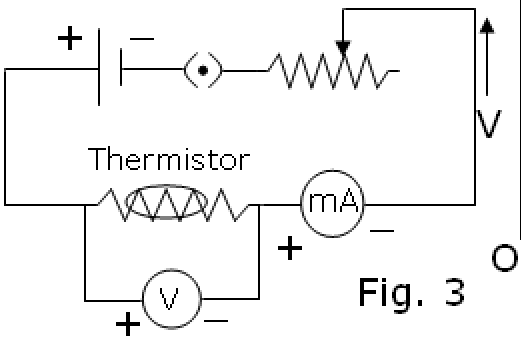


Fig. 3

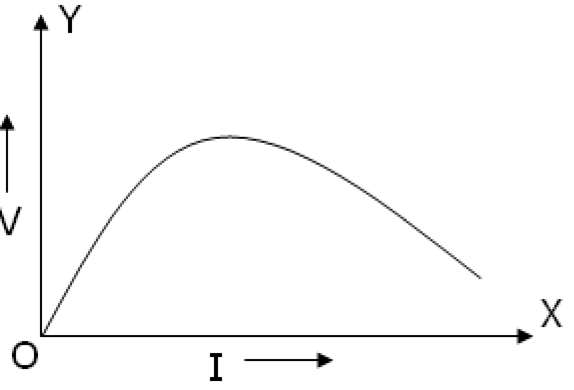


Fig. 4

EXPT NO 10 COMPOUND PENDULUM

Aim of the experiment

- To determine acceleration due to gravity, g, using a compound pendulum.
- To determine radius of gyration about an axis through the center of gravity for the compound pendulum.

Apparatus required

Compound
pendulum Stop
watch

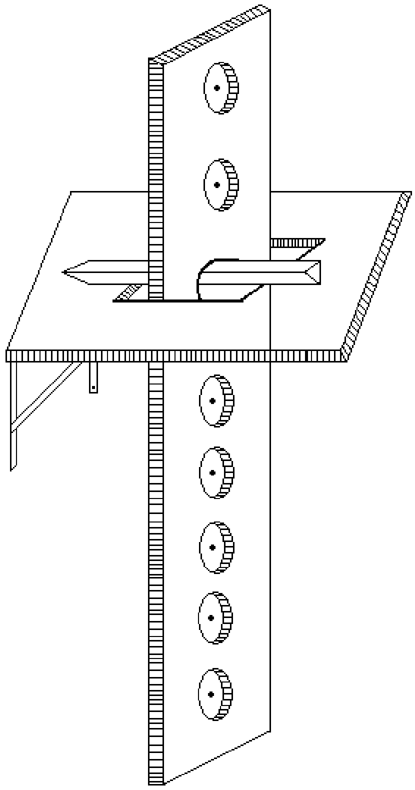
Formula : $g = 4\Pi^2 L/T^2$ cm/s^2

Where g is acceleration due to gravity-cm/s^2

L is length of the equivalent simple pendulum from graph -cm

T is the time period from graph -sec

Procedure:



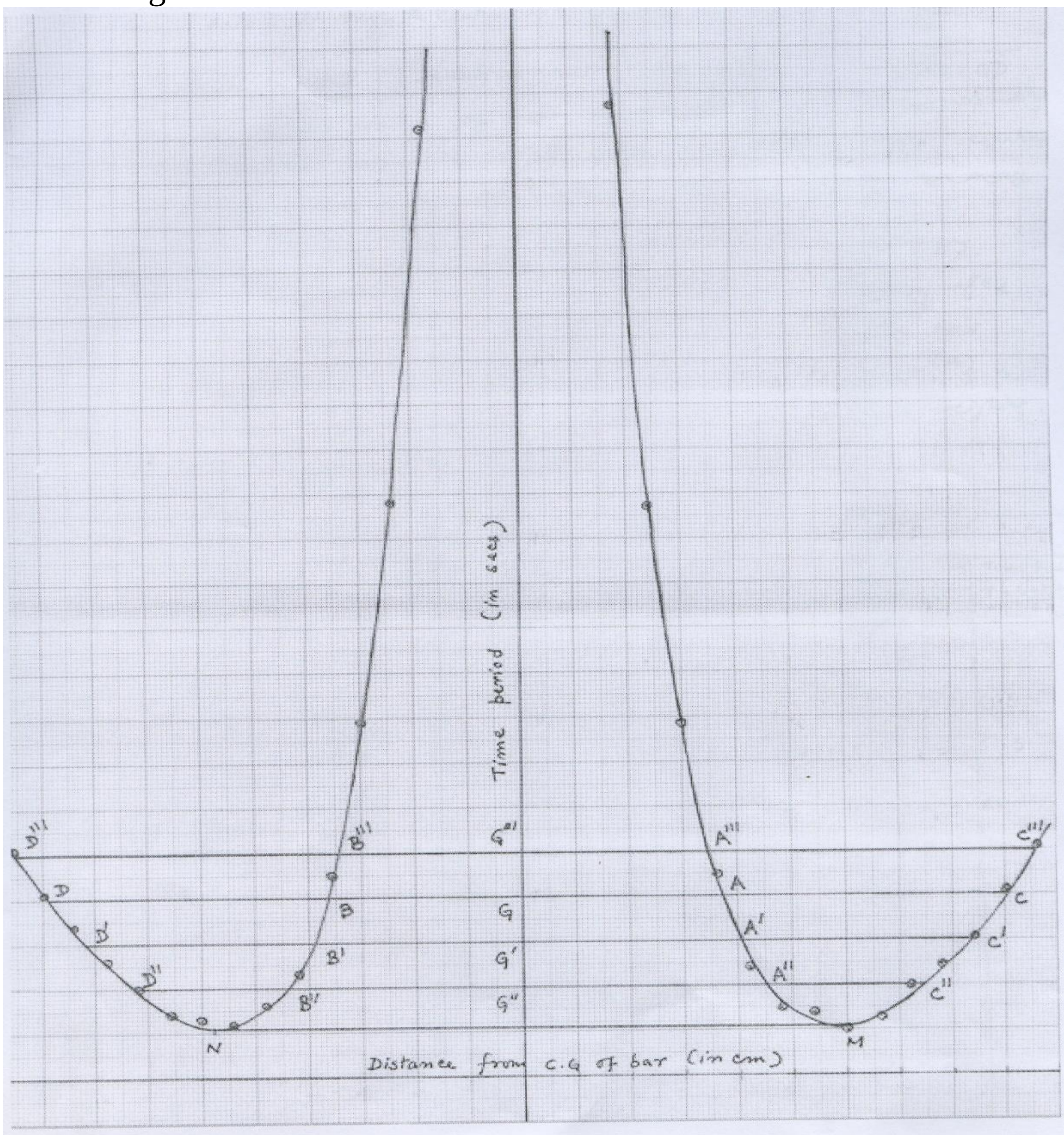
1. Place the knife-edge in the first hole say at a distance 5cm from one end of the bar and suspend the pendulum vertically from the knife edge.
2. Now, draw the bar slightly to left or right side and release it. Then, it begins to oscillate in the vertical plane with a small amplitude of about 5^0.
3. Start a stop watch and note the time t_1 taken for the completion of 20 oscillations. Repeat the same procedure for another trial and note the time t_2 taken for 20 oscillations. Find the mean time t taken for 20 oscillations. From this find the period of oscillation T of the bar that is for one oscillation.
4. Repeat the experiment by placing the knife edge on successive or alternate holes which are say at distances of 10cm, 15cm, 20cm, 25cm, 30cm, 40cm, 45cm, and in each case find the time period of oscillation T.
5. After crossing centre of gravity reverse the bar and fix the knife edge at a distance of 95cm and find the period of oscillation. Repeat the experiment by placing the knife edge at distances of 90cm,85cm, 80cm, ……. 55cm, and find the corresponding period T.
6. While taking the observations, the distance of the knife edge must be considered from one (same) end of the bar only.

1. L,T Graph:

Plot a graph between the period of oscillation T on Y-axis and the distance of knife edge from one end of the bar, on X-axis. Two curves which are symmetrically about the centre of gravity will be obtained as shown in graph. Draw a line parallel to X-axis. This line cuts the two curves at four points A,B,C,D about which the time periods are same. From, the graph, note the values of AC and BD. The mean value of AC and BD is a measure of the length of the equivalent simple pendulum (L = AC+BD/2).Note the time period T corresponding to that. The acceleration due to gravity g can be determined by substituting the above values in the formula. Similarly, draw three straight lines corresponding to different time periods parallel to X-axis. For each value of L and T , find the value of L/T^2. The value of g can be calculated using the same formula.

2. L,T^2 Graph;

Draw a graph between L and T^2. Here, the values of L and T should be taken from the graph. A straight line passing through the origin will be obtained. The value of g can be determined by taking the value L,T^2 from the graph and substituting in the formula.



(Fig 3)

Observation:

Table 1 : To determine the period of oscillation T of the compound pendulum

S.No	Distance of knife edge from one end of the bar L cm	Time for 20 oscillations			Period of oscillation T =t/20 sec
		Trial-I t_{1} sec	Trial II t_{2} sec	Mean $t=t_{1}+t_{2}/2$ sec	

Table 2 : To find the values of L,T^2 from the graph and to determine g

S.NO	Time period T sec	T^2	Length of the equivalent simple pendulum			L/T^2 cm/s^2
			AC cm	BD cm	L = AC+BD/2	

Radius of gyration K :From Graph1, $AG = h_1$, $GC = h_2$

$K = \sqrt{AG \times GC} = \sqrt{h_1 h_2}$

If E and F are points on the curves corresponding to minimum period, then K= EF/2

Precautions :

1. The knife edge should perfectly rest on the smooth horizontal surface.
2. The knife edge should be horizontal and the pendulum should oscillate in a vertical plane.
3. Amplitude of oscillation must be small (about 5^0)
4. The distance should be measured from the same end of the bar throughout
5. The time should be noted when the oscillations are regular.
6. The graph drawn should be a free-hand curve.

Result: 1.Acceleration due to gravity at Chittoor is found to be equal to cm/s^2.

3. Radius of gyration about on axis through the center of gravity is found to be equal to (MN/2)…cm.