ENGINEERING PHYSICS LABORATORY MANUAL

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Sl. No.	Date	Name of the Experiment	Page No.	Remarks

Instructions for Laboratory

- 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 (the whole purpose of experimentation is to make reliable measurements!) and equally share the work with your partners.

- Be honest in recording and representing your data. Never make up readings or doctor them to get a better fit for a graph. If a particular reading appears wrong repeat the measurement carefully. In any event all the data recorded in the tables have to be faithfully displayed on the graph.

- All presentations of data, tables and graphs calculations should be neatly and carefully done.

- Bring necessary graph papers for each of experiment. Learn to optimize on usage of graph papers.

- 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 idly 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.

Experiment No- **Date:__________**

1. TORSIONAL PENDULUM - RIGIDITY MODULUS

Aim :

To determine modulus of rigidity (n) of the material of given wire by using Torsional Pendulum.

Apparatus :

Torsional pendulum with steel or brass wire, wall bracket with a chuck nut rigidly clamped, stop watch, screw gauge.

Formula: = rigidity modulus of the wire $n = \frac{8\pi I}{a^4}\left(\frac{l}{T^2}\right)$ dynes/cm^2

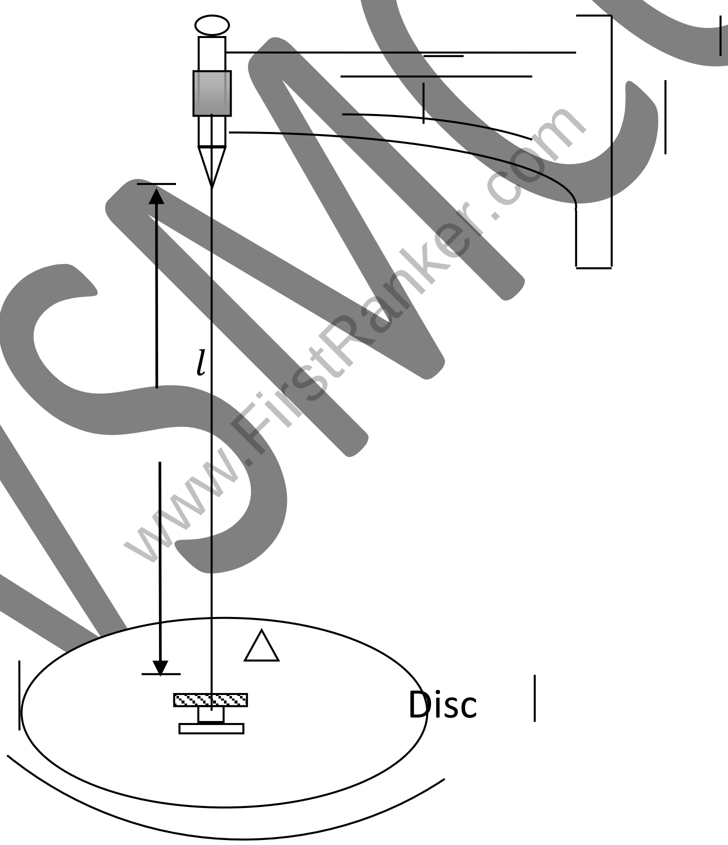
Where l = length of the wire.

a=radius of the wire.

The moment of inertia of circular disc is

$$I = \frac{MR^2}{2} \quad \text{gm.cm}^2$$

Where M = Mass of the disc R = Radius of the disc



Observations:

1. Average radius of the wire r = ... cm
2. Mass of the disc M =...........gm
3. Circumference of circular disc L= 2 π R = ... cm
4. Mean radius of the disc R= $\frac{L}{2\pi}$ =.......... cm

Table 1:

S.NO	Length of the wire l cm	Time for 20 oscillations			Period T=t/20	T^2	$\frac{l}{T^2}$
		Trial 1 t_1 sec	Trial 2 t_2 sec	Mean (t)			

Avge $\frac{l}{T2}$ **=**

Table 2:

S.NO	P.S.R (a)mm	Head scale reading		nxL.C= (b)mm	Total reading (a+b) mm
		Observed	Corrected(n)		

Precautions:

1. The wire should be free of kinks.

2. The radius of the wire 'a' should be determined accurately since it is in fourth power.

Result :

The rigidity modulus of the given wire is ……………….

Calculations:-

Experiment No- **Date:__________**

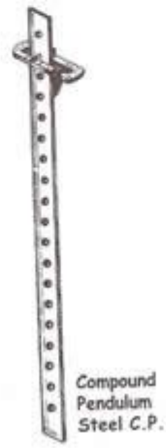
2.COMPOUND PENDULUM

AIM:

To determine acceleration due to gravity using a Compound Pendulum.

APPARATUS:

Compound pendulum , Knife edge, Wall bracket, Stop-watch, Meter scale,telescope.



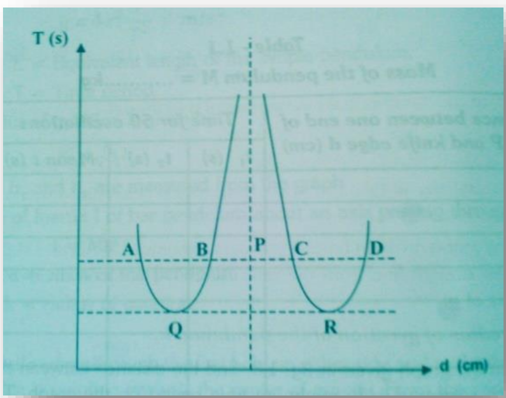
Formula: Acceleration due to gravity is given by

$$g = 4\pi^2 \frac{\ell}{T^2} \text{ cm/sec}^2$$

l=equivalence length to the simple pendulum

T= time period= time taken for one oscillation

GRAPH: - Drawn a graph the distance d of various holes from one end along the X-axis and the corresponding time period T of the pendulum along the Y-axis as shown in fig.



Observations & calculations:

Table 1 :

S.No.	Distance of the point suspension measured only from one end of the bar d cm	Time for 20 oscillations			Period of oscillation T=$\frac{t}{20}$ sec
		Trial 1 t_1 sec	Trial 2 t_2 sec	Average t= $\frac{t1+t2}{2}$	

S.No.	Period of oscillation Tsec	Length of equivalent simple pendulum			$\frac{\ell}{T^2}$
		AC cm	BD cm	Mean value $\ell=\frac{AC+BD}{2}$	

Precautions : **1. The pendulum must be oscillated in a vertical plane without any wobbling with small amplitude.**

2.The knife edge should be horizontal.

Result : **1. Acceleration due to gravity (g)= ………** Cm/sec^2

2. Radius of gyration (k)=………. cm.

Calculations:-

Experiment No. Date: ____________

3.Melde's Experiment

Aim :

To determine the frequency of an electronic vibrator, using Melde's arrangement.

Apparatus:

Electrically maintained vibrator, light smooth pulley fixed to a stand, Thread, Card board scale Pan, weight box. Plug key, connecting wires.

Principle :

The frequency n of the transverse vibrations of a stretched string under tension T is given by

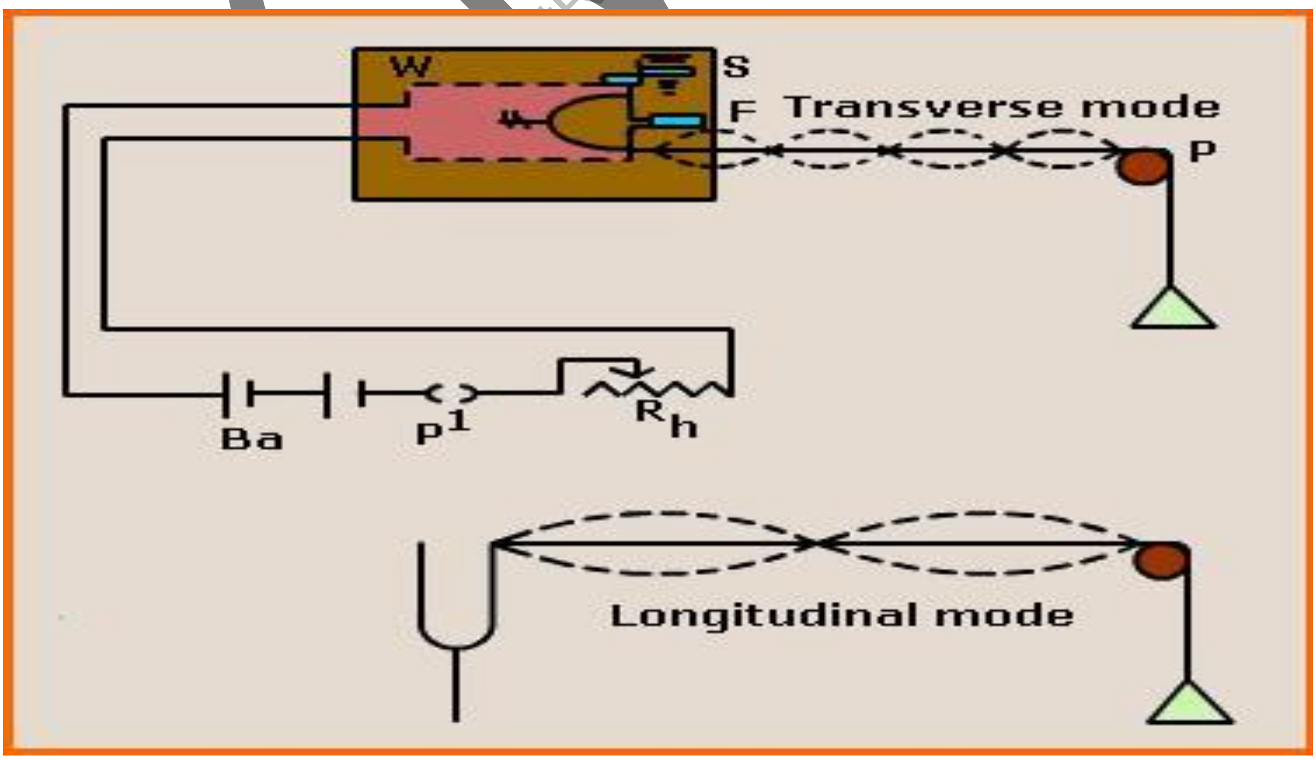
$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}\ \text{Hz}$$

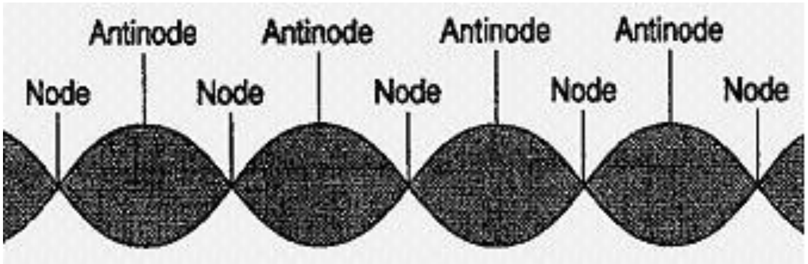
Where m = linear density of the string.

l = the length of the single loop.

For transverse arrangement of vibrations the frequency (n) of the tuning fork is

When the fork is in the in the longitudinal arrangement, the frequency of the stretched string is half of the frequency (n) of the tuning fork $n = \frac{1}{l}\sqrt{\frac{T}{m}}$





The Envelope of standing waves

Table 1: Transverse arrangement

S. No	Load applied M gm	Tension T=Mg	No of loops (X)	Length of x loops(S)	Length of one loop $l = \frac{S}{X}$	$\frac{\sqrt{T}}{l}$

Average value of $\frac{\sqrt{T}}{l}$ =

The frequency N of the fork n = $\frac{1}{2l}\sqrt{\frac{T}{m}} = \frac{1}{2\sqrt{m}}\frac{\sqrt{T}}{l}$

Table 2: Longitudinal arrangement

S.No	Load applied M gm	Tension T=Mg	No of loops (X)	Length of x loops(S)	Length of one loop $l = \frac{S}{X}$	$\frac{\sqrt{T}}{l}$

Average value of $\frac{\sqrt{T}}{l}$ =

The frequency of the fork is $n = \frac{1}{l}\sqrt{\frac{T}{m}}$ (or) $N = \frac{\sqrt{T}}{l}\frac{1}{\sqrt{m}}$

Precautions:

1. The thread should be uniform and inextensible.

2. The loops formed must be well defined.

Result:

The frequency of a vibrator in Transverse arrangement is _________

The frequency of a vibrator in Longitudinal arrangement is _________

Experiment No. Date: ____________

4. SONOMETER

Aim: To verify the laws of transverse vibrations in stretched strings.

Apparatus:

A sonometer with suitable wires, a rubber hammer, a weight hanger with slotted weights, tuning forks of different frequencies.

Principle: The laws of transverse vibrations in stretched strings are as follows .

1. The frequency (n) of a stretched string is inversely proportional to its length (l), T and m being constant, ie; n l = k
2. The frequency (n) of a stretched string is inversely proportional to the square root of its linear density (m). T and l being constant, ie; $n\sqrt{m} = k$
3. The frequency (n) of a stretched string is proportional to the square root of its tension (T) . ‘ l’ and ‘m’ being constant, ie; $\frac{n}{\sqrt{T}}$ = k

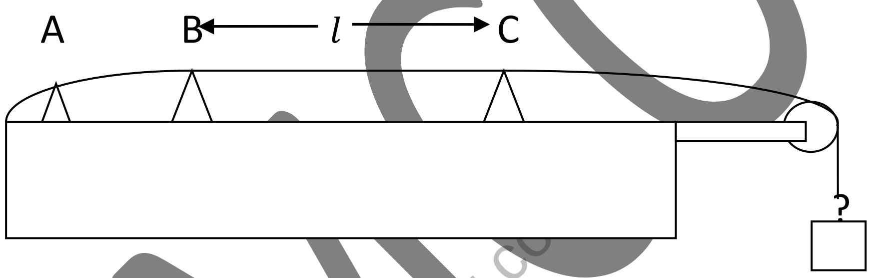


Table 1 : To verify first law

S.NO	Frequency of the fork (n) Hz	Length l of the vibrating segment			n x l
		Trial 1 l_1 cm	Trial 2 l_2 cm	Mean length l cm	

Table 2 : To verify second law

S.NO	Mass added M	Tension T=Mg	Length of the wire in resonance with the same fork			$\frac{\sqrt{T}}{l}$=const
			Trial 1 l_1 cm	Trial 2 l_2 cm	Mean length l cm	

Table 3 : To verify third law

S.NO	The linear density of the wire (m)	Length of the wire resonating with the fork			l x √m= const
		Trial 1 l_1 cm	Trial 2 l_2 cm	Mean length l cm	

Table 4 : To calculate radius of the wire

S.NO	P.S.R (a)mm	Head scale reading		nxL.C (b)mm	Total reading (a+b) mm
		Observed	Corrected(n)		
1 2 3					
1 2 3					

Precautions:

1. The wire must be stretched with suitable weight so that it does not hang loosely.
2. The total weight added must be within limits.

Result :

The laws of transverse vibrations are verified.

Calculations:-

Experiment. No Date: ____________

5. Newton's Rings

Aim:

To determine the radius of curvature of a Plano convex lens.

Apparatus:

A travelling microscope, a sodium vapour lamp, glass plate, Plano convex lens of large focal length.

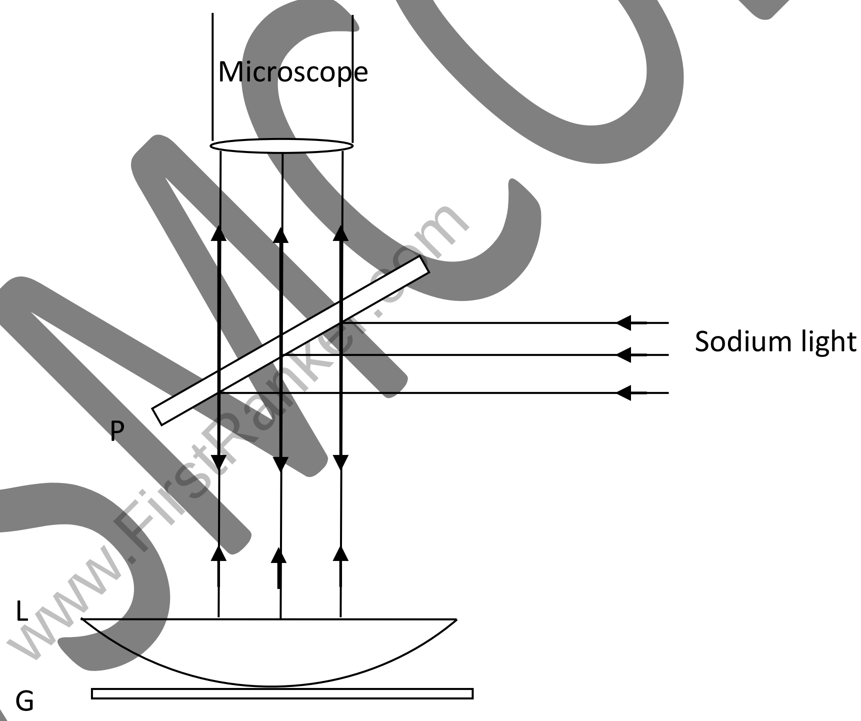
Formula :

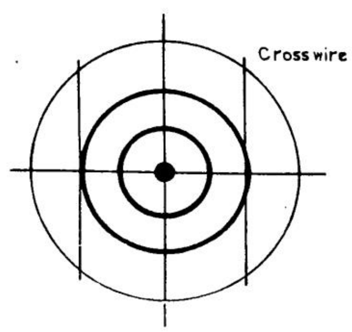
$$R = \frac{D^2_m - D^2_n}{4(m-n)\lambda}$$

D_m , D_n = The diameters on m^{th} and n^{th} dark rings respectively.

R = The radius of curvature of the surface of the lens in contact with the glass plate.

λ = The wave length of the light radiation = 5893×10^{-8}cm





Observations:

Least count of the Travelling microscope (L.C) = $\frac{One\ main\ scale\ division\ (MSD)}{no\ of\ vernier\ scale\ divisions}$

=

No of the ring n	Microscope readings						Diameter of the ring D= x ~ y	D^2	$D^2_m - D^2_n$
	On the left side (x)			On the right side (y)					
	MSR (a)	V.C (b)	X=a+(bxL.C)	MSR (c)	V.C (d)	Y=c+(dxL.C)			

Mean of $D^2_m - D^2_n$ =

$$R = \frac{D^2_m - D^2_n}{4(m-n)\lambda}$$

Precautions:

1. Light should be incident normally on the lens.
2. Microscope should be focused at the point of contact.
3. The glass plate and the lens must be clean.
4. Back lash error should be eliminated.

Result:

The radius of curvature of the given lens is ___________.

Calculations:-

Experiment No Date:____________

6. Diffraction Grating – Normal Incidence Method

Aim:

To determine the wavelength of a given light using diffraction grating.

Apparatus:

Spectrometer, spirit level, sodium Vapour lamp, diffraction grating.

Description:

A plane diffraction grating consists of a rectangular glass plate with equidistant fine parallel lines drawn on it by means of a diamond point. The number of lines drawn is 15,000 per inch.

Formula:

When the light is normally incident on a grating with N lines per cm, and θ is the angle of diffraction of light of wavelength λ in the n^{th} order spectrum, then

$$nN\lambda = \sin\theta \quad (\text{or}) \quad \lambda = \frac{\sin\theta}{Nn}$$

Procedure:

The usual adjustments of the spectrometer are made. Then the diffraction grating is set for normal incidence as follows

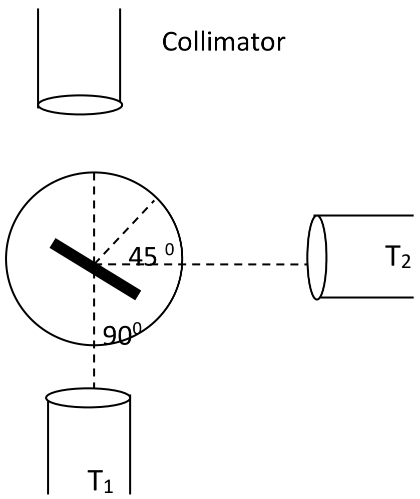
1. The telescope is placed in line with the axis of the collimator and the direct image of the slit is observed . The slit is made narrow and the vertical cross-wire is made to coincide with it. The reading on one vernier is noted. This is the position T_1 of the telescope.
2. The prism table is clamped firmly and the telescope is turned exactly through 90^0 and fixed in the position T_2.
3. The grating is held with its ruling vertical and is mounted on its holder. The prism table is released and rotated until the image of the slit is seen by reflection of light from the ruled surface of the grating the image is made to coincide with the cross-wire.
4. The vernier table is released and rotated through exactly 45^0 from its position. Now the ruled surface of the grating faces the collimator. The vernier table is fixed.
5. The telescope is released and brought back to direct reading position.
6. The light now strikes the grating normally.

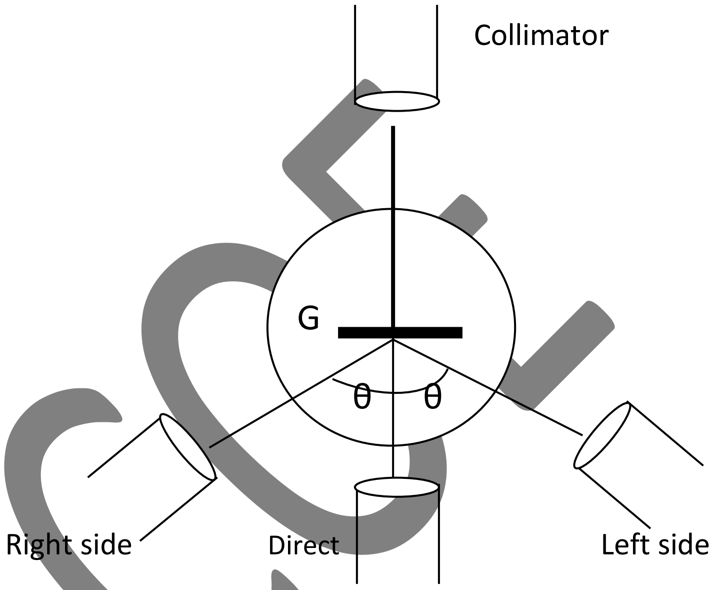
Next release the telescope and rotate it so as to catch the first order diffracted image on one side. With sodium light two images of the slit, very close to each other, can be seen. They are called D_1 and D_2 lines. Using the cross-wires note the readings corresponding to D_1 and D_2 lines .

Next, turn the telescope to the other side and similarly take the readings corresponding to D_1 and D_2 lines of the first order spectrum. Half the difference in the readings corresponding to any one line gives the angle (θ) for that line in first order spectrum. Repeat the experiment for second order spectrum and tabulate the results as shown below. Note down the number of lines per inch marked on the grating and estimate the number of lines per cm by using the relation.

$$N = \frac{No\ of\ lines\ per\ inch}{2.54}\ \text{(Since 1 Inch = 2.54cm)}$$

=





Observations: No of lines per inch =

No of lines per cm (N) =

Color	vernier	Readings of spectrometer						2θ	θ	$\lambda=\frac{\sin\theta}{Nn}$
		Left side			Right side					
		M.S.R	V.C (n)	Total Reading	M.S.R	V.C (n)	Total Reading			
D_1	Vernier 1									
	Vernier 2									
D_2	Vernier 1									
	Vernier 2									

Mean value of λ for D_1 line =

Mean value of λ for D_2 line =

Precautions :

1. The surface of the grating should not be touched.
2. The light should be incident on the side of the grating on which there are no rulings.

Result:

The wave lengths of the D_1, D_2 spectral lines are ___________.

Calculations :-

Experment No Date:____________

7. Air Wedge – Thickness of a wire

Aim:

To determine thickness of a thin wire, by measuring width of interference fringes formed by an air wedge.

Apparatus:

A traveling microscope, two optically plane glass plates, a thin wire, black paper, sodium Vapor lamp, a glass plate.

Formula:

The thickness of the wire is given by d = $\frac{\lambda l}{2\beta}$ cm

Where λ = wave length of light used.

l = Distance between the wire and point of contact of the glass plates.

β = Fringe width.

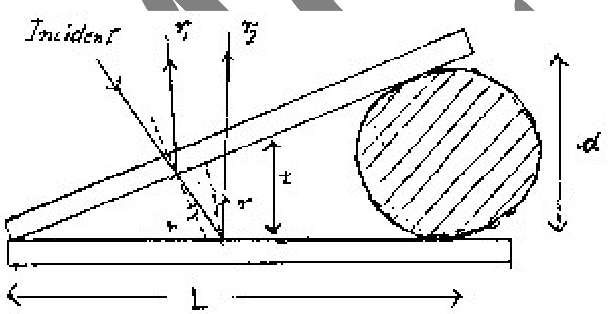


Fig. 1 Air Wedge

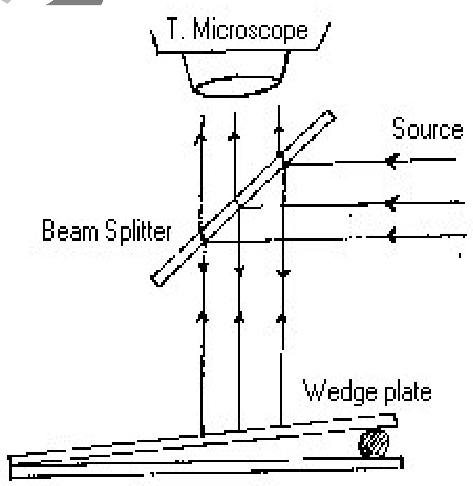


Fig. 2 Experimental setup

Observations: Wave length of sodium light = 5893A°

= 5893×10^{-8} cm.

Least count of the Travelling microscope (L.C) = $\frac{One\ main\ scale\ division\ (MSD)}{no\ of\ vernier\ scale\ divisions}$

=

To find the fringe width:

No of the fringe	Microscope readings			Width of the five fringes 5β
	MSR(a)	V.C(b)	X=a+(bxL.C.)	

Mean 5β =

Mean β =

Measuring of $'l'$ **:**

S.No	Microscope reading at		l
	Thin wire	Line of contact	

Mean l =

Precautions :

1. The two glass plates should be clean and optically plane.
2. The microscope is moved in the same direction to avoid back-lash.

Result :

The thickness of the wire is given by d = ______________

Experment No : Date:____________

8.ENERGY BAND GAP OF A SEMI CONDUCTOR

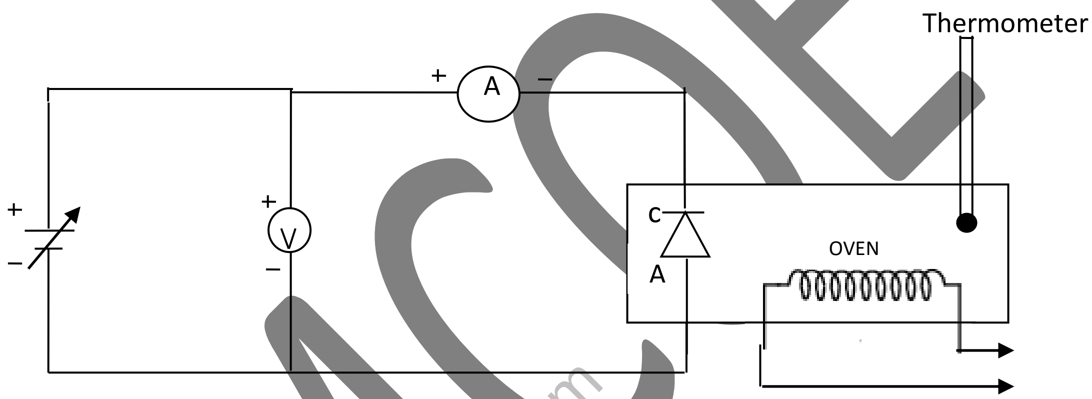
Aim:

To determine the energy gap of a semi conductor using a p-n junction.

Formula:

$$E_g = \frac{2 \times 2.303 \times K \times slope}{1.6 \times 10^{-19}} \ eV$$

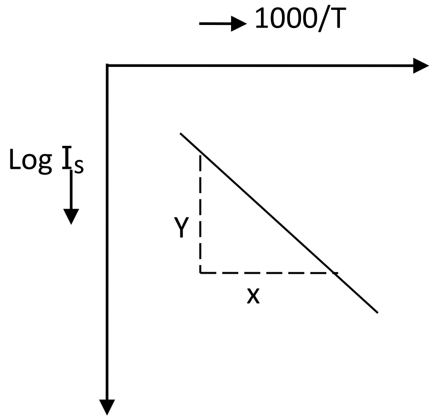
Circuit Diagram:



Tabular Form:

S.No	Current I_S μA	Temperature t°C	Kelvin T	1000/T	$Log_{10} I_s$

Graph:



Energy Gap ;

$$E_g = \frac{2 \times 2.303 \times K \times slope}{1.6 \times 10^{-19}} \text{ eV}$$

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

Result:

The energy gap of the given semi conductor is found.

E_g = ________________ eV.

Calculations:

Experment No Date:____________

9.Magnetic Field along the axis of a current carrying coil
STEWART AND GEE'S METHOD

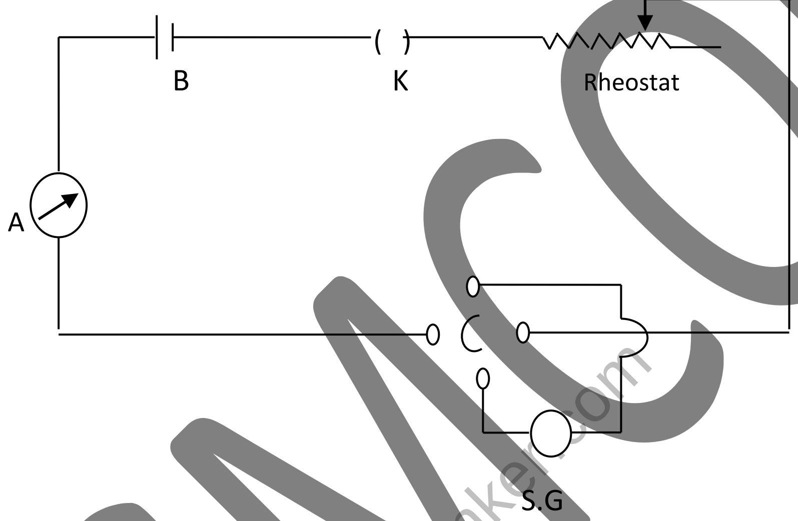
Aim:

To measure the magnetic field of induction along the axis of a circular current carrying coil.

Apparatus:

Stewart and gee's galvanometer, battery, ammeter, commutator, rheostat, plug key, connecting wires.

Circuit Diagram:



Formula:

$F = H \tan\theta$

Where H = 0.38 oersteds = Horizontal component of the earth magnetic field.

θ=Average deflection of magnetic needle.

$$F = \frac{2\pi n i a^2}{10(x^2 + a^2)^{3/2}}$$

Where n = number of turns in the coil;

i = current flowing through the coil.

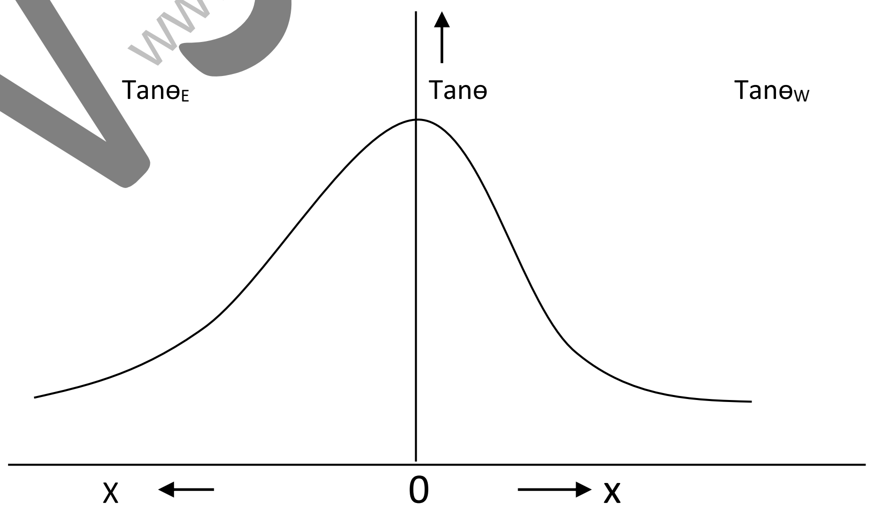
X = distance of the point from centre of coil.

a = radius of the coil.

Tabular Form:

S.NO	Distance of the compass from centre of coil	Deflection								Mean θ	Tanθ	F=HTanθ	$F= \frac{2\pi nia^2}{10(x2 + a2)^{3\backslash 2}}$
		East of the coil				West							
		Current direct		Current reverse		Current direct		Current reverse					
		θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	θ_7	θ_8				

Graph: A graph is drawn talking tan θ values along y- axis and distance along x-axis . It is symmetrical about the y- axis and the magnetic field is maximum at the centre of the coil.



Precautions: 1. Galvanometer should not be disturbed after making preliminary adjustments.

2.The deflections should be observed without parallax.

3. Magnetic objects should be kept away from the coil.

Result:

Experiment No. Date: ____________

10.ZENER DIODE CHARACTERISTICS

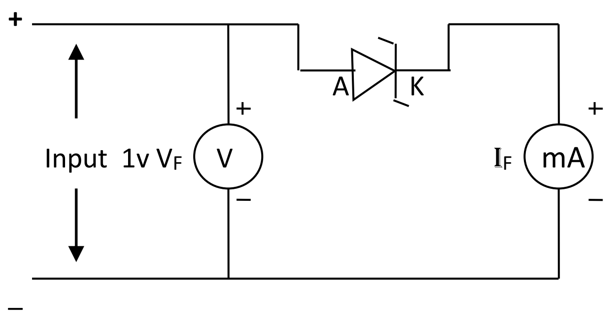
Aim:

To study the characteristics of a zener diode and hence determine its breakdown voltage.

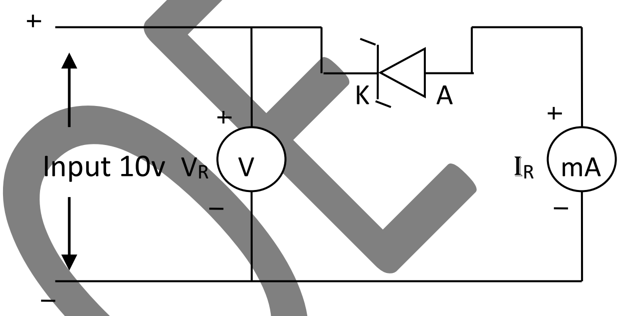
Apparatus:

Zener diode, variable power supply (0-15v), potentiometer, milli ammeter, multimeter.

Circuits:



Forward Bias



Reverse Bias

Observations Table-1:

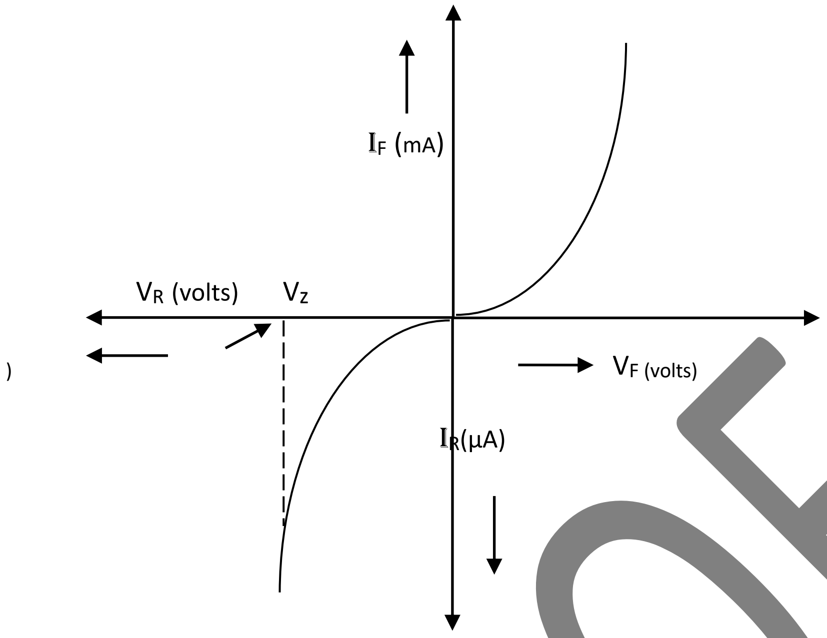
Forward Bias

S.No	V_F (volts)	I_F mA

Table-2: **Reverse Bias**

S.No	V_R (volts)	I_R mA

Graph:



Result: The characteristic curves of zener diode are drawn.

The breakdown voltage of the given zener diode V_Z = _________ volts.

Experiment No. Date: ____________

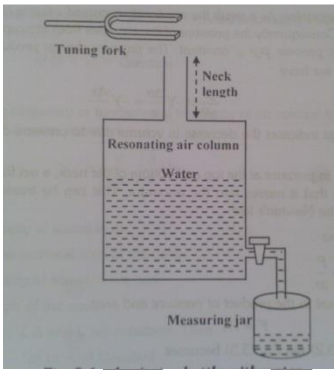
11.VOLUME RESONATOR EXPERIMENT

Aim: To verify the relation between the volume of the resonating air column in the resonating cavity and the frequency of the note producing resonance in it usig volume resonator.To find the frequency of the unknown tuning using volume resonator.

Apparatus:

Aspirator bottle, tuning forks(known frequencies),rubber hammer,measuring jar,a beaker and water

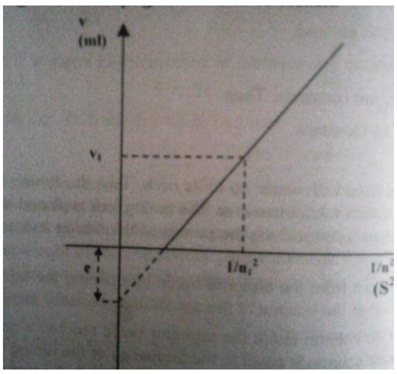
Diagram:



Observations:

s.no	Frequency of the tuning fork 'n ' Hz	Resonating air volume, V ml			n^2 Hz	$\frac{1}{n^2}$ Hz	$n^2(V+e)$=Constant
		Trial-I	Trial-Ii	Mean V			
	Unknown						

Graph: in order to find the end correction, a graph is drawn between $\frac{1}{n^2}$ (on x-axis) and V (on y-axis).The negative intercept gives the end correction.



Result:

i)The relation between resonating frequency and its resonating air volume has been verified

ii)The caluculated unknown frequency=……………………….Hz

Calculations

12.L C R Series Resonant Circuit

Aim

1. To study resonance effect in series circuit
2. To determine the resonant frequency

Apparatus

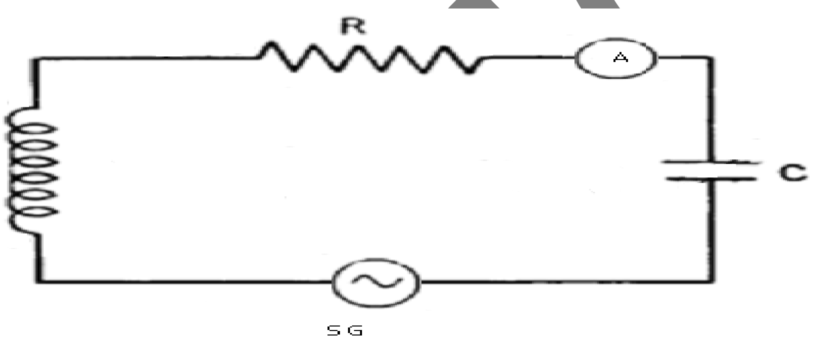
Signal generator, LCR Kit and connecting wires

Formula

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$ where f_r is the resonance frequency

C is the Capacitance in microfarad
L is the Inductance in henry
R is the resistance in ohm

Circuit:



Graph:

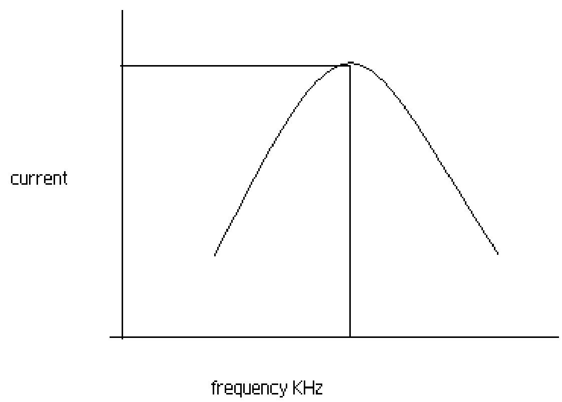


Table : To determine resonant frequency

Capacitance (C)= µF

S.No	Frequency(KHz)	Current(mA)	
		Resistance(100 ohm)	Resistance(200 ohm)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Precautions:

1. The out putt voltage of signal generator should be kept constant throughout the experiment.
2. Readings should be taken on both sides of f_0
3. R should be less in series and high in parallel circuit.
4. R should be at least 10 times the output impedance of signal generator.

Result:

1. Frequency response of LCR Series circuit is observed
2. The resonant frequency f_r= ------------------------------------ KHz

MODEL VIVA – VOCE QUESTIONS

1. Torsional pendulum:

1. Define moment of inertia.
2. Define rigidity modulus.
3. What is the difference between simple pendulum and torsional pendulum?
4. Two wires are made of same material but different radii. Which will have higher rigidity modulus?
5.

2. Compound Pendulum:

1. What is meant bycompound pendulum?
2. What is 'L' in the formula for finding 'g' value?
3. Why 'L' values are taken from graph?
4. Define one oscillation?
5. What is value of 'g' in S.I units and C.G.S units?

3. Melde's Experiment:

1. What is the difference between longitudinal and transverse modes?
2. Define standing wave.
3. Define nodes and anti nodes.
4. Define resonance.
5. Define frequency, what are its units?

4. Sonometer:

1. What are natural and forced vibrations?
2. Define resonance
3. Define standing wave.
4. Define nodes and anti nodes.
5. State the laws of stretched strings?

5. Newton's Rings:

1. Why are the fringes circular in shape?
2. Define interference.
3. Which type of interference is taking place?
4. Why is the central fringe dark?
5. Why do we use sodium light in this experiment?

6. Diffraction- Grating Minimum deviation:

1. Define diffraction?
2. What is diffraction grating?
3. Define dispersive power of a diffraction grating?
4. How many orders of spectra are visible?
5. Why should the diffraction grating be placed in minimum deviation position?

7. Air wedge – Thickness of a wire :

1. How do you form wedge shaped film?
2. Why are the fringes parallel?
3. What is the use of the glass plate fixed at 45^0 angle?
4. Why do we use sodium light in this experiment?

8 Energy Gap Of A Semi Conductor :

1. How many types of semiconductors are available?
2. What is a p-type of semiconductor?
3. What is n-type of semiconductors?
4. What is a p-n junction diode?
5. Define energy gap. What are the units of energy gap?
6. What are the applications of junction diode?
7. What is negative temperature coefficient of resistance?

9. Stewart-Gee's:

1. What is the direction of magnetic field at the centre of the coil?
2. Where magnetic field is maximum in Stewart-Gee's method?
3. State some of the applications of magnetic field produced by a circular coil.
4. In the present experiment why galvanometer should be kept away from ammeter and rheostat?

10 . Zener Diode:

1. What is depletion layer?
2. What is unidirectional property of diode? Mention its uses.
3. Compare diode and zener diode.
4. State the effect of doping on diode characteristics?
5. What are the majority charge carriers in forward biased diode?
6. What will happen if voltage more than reverse breakdown voltage is applied across diode?

11. **Volume Resonator:**

1. What is resonance?
2. What types of waves are generated?
3. What is meant by standing waves?
4. What is the principle involved in volume resonator experiment?

12. L-C-R Circuit :

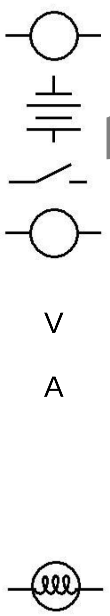
1. What will happen if both capacitor and inductor are connected in a circuit ?
2. What is resonant frequency?
3. LCR series circuit is called Acceptor. Why?
4. What is he status of a current in series and parallel connections?

List of Physical Constants		
Name	**Symbol**	**Value**
Acceleration due to gravity	*g*	9.8 m/S^2
Speed of light in a vacuum	*c*	$3x10^8$ m/S
Speed of sound in air at STP		330m/S
1 elementary charge	*e*	$1.6x10^{-19}$ C
1 coulomb (C)	C	$6.25x10^{18}$ elementary charges
1 electronvolt (eV)	eV	$1.6x10^{-19}$ V
Planck's constant	*h*	$6.625x10^{-34}$ J.S

Prefixes for Powers of 10

Prefix	Symbol	Notation
Tera	T	10^{12}
Giga	G	10^9
Mega	M	10^6
Kilo	k	10^3
Deci	d	10^{-1}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	µ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}

Circuit Symbols



cell
battery
switch
V voltmeter
A ammeter
resistor
variable resistor
lamp

ADD GRAPH SHEETS AT THE END OF EACH EXPERIMENT