DEPT OF SCIENCE & TECHNOLOGY, BIHAR

Govt. Polytechnic, Nawada

Established under Department of Science and Technology, Patna, Bihar

Applied Physics Lab Manual

For :

Diploma Students (All Branches) First Semester

Acknowledgements

During the course of applied physics lab manual preparation I have received much support, encouragement, advice and assistance from many people and I am deeply grateful to all of them.

I wish to thank and express my gratitude to Dr. Anand Krishna, Principal In charge G. P., Nawada for his valuable suggestions, inspiring spirits, extensive guidance, constant encouragement, constructive criticism in course of present assignment and for a critical review of the entire manual.

I also wish to express heartfelt thanks to all my colleagues for their ceaseless help and co-operation throughout this task.

I am greatly obliged to all the non-teaching staff of our institute for providing me time to time help at various stages of my work.

Prof. Ravi Kumar

Lecturer (Physics)

Govt. Polytechnic, Nawada

PREFACE

This Laboratory manual is designed to cover the applied physics experiments prescribed for I^st semester diploma students by SBTE, Bihar.

Each article contains list of equipment, theory, procedure, observation table and method of final calculation, precaution etc.

The present manual contains eight experiments (Complied by Prof. Ravi Kumar) and kept open ended for incorporating additional experiments in future.

The manual is meant for internal use only.

INDEX

Experiment No. 1

Subject Code : 1602107

Practical Name : Spring Constant

Aim:

To determine the force constant or spring constant (stiffness constant k) by using oscillation method.

Apparatus and material required: A light weight helical spring with a pointer attached at the lower end and a hook, A rigid support, hanger and five slotted weight of 10 gram Clamp stand, A measuring scale and Stop watch.

Principle:

Spring constant or force constant of a spring is given by

$$\text{Spring constant,} \quad K = \frac{\text{Restoring force}}{\text{Extension}}$$

(1) Thus, spring constant is the restoring force per unit extension in the spring. Its value is determined by the elastic property of the spring. A given object is attached to the free end of a spring which is suspended from a rigid point support (a nail, fixed to a wall). If the object is pull down and the released, it executes simple harmonic oscillation.

The relationship between time period (T) and spring constant is given by

$T = 2\pi\sqrt{\frac{m}{k}}$ Where m is the load of the object. If spring has large mass itself then expression change to

$$T = 2\pi\left(\frac{mo + m}{k}\right)^{1/2} \qquad (2)$$

Where mo. and m are the effective masses of the spring system.

One can easily eliminate the term m0 of the spring system appearing in equation

(2) by substituting two different object (load) of masses m1 and m2 and measuring their respective period of oscillation T_1 and T_2.Then

$$T_1 = 2\pi\left(\frac{mo+m_1}{k}\right)1/2 \quad (3)$$

$$T_2 = 2\pi\left(\frac{mo+m_2}{k}\right)1/2 \quad (4)$$

Eliminate the term mo. from equation and above equation and subtract the equation 4 from 3, we get

$$K = 4\pi^2(m_1 - m_2) / (T_1^2 - T_2^2) \quad (5)$$

Using equation (5) we can calculate the value of spring constant

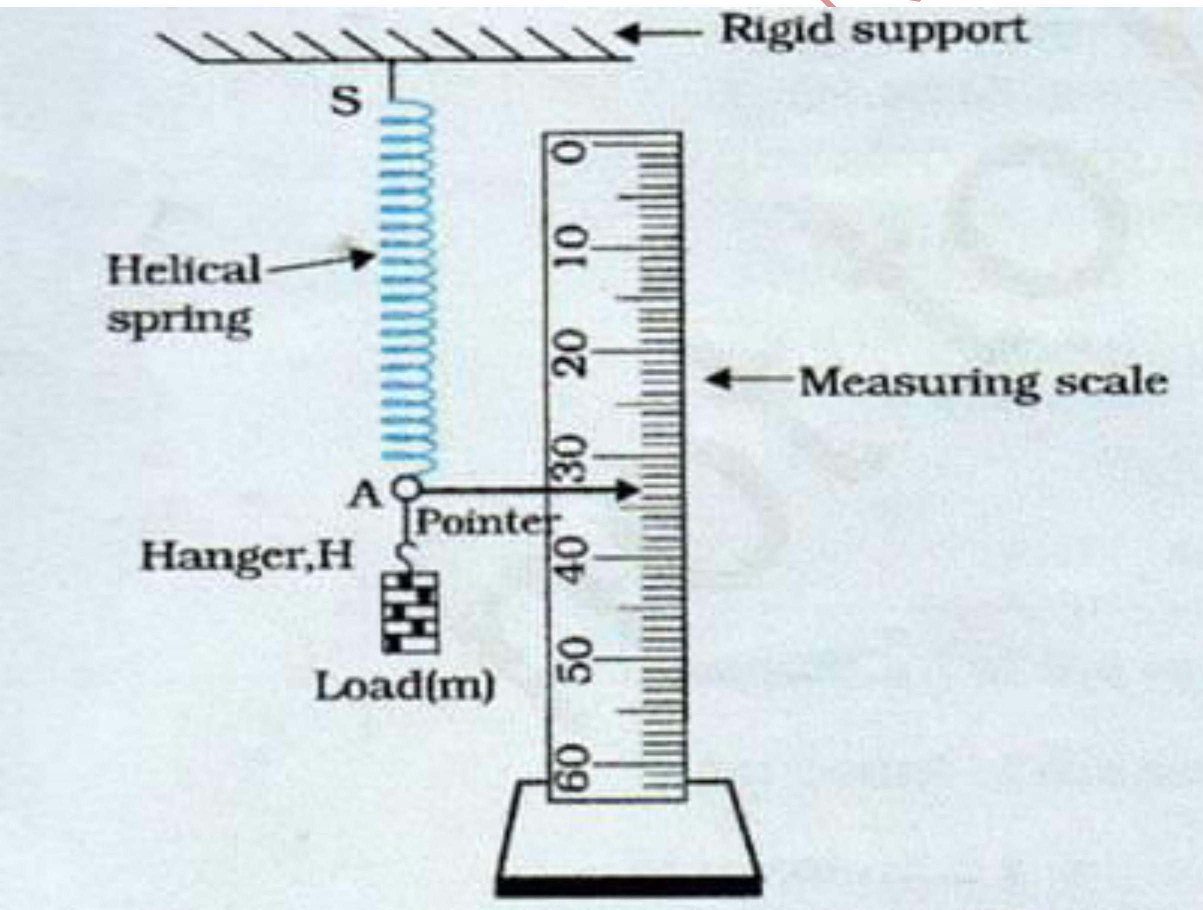


Fig. E 10.1 : Experimental arrangement for studying spring constant of a helical spring

1. Suspend the helical spring SA (having pointer P and the hanger H at its free end A), from a rigid support, as shown in figure (1).
2. Set the measuring scale, close to the spring vertically. Take care that the pointer P moves freely over the scale without touching it.
3. Suspended the load or slotted weight with mass m1 on the hanger gently. Wait till the pointer comes to rest. This is the equilibrium position for the given load. Pull the load slightly downwards and then release it gently so that it is set into oscillation in a vertical plane about its rest (or equilibrium) position. The rest position (X) of the pointer P on the scale is the reference or mean position for the given load. Start the Stop watch as the pointer P just crosses its mean position (say, upward to downwards) and simultaneously being to count the oscillations.
4. Keep on counting the oscillation as the pointer crosses the mean position (x) in the same direction. Stop the watch after n (say, 10 to 2o) oscillation are complete. Note the time (t) taken by the oscillating load for n oscillations.
5. Repeat this observation at least thrice and in each occasion note the time taken for the same number of oscillation (n). Find the mean time (t_1), for n oscillation and compute the time for one oscillation, i.e., the time period T_1 (=t_1/n) of oscillating helical spring with load m_1.
6. Repeat steps 3 and 4 for two more slotted weights.
7. Calculate time period of oscillation T=t/n for each weight and tabulate your observations.
8. Compute the value of spring constant (K_1, K_2 and K_3) for each load and find out the mean value of spring constant K of the given helical spring.

Observation :

Least count of the measuring scale = ….. mm = ……cm.

Least count of the stop watch = …..s

Mass of load m_1 = ……g = …..Kg

Mass of load m_2 =…….g =……kg

Mass of the load m_3 =….g = …….kg

Table

Measuring the time period T of oscillation of helical spring with load.

S.No.	Mass of the load m (kg)	Mean position of the pointer. X in cm	No. of oscillation. N	Time for n oscillation t(s)				Time period T = t/n(s)
				1	2	3	Mean	

Substitute the value of m_1, m_2, m_3 and T_1, T_2, T_3 in above equation. We get

$$K_1 = 4\pi^2 (m_1 - m_2) / (T_1^2 - T_2^2);$$

$$K_2 = 4\pi^2 (m_2 - m_3) / (T_2^2 - T_3^2);$$

$$K3 = 4\pi^2 (m_1 - m_3) / (T_1^2 - T_2^2);$$

Compute the value of k_1, k_2, and K_3 and find the mean value of spring constant K of the given helical spring. Express the result in proper SI unit sand significant figure.

Result:

Thus spring constant of the given helical springs …….N/m.

Precaution:

1. The spring should be suspended freely from a rigid support.
2. Loading of weight must be done gently.
3. Reading should be noted only when tip of the pointer comes to rest.
4. Pointer tip should not touch the scale surface.
5. Loading should note be beyond the elastic limit.

Experiment No. 2

Subject Code : 1602107

Practical Name : Determination of (g)

Aim :

To determine the value of acceleration due to gravity (g) with the help of bar or compound pendulum.

Apparatus used :

Bar pendulum, stop watch, Knife edges fixed to rigid support, Telescope and Meter scale.

Theory :

This experiment is based on the interchange ability of the centers of sustention and oscillation. The distance between center of sustention and center of oscillation is known as "length of equivalent simple pendulum".

L= $\frac{k^2}{l} + l$ Knowing this value, 'g' can be calculated.

The relation between time period and acceleration due to gravity is given by

$$T = 2\pi\sqrt{L/g} \qquad (1)$$

$$g = \frac{4\pi^2 L}{T^2} \qquad (2)$$

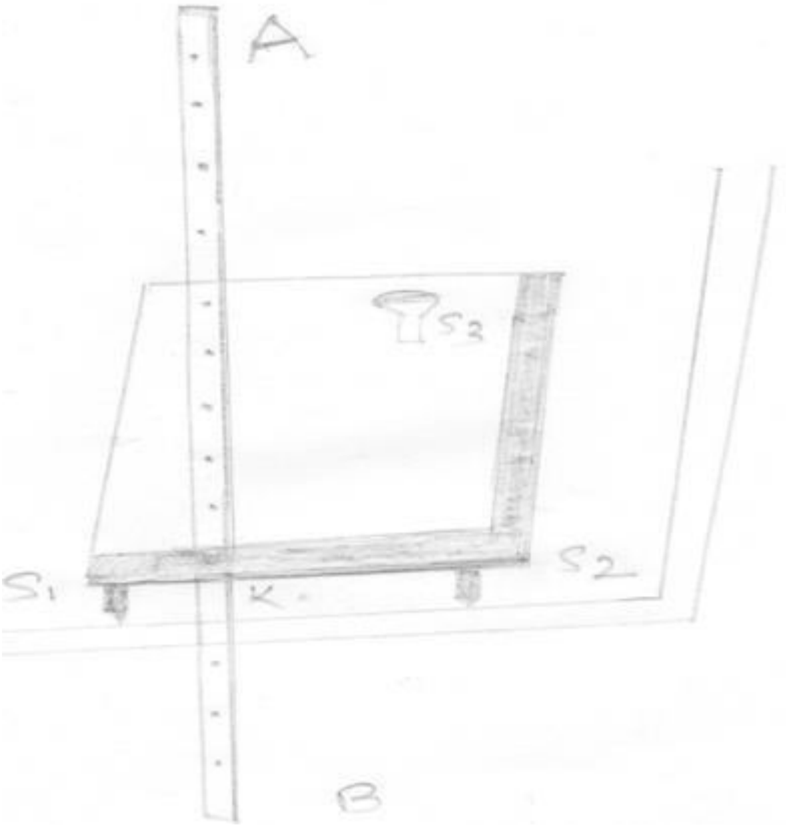
Where T= time period of oscillation.

L= Distance between center of oscillation and suspension.

Description :

A bar pendulum consist of uniform rectangular bar AB about one meter (100cm) long and 2cm in breath, with holes drilled along its length at equal distance from each other. The lies on the straight line passing through the center of gravity of the pendulum. A sharp knife edge is attached to some heavy frame provided with leveling screw s_1, s_2 and s_3

to make the knife edge horizontal. The bar can be suspended from any holes with the help of knife edge.



Procedure:

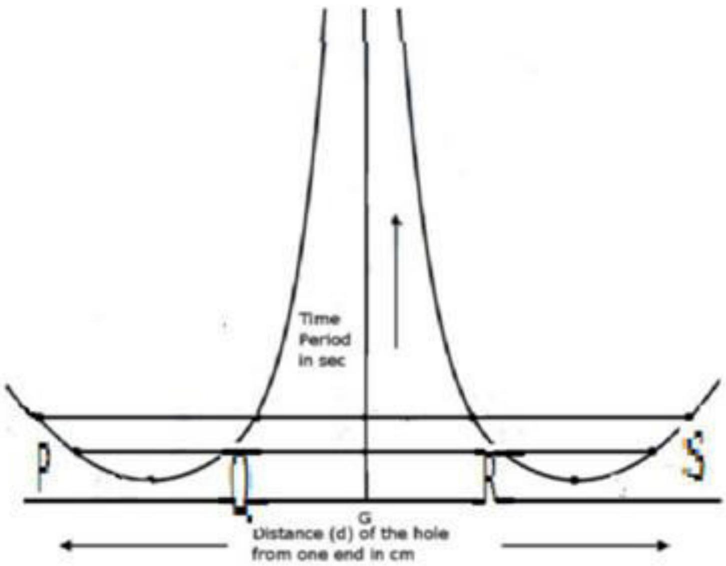
1. The bar pendulum is suspended vertically about the knife edge from the hole nearest to one end.
2. The knife edge is made horizontal by means of levelling screws.
3. A telescope is focused on the lower end of the pendulum. The bar is allowed to oscillate through small angle with knife edge passing through the hole no (1) and the time for 30 oscillation is noted with the help of stop watch. The time period of thirty oscillation is calculated.
4. Then the bar pendulum is suspended successively from its other hole and the corresponding time for 30 oscillation is noted. This distance of each hole from any

one end of the bar pendulum is also noted. Further the position of C.G, is determined by balancing the pendulum about a knife edge.

5. A graph is plotted between the measured distance and the corresponding time period.

Observation Table

No. of Holes	**Distance of the knife edge from the end A**	**No. of oscillation**	Time taken in (s)				**Total Period**
			1	**2**	**3**	**Mean**	



Result : From graph

PR= …….. cm= ……. m

QS= ………cm=………m

OE = T = ……. S.

$G = 4\pi^2\left(\frac{L}{T^2}\right) = \ldots\ldots m/s^2.$

Sources of error and Precaution:

1. The knife edge is made horizontal before starting the experiment.
2. The amplitude of oscillation should be kept small.
3. The time of oscillation should be counted at least for 30 oscillation with the help of telescope.
4. The pendulum should be oscillate only in a vertical plane.
5. Smooth curves should be drawn on the graph paper.

EXPERIMENT NO. 3

Subject Code: 1602107

Practical Name: Speed of sound

Aim :

To find the speed of sound in air at room temperature using a resonance tube apparatus by two position method.

Apparatus:

1. Resonance tube apparatus
2. Two tuning fork of different frequencies
3. A rubber pad
4. Water in a beaker.
5. A plumb line.
6. A thermometer.
7. A set-square.

Theory :

If l_1 and l_2 are the length of the air column for first and second resonance position as shown in figure (3).

Then $l_1 + x = \lambda/4$ (1).

$l_2 + x = \lambda/4$ (2).

Where x is the end- correction and ë is the wave length of the sound wave. From (1) and (2) we have

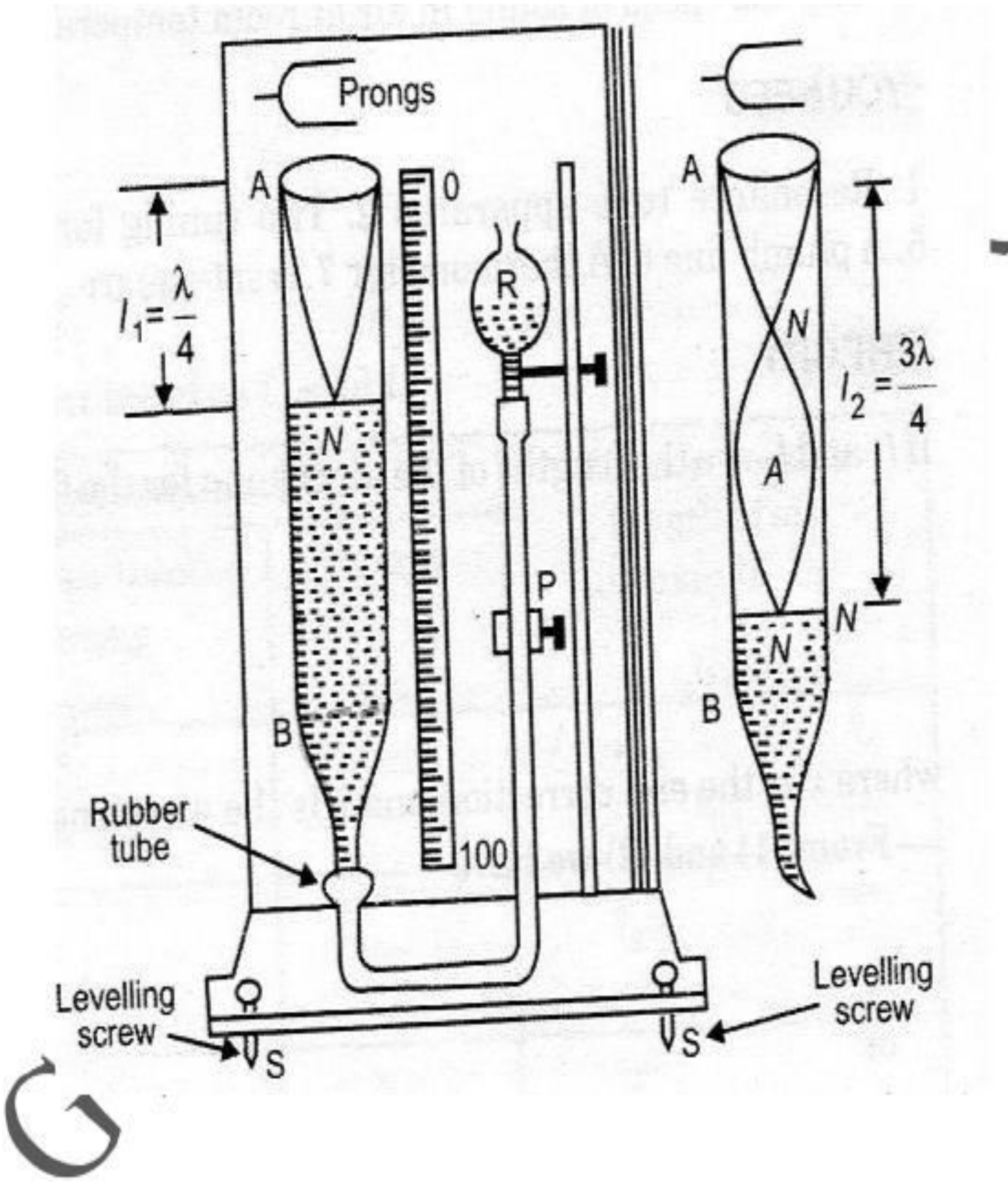
$l_2 - l_1 = \lambda/2$ (3)

or $\lambda = 2(l_2 - l_1)$ (4).

Let v is the velocity of sound and n is the frequency, then

$V = n\lambda$

From equation (3) and (4), we get, $v = 2n(l_2 - l_1)$ (5).


Prongs
A
0
R
$l_1 = \frac{\lambda}{4}$
N
P
B
100
Rubber tube
Levelling screw
S
Levelling screw
S
A
N
$l_2 = \frac{3\lambda}{4}$
A
N
N
B

Procedure:

1. Set the resonance tube apparatus vertically with the help of plumb line and by adjusting the leveling screw S-S provided with the base of the apparatus.
2. Note the room temperature with the help of the thermometer and fill some portion of resonance tube and reservoir with water.
3. Open the pinch cock P and adjust the level of water in the resonance tube near the end A by adjusting the position of the reservoir R and then close the pinch cock. Now lower down the reservoir, keeping the pinch cock tight.
4. Strike the tuning fork gently on the rubber pad and place it just above the open end A of the resonance tube in such a manner so that it prongs are in vertical plane. Open the pinch cock and allow the water level to fall gradually till the intensity of the sound heard maximum. At this position close the pinch cock at once and note the position of the water level with the help of set- square keeping one of its perpendicular edges tangential to meniscus of the water and other edge parallel to the line of graduation on the meter scale. Record this reading of first resonance length l1 when the water level is falling.
5. Now lower the water level in resonance tube by a few cm, close the pinch cock and rise the reservoir to the highest position. Now place the vibrating tuning fork over the open end of tube and release the pinch cock. Allow the water in the tube to rise slowly till the intensity of sound heard maximum. Note this position of water level with the help of set-square and record this reading of first resonating length l1 when the water level is rising.
6. Find the first resonant length of air column with the same tuning fork for two times more and hence find the mean first resonant length l1.
7. To find the second resonant length l2 with the same tuning fork, lower the position of water level so that the length of air column is increased about three times the length l1. Repeat the steps3, 4, 5and 6to get the second position of resonance with the same tuning fork. Record this length l2 of the air column.
8. Now take the second tuning fork and repeat the steps 3,4,5,6 and 7.
9. Note the room temperature with the help of thermometer.
10. Record all the observation in the table.

Observations:

Room temperature in the beginning of the experiment t_1 = t_1=…….C^0.

Room temperature at the end of the experiment = t_2 = …..C^0.

Frequency of the first tuning fork = ….Hz.

Frequency of the second tuning fork = …..Hz.

Reading of the upper end (open end) A of the resonance tube = a = ……cm.

Table for the calculation of the resonant length l_1 and l_2.

Frequency of tuning for k(Hz)	**Resonance**	**S. No.**	**Position of Water resonance (b)**			**Mean resonant length of air column (b – a) cm.**
			Water level falling (cm.)	**Water level rising (cm.)**	**Mean (b)**	
N_1	**First**	**1** **2**				**l_1**
	Second	**1** **2**				**l_2**
N_2	**First**	**1** **2**				**l_1**
	Second	**1** **2**				**l_2**

Calculate the velocity of sound v_1 in air by putting the value of n_1, l_1 and l_2 in the formula

$$V_1 = 2n_1 (l_2 - l_1)$$

$$= \ldots\ldots \text{m/s.}$$

In the same manner, calculate the velocity of in air v_2 by putting the value of n_1, l_1 and l_2 in the formula

$$V_2 = 2n_2 (l_2 - l_1)$$

$$= \quad \ldots.. \text{ M/s.}$$

Mean value velocity of sound at room temperature = v1+v2/2

$$V_t = \ldots.. \text{ M/s.}$$

Result :

Velocity of sound in air at room temperature (t = c) using a resonance tube by two resonance position method is ….m/s.

Precaution :

The resonance tube apparatus should be placed vertically.

The tuning fork should be strike gently on the rubber pad.

The vibrating tuning fork should be held horizontally over the open end of the tube.

The prongs of vibrating tuning fork should note touch the tube.

Sources of error :

The resonance tube may not be vertical.

The pinch cock may be loose.

The presences of moister in the tube will be increase the velocity of sound.

EXPERIMENT NO 04

Subject Code :1602107

Aim :

To measure to coefficient of absorption for acoustical materials .

Apparatus :

Sound proof box of 3 ft × 1 ft × 1 ft size, coated with sound proof materials, with a glass window on the top for observing Sound Level Meter at the position shown in Fig 4.1, Sound Level Meter, Frequency generator, Audio amplifier, sound absorbing materials (plywood, medium density fiber board (MDF), glass and bakelite)

Significance of the experiment :

One of the major acoustical defects of an auditorium, concert hall or theatre is excessive reverberation (and echo). A well proven method for optimizing the reverberation time is to use sound absorbing materials in the construction of the auditorium. The capacity of a material to absorb the sound is measured in terms of absorption coefficient. Sound absorbing materials are also used for noise reduction, coating the submarines and in acoustic delay lines and acoustic filters

Theory :

When sound wave falls on any material, part of it is reflected, a part is transmitted and a part is absorbed. The property of a material by which sound energy incident on it is converted in to other form of energy (mostly heat) is called as absorption. Absorption results into attenuation of the sound. The mechanisms responsible for absorption of the sound by a material are heat conductivity, sound scattering due to grain boundaries, magnetic domain losses due to ferromagnetic materials, interstitial diffusion of atoms, dislocation, relaxation process in metals, interaction of sound with lattice vibrations called phonons etc. The ability of the substance to absorb the sound is measured in terms of absorption coefficient (a), It is defined as the ratio of the sound energy absorbed to sound energy incident upon it.

Absorption coefficient = sound energy absorbed by the substance/sound energy incident upon it = $W_{\alpha}/W_{I} = W_{T}/W_{I}$ 4.1

An open window is considered as an ideal absorber, as it transmits the entire acoustic energy incident upon it. Thus the absorption coefficient of open window is 1. For an open window the absorption coefficient is same as transmission coefficient. The absorption coefficient of all the other substances is expressed in terms of absorption coefficient an open window. This unit is called as Open Window Unit (O.W.U.) or Sabine in the name of Prof. W.C. Sabine who developed Sabine's formula and contributed in the theory of architectural acoustics.

Three key factors on which absorption coefficient depends are…nature of material, frequency of sound and the temperature. The ideal methods that are used to measure absorption coefficient are based on reverberation chambers and impedance tubes. Sound absorption coefficient can also be calculated using a formula given below

$$\alpha = (WI - W)/WI = 1 - WR/WI..... \quad (4.2)$$

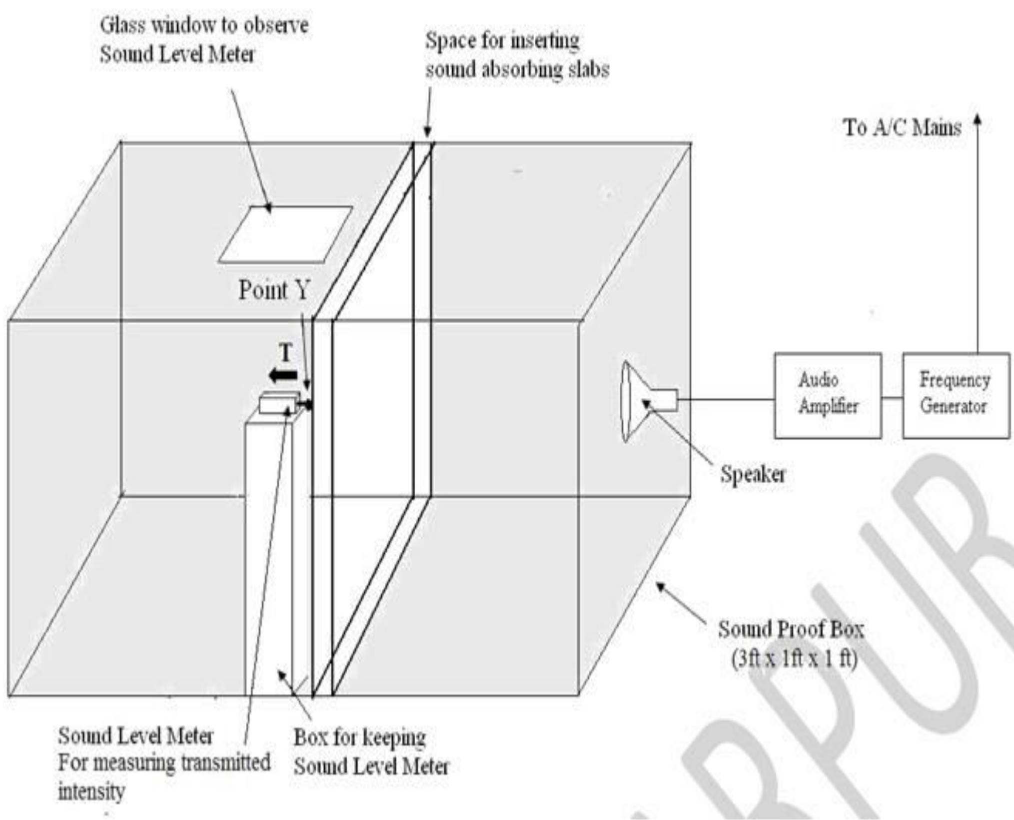


Figure 4.1: The experimental set up for measuring sound absorption coefficient

Procedure :

1. Make the sound level meter ON and adjust it's range to 80 to 130 dB. Keep the sound level meter at position Y as shown Fig 4.1. Close the sound proof box
2. Make a/c mains, frequency generator, audio amplifier and speaker ON. At first adjust the frequency in the frequency generator to 500 Hz.
3. Measure the intensity in sound level meter in dB (decibels) at position Y in the absence of material as shown in Fig 4.1. Let this reading be W_I. This is direct reading.
4. Measure the direct sound intensities at other frequencies; 1000 Hz, 1500 Hz, 2000 Hz and 2500 Hz. Record these intensities in the observation tables 4.1, 4.2, 4.3, 4.4. Direct readings are common to all four observation tables.
5. Now place the first sound absorbing material at the place as shown in the Fig. 4.1. By keeping the sound level meter at same position Y, measure the intensity of sound in *dB* at the frequencies 500 Hz to 2500 Hz as mentioned earlier. Let this reading be W_T.
6. Calculate the sound absorption coefficient by using following Eqn.

$$\alpha = WT / WI \qquad (4.3)$$

7. Repeat the same procedure for all given absorbing materials.
8. Tabulate all observations and calculations as per tables 4.1 to 4.4
9. Plot the graphs of sound absorption coefficient Vs frequency for each material

Observations and Calculations

Table 4.1: Name of the material: Plywood, Thickness = ... mm

Sr. No.	Frequency Hz	Direct intensity W_1, dB	Absorbed/transmitted intensity, W_T, dB	Sound absorption Coefficient, a
1	500			
2	1000			
3	1500			
4	2000			
5	2500			

Table 4.2: Name of the material: MDF (Medium Density Fiberboard), Thickness = ... mm

Sr. No.	Frequency Hz	Direct intensity W_1, dB	Absorbed/transmitted intensity, W_T, dB	Sound absorption Coefficient, a
1	500			
2	1000			
3	1500			
4	2000			
5	2500			

Table 4.3 Name of the material: Bakelite, Thickness = ... mm

Sr. No.	Frequency Hz	Direct intensity W_1, dB	Absorbed/transmitted intensity, W_T, dB	Sound absorption Coefficient, a
1	500			
2	1000			
3	1500			
4	2000			
5	2500			

Table 4.4: Name of the material: Glass, Thickness = ... mm

Sr. No.	Frequency Hz	Direct intensity W_1, dB	Absorbed/transmitted intensity, W_T, dB	Sound absorption Coefficient, a
1	500			
2	1000			
3	1500			
4	2000			
5	2500			

Viva Voce :

1. Why is sound reflected by a substance?
2. Why is sound absorbed by substance?
3. How is sound transmitted by the substance even if it is not porous?
4. The sound absorption coefficient is the ratio of two intensities in the same unit, which is dB. So it is the dimensionless quantity. How does then it has a unit of O.W.U. (Sabine)?
5. Most of the sound energy that is absorbed by a sound absorbing material is converted in to heat. What must be the mechanism?
6. Why different substances have different absorption coefficients?
7. Amongst the materials that you have used, which material has least absorption coefficient? Why?
8. Amongst the materials that you have used, which material has maximum absorption coefficient? Why?
9. Why should absorption coefficient depend upon the frequency of the sound?
10. Does sound absorption coefficient depend upon the temperature?
11. The sound absorbing materials are used to absorb the excess sound in the auditoria, concert halls etc. Why the sound needs to be absorbed at such places?
12. In the same theater/auditorium different sound absorbing materials are used at different locations. Why?
13. Sound absorbing materials are also used for noise reduction. What do you mean by noise?
14. What are the typical places where noise is excessive?
15. A person has his house very near to the highway. So he is troubled due to noise. Out of the materials that you have tested for the experiment, which material you will suggest for noise reduction?

16. Do you think that the materials with low absorption coefficients and high reflection coefficients can have applications? If, yes then what are these applications?

17. Sound absorbing materials are used in acoustic delay lines. What is acoustic delay line? Where it is used?

18. Sound absorbing materials are used in acoustic filters. What is acoustic filter? Where it is used?

19. Suppose you did this experiment by taking all absorbing materials with thickness of 3 mm and in some other institute the same experiment is performed by taking the same materials but having 6 mm thickness or say 1.5 mm thickness. Do you think that the results will be affected? Why? Why not?

EXPERIMENT NO. 05

Subject Code: 1602107

Aim :

To determine Joule's constant (J) by electric method.

Apperatus :

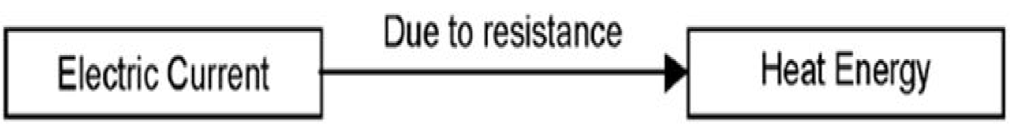
Joules calorimeter , Voltmeter , Power supply , Ammeter, Thermometer, Connecting wires, Measuring cylinder.

Theory :

Heating effect of electric current :

It states that, current flowing through conductor is opposed by its resistance and re-appears in the form of heat. This is called heating effect of electric current.

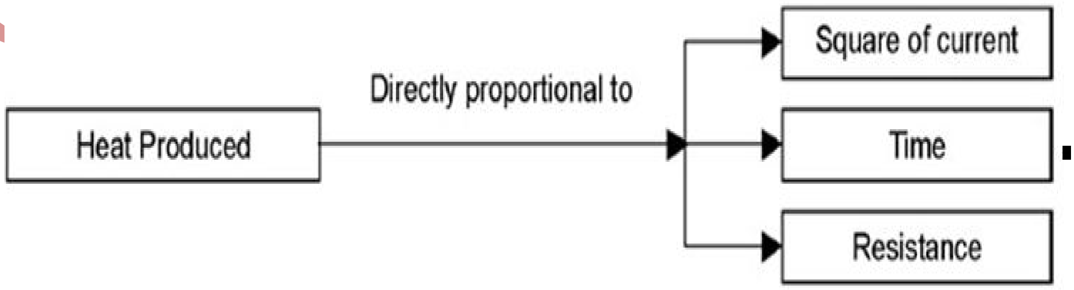
Concept Structure :



Joule's Law :

It states that quantity of heat (H) produced in conductor is directly proportional to square of electric current (I2) time (t) during which current flows and resistance (R) of the conductor.

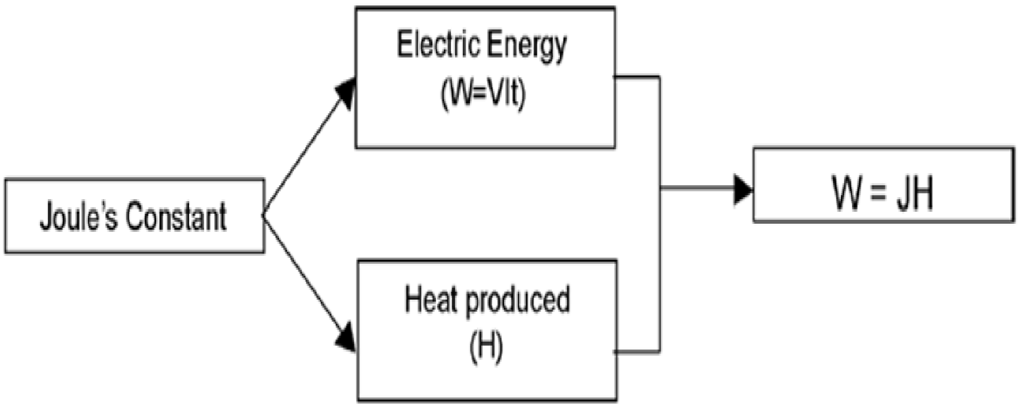
Concept Structure :



Joule's Constant (J) :

Joules constant is conversion factor between heat energy in joule and heat in calories.

Concept Structure :

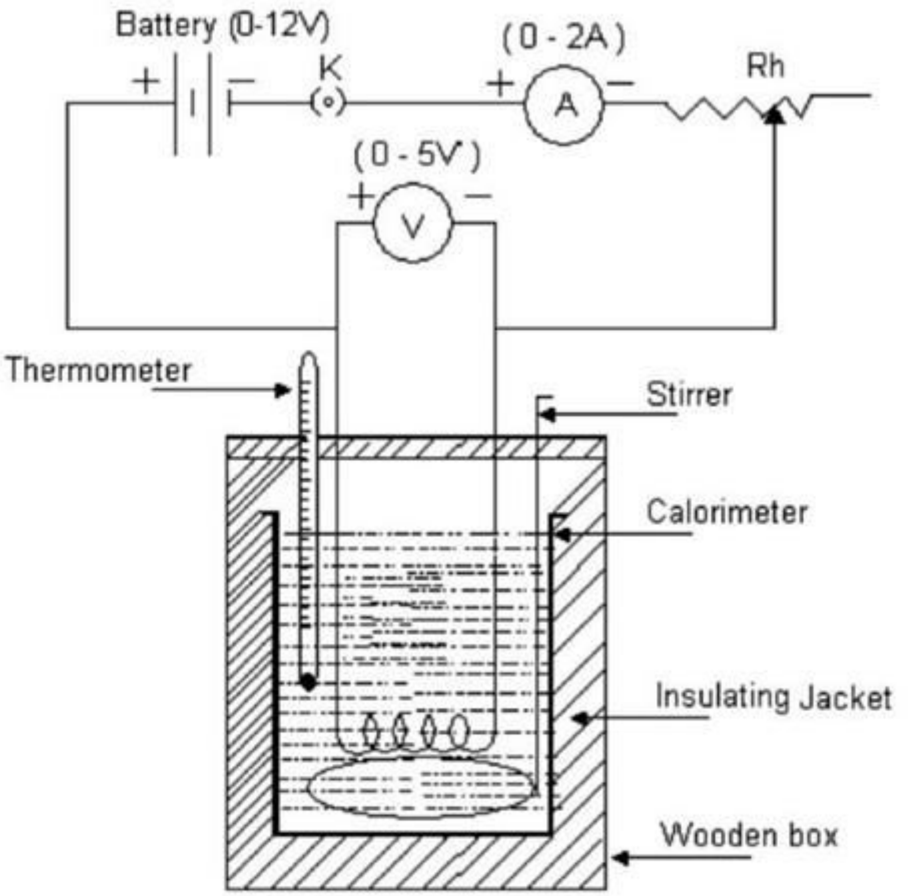


THEORY :

In 1844-1854 the English scientist J. P. Joule conducted experiments which were destined to play an important role in science. The objective of Joule's experiment was to establish a relation between the amount of work spent to bring about the liberation of heat and the amount of the heat liberated.

Heat is one of the most essential concepts of thermodynamics. By its nature the concept of heat is very close to the concept of work. Both heat and work are forms of transfer of energy. We can only state that a certain amount of heat or work has been imparted to, or taken away from, a body. It is customary to assume that addition of heat involves a rise in the temperature of the body, determined by the energy of the micro particles constituting the body, which is often the case. But, as it will be seen later on, it happens that notwithstanding the addition of heat to a body its temperature decreases. All depends on the balance of the energy transferred to the body and removed from it. In the special but most widespread case the change in the temperature of a body is determined by the relation between the amounts of heat and work imparted to the body and removed from it.

Circuit Diagram :



Amount of heat produced by electricity is, H= I^2Rt/J

But, $V = IR$

$H = VIt/J$ .... (1)

Amount of heat absorbed by calorimeter and water is,

$H = [M_c S_c + M_w S_w][\theta_2 - \theta_1]$ .... (2)

Equating (1) and (2) we get,

$VIt/J = [M_c S_c + M_w S_w][\theta_2 - \theta_1]$

$J = \frac{VIt}{[M_c S_c + M_w S_w][\theta_2 - \theta_1]}$

= ………………………… J/kcal

EXPERIMENT NO. 06

Subject Code - 1602107

Practical Name : NEWTON'S RINGS - RADIUS OF CURVATURE OF PLANO CONVEX LENS.

AIM :

To determine of Radius of curvature of a Plano convex lens by Newton's rings method.

APPARATUS:

A convex lens is focal length about 100 cm, two optically plane glass plates, and travelling micro scope, a condensing lens and sodium Vapour lamp.

DESCRIPTION :

The convex lens is placed on the optically plane plate B as shown in the below fig. On the platform of the travelling microscope. A black paper is placed under the glass plate.

The condensing lens C is placed at a distance equal to the focal length of the lens from the sodium Vapor lamps. The emergent parallel beam of the light is directed towards the glass plate A kept directly above the center of the lens and inclined at 45^0 to the vertical. The beam of light is reflected on the lens L. As a result of interference between the light reflected from the lower surface of the lens and the top surface of the glass plate B. Newton's rings with alternate bright and dark rings are formed having a black center. The microscope can focus these rings. (It may happen that the center of the ring system is bright. This is due to the presence of dust particles between the lens and the thick glass plate. In such a case the surface of the lens and the glass plate has to be cleaned.)

PROCEDURE :

The microscope is focused at the center of the ring system. The microscope is moved so that the cross wires pass over 16 or 17 dark rings. Then the microscope is moved back until the vertical cross wire is set at the middle (or end) of the 15^{th} dark ring. The reading of the main scale and the number of Vernier coincidences are noted from which the reading of the microscope can be determined. The microscope is moved so that the vertical cross wire is set at the middle of the 14th dark ring. The readings of the microscope are noted. Similarly the readings of the microscope with crosswire set Successively at the middle of 13th, 12th, 11th etc…………..5th dark ring. The microscope corresponding to 5th, 6th, 7th …. 15th dark ring on the other side of the center are noted. From these observations the diameters of the 5th, 6th, etc………15th dark rings can be found.

The convex lens L is removed and its radius of curvature R is determined either by a spherometer or by Boy's method.

A graph is drawn with number of the dark ring on the x-axis and the square of the diameter (D^2) on the y-axis. The graph is a straight line passing through origin. From the graph the values of Dm^2 and Dn^2 corresponding to nth and mth rings are found.

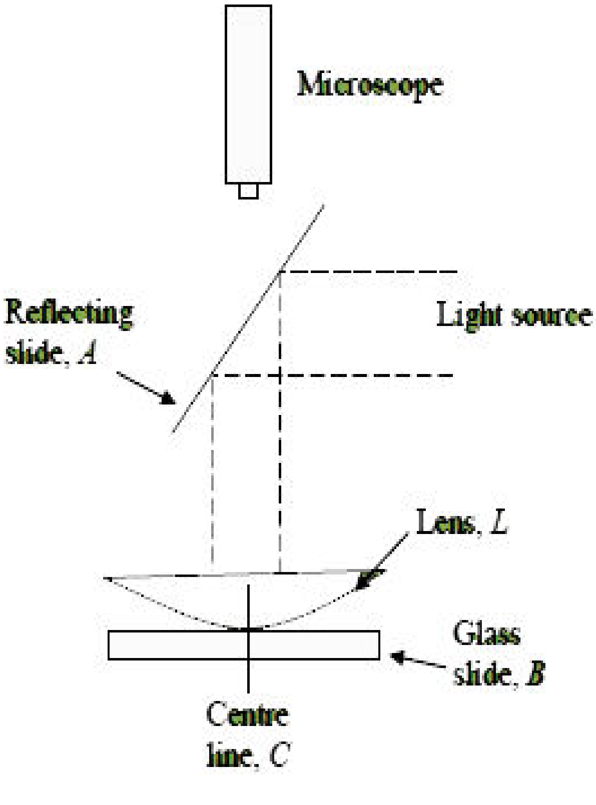
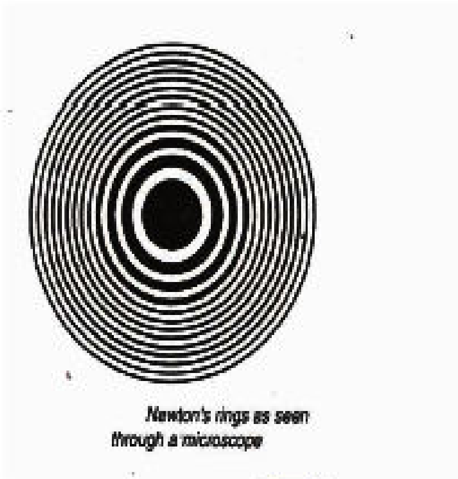
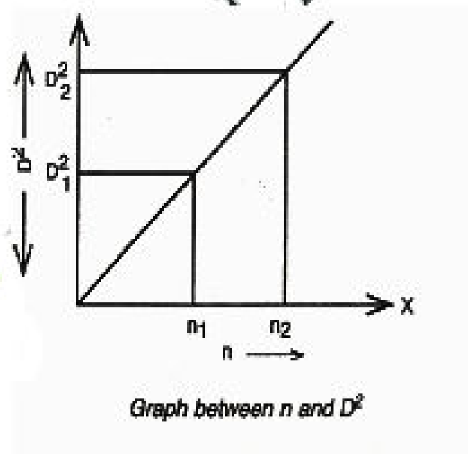


Figure 1: Apparatus





The wavelength λ of sodium light is found by the formula

$$\lambda = \frac{D_n^2 - D_m^2}{4R(n-m)} A^0$$

Radius of curvature can be obtained by

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

On taking the standard wave length of sodium light, the radius of curvature of the lens can be calculated.

The value of the radius of the curvature of the lens is verified using spherometer.

OBSERVATIONS :

$$\text{Least Count} = \frac{1 MSD}{\text{No div in vernier scale}}$$

S.No.	Number of the dark ring	Microscope Reading		Diameter D = b – a	D^2
1	14				
2	12				
3	10				
4	8				
5	6				
6	4				
7	2				

CALCULATIONS :

$$R = \frac{D_n^2 - D_m^2}{4\lambda(n-m)} \text{ or } R = \frac{\text{Slop}}{4\lambda}$$

Wavelength of sodium light λ = 5893 A^0.

PRECAUTIONS :

1. While taking the observations the microscope should be moved only in one direction to avoid error due to back lash.
2. The lens L and the glass plate P should be perfectly clean.
3. The slow motion tangent screw alone should be moved in taking the observations.

RESULT :

Radius of curvature of the lens= ………….. cm.

EXPERIMENT NO. 07

Subject Code - 1602107

Practical Name : The Travelling Microscope

AIM :

To learn the parts of Travelling Microscope and to read a reading.

Apparatus :

Reading lens and capillary tube.

Description :

It is a compound microscope attached to a graduated vertical pillar, which is mounted on rigid platform (Fig. 1). The platform is provided with three levelling screws. The microscope can be set with its axis either in the vertical or the horizontal position. The microscope can be moved in the vertical or horizontal direction by means of a screw arrangement attached to it. The distance through which the microscope is moved is reared on the scale. There are two scales one for horizontal movement and the other for the vertical movement. Each scale has a main scale (M_1, M_2) and a vernier scale (V1, V2). The vernier moves with the microscope. As in the spectrometer, there is a set of main screw and fine adjustment screw, for the horizontal and the vertical movements. One set is fixed to the pillar for vertical movement and the other set is fixed to the platform for horizontal movement. The eyepiece of the microscope is provided with cross-wires. The image of an object is focussed by the microscope using a side screw (focusing screw) attached to the microscope.

Procedure :

1. **To find the Least Count (LC) of the travelling microscope.**

The main scale is graduated in mm. There are 50V V.S.D. equivalent to 49 M.S.D. The value of one M.S.D. is 0.5mm = 0.05cm.

LC = 1 M.S.D. – 1 V.S.D.

1 M.S.D. = 0.05cm

50 V.S.D.	=	49 M.S.D.
1 V.S.D.	=	$49/50 \times 0.05 = 0.049$cm.
LC	=	$0.05 - 0.049$cm.
LC	**=**	**0.001cm.**

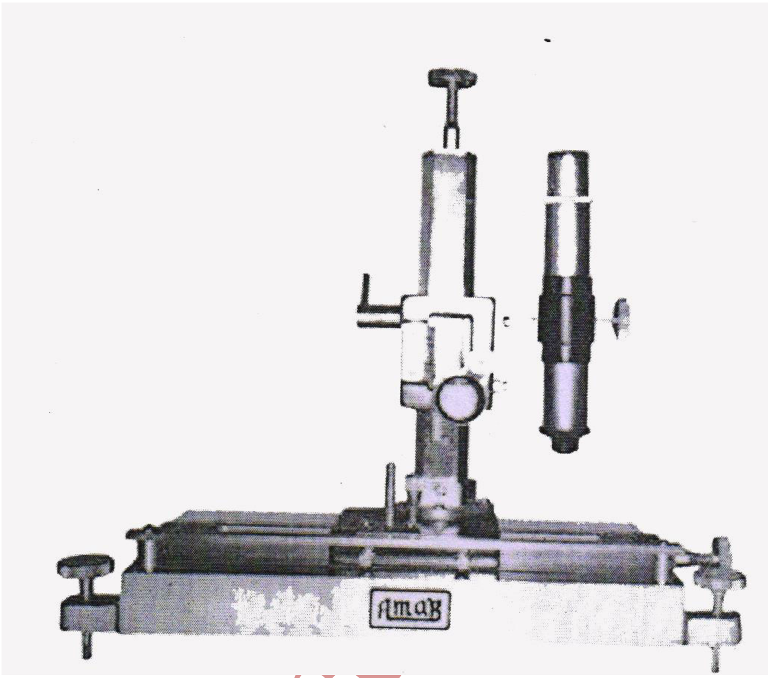


Fig. 1 Travelling Microscope

2. To read a reading

When the microscope is clamped by the main screw or fine adjustment screw at any position, the reading is taken in the vertical scale or in the horizontal scale according to the requirement. M.S.R. and V.S.R. are taken as in the vernier callipers. For example see Fig. 2. And write the M.S.R. and V.S.R.

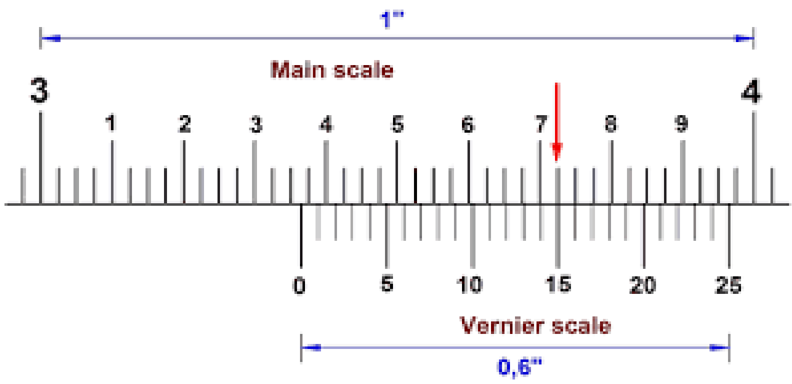


Fig. 2 Vernier and Main Scale

Note :

In the Vernier callipers, travelling microscope and the spectrometer, the MS zero may coincide with the VS zero. In such cases, the MSD, which coincides with the VS zero is the MSR reading.

Exampe :

Travelling microscope readings :

LC = 0.001

S.N.	M.S.R. cm.	V.S.C. div.	V.S.R. = (V.S.C. × LC) cm.	T.R. = M.S.R. + V.S.R.cm.
1	20		0.02	5.07
2				
3				
4				
5				

Result :

The parts and function of the travelling microscope are studied and a few readings are taken.

EXPERIMENT NO. 08

Subject Code: 1602107

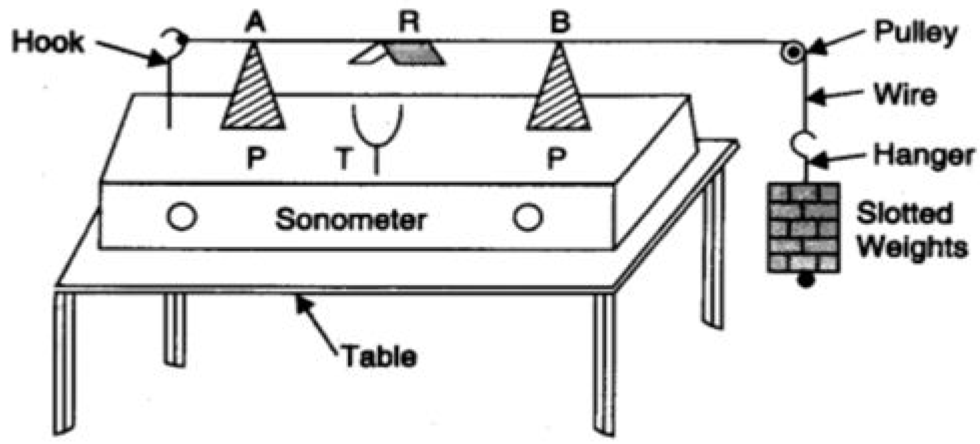
Practical Name: Sonometer

Aim :

To determine the frequency of sound using sonometer.

Apparatus :

1. A sonometer
2. A set of tuning forks of known frequency.
3. 0.5kg weight hanger.
4. Some 0.5kg slotted weights.
5. Rubber pad.
6. Paper rider.
7. Meter scale.



Sonometer in experimental set-up.

Theory :

When a stretched wire is set in vibrations, the frequency n of the fundamental note is produced by it, is given by

$$n = 1/2l\sqrt{T/M} \qquad \text{.........} (1)$$

Where l is the length of the vibrating wire.

T is the tension in the wire.

m is the mass per unit length of the wire.

For a give wire, m (mass per unit length) is constant, and wire is stretched under given tension i.e., T is constant, i.e., if m and T are kept constant then equation (1) gives

$$n \propto 1/l \text{ or } n\, l = \text{constant}$$

Hence if we plot a graph between n and 1/l the graph will be a straight line.

To find the relation between frequency and length

1. Place the sonometer on the table.
2. Make sure that the pulley is frictionless. If you feel any friction, oil them.
3. Stretch the wire by placing a suitable maximum load on the weight hanger.
4. Move the wooden bridges outward, so that the length of wire between the bridges is maximum.
5. Take a tuning fork of known frequency. Make it vibrate by strike its prong with a rubber pad. Bring it near the ear.
6. Pluck the sonometer wire and leave it to vibrate.
7. Compare the sounds produced by tuning fork and sonometer wire. (Sound which has low pitch has less frequency).
8. Gently adjust the bridges for decreasing the length of wire, till the two sounds appear alike.
9. Put an inverted V shaped paper rider on the middle of the wire.

10. Vibrate the tuning fork and touch the lower end of its handle with sonometer board. The wire vibrates due to resonance and the paper rider falls.
11. Measure the length of wire between the bridges using a meter scale. It is the resonant length and record it in the 'length decreasing' column.
12. Now, bring the bridges closer and then slowly increase the length of the wire till the paper rider falls.
13. Measure the length of wire and record it in 'length increasing' column.
14. Repeat the above steps with tuning forks of other frequencies, and find resonant length each time.

To find the relation between length and tension

1. Select a tuning fork of known frequency
2. Set the load in the weight hanger as maximum.
3. Repeat the steps in the previous section to find out the resonant length.
4. Now, remove 0.5kg weight from the weight hanger and find resonant length with same tuning fork.
5. Repeat the experiment by removing slotted weights one by one in equal steps of 0.5kg.
6. Record the observations each time.
   1. Change the position of bridge A using the slider.
   2. Change the position of bridge B using the slider.
   3. Click on the 'Place the paper rider' button to place the paper rider back.
   4. To redo the experiment, click on the 'Reset' button.

Observations :

Constant value of load on the wire = M kg

Constant value of tension on the wire = T = …..N

Table for the calculation of frequency and resonant length

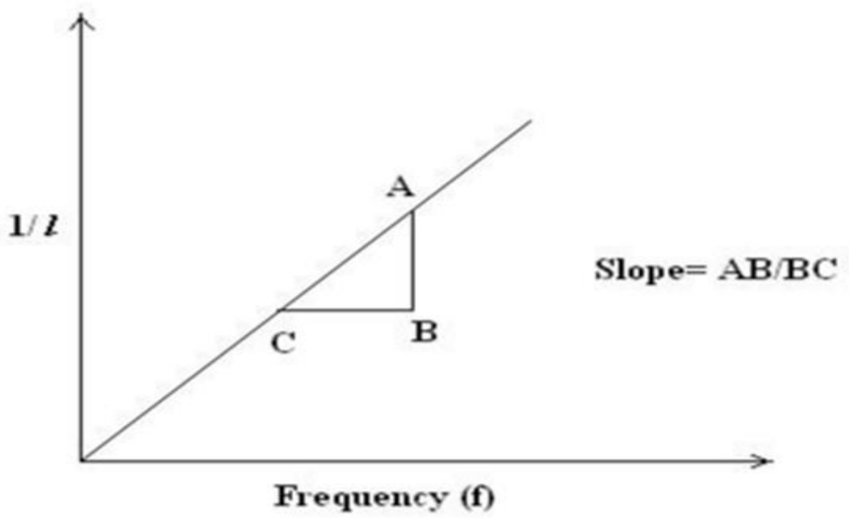
Sl. No.	Frequency of tuning fork used f(Hz)	Resonant length of wire				L 1/l (cm^{-1})
		Length increasing l_1(cm)	Length increasing l_2(cm)	Mean	$l = (l_1 + l_2)/2$	

Calculations :

1. Plot a graph between 1/l and frequency n of the tuning fork, taking n along X-axis and 1/l along Y- axis. It will be a straight line as shown in figure.
2. The product of $n \times l$ = constant for all the observation within the experimental error.

Result :

The frequency V/s reciprocal of length graph is a straight line, which indicates that, frequency is inversely proportional to resonant length.



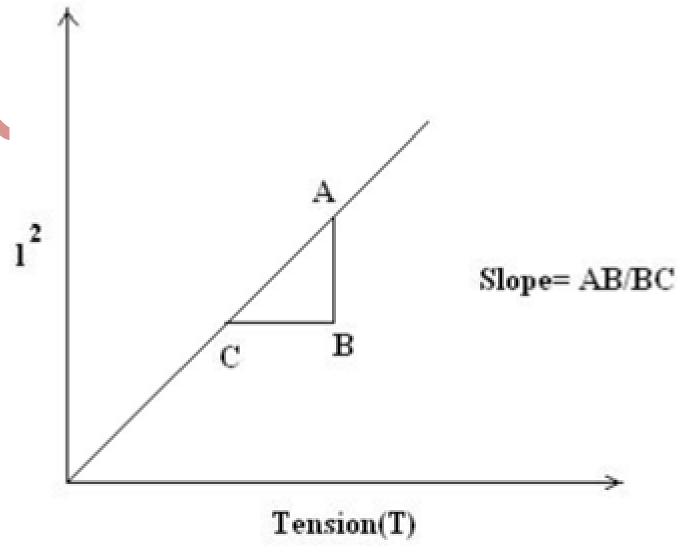
Observation :

Constant frequency of tuning fork = n = ……Hz.

Table for the calculation of resonant length and tension in the wire

Sl. No.	Load, M(kg)	Tension, T = Mg(N)	Resonant Length of Wire			l^2(cm^2)	l^2/(cm^2/N)
			Length increasing l_1(cm.)	Length increasing l_2(cm.)	Mena l = (l_1+l_2)/2		

Mean, l^2 / T =................. cm^2 / N



* Find square of resonant length (l^2) each time.
* Calculate corresponding l^2/T value.
* Plot a graph between square of length and tension, taking tension along X axis and square of length along Y axis.

Results :

From the tabular column, it is found that; l2/T is a constant. The graph between square of length and tension is a straight line, which shows that tension is directly proportional to square of resonant length.

Precaution :

1. The wire should be free from kinks and it should have uniform area of cross-section.
2. The fully should be frictionless.
3. The wire should not be loaded beyond the elastic limit.
4. The paper rider should be always kept in middle of the wire between the bridges.
5. While finding the resonant length, start with a small distance between the bridges.
6. The stem of the tuning fork should be placed gently on the top of the sonometer box.
7. The weight of the hanger should be counted for the calculation of tension on the string.

Sources of error :

1. Wire may not have uniform area of cross section.
2. Pulley may not be frictionless.
3. Weight used may not be standard.
4. Bridges may not be sharp.

EXPERIMENT NO. 09

Subject Code1602107

Practical Name : DISPERSIVE POWER OF THE MATERIAL OF A PRISM – SPECTROMETER.

AIM :

To determine the dispersive power of the material of a given prism by the spectrometer

APPARATUS:

Spectrometer, Prism and Mercury Vapour Lamp

PRINCIPLE :

The Dispersive power of the material of the given prism is expressed as

$$\omega = \frac{(\mu_2 - \mu_1)}{(\mu - 1)}$$

Where μ_1 and μ_2 are the refractive indices of two colors

$$\mu = \frac{(\mu_1 + \mu_2)}{2}$$

Usually the colors chosen are blue and red so that

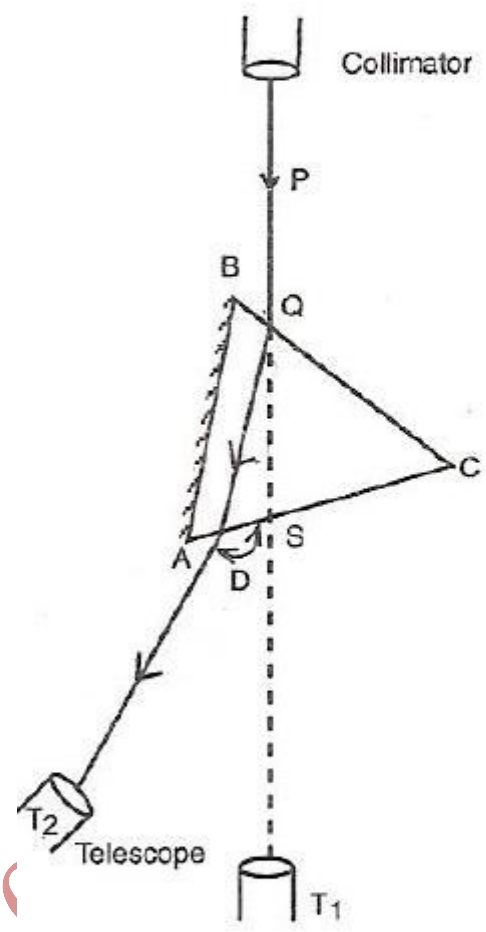
$$\omega = \frac{(\mu_b - \mu_r)}{(\mu - 1)},$$

$$\text{Where } \mu = \frac{(\mu_b + \mu_r)}{2}$$

PROCEDURE :

1. The usual adjustments of the spectrometer are made .The refractive angle of the Prism is found.
2. Then the prism is mounted on the prism table and the position of prism is adjusted to observe the spectrum of the mercury vapor.

3. Observing the blue line in the spectrum through the telescope, the prism is adjusted for minimum deviation position.



4. Working with the tangent screw of the telescope, the position of the prism is Adjusted so that the blue line is just one point of refracting its path after coming to the point of intersection of the cross wires.
5. The readings of the telescope for the minimum deviation of red line are noted.
6. The telescope is brought in line with the collimator and removing the prism, the direct readings on both verniers are noted.
7. The respective differences give the minimum deviations for blue and red colors.

Their refractive indices are found by

$$\mu_b = \frac{\mathrm{Sin}\frac{(A+D_b)}{2}}{\mathrm{Sin}(A/2)} \quad \& \quad \mu_r = \frac{\mathrm{Sin}\frac{(A+D_r)}{2}}{\mathrm{Sin}(A/2)}$$

The Dispersive power of the material of the prism, for blue and red colors is found by the relation

$$\omega = \frac{(\mu_b - \mu_r)}{(\mu - 1)}$$

OBSERVATIONS :

The observations of the above experiment are as follows

$V_1 = MSR_0 + (LC)VC$

Spectral Line	**Direct Reading**		**Minimum Deviation Position**		**Angle of Min. Deviation**			$\mu = \frac{\mathrm{Sin}\frac{(A+D_m)}{2}}{\mathrm{Sin}(A/2)}$
	LHS V_1	**RHS V_2**	**LHS V_1**	**RHS V_2**	**D_{m-} (LHS) $\|V_1 - V'_1\|$**	**D_{m-} (RHS) $\|V_2 - V'_2\|$**	**AVG D_m**	

Dispersive power $$\omega = \frac{(\mu_b - \mu_r)}{(\mu - 1)}$$

PRECAUTIONS :

1. The prism should be adjusted for each colour separately.
2. Readings are noted without any parallax error.

RESULT :

The Dispersive power of the material of the prism = ——————————

REFERENCE BOOKS :

1. Fundamentals of physics" D.Halliday,R.Resnick and J.walker,John wiley and sons.New York 2001
2. PHYSICS",M.Alonso and E.J.Finn,Addison Wesley, 1992
3. LABORATORY MANUAL IN APPLIED PHYSICS" -Second edition-H. Sathyaseelam-New age International

EXPERIMENT NO. 10

Subject Code1602107

Practical Name : THE SPECTROMETER.

AIM :

To learn the parts of a spectrometer and to read a reading.

APPARATUS:

Spectrometer, reading lens and spirit level.

DESCRIPTION :

I. It has the following three main parts (See Fig. 1)

1. The collimeter 2. The telescope 3. The Prism

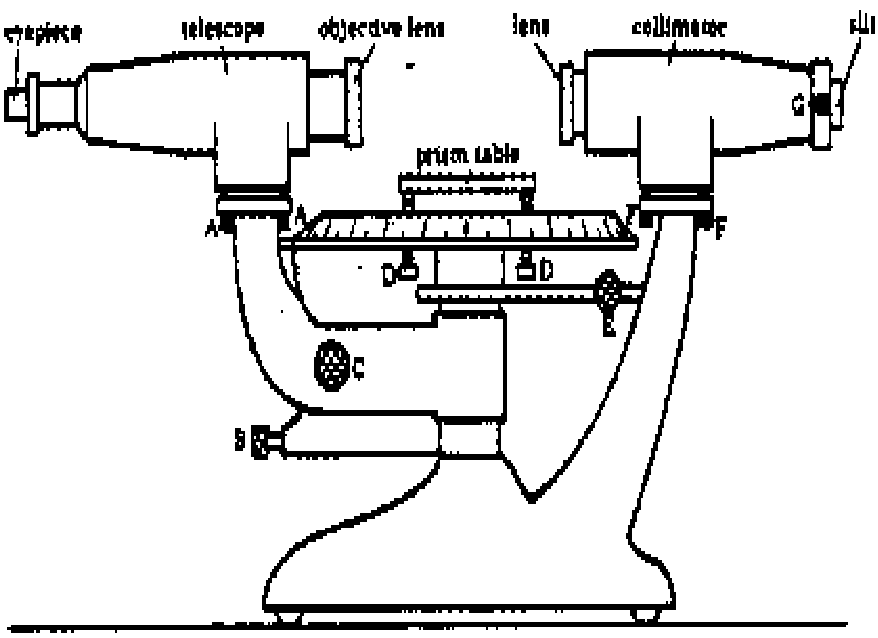


Fig. 1 Spectrometer

1. **The collimator :** Its purpose is to produce a parallel beam of light. It consists of a lens and slit. The slit faces the source of light. The distance between the slit and the lens can be adjusted by a screw fixed to the collimator tube C to obtain paralled beam of rays. The slit consists of two sharp edges. One of the edges is fixed while the other can be moved parallel to it by working the screw provided at its side. The collimator cannot be rotated.
2. **The telescope :** The telescope T consists of an objective 0 at one and an eyepiece fised with the cross wires on the other end. The telescope is fixed to the circular scale graduated in degrees. The circular scale is in between the collimator and telescope. The telescope can be turned with the scale about a vertual axis passing through the center of teh spectrometer. The eyepiece of the telescope is provided with cross wires. The telescope can be fixed in any position by a main screw. Fine adjustment can be made by a fine adjustment screw which is tangential to the main screw. The focusing of the telescope is done by a screw to the side of the telescope.
3. **The prism table :** This consists of a upper plate and a lower plate separated by three springs. Three screws pass through these springs. There are lines engraved in the upper plate so as to mount the prism in proper position. The prism table P can be mounted in any position by means of a screw at its bottom. The prism table can be rotated about the same vertical axix as the telescope.

ii. The initial adjustments :

1. **Telescope adjustment :** The telescope is turned towards a distant object and its focusing screw is adjusted till the image of the object is clearly seen. In this position, the telescope is capable of receiving parallel rays.
2. **Collimator adjustment :** The silt is illuminated with sodium vapour lamp or Hg vapour lamp. The telescope is turned so that the telescope and the colimator are in a line. In this position one can see the image of the slit through the telescope. The clear image of the slit is obtained by adjusting the collimator screw. The silt must be adjusted to be narrow and vertical.
3. **Levelling of the prism table :** This is done with a spirit level. The spirit level is kept on the prism table and the three leveling screws of the prism table are adjusted till the air bubble comes to the centre.

Procedure :

1. To find the least count of the spectrometer :

The main scale is a circular scale graduated in degrees. The value of one MSD is half degree. Each vernier scale consists of 30 divisions (Fig. 2)

29 MSD are equal to 30 VSD (Fig. 2)

LC = 1 MSD - 1 VSD

1 MSD = $0.5^0 = 30(1^0\ 60)$

30 VSD = 29 MSD

1 VSD = 29/30 MSD

= $(29/30) \times 30$

= 29

1 LC = 30' - 29'

LC = 1

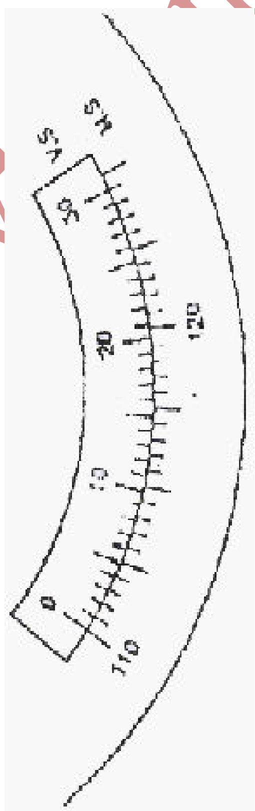


Fig. 2 Circular scale of the sepctrometer

2. To read a reading :

Main scale reading (MSR) and vernier scale reading (VSR) are noted as explained in the vernier callipers when the telescope and the disc (prism table) are fixed at the required position by the main or fine adjustment screw.

The two vernier scales VA and VB are fixed to the disc, which can be rotated about the same vertical axis. A main screw and a fine adjustment screw as in the telescope control the movement of the vernier scales.

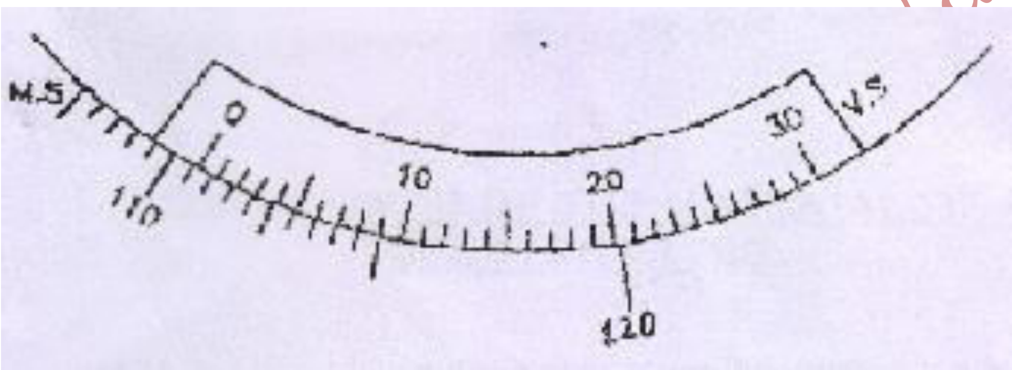


Fig. 3 Spectrometer readings

Exampe :

Spectrometer readings : (see fig. 3)

LC = 1'

Sl. No.	M.S.R.	V.S.C.	V.S.R. = V.S.C × L.C.	T.R. = M.S.R. + V.S.R.
1	$110.5^{0} = 110^{0}30'$	9	9	$110^{0}30'$

EXPERIMENT NO. 11

Subject Code1602107

Practical Name : Determination of Angle of Divergence of Laser Beam

Objectives :

* To learn about the characteristics of lasers
* To study angle of divergence of the laser beam

Aim :

To determine the angle of divergence of tasar beam using He-Ne laser and semiconductor laser and to find out which laser is highly directional.

Apparatus required :

He-Ne laser, Semiconductor laser, Optical bench, Screen and Ruler.

Formula :

$$\text{Angle of divergence of the laser beam, } \Phi = \frac{(a_2 - a_1)}{(d_2 - d_1)} \text{ m}$$

Where d_1 is the distance between laser source and the screen in m

a_1 is the spot size of the laser beam on the screen for distance d_1 in m

d_2 is the new distance between laser source and the screen for distance d_2 in m

Procedure :

The experimental setup used to find the angle of divergence of the laser beam is shown as in fig. 1.

Fig. 1 Measurment of Divergence of Laser beam

The Laser beam is allowed to fall on the screen and the spot of the beam is observed and the spot of the size of the beam is measured as shown in Fig. 1

1. The laser beam from He-Ne is made to fall on the screen which is kept at a distance of d_1 from the source.
2. The spot size of the beam is noted and is taken as a_1.
3. Now the position of the screen is altered to a new position d_2 from the laser source and again the spot size of the beam is noted as a_2.
4. The same procedure is repeated by changing the position of the screen at equal intervals atleast 5 times.
5. The readings corresponding to the position of the screen and spot size of the beam is tabulated.
6. From this, the angle of divergence of the laser beam is calculated using the formula

$$\Phi = (a_2 - a_1)/(d_2 - d_1) \text{ radians}$$

7. The same is repeated by using semiconductor laser diode for the same distances as done with He-Ne laser.
8. The angle of divergence calculated was compared and the results are interpreted using two different types of laser beam.

1. Measurment of angle of divergence using He-Ne laser

Sl. No.	**Distance between laser beam and screen X 10^{-2}m**	**Diameter of the spot (Horizontal) X 10^{-2}m**	**Diameter of the spot (Vertical) X 10^{-2}m**	**Mean Diameter of the spot X 10^{-2}m**	**$\Phi = (a_2-a_1)/(d_1-d_2)$ radians**

2. Measurment of angle of divergence using semiconductor laser diode

Sl. No.	Distance between laser beam and screen X 10^{-2}m	Diameter of the spot (Horizontal) X 10^{-2}m	Diameter of the spot (Vertical) X 10^{-2}m	Mean Diameter of the spot X 10^{-2}m	$\Phi = (a_2 - a_1)/(d_1 - d_2)$ radians

Calculation :

Distance between laser source and the screen (d_1) = m

Spot size of the laser beam on the screen for distance d_1 (a_1) = m

Distance betwwn laser source and the screen (d_2) = m

Spot size of the laser beam on the screen for distance d_2 (a_2) = m

Analog of divergence of the laser beam, $\Phi = (a_2 - a_1)/(d_2 - d_1)$ radians.

Result :

1. Angle of divergence of the beam using He-Ne laser =
2. Angle of divergence of the beam using semiconductor laser =

Outcome :

At the end of the experiment, the students would be able

* To understand the importance of laser beam compared to ordinary light.
* To determine the angle of divergence of the laser beam.
* To understand the applications of Lasers in Engineering and Medical fields.