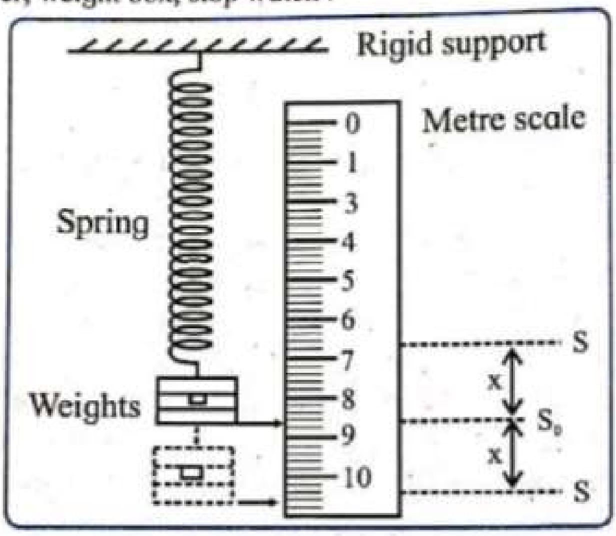
EXPERIMENT NO. 1
SPRING - MASS OSCILLATOR

Aim : a) To determine the force constant (k) of the given spring.

b) To determine the mass of the spring.

Apparatus : Light spiral spring with clamping arrangement and attached pointer, meter scale, hanger, weight box, stop watch .

Diagram :



Formula :

1) $F = -kx$ 2) Potention energy (P.E) = $\frac{1}{2}Kx^2$ 3) mass of spring m_s = $3\times$(x-intercept)

Where, F - is restoring force.

x - is extension of the spring.

k - is force constant of the spring.

Theory:

The period (T) of S.H.M. about the position of equilibrium

$$T^2 = \frac{16\pi^2 R^3 N}{r^4 n}\left[M = \frac{m_s}{3}\right]$$

differentiating above equation, we get

$T^2 = 0,$

$$0 = \frac{16\pi^2 R^3 N}{r^4 n}\left[M = \frac{m_s}{3}\right]$$

$$\therefore M + \frac{m_s}{3} = 0$$

$$\therefore M = \frac{m_s}{3}$$

$$\therefore m_s = 3\times(x\text{ intercept})$$

$$\frac{m_s}{3} = x\text{ intercept}$$

$$\therefore m_s = 3x(x\text{ intercept})$$

Where,

R	-	Radius of spring
N	-	No. of turns in the spring
r	-	Radius of the wire used for spring
n	-	• Rigidity of the material of the spring
T	-	Time period of oscillation
Ref	:	Advanced Practical Physics for students by B. L. Warsnop & Flint

Procedure :

PART - A To find force constant (K) & (P.E)

1) Weigh the hanger and determine the mass of the hanger (m_0).
2) Clamp the given spiral spring to a rigid support and attach the hanger with pointer at its lower end.
3) Add a suitable mass to the hanger so that the spring is stretched to about triple of the unstretched length. i.e each turn of the spring will be free from each other.
4) Note down total mass attached to the spring (M) and also note down the reading (S_0) i. e. mean position on the scale according to position of the pointer.
5) Add one slotted weight of 50g in the hanger and note the position of the pointer say S. Repeat the procedure twice by adding weights in steps of 50g. (m is more than M.)
6) Remove weights from the hanger and bring the pointer to its mean position S_0. Take three readings by reducing weights in steps of 50g. (m less than M)
7) Determine the extension $(S_0 - S) = x$ in each case.
8) Plot the graph of F against x and determine slope of the graph. Slope of the graph is force constant (k)
9) Calculate the potential energy $\left(\frac{1}{2}kx^2\right)$ for each value of extension x and plot the graph of potential energy against extension x.

PART - B To find mass of the spring m_s

1) Put suitable weights in the hanger and determine the time to complete 20 oscillations by using stop watch. Repeat this step two times, hence calculate mean time (t) for 20 oscillations.
2) Calculate the periodic time (T).
3) Note down the next four observations by changing the mass in steps of 50g. Find the time for 20 oscillations in each case. Where, total mass M (mass of the hanger + mass kept in the hanger).
3) Determine mean time (t) in each case. Calculate periodic time (T) for each mass.
4) Plot the graph of T^2 against M and hence find the mass of the spring m_s

Observations :

PART - A To determine force constant (k) and Potential Energy (P.E.):

1. Mass of the hanger (m_0) = ..50 g
2. Mass attached to the hanger = m_1 = .100 g, so that spring gets stretched to about triple of its unstretched length. Therefore total mass attached $M = (m_1 + m_0)$ = 150 g.
3. Position of the pointer when the spring is stretched to about triple of the unstretched length S_0 = ..11..... cm.

4. To determine force constant (k) of the spring:

Sr. No.	Mass attached to the spring m gwt	F = (m-M) gwt	S cm	Extension S_0 - S = x cm	P.E. = ½ k x^2
1	300	-150	20	+9	675.13
2	250	-100	17.5	+6.5	352.15
3	200	-50	14	+3	75.015
4	M = 150	0	S_0 = 11	0	0
5	200	+50	14	-3	75.015
6	250	+100	17	-6.5	352.15
7	300	+150	20.5	-9.5	752.23

Observations :

PART - B To determine the mass of spring (m_s):

1. Mass of the hanger (m_0) = ..50.. g
2. Least count of the stop watch = ...1.... s

Sr No.	Total Mass M kg	Time t for 20 oscillation (s)			mean t (s)	Periodic time T = mean t/20 (s)	T^2 (S^2)
		1	2	3			
1	100	23	21	22	22	1.1	1.21
2	150	25	23	24	24	1.2	1.44
3	200	27	30	29	29	1.45	2.11
4	250	30	31	29	30	1.5	2.25
5	300	32	31	33	32	1.6	2.56

Calculations:

1) force constant K of the spring = slope of graph of F against extansion X

= ...16.67..... gwt/cm.

= ...16333.... dyne/cm.

$= 1.6333 \times 10^4$ dyne/cm

2) potential energy $= \frac{1}{2}Kx^2$ $\Rightarrow \frac{1}{2}(16.67)(81) = 675.13$

$\Rightarrow \frac{1}{2}(16.67)(42.25) = 352.15$

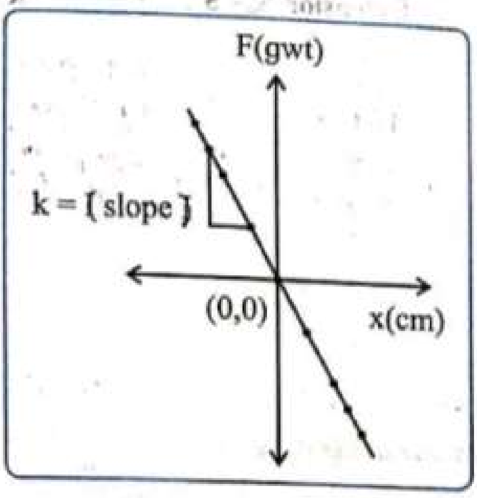
$\Rightarrow \frac{1}{2}(16.67)(9) = 75.015$

$\Rightarrow \frac{1}{2}(16.67)(90.25) = 752.23$

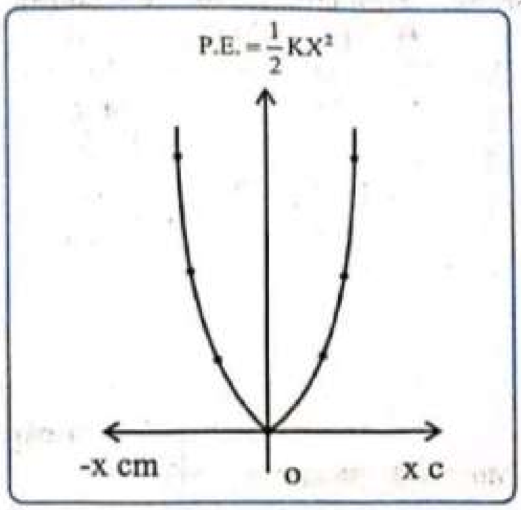
$\Rightarrow \frac{1}{2}(16.67)(36) = 300.06$

Graphs:

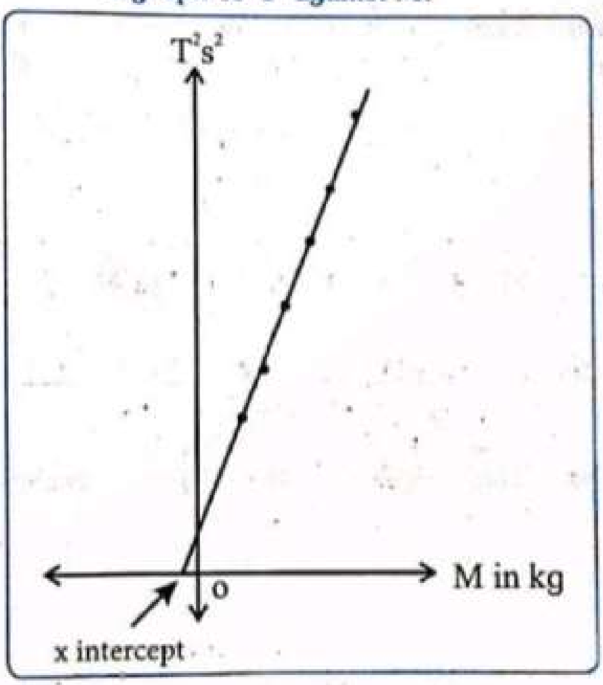
A graph of F against x:



A graph of P.E. against x:



A graph of T^2 against M:



Result :

1. Force constant of the given spring (k) = ...1·6333 x10^4..... dyne / cm
2. Mass of the given spring (m_s) from the graph of T^2 against M = ...50... g
3. The graph shows that potential energy of oscillator changes with distance x from equilibrium. The nature of graph is parabolic.

Precautions :

1. Record the mean position of the pointer carefully.
2. Oscillations of the spring mass oscillator should be in a vertical plane.
3. The pointer should move freely over the scale such that it should not touch the scale.
4. Spiral spring should not be stretched beyond the elastic limit.

Questions

1. What are damped oscillations?

A damping oscillation is one in which the moving particle gradually loses its kinetic energy on interaction with forces like air or friction. due to this resistance offered by external forces, the displacement of a particle slowly reduces with time and ultimately reaches its state of rest.

2. Define linear S. H. M.?

Linear S.H.M is defined as the linear periodic motion of a body in which the restoring force is always directed towards its mean position and its magnitude is directly proportional to the displacement from the mean position.

3. What are forced oscillations?

When a body oscillates by being influenced by an external periodic force it is called forced oscillation.

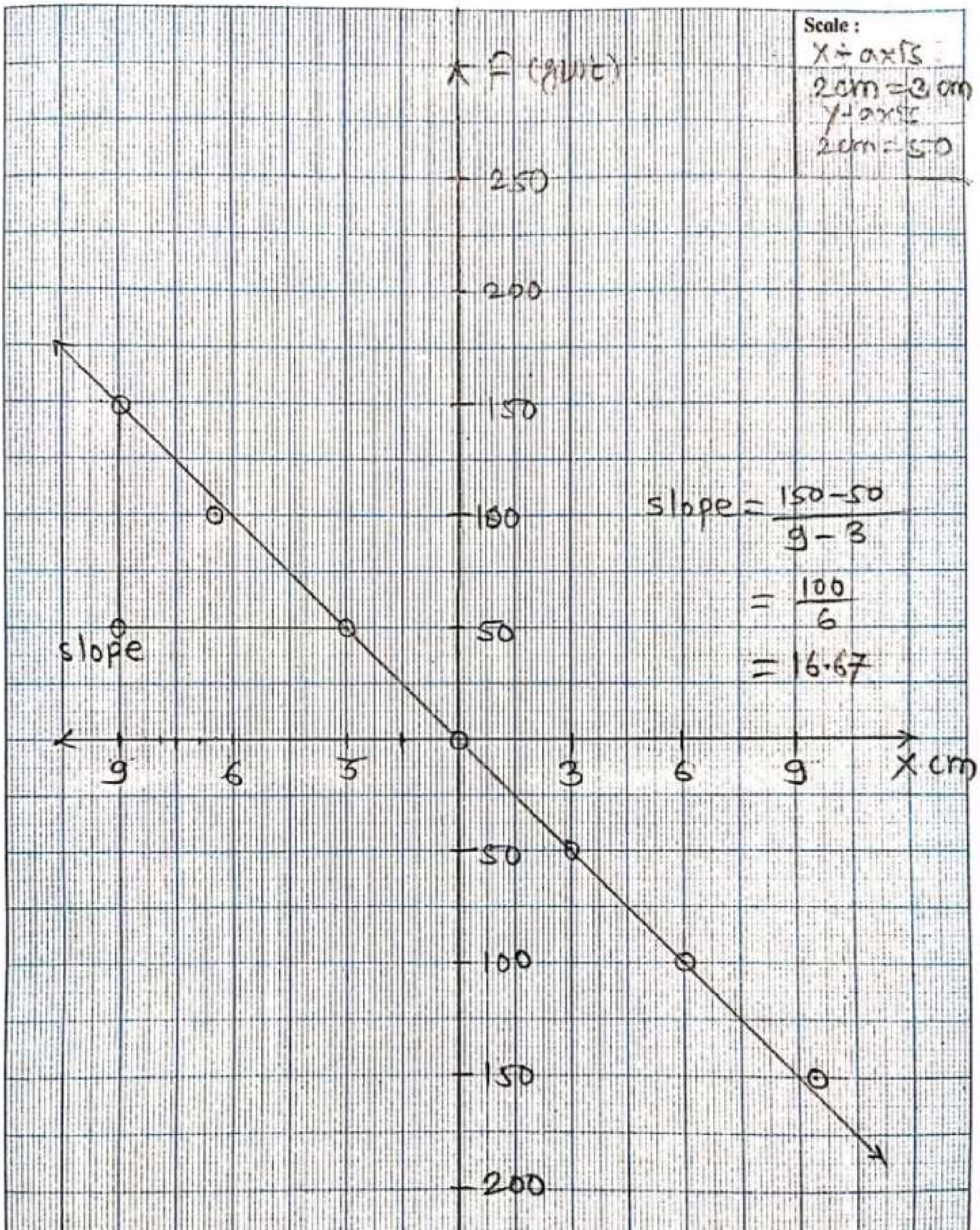
Here, the amplitude of oscillation experiences damping but remains constant due to the external energy supplied to the system.

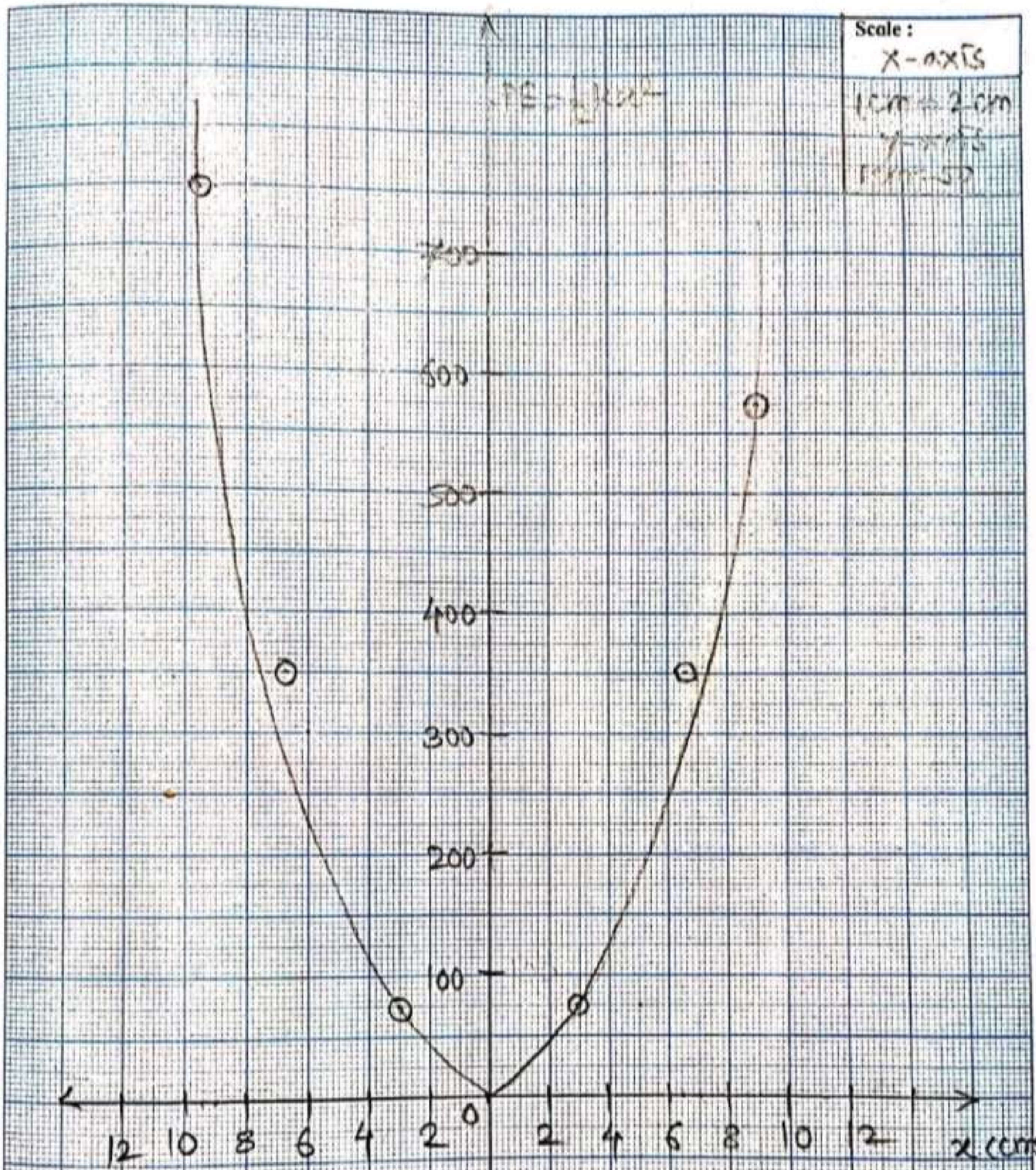
4. Define force constant.

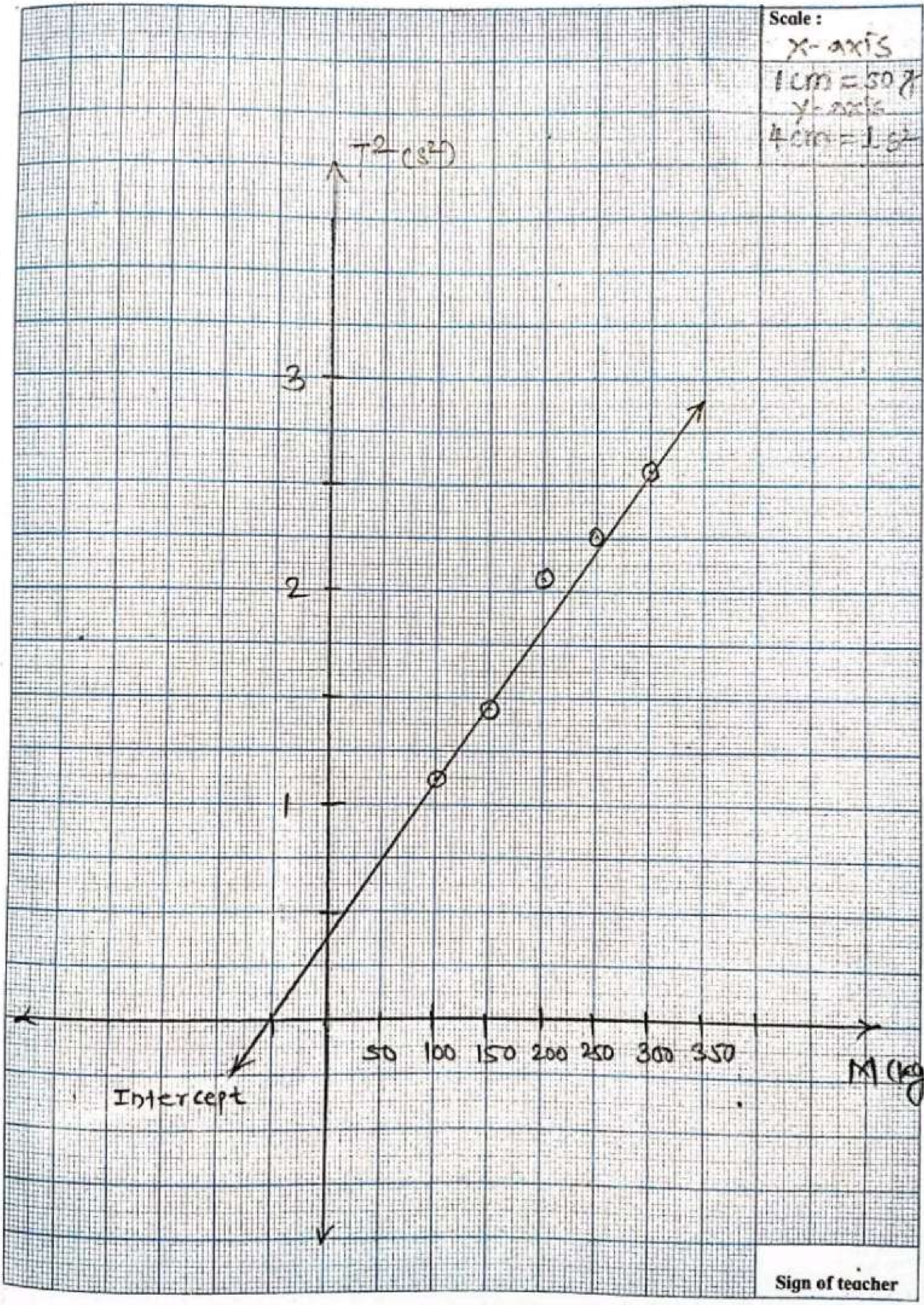
Force constant of a spring is defined as the force required to produce unit extension or compression in the spring

i.e $K = \frac{f}{x}$

Remark and sign of teacher :


Scale :
X-axis
2cm = 3 cm
Y-axis
2cm = 50
F (gwt)
250
200
150
100
50
slope
9
6
3
3
6
9
X cm
50
100
150
200
250
slope = $\frac{150-50}{9-3}$
= $\frac{100}{6}$
= 16.67
Sign of teacher


Scale :
X-axis
1cm = 2 cm
700
600
500
400
300
200
100
12 10 8 6 4 2
0
2 4 6 8 10 12
x (cm)
Sign of teacher



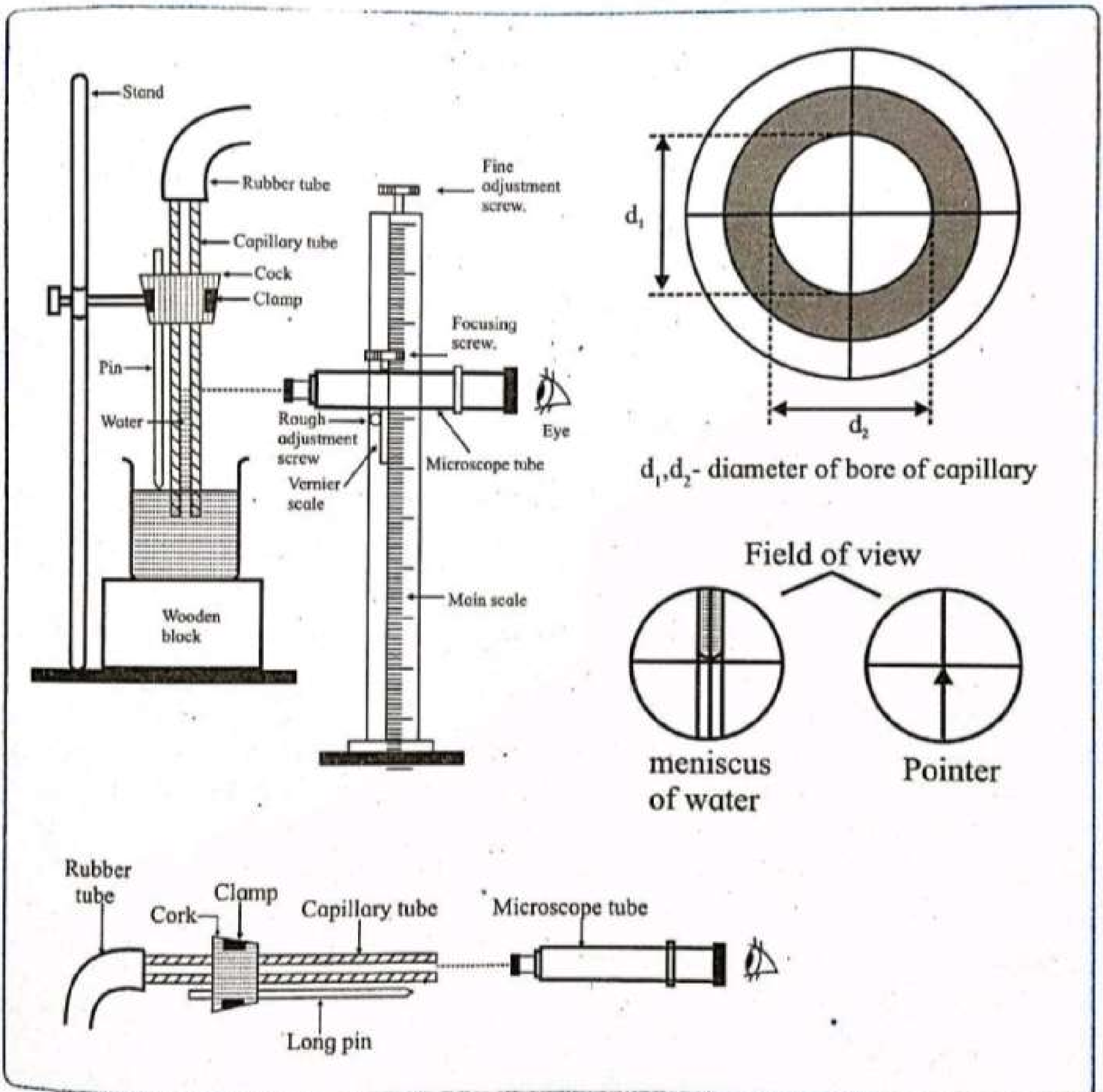
Scale :
x- axis
1 cm = 50 g
y- axis
4 cm = 1 s²
T² (s²)
3
2
1
50
100
150
200
250
300
350
M (kg)
Intercept
Sign of teacher

EXPERIMENT NO. 2
SURFACE TENSION

Aim: To determine the surface tension of the given liquid (water) by capillary rise method.

Apparatus : Travelling microscope, beaker, capillary tube, cork with pointer, stand with clamp, water.

Diagram :



Theory:

At N.T.P, when a liquid (water) rises in a Capillary tube the weight of the column of the water of density ρ (ρ=1) below the meniscus is supported by the up ward force of surface tension acting around the circumference of the point of contact. Therefore Approximately

(for water) $2\pi r T = \pi r^2 h \rho g$ or $T = \dfrac{h\rho g r}{2}$

Formula :

$$\therefore T = \frac{hrg}{2}$$

where, T = surface tension of liquid

h = height of liquid column in capillary tube

r = inner radius of the cross section of bore of the capillary

ρ = density of the liquid (water)

θ = angle of contact between water and glass

For water, ρ = 1.0 g/cm^3

Angle of contact between water and glass is very small.

i.e. $\theta = 0^0$, $\cos\theta = 1$

Procedure:-

To measure inner diameter of bore (d)

1. Determine the least count (L. C.) of travelling microscope.
2. Clamp the capillary horizontally with the help of retort stand.
3. Focus the microscope on the bore of the capillary.
4. Adjust the vertical cross wire such that it is tangential to one end of the bore. Record the reading on the horizontal scale (x).
5. With the help of the fine adjustment screw make the vertical cross-wire tangential to the other end of the bore. Record the reading on the horizontal scale (y).
6. Repeat the steps 4 and 5 for horizontal cross wire and record the reading on the vertical scale.
7. Immerse the capillary tube vertically in the beaker containing water.To measure h_1 & h_2
8. Remove the air bubbles by pressing the rubber tube and adjust the level of water in the beaker so that meniscus in the bore of capillary should be above the edge of the beaker and below the lower edge of the capillary stand.
9. Adjust the tip of the pointer so that it just touches the level of water. Focus the travelling microscope on the meniscus such that the horizontal cross -wire is tangential to the convex surface of the meniscus. Record the reading on vertical scale (h_1).
10. Remove the beaker without disturbing the position of the capillary tube.
11. Adjust the microscope such that the horizontal cross -wire is tangential to the tip of the pointer. Record the reading on the vertical scale (h_2).
12. Repeat the steps 8 to 11 for second set of observations.
13. Calculate the surface tension of the given liquid (water).

Observation :

Least count (L.C.) of travelling microscope :

Smallest division of main scale (P)	0·05... cm
Total no. of divisions on the Vernier scale (N)	50.....
L.C. of travelling microscope (P/N)	0·001 cm

Observation Tables :

1) Measurement of radius of bore (r) :

	Obs. No.	Reading when crosswire is tangential to: one side of the bore x cm	Reading when crosswire is tangential to: other side of the bore y cm	Diameter of bore $d = x - y$ cm	mean diameter d cm	mean radius r cm
Reading along diameter	1	3·225	1·450	d_1 = 1·775	r_1 = 0·126	0·06325
	2	3·270	1·493	d'_1 = 1·777	r'_1 = 0·127	
Reading along perpendicular to diameter	1	2·284	0·635	d_2 = 1·649	r_2 = 0·0630	
	2	2·524	0·874	d'_2 = 1·650	r'_2 = 0·0635	

1) Measurement of capillary rise (h):

Obs. No.	Reading when the microscope is focused on: The meniscus h_1 cm			the tip of the pointer h_2 cm			Capillary rise $h = h_1 - h_2$ cm	Mean Capillary rise h cm
	MSR a cm	VSR n	h_1 a+n×L.C	MSR b cm	VSR n	h_2 b+n×L.C		
1	5·9	14	5·914	3·6	30	3·630	2·284	2·282
2	5·9	30	5·930	3·6	50	3·650	2·280	

Calculations:

$$T = \frac{hr\rho g}{2} \quad \text{where } \rho = 1 \text{ g/cm}^3$$

$$\therefore T = \frac{hrg}{2} = \frac{2.282 \times 0.06325 \times 980}{2} = \frac{141.56}{2}$$

= 70·78 dyne / cm

= 0·07078 N/m

Results : Surface tension of given liquid (water)

T = 70·78 dyne/cm = 0·07078 N/m

Precautions :

1. The capillary should be thoroughly cleaned.
2. There should be no air bubbles inside the capillary. Capillary must be immersed in the liquid.
3. The capillary should be vertical.

Questions

1. Define angle of contact.

When a liquid is in contact with solid The angle between tangent drawn to the free surface of the liquid and the surface of solid at the point of contact measured inside the liquid, is called angle of contact.

2. List the factors affecting surface tension.

Temperature: Surface tension decreasing with increase in temperature.

Contamination: The presence of contaminated materials like dust particles or lubricating materials on the liquid surface decreases its surface tension.

3. Why should the capillary be cleaned every time before use ?

The rise of water in a thin tube - inserted in water is caused by forces of attraction between the molecules of water and the glass walls among the molecules of water themselves.

the narrower the bore of the capillary tube the higher the water rises.

4. Where do you observe capillary action in day to day life?

1) Sap and water rise upto the topmost leaves
2) Piece of sponge retains water due to capillary
3) Towel absorbs water or moisturer from body
4) Wick in oil lamp act as capillaries
5) Blotting paper quickly absorb the Ink.

Remark and sign of teacher :

EXPERIMENT NO. 3
NEWTON'S LAW OF COOLING

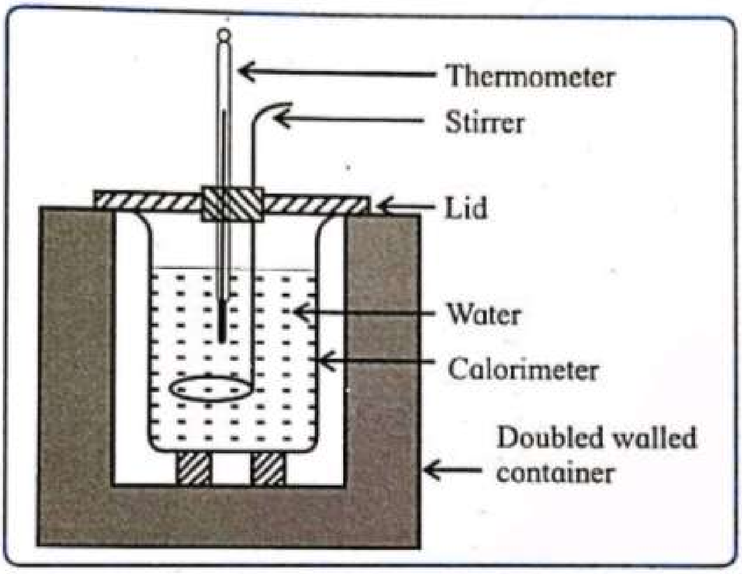
Aim : To study the relationship between the temperature of a hot body and time by plotting a cooling curve.

Apparatus : A thimble or calorimeter, constant temperature enclosure, a thermometer, stop clock, hot water bath etc.

Newton's law of cooling :

The rate of fall of temperature $\left(\frac{d\theta}{dt}\right)$ by a body is directly proportional to the difference of temperature $(\theta - \theta_0)$ of the body over the surroundings, provided the difference is small.

Diagram :



Theory:

The rate at which a hot body loses heat is directly proportional to the difference between the temperature of the hot body and that of its surroundings and depends on the nature of material and the surface area of the body. This is newton's low of Colling

Rate of loss of heat $\frac{d\theta}{dt} = K(\theta - \theta_0)$

Where, K = is the constant of proportionality $K = \frac{K'}{ms}$

also, $\frac{d\theta}{dt} = ms\ \frac{d\theta}{dt}$

$$\therefore ms\ \frac{d\theta}{dt} = -K'(\theta - \theta_0)$$

$$\therefore \frac{d\theta}{dt} = -\frac{k'}{ms}(\theta - \theta_0)$$

Formula :

$$\frac{d\theta}{dt} = -K(\theta - \theta_0)$$

$K' = k/ms$ is another constant it is water equivalent of the calorimeter negative fig indicates that loss of heat implies temperature decrease.

Procedure : experiment without wooden box.

1. Heat the water in water bath.
2. Note down the temperature of the surrounding (room temperature) by using thermometer.
3. Fill the thimble or calorimeter with hot water about 75 to 80°C upto $\frac{3}{4}^{th}$ of its capacity. Insert thermometer such that its bulb is well inside the hot water.
4. Note the initial temperature which is about 75° to 80°C above the room temperature.
5. start the stop watch.
6. Note the temperature after every minutes.
7. Take required number of readings till temperature of water falls about 40° C.
8. Plot the graph of temperature (θ_0 C) against time (t) in minutes. Draw smooth curve through the points.
9. Plot the graph of $\frac{d\theta}{dt}$ against temperature θ.Hence determine the room temperature (θ_0).
10. Plot a graph of rate of cooling against excess temperature above the surrounding Hence verify Newton's law of cooling.

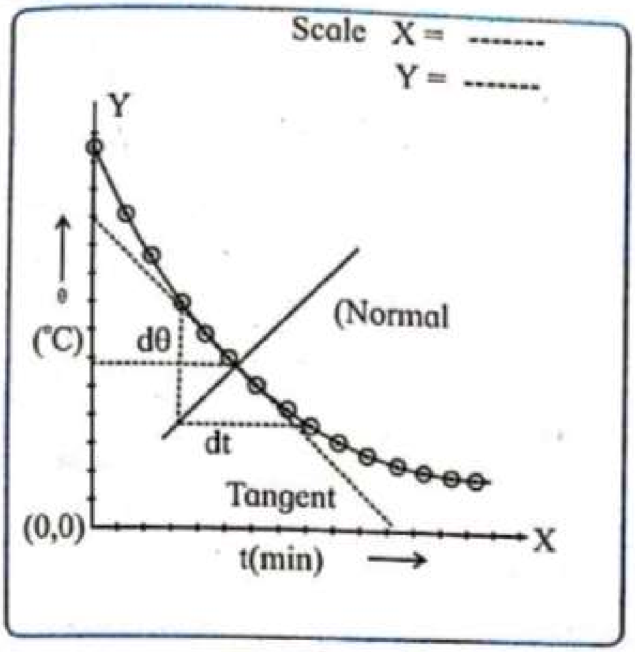
Observations :

1. Least count of stop watch = 1 s.
2. Least count of thermometer = 1 °C
3. Temperature of the surroundin[illegible] C.

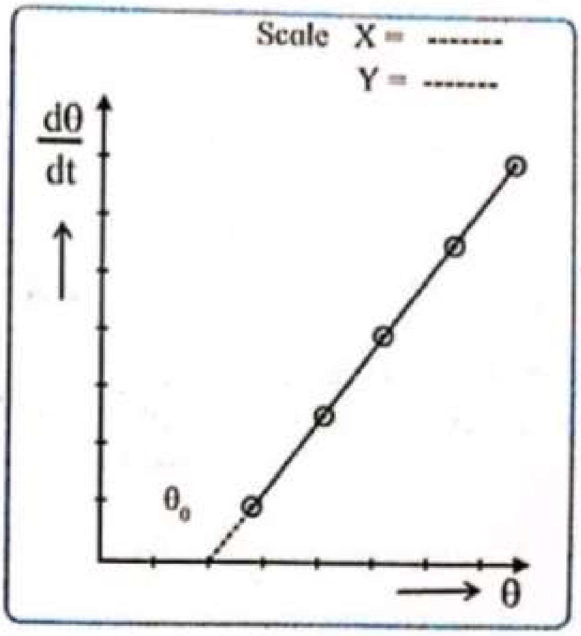
Observation Table (I) :

Ob. No.	Time in min	Temp[illegible] wa[illegible]		Time in min	Temperature of water °C
1	0	90	16	7.5	57.2
2	0.5	87	17	8.0	56.0
3	1.0	84	18	8.5	55.0
4	1.5	81	19	9.0	54.0
5	2.0	78.5	20	9.5	53.2
6	2.5	76.0	21		
7	3.0	73.5	22		
8	3.5	71.2	23		
9	4.0	69.0	24		
10	4.5	67.0	25		
11	5.0	65.0	26		
12	5.5	62.2	27		
13	6.0	61.0	28		
14	6.5	60.0	29		
15	7.0	58.5	30		

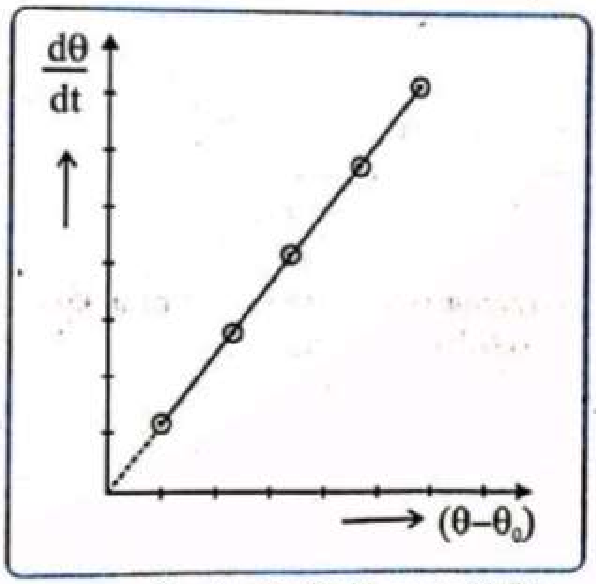
Graph of Temperature vs. Time.
Graph I ,II&III



Cooling curve



Graph of (dθ/ dt) versus θ



Scale X = -------
Y = -------

Graph of (dθ/ dt) versus(θ-θ$_0$)

Observation Table From cooling carve (II) :θ$_0$ = 30°C (Room temp.)

Obs. No.	Temp θ°C	$\frac{d\theta}{dt}$ °C/min	(θ - θ$_0$)
1	81.25	5.5	51.25
2	76.00	5.0	46.00
3	71.25	4.5	41.25
4	67.00	4.0	37.00
5	63.25	3.5	33.25

Result :

1. The nature of the graph of temperature against time is a curve. It is known as Newton's cooling curve.
2. This cooling curve will be steep at first, after it will become less steep as the temperature approaches to temperature of the surrounding.
3. As the graph of $\frac{d\theta}{dt}$ against $((\theta - \theta_0)$ is straight line, Passing through origin Newton's law of cooling is verified.
4. Room temperature by graph , θ_0 = 26 °C

Precautions :

i) Make sure that the bulb of thermometer is well inside the water.

ii) The enclosure should have proper insulation to avoid loss of heat due to conduction or convection from hot water.

iii) The water in the calorimeter should be gently stirred continually.

Questions

1. Certain quantity of water cools form 70°C to 60°C in the first 5 mint and 54° C in the next 5 min. Then what well be the temperature of the surrounding (Ans. 45°C).

$\frac{60-70}{5} = -k(65-T)$

$\frac{54-60}{5} = -k(57-T)$

$\therefore T = 45°$

$\frac{-10}{-6} = \frac{65-T}{57-T}$

$285 - 5T = 195 - 3T$

$90 = 2T$

2. You take an ice-cream out of the freezer, ketp at - 18°C. outside it is 32°C After one minute, the ice creeam has warmed to - 8°C what is the temperature of the icecream ofter five minutes? (Ans. ≈ 15.6°C).

$\frac{dT}{dt} = -k(T-32) = -kT + 32k$

$T = Ce^{-kt} + 32$

$T = -18,\ t = 0,\ -18 = C + 32$

$\therefore C = -50$

$T = -8,\ t = 1,\ -8 = -50e^{-k} + 32$

$T = -50e^{-(\log\frac{5}{4})t} + 32$

$= -50(\frac{4}{5})^t + 32$

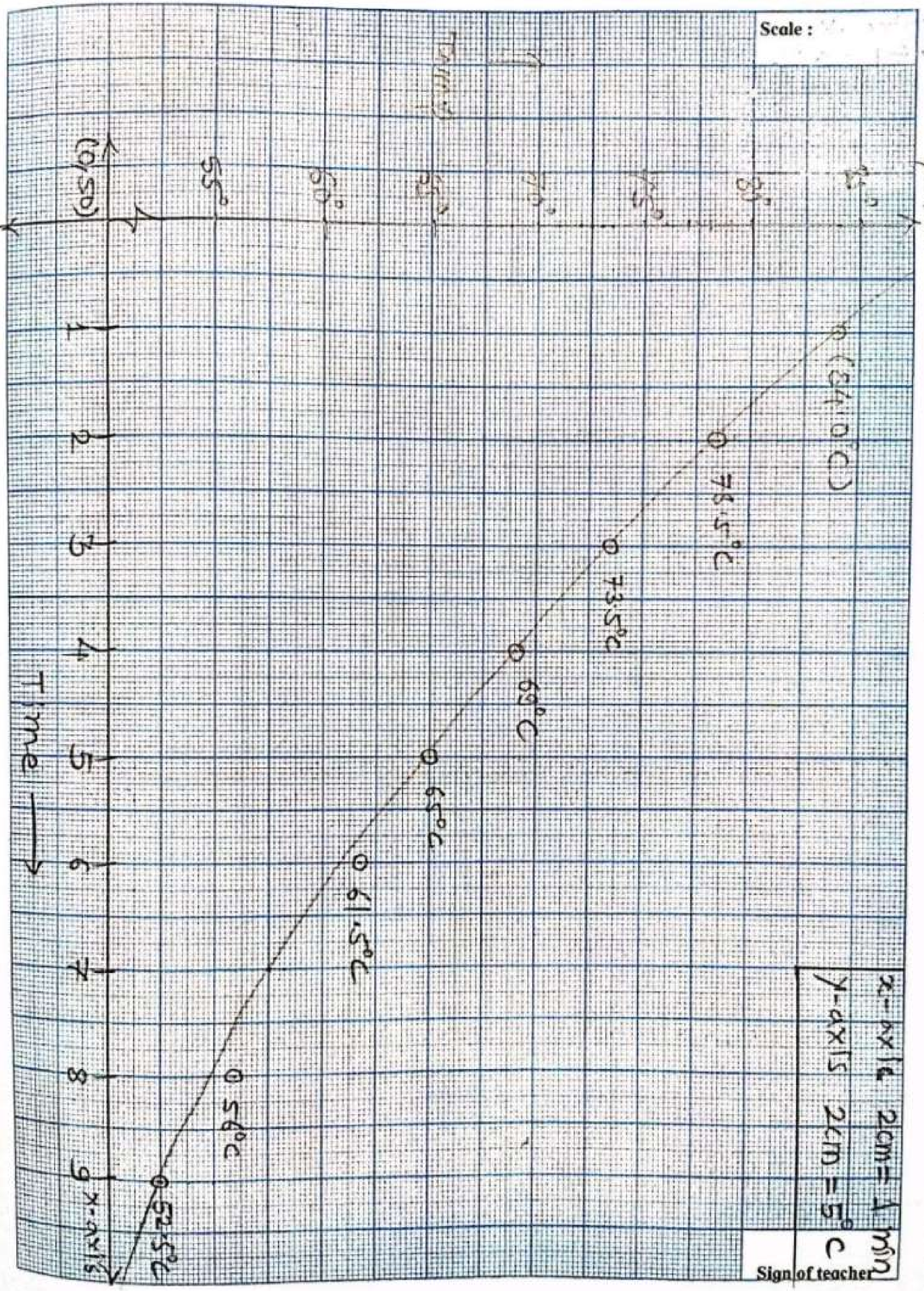
$= -50(\frac{4}{5})^5 + 32 = \frac{1952}{125} \approx 15.6°C$

3. State Newton's law of cooling. write its expresion in the form of specific heat.

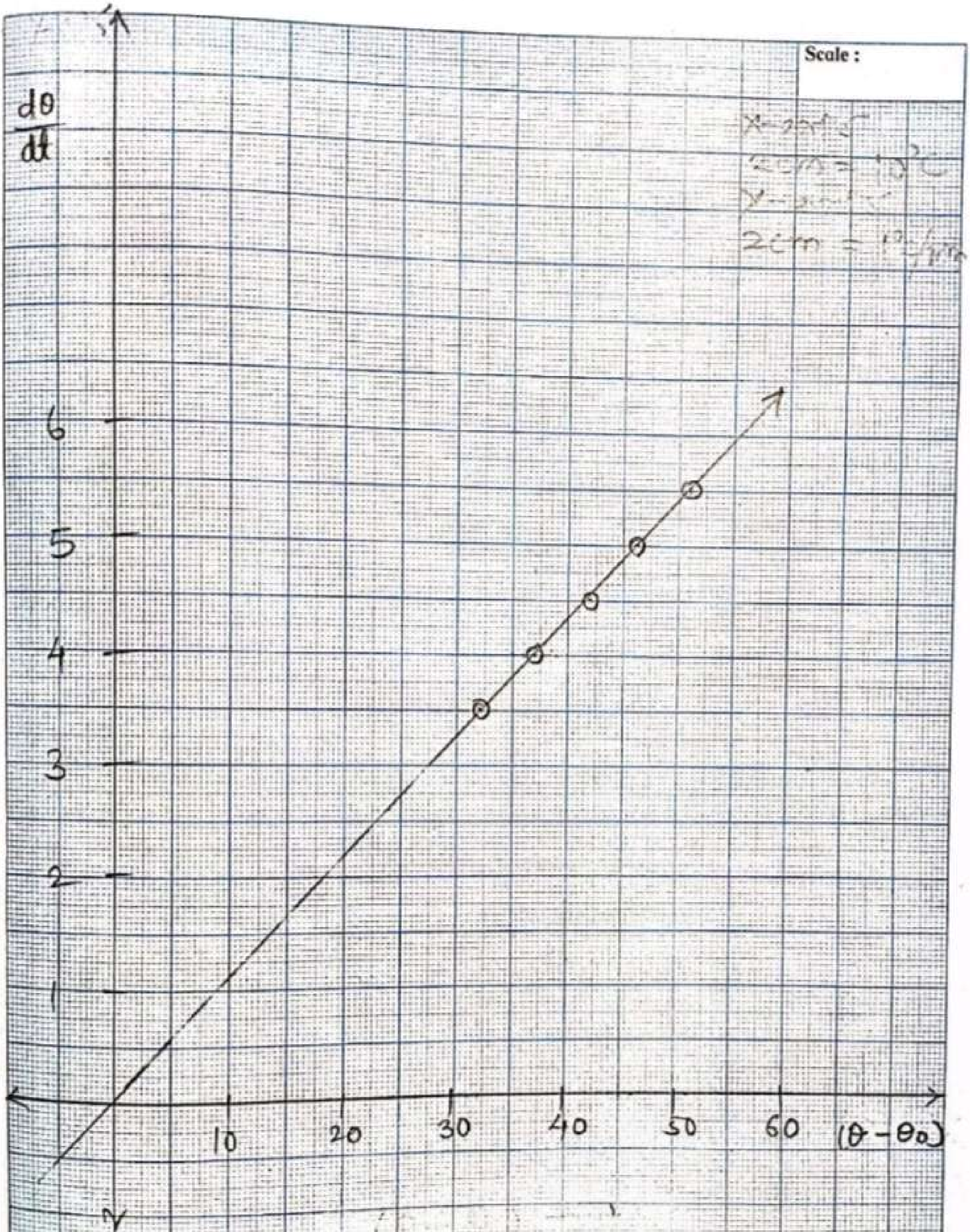
The rate of fall of temperater $(\frac{d\theta}{dt})$ by a body is directly propotional to the difference of temperature $(\theta - \theta_0)$ of the body over surrounding provided the difference small.

Remark and sign of teacher :

Scale :



Sign of teacher


Scale :
2cm = 10°C
2cm = 1°C/min
dθ/dt
6
5
4
3
2
1
10
20
30
40
50
60
(θ - θo)
Sign of teacher

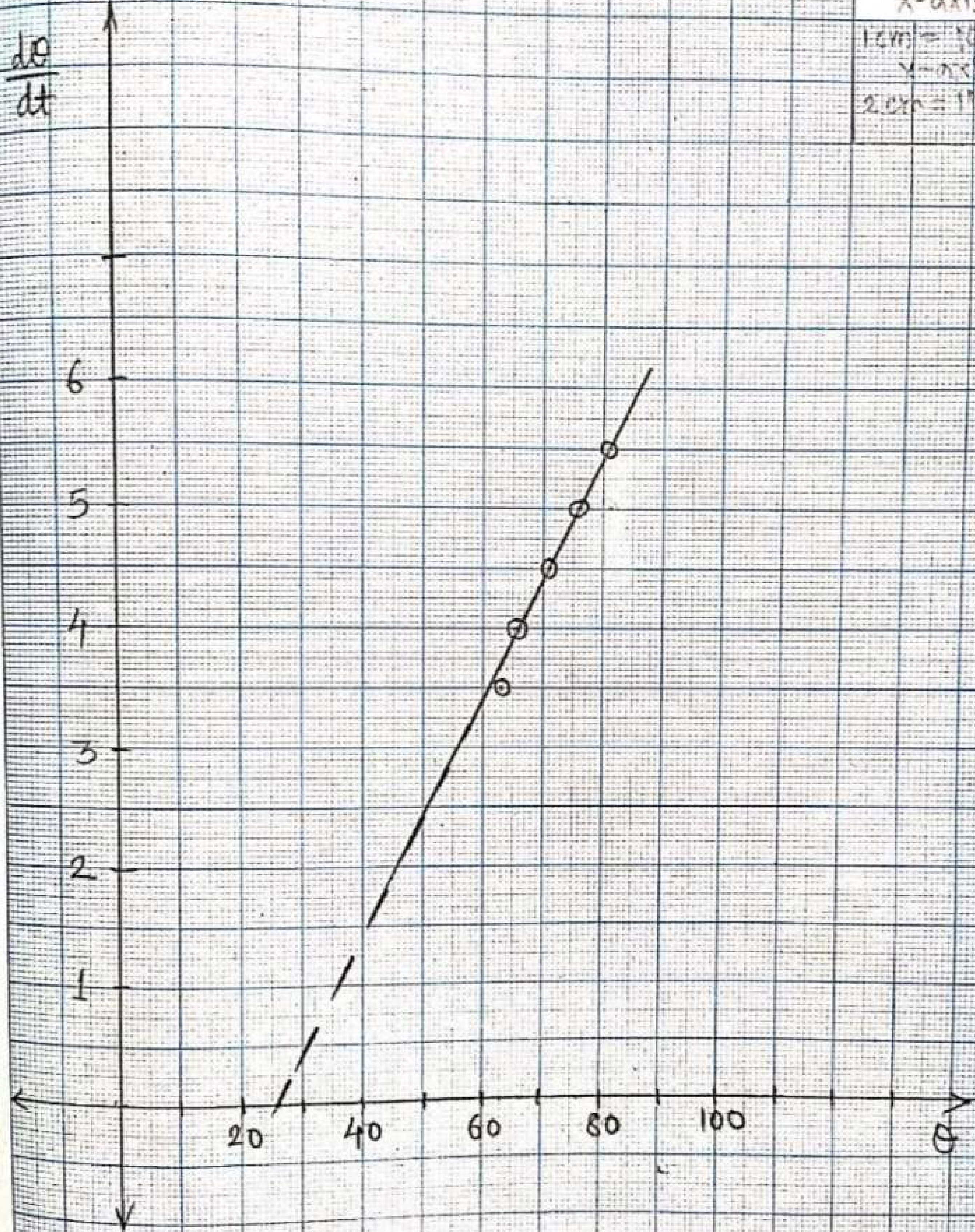
Scale :

x-axis

1 cm = 10°C

y-axis

2 cm = 1°C/min

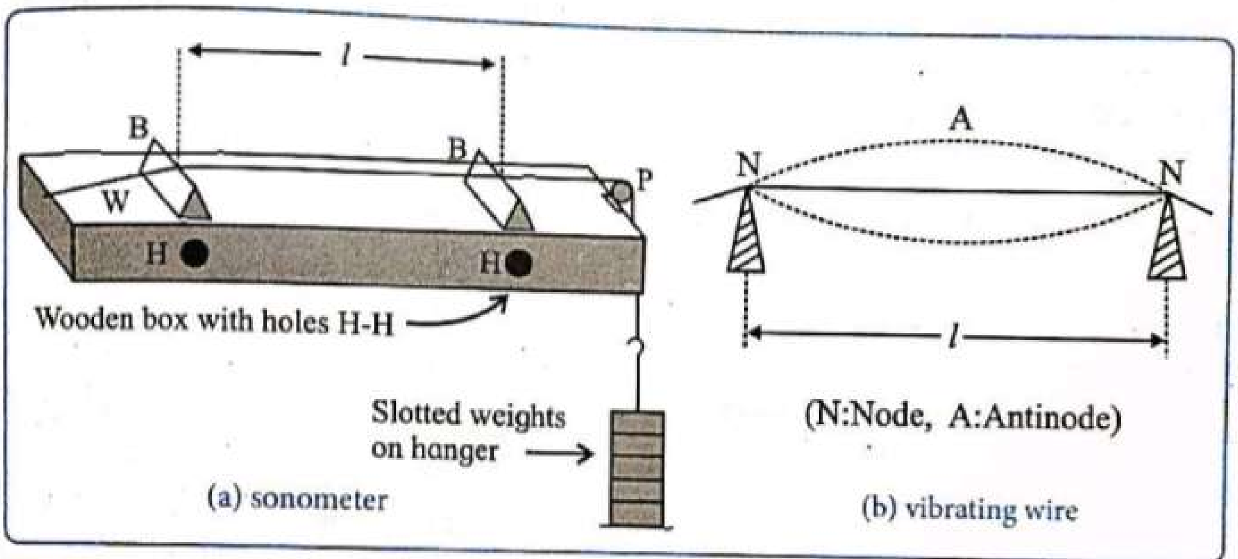


Sign of teacher

EXPERIMENT NO. 4
SONOMETER - LAW OF LENGTH

Aim: To study the relation between frequency and length of a given wire under constant tension using sonometer.

Apparatus : Sonometer, slotted weights with hanger, set of tuning forks, rubber pad, light paper rider, meter scale.



(a) sonometer (b) vibrating wire

Theory:

Law of Length: The frequency of stationary transverse vibrations of a stretched string is inversely proportional to its vibrating length when the tension and mass per unit length of the wire are kept constant.

Thus $n \propto \frac{1}{\ell}$ $\therefore n\ell =$ constant when T and m are constant.

Formula :

$$n = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$$

Where ,

n	=	frequency of vibration of the wire.
T	=	tension applied to the wire.
m	=	mass per unit length of the wire
ℓ	=	vibrating length of the wire.

Procedure :

1. Set up the sonometer on the table and clean the groove on the pulley to ensure that it has minimum friction. Stretch the wire by placing a suitable load on the hanger.
2. Add suitable mass to the hanger to the sonometer wire. Keep it constant throughout the experiment.
3. Place a light paper rider on the wire midway between knife edges.
4. Take a tuning fork of highest frequency, strike it on the rubber pad and set into vibrations.
5. Put the stem of vibrating tuning fork gently on the sonometer box.

6. Slowly, change the distance between two knife edges and adjust particular distance betweenthem so that paper rider falls off.
7. Measure the distance between two knife edges which is the vibrating length of the wire. Take one more reading with the same tuning fork and find mean vibrating length (ℓ)
8. Repeat the procedure with different tuning forks with decreasing order of frequency. Note the corresponding length of vibrating wire.
9. Calculate '$n\ell$' for each tunning fork.
10. Plot a graph of reciprocal of vibrating length $\frac{1}{\ell}$ on (Y-axis) against frequency n on X (axis).
11. Determine unknown frequency from the graph and calculations.
12. Calculate linear density of the wire using mean $n\ell$.

Observations:

Mass of the hanger M_0 =..100 gm Total mass M=...1000 gm

Tension applied to the wire T = .1000.. × 980 dyne.

To measure vibrating length:

Obs. No.	Frequency of tuning fork n Hz	Vibrating length of the wire			$\frac{1}{\ell}$	$n\ell$ Hz–cm
		ℓ_1	ℓ_2	Mean ℓ cm		
1	512	14·9	14·4	14·65	0·0682	7504·0
2	426	17	19·2	18·1	0·0549	7711·0
3	380	20·5	22·3	21·4	0·0467	8182·0
4	152	38·5	41·4	39·85	0·0252	6056·8
5	unkwon n'= ...312·4			ℓ'=.23·5		7350·75

Calculations :

To find $n\ell$

Ob. No	1	2	3	4	5
Log n = a	2·7093	2·6294	2·5798	2·1818	
Log ℓ = b	1·1660	1·2577	1·3304	1·6004	
a + b = c	3·8753	3·8871	3·9102	3·7822	
Antilog c = $n\ell$	7504·0	7711·0	8132·0	6056·0	

Mean ($n\ell$) = ...7350·75

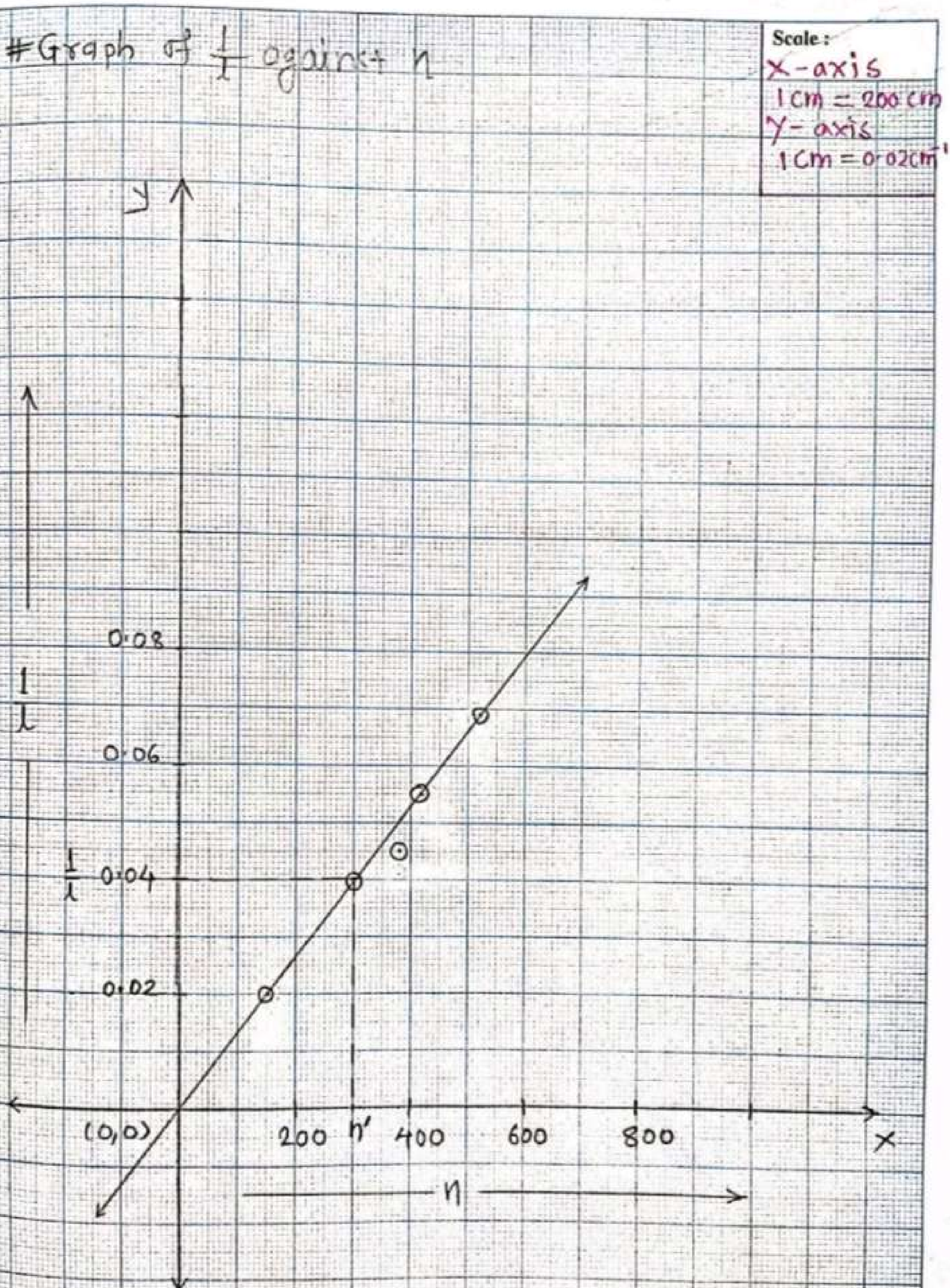
Umknown frequency n' = = Hz $\frac{(n\ell)mean}{\ell'}$ = 312·4 Hz

$\frac{7350 \cdot 75}{23 \cdot 5} = \frac{7351}{23 \cdot 5}$

= 312·8

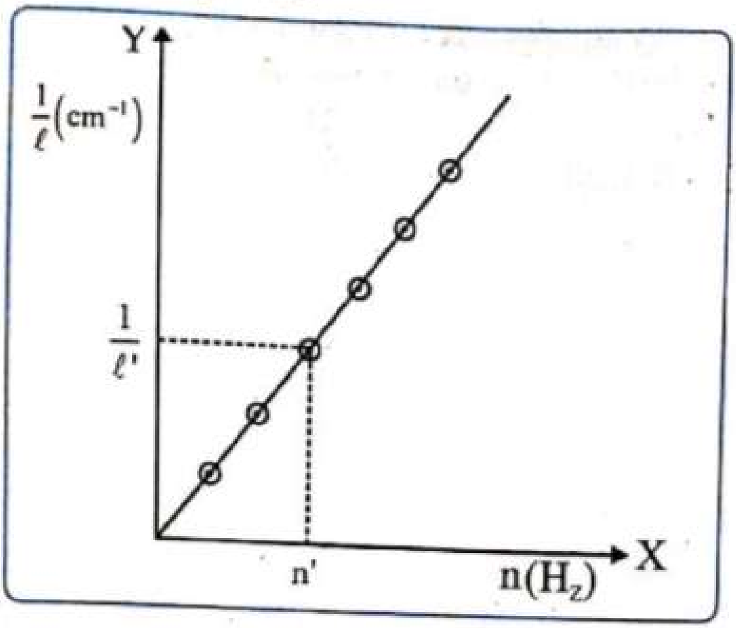
3·8664
1·3711
[illegible]

Graph of $\frac{1}{l}$ against n



Sign of teacher

Graph : A graph of $1/\ell$ angainst n



Scale $Y = \text{--------} cm^{-1}$
$X = \text{-------} Hz$

Result :

1. $n\ell$ = 7350.75 = constant, when T and m are kept constant, Hence law of length is verified.
2. The graph of reciprocal of vibrating length against frequency of vibrations of wire is straight line. Hence $n \propto \frac{1}{\ell}$
3. Unknown frequency of tuning fork by calculation n' = 312.4 Hz
4. Unknown frequency of tuning fork by graph n' = 300 Hz

Precautions :

1. Place the paper rider mid – way between knife edges.
2. Paper rider should be light and dry.
3. Strike tuning fork on the rubber pad gently.
4. Place the stem of the vibrating tuning fork gently on the sonometer box.
5. Measure the distances between the knife-edges accurately.

Questions

1. State the law of length of vibrating string.

Statement" The fundamental frequency is inversely proportional to the resonating length (L) of the string

$$f \propto \frac{1}{L}$$

2. What is fundamental mode of vibration?

The mode of vibration of a system in which frequency of oscillation is minimum is called fundamental mode of vibration.

3. What is resonance?

oscillation of object with maximum amplitude, when the frequency of the applied force equal to ~~to~~ the natural frequency of the object is called resonance.

4. What is forced vibrations?

Vibrations of a body under the constant influence of an external periodic force acting on it are called the forced vibrations.

The external applied force is called driving force.

5. Explain why holes are kept on one side of sonometer box?

The holes in the sonometer box provides a way so that vibrations from the tuning fork is transferred to the inside of the sonometer box. Thus the sonometer box the bridges and string are forced to vibrate with the frequency of tuning fork.

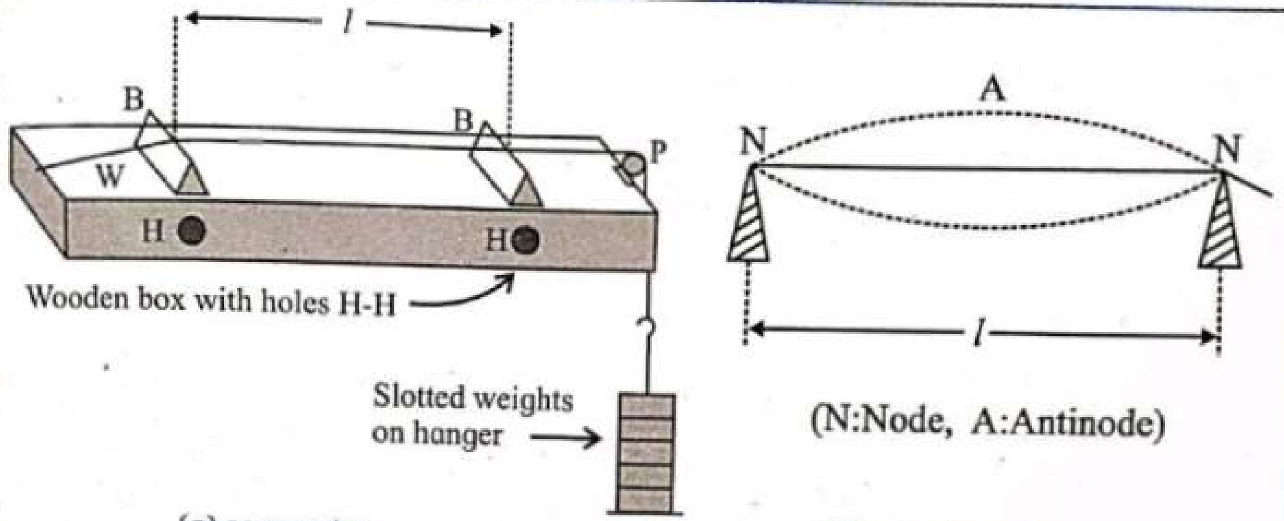
Hence holes are provided to the sonometer box to communicate the frequency of vibration of the string to the inside hallow portion of the box.

Remark and sign of teacher :

EXPERIMENT NO. 5
SONOMETER - LAW OF TENSION

Aim: To study the relation between the length of a given wire and tension for constant frequency.

Apparatus : Sonometer, slotted weights with hanger, a turning fork of known frequency, rubber pad, light paper rider, meter scale.



(a) sonometer (b) vibrating wire

Formula :

$$n = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$$

n	=	frequency of vibrations of the wire.
T	=	tension applied to the wire.
m	=	mass per unit length of the wire
ℓ	=	vibrating length of the wire
T	=	$4n^2\ell^2m$

i. e. $T \alpha \ell^2$ when n and m are kept constant

Theory:

The frequency of statinary transverse vibrations of a stretched string is directly proportional to the square root of the tension in the wire, when lengh of vibrating string and mass per unit length of the wire are kept constant.

$\therefore n \, \alpha \sqrt{T}$ $\qquad \therefore \frac{n}{\sqrt{T}} = \text{constant}$

for verification $\ell \alpha \sqrt{T}$ or $\frac{\sqrt{T}}{\ell} = \text{constant}$

Procedure :

1. Apply a weight of about 0.5 kg (500 gm) including hanger to the sonometer.
2. Place a light paper rider on the wire midway between the knife edges.
3. Strike the given tuning fork on rubber pad gently and set it into vibrations.
4. Put the stem of vibrating tuning fork gently on the sonometer box.
5. Slowly change the distance between knife edges and adjust distance between them so that the paper rider falls off.

Result :

1. As $\frac{T}{\ell^2}$ = constant, when n and m are kept constant. The law of tension is verified.
2. The graph of ℓ^2 against T is straight line $\therefore T \alpha \ell^2$ Hence law of tension is verified.
3. Unknown mass by calculation = 1250
4. Unknown mass by graph = 1275

Precautions :

1. Wire should be free form kinks and of uniform cross seation.
2. Keep the paper rider at the mid point of knife-edges.
3. The stem of tuning fork should rest on the sonometer box.
4. Strike the tuning fork on the rubber pad gently.

Questions

1. State the second law of vibrating string.

statement

The fundamental frequency of transverse vibration of stratched string is directly proporti-onal to the square root of the tension (T) in the string if linear density (m) and vibrating length (l) of the string are kept constant.

$n \alpha \sqrt{T}$

2. Why do we keep frequency constant instead of keeping vibrating length constant to verify second law of vibrating string?

A vibration in string is a wave. Resonance causes a vibrating string to produce a sound with constant frequency i.e. constant pitch. If the length or tension of the string is correctly adjested, the sound produced is a musical tone.

3. How many nodes and antinodes are formed when the wire vibrates in fundamental mode?

Two nodes and one antinode is formed when the wire is vibrates in the fundamental mode.

Remark and sign of teacher :

EXPERIMENT NO. 6
RESONANCE TUBE

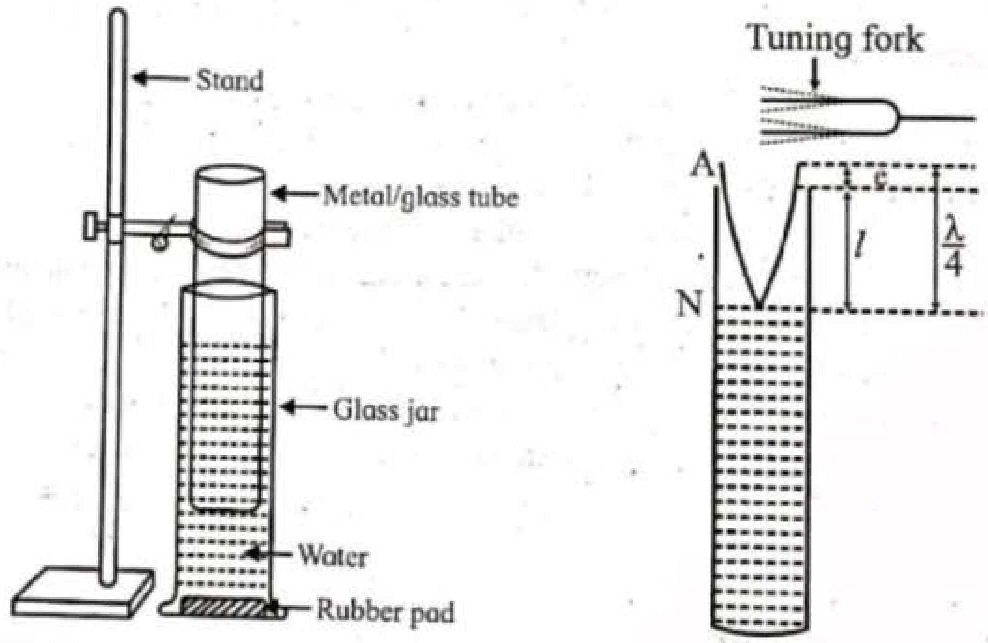
Aim : (i) To determine the speed of sound in air at room temperature

(ii) To find out the unknown frequency of a tuning fork using Resonance Tube

Apparatus :

A long plastic jar filled with water, resonance tube, set of tuning forks, retort stand, meter scale, vernier calliper, rubber pad, thermometer

Diagram :



Formula :

(i) End correction $e = 0.3d$ where d is the inner diameter of resonance tube

(ii) $V = 4\ (nL)_{mean}$ n= frequency of tuning fork

$= 4n\ (\ell + e)$ L = correct resonating length of air column

$= 4n\ (\ell + 0.3d)$ ℓ = observed resonating length of air column

(iii) $V = 4 \times \dfrac{1}{\text{slope}}$ (if graph is $\dfrac{1}{L}$ against n)

(iv) $n_x = \dfrac{(nL)\text{mean}}{L_x}$ (where L_x is the correct resonating length for fork of unknown frequency)

Procedure :

1. Measure the inner diameter of the resonance tube with the help of the upper jaws of vernier calliper. Take three readings and hence calculate end correction of resonance tube.
2. Note down the room temperature using the given thermometer.
3. Hold the resonance tube vertically in the plastic jar filled with water with the help of retort stand (as shown in the diagram).

4. Immerse the resonance tube in the plastic jar filled with water as deep as possible so that the length of the air column is minimum.
5. Arrange the tuning forks in descending order of frequency.
6. Strike the tuning fork of highest frequency gently on the rubber pad and hold it near the mouth of the resonance tube, so that the prong of the tuning fork vibrate in vertical plane.
7. Raise the resonance tube slowly along with the fork till a loud sound is heard indicating that the air column is vibrating in resonance with the fork. Clamp the tube.
8. Measure the length of air column from the surface of the water level to the open end of the resonance tube using meter scale
9. Repeat the procedure and measure the length (ℓ) three times for the same tuning fork and calculate mean length (ℓ)
10. Set the next tuning fork in to vibrations, hold it near the open end of the resonance tube, raise it slowly from the previous position till resonance is obtained and measure the corresponding length (ℓ) three times and calculate the mean length
11. Repeat the complete procedure for the rest of the tuning forks
12. Similarly find the mean resonating length (ℓ_x) for the unknown frequency tuning fork (n_x)
13. Add end correction (e) to mean resonating length (ℓ) and calculate corrected length (L) for all tuning forks. Calculate L_x for the tuning fork of unknown frequency
14. Calculate nL for all tuning forks except the tuning fork of unknown frequency
15. Calculate the speed of sound at room temperature and also unknown frequency
16. Plot a graph of n (y axis) against $\frac{1}{L}$ (x axsis) and calcualte the speed of sound by graph.

Observations :

1. Least count of vernier calliper

(i) Smallest division on the main scale of vernier calliper, x = 0.1 cm
(ii) Total number of divisions on the vernier scale of the vernier calliper, y = 10 div.
(iii) Least count (L.C) of vernier calliper, x/y = $\frac{0.1}{10}$ cm $= 0.01$ cm
(iv) Zero error (e') = 0.0 cm

Observation table :

1) For inner diameter of resonance tube

Obs. No.	MSR / (a)cm	VSD (b)cm	VSR (c= b x L.C) cm	Diameter / (total reading) (a+c = d') cm	Corrected reading (d = d' – e') cm
1	2.4	4	0.04	2.44	2.44–0
2	2.4	5	0.05	2.45	2.45–0
3	2.4	3	0.03	2.43	2.43–0

Mean d = 2.44 cm

End correction e = 0.3 d = 0.732 **cms** $= 0.3 \times 2.44 = 0.732$ cm.

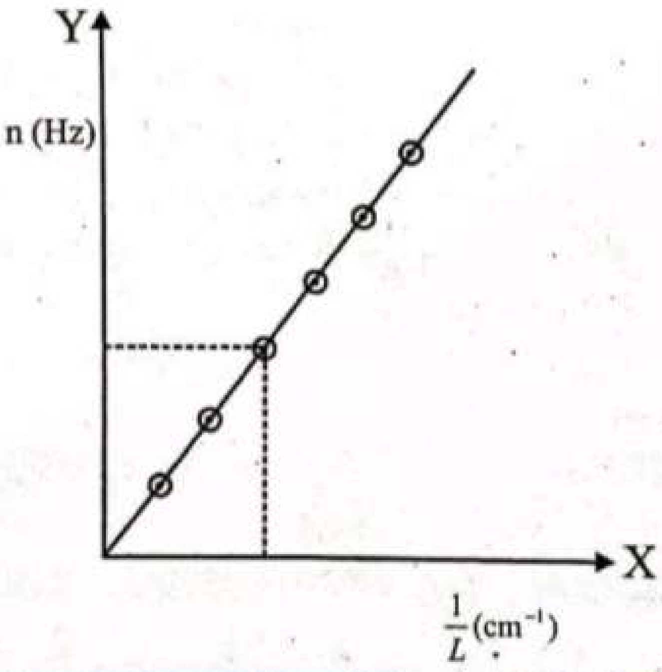
2) For resonating length :

Obs. No.	Frequency n (Hz)	Length of air column				Corrected length $L = \ell + e$ cm	$\frac{1}{L}$ (cm-1)	nL Hz - cm
		ℓ_1 cm	ℓ_2 cm	ℓ_3 cm	Mean ℓ cm			
1	512	14.9	17.4		16.15	16.88	0.0592	8644.
2	426	17.3	19.5		18.4	19.13	0.0523	8149
3	380	19.4	21.1		20.24	20.98	0.0477	7373
4	152	51.6	48.8		50.2	50.93	0.0196	7741.
5	Unknown $(n_x) =$ 2.60					$L_x =$ 33.33		$\frac{1}{L_x} =$ 0.03

Mean (nL) = 8126.75 Hz – cm or cm/s

Graph :

Plot a graph of n (y axis) against $\frac{1}{L}$ (x axis) and calculate the speed of sound by graph.



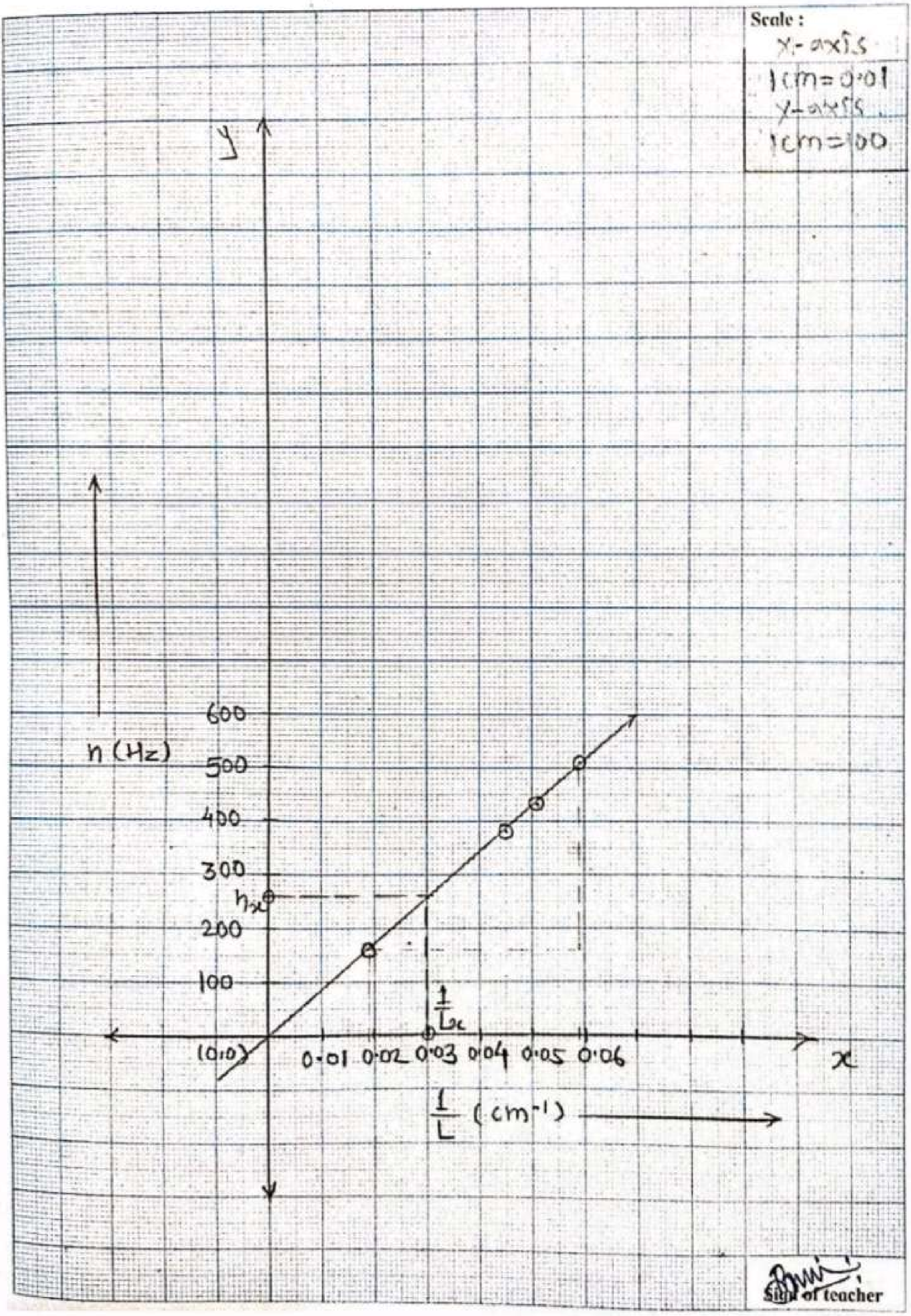
Scale X = ---------------

Y = ---------------

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{510 - 160}{0.059 - 0.019} = \frac{350}{0.04} = 8750$$

V = 4 × slope = 35000 cm/s = 350 m/s

Also determine the unknown frequency (n_X) from the graph


Scale :
x- axis
1cm = 0·01
y- axis
1cm = 100
y
n (Hz)
600
500
400
300
200
100
(0,0)
0·01
0·02
0·03
0·04
0·05
0·06
x
1/L (cm⁻¹)
Sign of teacher

Calculations :

Obs. No	Log n (a)	Log L (b)	a + b = c	Antilog (c) = 3nL
1	2.7093	1.2274	3.3367	8644.0
2	2.6294	1.2817	3.9111	8143.0
3	2.5798	1.3218	3.9016	7973.0
4	2.1818	1.7070	3.8888	7741.0

Mean (nL) = ___ Hz cm or cm / s 8126.75.

(1) Speed of Sound

$V = 4(nL)_{mean}$

$= 4 \times$ 8126.75

= 32507 Hz cm or cm / s = 325.07 m/s

(2) Unknown frequency

$$n' = \frac{\text{mean (nL)}}{\text{Corrected length corresponding to the unknown frequency } (L_x)} = \frac{8126.75}{33.33}$$

= 244 Hz

Result :

1) Speed of sound in air at room temperature
   - a) By calculation : V = 325 m/s
   - b) By graph : V = 350 m/s

2) Unknown frequency of fork
   - a) By calculation : n' = 244 Hz
   - b) By graph : n' = 260 Hz

Precautions:

1. Strike the tuning fork gently on rubber pad
2. Hold the vibrating tuning fork just above the mouth of the resonance tube
3. Do not bring ear close to the tube
4. While adjusting the resonating length, start with the minimum length of the air column and the tuning fork of highest frequency
5. Tuning fork should not touch the resonance tube
6. The prongs of the tuning fork must vibrate in vertical plane

Questions

1. What is meant by the term resonance ?

The phenomenon in which the body vibrates under action of external periodic force whose freqn is equal to the natural frequency of the driven body, so that amplitude becomes maximum is called as resonance.

2. What are forced oscillations ?

When a body oscillates by being influenced by an external periodic force it is called forced oscillation.

3. What are the sources of errors in this experiment ?

Common source of error includes; instrumental, environmental, procedural and human. All of these errors can be either random or systematic depending on how they affect the results.

4. What are nodes and antinodes ?

A node is where the amplitude of the wave is zero.

Antinodes are where the amplitude is maximum, halfway between two adjacent nodes.

5. What is end correction ? How do you eliminate it ?

The distance of antinode from the open end of the pipe is known as the end correction. It was shown by Regnault ;

Corrected length = $l + 0.3d$

6. State the factors on which velocity of sound depends ?

Velocity of sound depends on temperature as well as the medium through which a sound wave is propagating.

7. How does the speed of sound in the given medium vary with the temperature ?

Molecules at higher temperature have more energy, thus they can vibrate faster. Since the molecules vibrate faster, sound wave can travel quickly.

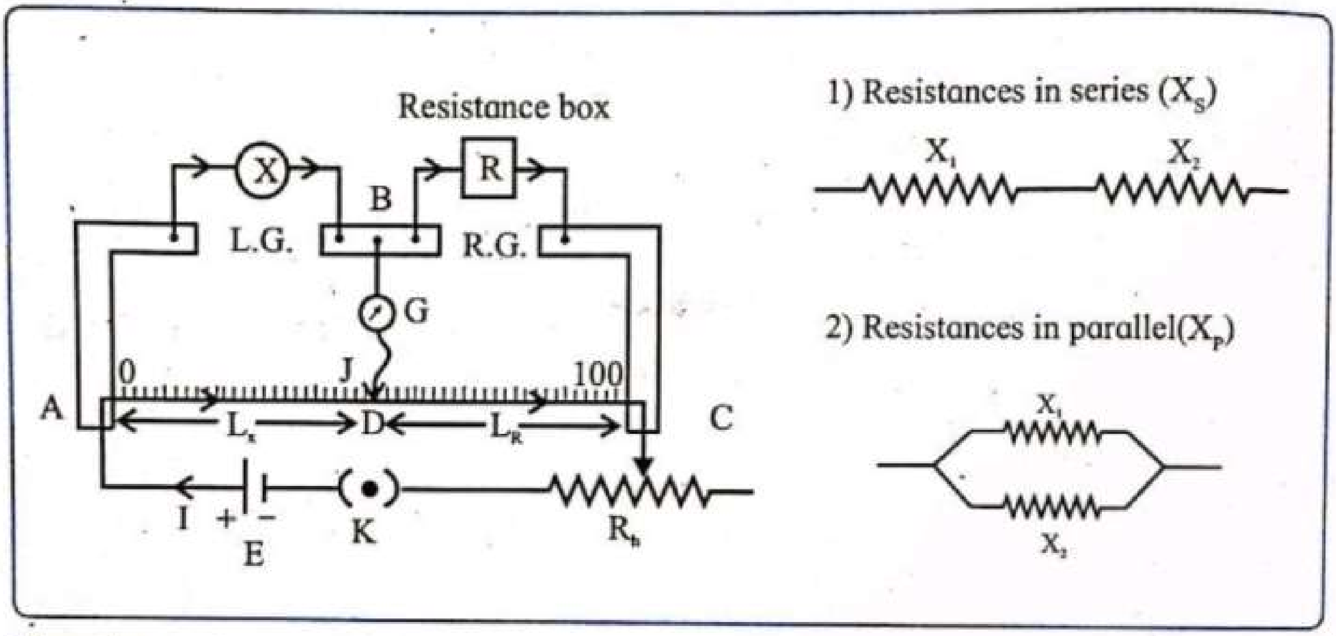
Remark and sign of teacher :

EXPERIMENT NO. 8
LAW OF RESISTANCES USING METER BRIDGE

Aim : To verify the laws of combination (series and parallel) of resistances using a meter bridge.

Apparatus : Meter bridge, two resistances, galvanometer, resistance box, rheostat, cell, jockey, plug key, connecting wires.

Circuit diagram :



Formulae :

1) $X = R\left(\frac{L_x}{L_R}\right)$ Where, L_X and L_R are balancing lengths corresponding to X and R.

2) For series combination, $X_s = X_1 + X_2$

3) For parallel combination, $X_P = \frac{X_1 \times X_2}{X_1 + X_2}$

Procedure :

1. Arrange and connect the circuit for series combination.
2. Take some suitable value of resistance form the resistance box and then close the plug key.
3. Touch the jockey at point A and C of the meter bridge wire, so that the galvanometer will deflection on either side of zero.
4. By touching the jockey at various points along the wire AC, locate the point where galvanometer shows zero deflection. This point is called as 'NULL POINT'
5. Measure the length L_X and L_R as shown in the figure. Hence, calculate the value of X_S.
6. By changing the resistance in the resistance box, take THREE sets of observations in the same way.
7. Repeat the experiment by interchanging the positions of X_S and R. Hence, calculate, the value of X_S.
8. Repeat the experiment by connecting X_1 and X_2 in parallel, and hence calculate the value of X_P.

Observations :

Resistance (X_1) = 10 Ω

Resistance (X_2) = 20 Ω

1) For series combination :

Resistance Position	Obs. No.	Resistance from Resistance Box (Ω) R	L_X (cm)	L_R (cm)	$X_s = R\left(\frac{L_x}{L_R}\right)$ Ω
Series in left gap	1	10	75	25	30
	2	20	60	40	30
	3	30	50	50	30
Series in right gap	1	10	75	25	30
	2	20	60	40	30
	3	30	50	50	30

Mean X_s = 30 Ω

2) For parallel combination :

Resistance Position	Obs. No.	Resistance from Resistance Box (Ω) R	L_X (cm)	L_R (cm)	$X_p = R\left(\frac{L_x}{L_R}\right)$ Ω
Parallel in left gap	1	10	20	80	2·5
	2	20	25	75	6·665
	3	30	30	70	12·85
Parallel in right gap	1	10	20	80	2·5
	2	20	25	75	6·665
	3	30	30	70	12·85

Mean X_s = 7·338 Ω

3) For series combination:

	Left gap			Right gap		
Obs. No	**1**	**2**	**3**	**1**	**2**	**3**
Log R = a	1·0000	1·30103	1·4771	1·0000	1·30103	1·4771
Log ℓ_x = b	1·8751	1·7782	1·6990	1·8751	1·7782	1·6990
c = a + b	2·8751	3·0792	3·1761	2·8751	3·0792	3·1761
Log L_R = d	1·3980	1·6021	1·6990	1·3980	1·6021	1·6990
c - d = e	1·4771	1·4771	1·4771	1·4771	1·4771	1·4771
Antilog e = X_s	30·00	30·00	30·00	30·00	30·00	30·00

2) For parallel combination :

	Left gap			Right gap		
Obs. No	**1**	**2**	**3**	**1**	**2**	**3**
Log R = a	1·0000	1·3010	1·4771	1·0000	1·3010	1·4771
Log L_X = b	1·3010	1·3979	1·4771	1·3010	1·3979	1·4771
c = a + b	2·3010	2·6989	2·9542	2·3010	2·6989	2·9542
Log L_R = d	1·9031	1·8751	1·8451	1·9031	1·8751	1·8451
c - d = e	0·3979	0·8238	1·1091	0·3979	0·8238	1·1091
Antilog e = X_p	2·500	6·665	12·85	2·500	6·665	12·85

Calculations :

1) $X_S = R\left(\frac{L_x}{L_x}\right)$

Mean X_S = 30 Ω

(experimental value)

2) $X_P = R\left(\frac{L_x}{L_x}\right)$

Mean X_P = 7.338 Ω

(experimental value)

Result :

1) In series

a) Experimental value of X_S = 30 Ω

b) Theoretical value of $X_S = X_1 + X_2$ = 30 Ω

2) In parallel

a) Experimental value of X_P = 7.338 Ω

b) Theoretical value of $X_P = \frac{X_1 \times X_2}{X_1 + X_2}$ 6.667 Ω

Hence laws of series and parallel is verified.

Precautions :

1. All the connections and plugs in the resistance box should be tight.
2. Null point is obtained in the middle $(\frac{1}{3})^{rd}$ portion of the metre bridge wire.
3. Do not slide the jockey on the wire.
4. Remove the plug key after completion of experiment.

Questions

1. What is a balance point in meter bridge?

The point when Galvanometer shows Null Deflection is called Balanced point.

2. Resisitance of a wire is x Ω, The wire is stretched to triple its length, then the resistance becomes ?

The resistance of wire is inversely proportional to its area and directly proportional to its length when length is tripled then resistance will also

Remark and sign of teacher : becomes three times.

EXPERIMENT NO. 9
RESISTANCE OF GALVANOMETER BY KELVIN'S METHOD

Aim : To determine the resistance of a galvanometer by Kelvin's method using Wheatstone's meter bridge

Apparatus : Wheatstone's meter bridge, a rheostat, a cell, a galvanometer, a resistance box, a jockey, connecting wires, a cell or battery, a plug key etc.

Formula :

$$G = R\,\frac{\ell_G}{\ell_R}$$

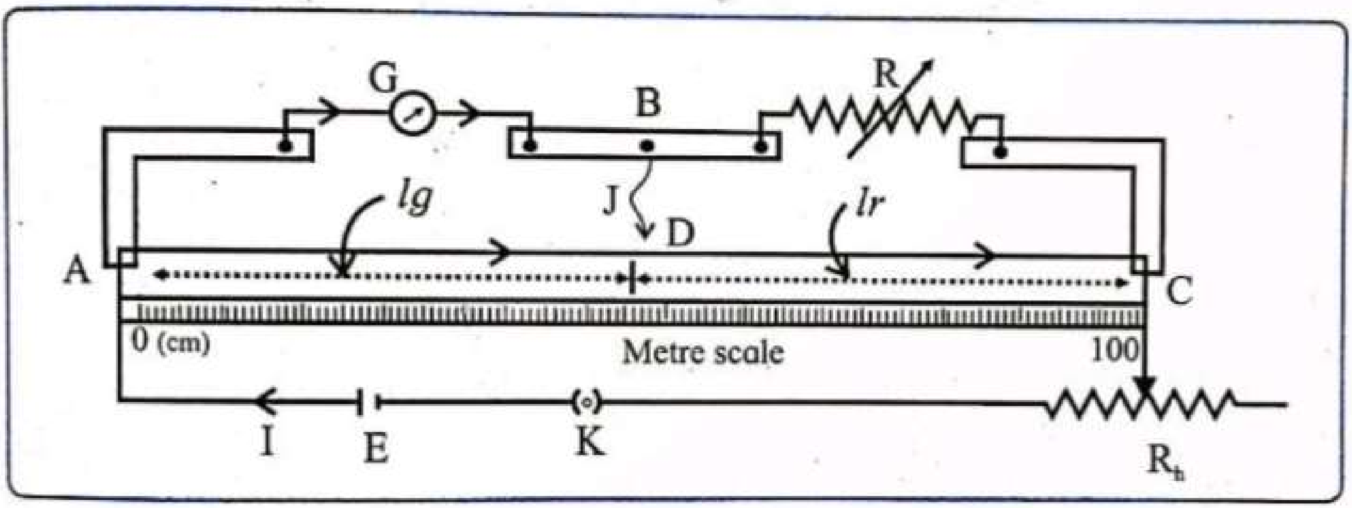
where ℓ_G = length of the bridge wire corresponding to G

ℓ_R = length of the bridge wire corresponding to R

G = resistance of Galvanometer

R = resistance introduced in R.B

Circuit Diagram :



Procedure :

1. Connect the circuit as shown in figure
2. The galvanometer, whose resistance G is to be determined is connected in one arm and a resistance box is connected in the other arm of the Wheatstone's meterbridge. A jockey is directly connected from point B. A suitable resistance is introduced in the resistance box.
3. The circuit is closed and the galvanometer deflection is noted. The rheostat is adjusted so that the galvanometer shows nearly half the full scale deflection.
4. When the jockey is touched on the wire, the galvanometer deflection either increases or decreases. Move the jockey along the wire till the galvanometer deflection is restored to the original value. This is the null point or balance point. Thus in this position, the null point is constant when the jockey is touched or removed from the wire. Adjust R so that the balance point is between 30 cm and 70 cm, preferably one reading near or in the middle of the bridge wire. Measure ℓ_G and ℓ_R
5. Take three more readings by changing the values of R
6. Interchange the position of G and R and take four readings by adjusting R. calculate the value of G in each case. Find mean G.

Observation table :

1) Galvanometer in left gap

Obs. No.	R ohm	ℓ_G cm	ℓ_R cm	$G = R\dfrac{\ell_G}{\ell_R}$ ohm	Mean G ohm
1	50	67	33	101·3	98·25
2	70	58·5	41·5	98·68	
3	90	51·3	48·7	94·79	
4					

2) Galvanometer in right gap

Obs. No.	R ohm	ℓ_G cm	ℓ_R cm	$G = R\dfrac{\ell_G}{\ell_R}$ ohm	Mean G ohm
1	50	34	66	25·69	53·55
2	70	42·1	57·9	50·90	
3	90	48·3	51·7	84·07	
4					

Calculations :

Log calculation table : $G = R\dfrac{\ell_G}{\ell_R}$

1) Galvanometer in left gap

Obs. No.	1	2	3	4
$\log R = a$	1·6980	1·8451	1·9542	
$\log \ell_G = b$	1·8261	1·7672	1·7101	
$a + b = c$	3·5241	3·6123	3·6643	
$\log \ell_R = d$	1·5185	1·6181	1·6875	
$c - d = e$	2·0056	1·9942	1·9768	
antilog $e = G$	101·3	98·68	94·79	

2) Galvanometer in right gap

Obs. No.	1	2	3	4
$\log R = a$	1·6980	1·8451	1·9542	
$\log \ell_G = b$	1·5314	1·6243	1·6839	
$a + b = c$	3·2294	3·4694	3·6381	
$\log \ell_R = d$	1·8195	1·7627	1·7135	
$c - d = e$	1·4099	1·7067	1·9246	
antilog $e = G$	25·69	50·90	84·07	

∴ the resistance of the galvanometer

$$G = \frac{\text{mean G (of left gap)} + \text{mean G (of right gap)}}{2}$$

G = 75·9 Ω

Result :

The resistance of the galvanometer G = 75.9 Ω

Precautions :

1. Make all connections and the keys in the resistance box tight
2. Adjust the resistance R such that the point lies in the middle one third of the meterbridge wire or between 30 cm and 70 cm, preferably one reading near or on the mid of the bridge wire
3. Keep the circuit on only at the time of observation
4. Do not slide the jockey on the wire but tap it gently to get the exact null point

Questions

1. What is a balance point?

The point when Galvanometer shows Null Deflection is called Balanced point.

2. What will happen if the cell and galvanometer are interchanged?

If the galvanometer and the cell are interchanged then the balance point remains unchanged. Hence the galvanometer will not show any current and there will be null deflection.

3. Can you use a shunt for the galvanometer? Explain

A shunt resistance is connected in parallel to the galvanometer so as to keep the resistance low. such low resistance galvanometer is used in series with the circuit to measure the strength of current through the circuit.

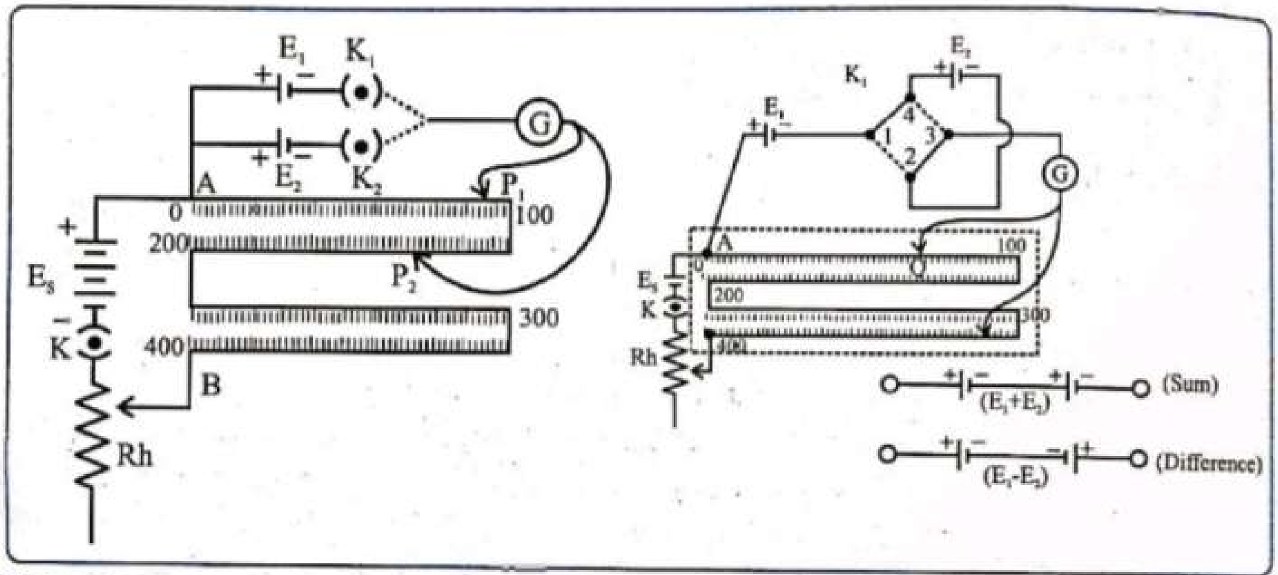
Remark and sign of teacher :

EXPERIMENT NO. 10
E1/E2 USING POTENTIOMETER

Aim: To compare e. m. f. of the two given cells using a potentiometer.

Apparatus: A potentiometer, a plug key, a rheostat, two cells, jockey, four way key, battery, galvanometer, connecting wires etc.

Diagram:



Formula:

1) Individual cell method or Separate cell method –

$$\frac{E_1}{E_2} = \frac{L_1}{L_2}$$

Where, L_1 is the balancing length when cell E_1 is in the circuit and L_2 is the balancing length when cell E_2 is in the circuit.

2) Sum and difference method –

$$\frac{E_1 + E_2}{E_1 - E_2} = \frac{L_1}{L_2}$$

Where, L_1 is the balancing length when both cells assist each other i.e. $E_1 + E_2$ (sum method) and L_2 is the balancing length when both cells oppose each other i.e. $E_1 - E_2$ (difference method).

Procedure:

Part – I (Individual cell Method or Separate cell method)

1. Measure the e.m.f. (E_S) of the battery and the e.m.fs. (E_1 and E_2) of the cells. See that $E_S > E_1$ and also $E_S > E_2$.
2. Connect the circuit as shown in fig.(i). Close the key K to bring the circuit in working, as current will start flowing. Adjust the rheostat at minimum resistance for maximum current in the circuit.
3. Take the cell E_1 in the circuit by closing key K_1. Then touch the jockey at zero end of the potentiometer wire and note the direction of deflection in the galvanometer. Touch the jockey at the other end of the potentiometer wire. If the direction of deflection is opposite to that in the first case, the connections are correct. (If the deflection is in the same direction then either

connections are wrong or e.m.f. of the cell used is less). Starting from the point A touch the jockey on the wire at various points and obtain the null point P_1. Note the length L_1 of the potentiometer wire between the point A and P_1.

4. Now disconnect the cell E_1 by opening key K_1. And connect the cell E_2 by closing key K_2. Obtain the null point P_2 and note the length L_2 of the potentiometer wire between the points A & P_2. Make sure that rheostat position is same as in step 2.
5. Repeat the observations alternately for each cell again by adjusting the rheostat at different positions.

Part –II (Sum and difference method)

1. Measure the e.m.f. (Es) of the battery and the e.m.fs. (E_1 and E_2) of the cells. See that $Es > E_1+E_2$, $Es > E_1-E_2$ and $E_1 > E_2$.
2. Connect the circuit as shown in fig.(ii) such that the positive terminal of E_1 is connected to the negative terminal of E_2. In this case both cells assist each other i.e. sum method. Close the key K to bring the circuit in working, as current will start flowing. Adjust the rheostat at minimum resistance for maximum current in the circuit.
3. Then touch the jockey at zero end of the potentiometer wire and note the direction of deflection in the galvanometer. Touch the jockey at the other end of the potentiometer wire. If the direction of deflection is opposite to that in the first case, the connections are correct. (If the deflection is in the same direction then either connections are wrong or e.m.f. of the cell used is less). Starting from the point A touch the jockey on the wire at various points and obtain the null point P_1. Note the length L_1 of the potentiometer wire between the point A and P1.
4. Now connect cells, such that the negative terminal of E_1 is connected to the negative terminal of E_2. In this case both cells oppose each other i.e. difference method. Obtain the null point P_2 and note the length L_2 of the potentiometer wire between the points A & P_2. Make sure that rheostat position is same as in step 2.
5. Repeat the observations for each sum and difference method by adjusting the rheostat at different positions.

Observations :

E.M.F. of battery, E_S = 6 V.

E.M.F. of cell, E_1 = 1·5.

E.M.F. of cell, E_2 = 1·5.

Part – I (Individual cell Method or Separate cell method)

Obs. No.	Balancing length when E_1 is in the circuit L_1 (cm)	Balancing length when E_2 is in the circuit L_2 (cm)	$\frac{E_1}{E_2}=\frac{L_1}{L_2}$
1.	113	105	1·0762
2.	129	120·5	1·0705
3.	171	156·5	1·0926
4.	210·5	201	1·0473
			Mean 1·07165

Part – II (Sum method and difference method)

Obs. No.	Balancing length when cells assist (E_1+E_2) each other in the circuit L_1 (cm)	Balancing length when cells oppose (E_1-E_2) each other in the circuit L_2 (cm)	$\frac{E_1+E_2}{E_1-E_2}=\frac{L_1}{L_2}$
1.	315	140·7	2·2388
2.	290	107	2·7103
3.	285	101·5	2·8079
4.	291	107·5	2·7070
			Mean 2·6160

Calculations:

Part -I (Individual cell method)

1) $\frac{E_1}{E_2} = \frac{113}{105} = 1{\cdot}0762$

2) $\frac{E_1}{E_2} = \frac{129}{120{\cdot}5} = 1{\cdot}0705$

3) $\frac{E_1}{E_2} = \frac{171}{156{\cdot}5} = 1{\cdot}0926$

4) $\frac{E_1}{E_2} = \frac{210{\cdot}5}{201} = 1{\cdot}0473$

$\text{mean} = \frac{1{\cdot}0762+1{\cdot}0705+1{\cdot}0926+1{\cdot}0473}{4}$

$= \frac{4{\cdot}2866}{4}$

$= 1{\cdot}0716$

Part-II (Sum & Difference method)

1) $\frac{E_1+E_2}{E_1-E_1} = \frac{315}{140{\cdot}7} = 2{\cdot}2388$

2) $\frac{E_1+E_2}{E_1-E_2} = \frac{290}{107} = 2{\cdot}7103$

3) $\frac{E_1+E_2}{E_1-E_2} = \frac{285}{101{\cdot}5} = 2{\cdot}8079$

4) $\frac{E_1+E_2}{E_1-E_2} = \frac{291}{107{\cdot}5} = 2{\cdot}7070$

$\text{mean} = \frac{2{\cdot}2388+2{\cdot}7103+2{\cdot}8079+2{\cdot}7070}{4}$

$= \frac{10{\cdot}464}{4}$

$= 2{\cdot}6160$

Result:

1) E_1/E_2 using separate or individual cell method = 1:07.6

2) E_1/E_2 using sum and difference method = 2:61.60

Precautions:

1. All the connections and plug keys should be tight.
2. In part – I, see that $Es > E_1$ and $Es > E_2$.
3. In part – II, see that $Es > E_1+E_2$, $Es > E_1-E_2$ and $E_1 > E_2$.
4. For a given set, the setting of the rheostat should be the same while determining the balance point P_1 and P_2.
5. The balancing lengths should be measured from the point A.

Questions

1. What is an EMF of a cell?

The electromotive force of a cell or emf of a cell is the maximum potential difference between two electrodes of a cell.

EMF can also defined as the net voltage between the oxidation and reduction half-reactions

Electromotive force is also known as voltage.

2. What is potentiometer?

Potentiometer is a device used to compare the emf of two cells, to measure the internal resistance of a cell and potential difference across a resistor.

It consists of a long wire of uniform cross-sectional area and of 10 m in length.

the material of wire should have a high resistivity. The wires are stretched parallel to each other on a wooden board. The meter scale is also attached on wooden board.

3. On what principle does the potentiometer work?

"Potential difference across length of potentiometer wire is propotional to the length of the wire!!"

$$E \propto L$$

"The potential dropped across a segment of a wire of uniform cross-section carrying a constant current is directly proportional to its length.

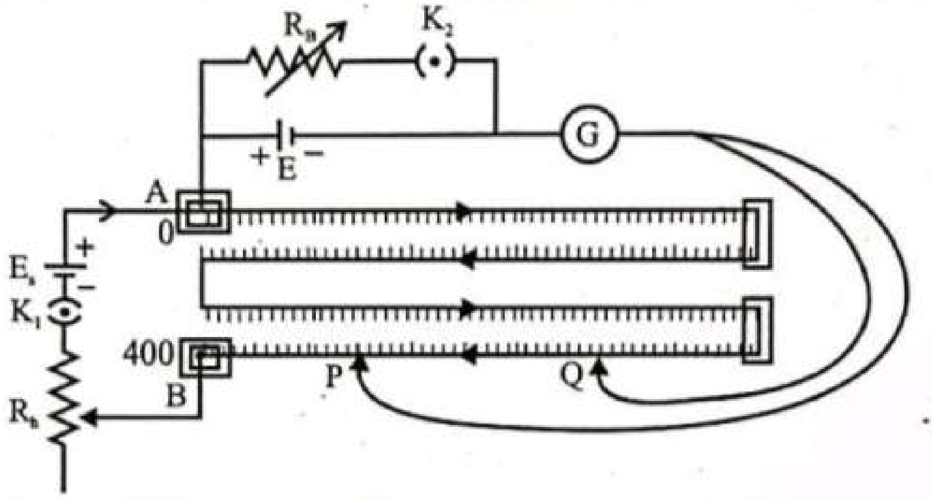
Remark and sign of teacher :

EXPERIMENT NO. 11
INTERNAL RESISTANCE OF A CELL

Aim: To determine the internal resistance of a given cell using potentiometer.

Apparatus: Potentiometer, rheostat, resistance box, battery, cell, jockey, plug key, galvanometer etc.

Diagram:



Formula:

$$r = \frac{(L_1 - L_2)S}{L_2}$$

Where, S is the shunt resistance in parallel with the given cell, L_1 and L_2 are balancing length without and with shunt respectively and r is the internal resistance of the cell.

Procedure:

1. Measure the e.m.f. (E_S) of the battery and the e.m.f. (E) of the cells. See that $E_s > E$.
2. Make the connections as shown in the figure above. Close the key K to bring the circuit in working. Adjust the rheostat at minimum resistance for maximum current in the circuit.
3. Then touch the jockey at zero end of the potentiometer wire and note the direction of deflection in the galvanometer. Touch the jockey at the other end of the potentiometer wire. If the direction of deflection is opposite to that in the first case, the connections are correct. (If the deflection is in the same direction then either connections are wrong or e.m.f. of the cell used is less).
4. First keep K_2 open and K_1 closed. Starting from the point A touch the jockey on the wire at various points and obtain the null point P_1. Note the length L_1 of the potentiometer wire between the point A and P_1.
5. Now, close K_1 as well as K_2 and keep suitable resistance S (10 Ω to 20 Ω) from resistance box. Again touch the jockey from point A on the wire at various points and obtain the null point P_2. Note the length L_2 of the potentiometer wire between the point A and P_2.
6. Take two more readings by changing the value of S.

Observation:

Balancing length when K_2 is open L_1 =...322... cm

Observation Table:

Obs. No.	Resistance in resistance box R_B (Ω) shunt	Balancing length L_2 (cm)	Internal resistance of a cell r (Ω)
1.	2	219	0·941
2.	3	222	1·351
3.	4	231	1·576
4.	5	243	1·625
			Mean 1·373

Calculations:

$$r = \frac{(L_1 - L_2)S}{L_2} = \frac{(322-219)2}{219} = 0·941$$

$$= \frac{(322-222)3}{222} = 1·351$$

$$= \frac{(322-231)4}{231} = 1·576$$

$$= \frac{(322-243)5}{243} = 1·625$$

Result:

Internal resistance of the given cell, r = 1·373 Ω

Precautions:

1. Once the rheostat is adjusted, the setting of the rheostat should not be changed throughout the experiment.
2. Current should be passed for short time.
3. See that $E_s > E$.

Questions

1. What do you mean by the internal resistance of cell?

The resistance offered by the electrolyte, inside the cell, to the flow of current is called internal resistance

2. What are the factors on which internal resistance of cell depends?

The internal resistance of a cell is directly propotional to the distance between electrodes, and inversly propotional to the effective area of the electrodes.

3. Does internal resistance of cell depends on the current drawn from the cell?

Internal resistance of a cell doesnt depends on the current drawn from it.

Remark and sign of teacher :

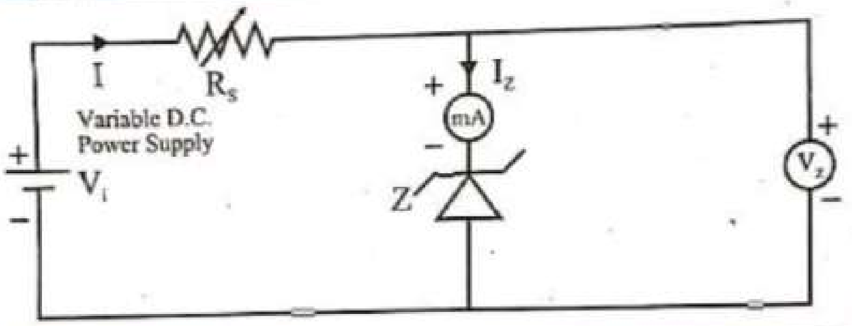
EXPERIMENT NO. 13
CHARACTERISTICS OF ZENER DIODE

Aim: To study the characteristics of Zener diode in reverse bias and determine its reverse breakdown voltage.

Apparatus: DC power supply, Milliameter, Voltmeter, Connecting wires etc

Theory: The Zener diode is used to regulate the voltage across a load when there are variations in the supply or load current. The Zener regulator is connected between the output of the bridge rectifier with the filter & the load. The Zener regulator consists of a current limiting resistor R_s connected in series with the input voltage V_s & the Zener diode is connected in parallel with the load R_L. The Zener diode is reverse biased. It is selected with a breakdown voltage V_Z equal to the desired across the load. $R_S = V_S - V_Z$ As long as V_s is greater then V_Z is the Zener diode operates in the breakdown region & output voltage remains constant.

Circuit diagram:



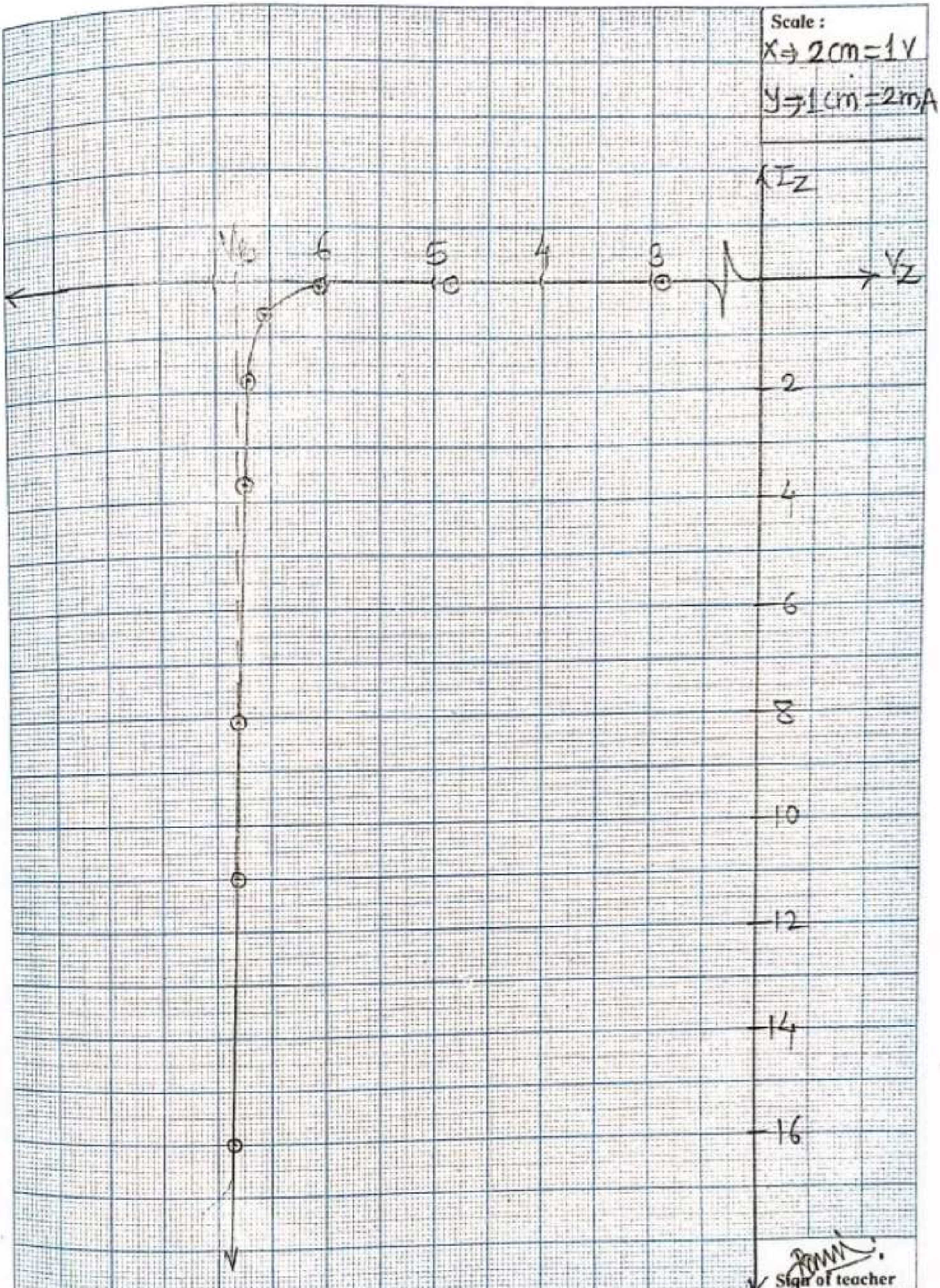
V_i = Variable input voltage
R_S = Resistance
mA = milliameter
Z = Zener Diode
R_l = Load Resistance

Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Vary the voltage (vi) of the D.C. supply as shown in the observation table.
3. Note the current through the Zenerdiode (Iz).
4. Measure the voltage across Zenerdiode (Vz)
5. Plot a graph of Iz (-ve Y axis) Vz V (-ve X axis)
6. Note the breakdown voltage (V_B).

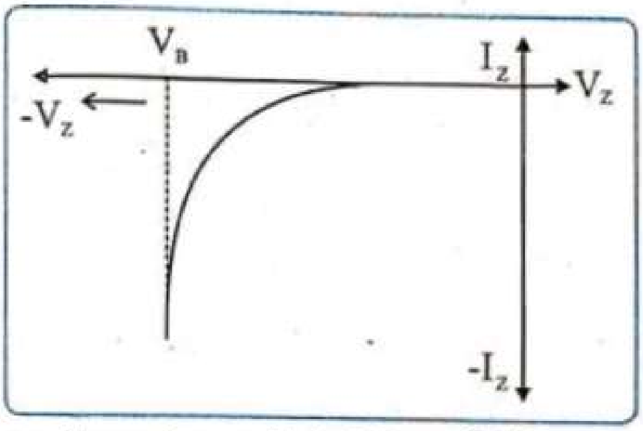
Observation table:

Sr. No.	INPUT VOLTAGE (Vi) volts	CURRENT THROUGH ZENER Iz (mA)	OUTPUT VOLTAGE ACROSS ZENER (Vz) volts
1	1·1	0·	1·03
2	3·0	0	2·96
3	5·1	0	4·86
4	6·5	0·01	5·28
5	7·2	0·42	6·60
6	8·1	1·82	6·72
7	9·4	3·75	6·75
8	12·2	8·17	6·78
9	14·0	11·04	6·80
10	17·4	16·05	6·82


Scale :
X→2cm=1V
Y→1cm=2mA
I_Z
V_Z
V_b
6
5
4
3
2
4
6
8
10
12
14
16
Sign of teacher

11			
12			
13			
14			
15			

Graph:



Result: Breakdown voltage of zener diode (V_B) = 6·80 volt

Precautions:

1. All the connections should be tight.
2. Input voltage should be adjusted in suitable range.
3. Increase reverse voltage gradually.

Questions

1. How is the breakdown voltage related to doping level of a diode?

The breakdown voltage is inversely proportional to the square of the doping density.

2. State the applications of Zener diode.

1). It is used As a voltage regulator.
2). It protects from over voltage.
3). It is used in clipping circuits.
4). It is used to shift voltage.

3. Distinguish between zener diode and rectifier diode.

Zener diode can conduct current in opposite direction without damaging, when V_z is reached.

The maximum reverse voltage of rectifier diode is much higher. Zener diode conduct only specified voltage in contrast to rectified.

Remark and sign of teacher :

EXPERIMENT NO. 14
STUDY OF LOGIC GATES

Aim : To identify given IC's and to verify the truth table for each type of logic gate.

Theory: Gate is a logic circuit with one or more input signals, but only one output signal. Gates are digital circuits because the input and output signals are either low (0) or high (1) voltages. A truth table shows all input and output possibilities for a logic circuit. Total number of combinations is 2n variables the number of inputs. OR, AND and NOT are the basic gates, NAND and NOR are derived gate the OR get has a high output if any input is high. The AND gate provide a high output only when all inputs are high. For Not gate output is always opposite the input. it provides light output when its input is low The NAND gate has a high output when at least one of its inputs is low. The NAND gate has a high output when all inputs are low.

The ICs 7400, 7402, 7404, 7408, 7432 are from standard TTL family. For TTL devices, any voltage from 0 to 0.8 V is considered low input and any voltage from 2 to 5V is consider high input. Any voltage from 0 to 0.4 V is low output and any voltage from 2.4 to 3.9 V is high output. For 7400 series supply voltage rage is 4.75 to 5.25 V over a temperature range of °0 C to 70°C.

Logic gates can be used to build flip-flops, digital counters etc. which can be used calculators, computers and other digital systems.

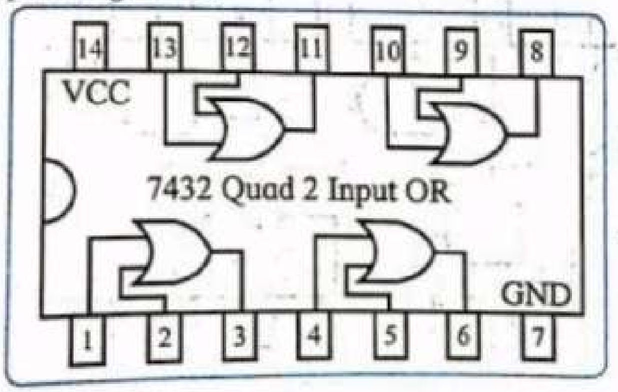
Apparatus : 5V DC power supply, IC block ,probes, digital multimeter. IC7408 (AND Gate), IC 7432 (OR Gate), IC 7402 (NOT Gate), IC 7400 (NAND Gate), IC 7404 (NOT Gate)

Procedure:

1. Mount the IC to be tested on the IC block.
2. Connect the positive of the supply to pin 14 and negative to the 7^{th} pin of the IC.
3. Consider any one of its gate out of four gates.
4. Give different combinations of input from 0 to 1. Here 0 indicates zero voltage and 1'1 indicate +5V.
5. Connect a voltmeter across the output terminal of IC and the ground terminal to pin no.7.
6. Measure the output voltage, which will be zero for 0 and around +5V for 1 state.
7. Repeat the same procedure to test the other gates.
8. Verify the truth table and observation table for different input combinations.
9. Repeat the above procedure to test the other IC's i.e. 7408, 7404, 7400,7432 etc.

Pin Diagram and observations :

(1) Quad – dual – Input OR gate IC .



For ... and pin no. 3 is output.

IC 7432 (OR GATE)

Logic Equation

$Y = A + B$

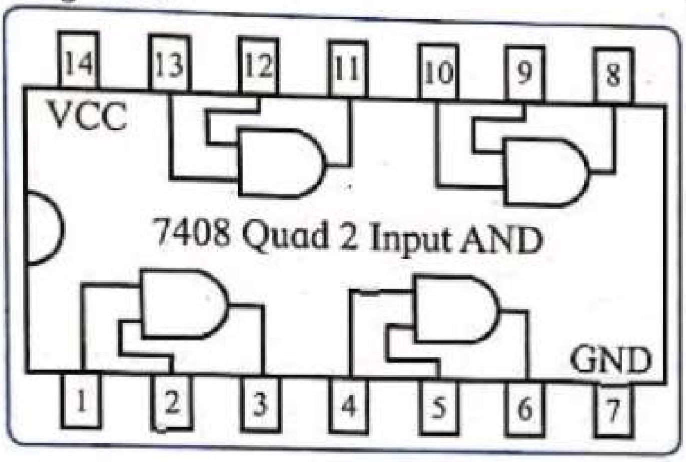
Truth table

INPUT		OUT PUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Observation table

INPUT		OUT PUT
A (V)	B (V)	Y (V)
0	0	0
0	1	1
1	0	1
1	1	1

2) Quad – dual – input AND gate IC



IC 7408 (AND GATE)

Logic Equation

$Y = AB$

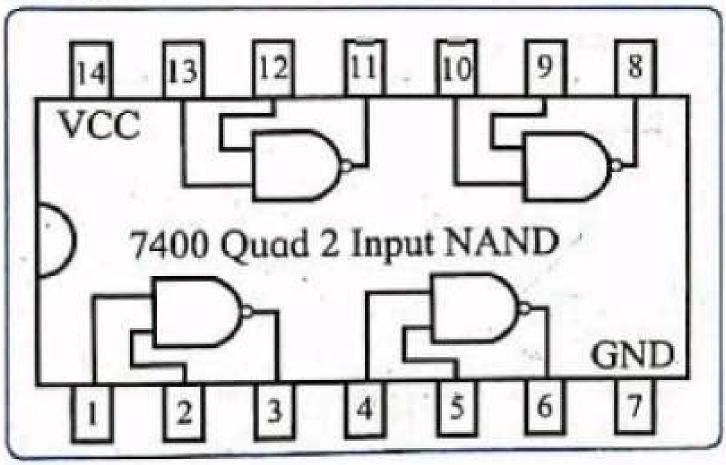
Truth table

INPUT		OUT PUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Observation table

INPUT		OUT PUT
A (V)	B (V)	Y (V)
0	0	0
0	1	0
1	0	0
1	1	1

3) Quad- dual- input NAND gate IC



IC 7400 (NAND GATE)

Logic Equation

$Y = \overline{A.B}$

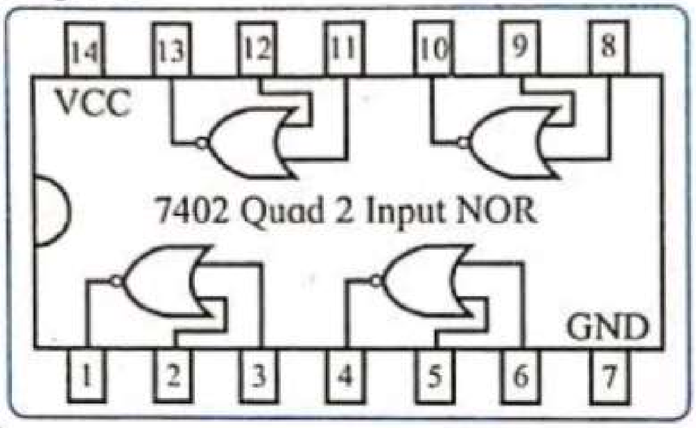
Truth table

INPUT		OUT PUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Observation table

INPUT		OUT PUT
A (V)	B (V)	Y (V)
0	0	1
0	1	1
1	0	1
1	1	0

4) Quad-dual- input NOR gate IC



IC 7402 (NOR GATE)

Logic Equation

$Y = \overline{A + B}$

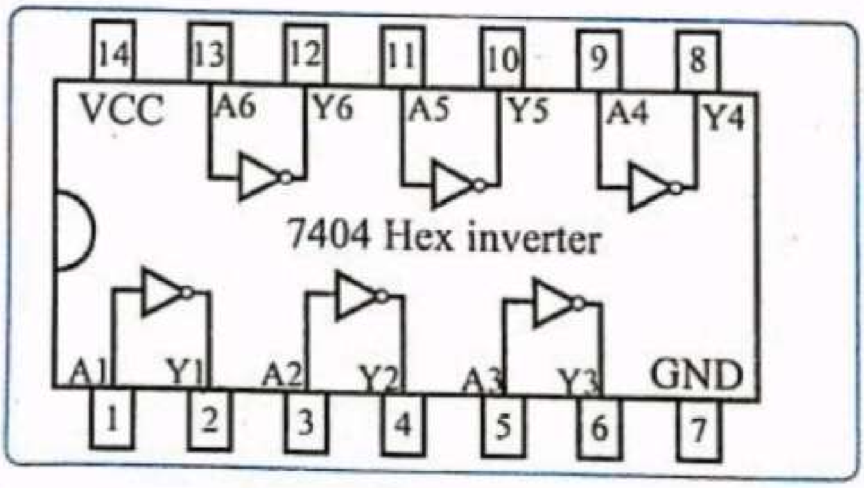
Truth table

INPUT		OUT PUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Observation table

INPUT		OUT PUT
A (V)	B (V)	Y (V)
0	0	1
0	1	1
1	0	1
1	1	0

Hex Inverter (NOT Gate)



IC 7404 (HEX INVERTER) NOT GATE

Logic Equation

$Y = \overline{A}$

Truth table

INPUT		OUT PUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Observation table

INPUT		OUT PUT
A (V)	B (V)	Y (V)
0		1
0		1
1		0
1		0

Precautions :

1. Input voltage must be 5 volts.
2. Connections should be joined correctly.
3. Grounding should be proper for input, O' volt.
4. Connections must be tight.

Result: The different given logic IC's are tested and their truth table is verified.

Questions

1. Explain what are the basic logic elements?

All digital systems can be constructed by only three basic logic gates. These basic gates are called the AND gate, OR gate, and NOT gate.

2. What are the applications of logic gates?

NAND Gates are used in Burglar alarms logic gates are also used in push button. Logic gates are used in the functioning of street lights.

3. NAND Gate is combination of which two basic Gates?

NAND Gate is just a combination of NOT gate as well as AND Gate.

4. NOR Gate is combination of which two basic Gates?

NOR Gate is just a combination of NOT gate as well as OR Gate.

Remark and sign of teacher :

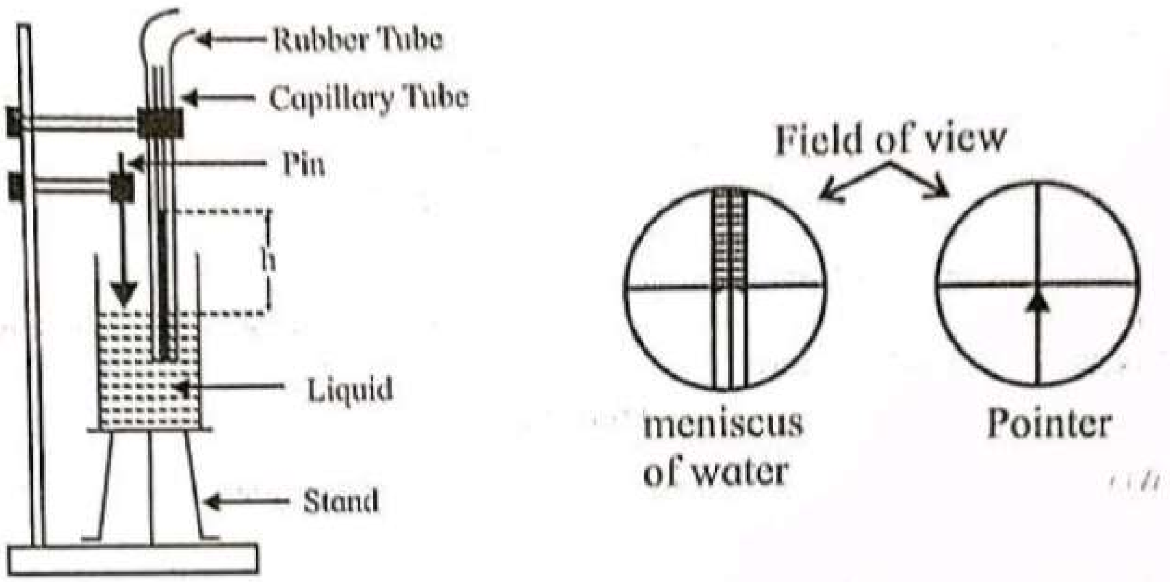
ACTIVITY NO. 1
EFFECT OF DETERGENT ON SURFACE TENSION

Aim : To study the effect of detergent on surface tension of water by capillary rise method.

Apparatus : Travelling microscope, beaker, index pin, stand, water, detergent powder.

Formula : $T = \frac{hr\rho g}{2\cos\theta}$

Diagram :



Procedure :

1. Determine the least count of travelling microscope.
2. Immerse the capillary tube vertically in the beaker containing water.
3. Remove the air bubbles by pressing the rubber tube. Adjust the level of water in the beaker so that meniscus in the bore of capillary should be above the edge of the beaker and below the lower edge of the capillary stand.
4. Adjust the tip of the pointer so that it just touches the level of water. Focus the travelling microscope on the meniscus such that the horizontal cross - wire is tangential to the convex surface of the meniscus. Note the reading on vertical scale (h_1) of travelling microscope
5. Remove the beaker without disturbing the position of the capillary tube.
6. Adjust the microscope such that the horizontal cross - wire is tangential to the tip of the pointer. Record the reading on the vertical scale (h_2) of travelling microscope
7. Repeat the steps 2 to 6 for solution of detergent powder .

Observations:

L. C. of travelling microscope:

Smallest division of main scale (P)	0.05	cm
Total no. of divisions on the Vernier scale (N)	50...	
L.C. of travelling microscope (P/N)	0.001	cm

Observation:

Measurement of capillary rise (h):

Liquid	Reading when the microscope is focused on		$h = (h_1 - h_2)$ cm
	Meniscus h_1 cm	Tip of the pointer h_2 cm	
Water	5·914	3·630	h_w = 2·284
Detergent Solution	5·985	3·989	h_d = 1·996

Calculation : $h = (h_1 - h_2)$ cm

Result : 1) h_w = 2·284 cm

2) h_d = 1·996 cm

Conclusion : Rise of water in capillary is greater than rise of soap solution in capillary. Therefore Surface tension of water is greater than that of soap solution. Thus surface tension decreases due to the addition of detergent.

Precautions :

1. The capillary should be thoroughly cleaned.
2. There should be no air bubbles inside the capillary. Capillary must be immersed in the liquid.
3. The capillary should be vertical.

Questions

1. Why surface tension of a liquid decreases due to presence of detergent ?

It helps to reduce the surface tension of water Detergent acts as a surface-active agent or surfactant for short. They act with a water molecule to create a gap between them, which lowers the surface-tension among them.

2. What is the role of detergent in washing clothes ?

Detergent mixes with water to remove dirt and oil from clothes. water cant remove oil and dirt from clothes. Detergent acts as surface-active agent. Detergent cleans by causing a chemical reaction with water to force dirt and debris out of clothing.

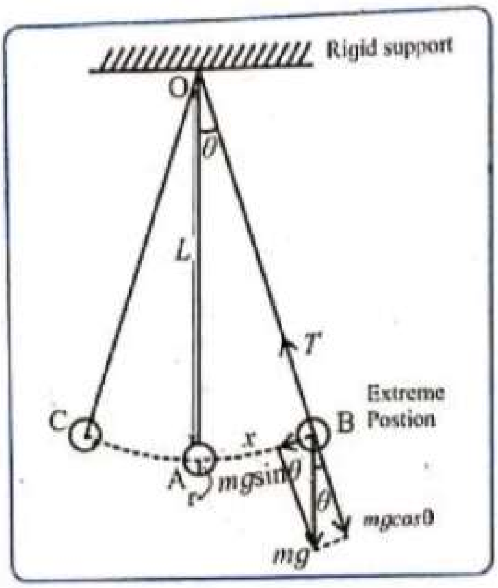
Remark and sign of teacher :

ACTIVITY NO. 2
SECOND'S PENDULUM

Aim : To determine the length of the seconds pendulum

Apparatus : Metal sphere (bob), inextensible string, retort stand, meter scale, stop watch, vernier calliper

Diagram :



Formula :

$$\frac{L_S}{T_S^2} = \frac{L_S}{4} = \left(\frac{L}{T^2}\right)_{mean} \qquad \therefore L_S = 4\left(\frac{L}{T^2}\right)_{mean}$$

Procedure :

1. Suspend the bob (radius given) from the fixed support of a retort stand by means of inextensible string
2. Adjust the length of the string to 80 cm.
3. Displace the bob to its equilibrium position and release, so that it performs linear S.H.M.
4. Measure the time (t) for 20 oscillations.
5. Record the observation for two sets of oscillations..
6. Hence find the time period T = t/20 (seconds).
7. Repeat the steps 4 to 7 by adjusting the lengths of the string 90 and 100 cm.

Observations:

Radius of the bob = ..0.5... cm

Period of second's pendulum $T_s = 2$ sec

Observations for period oscillations T : Period

Obs. No.	Length of the string ℓ cm	Length of the pendulum $L=(\ell + r)$ cm	Time for 20 oscillations			T = t/20 sec	$\frac{L}{T^2}$ $\frac{cm}{S^2}$
			t_1 sec	t_2 sec	Mean t(sec)		
1	80	80.5	40	42	41	2.05	19.155
2	90	90.5	38	40	39	1.95	23.800
3	100	100.5	38	36	37	1.85	29.364

mean = $\frac{L}{T^2}$ 24.106. cm s^{-2}

Calculations :

(1) $\frac{L}{T_1^2} = \frac{80.5}{4.2025} = 19.155$

(2) $\frac{L}{T_2^2} = \frac{90.5}{3.8025} = 23.800$

(3) $\frac{L}{T_3^2} = \frac{100.5}{3.4225} = 29.364$

$$L_S = 4 \times \left(\frac{L}{T^2}\right)_{mean} = 4 \times 24.106 = 96.42 \text{ cm}$$

$\Rightarrow \frac{L_S}{T_S^2} = (24.106)$

$\frac{96.42}{(24.106)} = T_S^2$

$4.000 = T_S^2$

$2 = T_S$

Result :

Length of seconds pendulum T_S = 2 sec.

Precautions :

1. Amplitude of oscillations should be small
2. String used in the experiment should be inextensible and light.

Questions

1. Define Amplitude in SHM

The maximum distance that an object moves from its equilibrium position. A simple harmonic oscillator moves back and forth between the two positions of max. displacement at $x = A$ and $x = -A$

2. State the nature of vibrations of a pendulum (LSHM)

A simple pendulum consists of a relatively massive object hung by string from a fixed support. It typically hangs vertically in its equilibrium position. When the bob is displaced from equilibrium & then ~~vibratory about~~ released it begins its back and forth vibration about fixed posn.

3. Define force constant

Force constant of a spring is defined as the force required to produce unit extension in the spring.

4. What is a seconds pendulum ?

Seconds pendulum is a pendulum whose period is precisely two seconds.

Remark and sign of teacher :

ACTIVITY NO. 5
DIFFRACTION PATTERN USING A LASER BEAM

Aim: To determine the grating element (d) of the given grating .

Apparatus: Diffraction grating, laser pointer, stands, screen and meter Scale.

Formula:

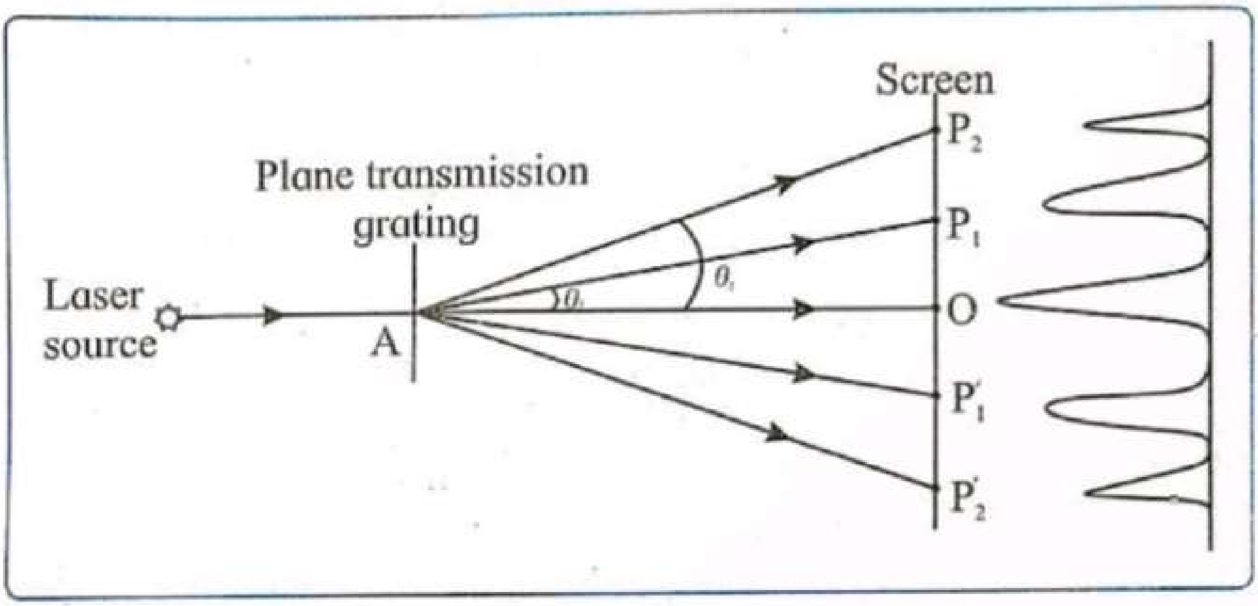
$$n\lambda = d \sin\theta ,$$

Where, λ = the wavelength of the laser light,

d = grating element

and θ = the angle of diffraction.

Diagram :



Diffraction by plane transmission grating   Intensity distribution curve

Theory :

Diffraction grating:- suppose that instead of a single slit, or two slits side by side as in young's experiement, we have a very large number of parallel slits all of the same width and spaced at regular intervals, the arrangement is known as diffaraction grating. It was first constraucted by Fraunhofer. Gratings are made by ruling ,with a diamond point, a large number of equidistant grooves on a glass or metal surface. The distance between consecutive slits of a grating is its grating element (d).

Procedure :

1. Adjust the laser pointer (red or green) on its stand and switch it on.
2. Mount the grating on the retort stand and place it in the path of the laser beam. The position of the grating is so adjusted, that the plane of the grating is nearly perpendicular to the laser beam.
3. Red spots appear on the screen. These spots represent the diffraction maxima of various orders. If the spots are not symmetrical about the central spot, adjust the plane of the grating to make them so.

4. Measure the distance D between the grating and the screen. (Distance AO in the diagram).
5. Measure the distance L of the central spot from the first and second spot on either side of it. (Distances OP_1, OP_2, OP', OP'_2 in the diagram.)

Observations :

1.Wavelength of the laser light used(red) : $\lambda = 6328\ \text{Å} = 6.328 \times 10^{-5}$ cm

Observation Table :

Set no	Distance between grating and screen D (cm)	Order number	Distance between the central spot and nth spot			$\tan\theta$ = (L/D)	$\theta = \tan^{-1}$ (L/D)	d = $n\lambda/\sin\theta$ (cm)
			L_1	L'_1	mean			
1	3	1	1·3	1·4	1·35	0·45	24·2	15.43×10^{-5}
	6	2	2·6	2·7	2·65	0·44	23·8°	15.68×10^{-5}

Note the Experiment can be done by single slit method using D > 1.5 m

Result :

The grating element of the diffraction grating is 15.555×10^{-5} cm

Precautions:

1. Do not look directly into the laser beam.
2. Adjust the grating such that the diffraction pattern is symmetric about the central maxima.

Questions

1. What do you mean by diffraction of light?.

Diffraction is the phenomenon of bending of light around corners of an obstacle in the path of light.

2. Can we get a diffraction grating in our daily life?.

1) Holograms
2) x-ray diffraction
3) sun appears red during sunset.
4) CD reflecting Rainbow colours.
5) To separate white light.

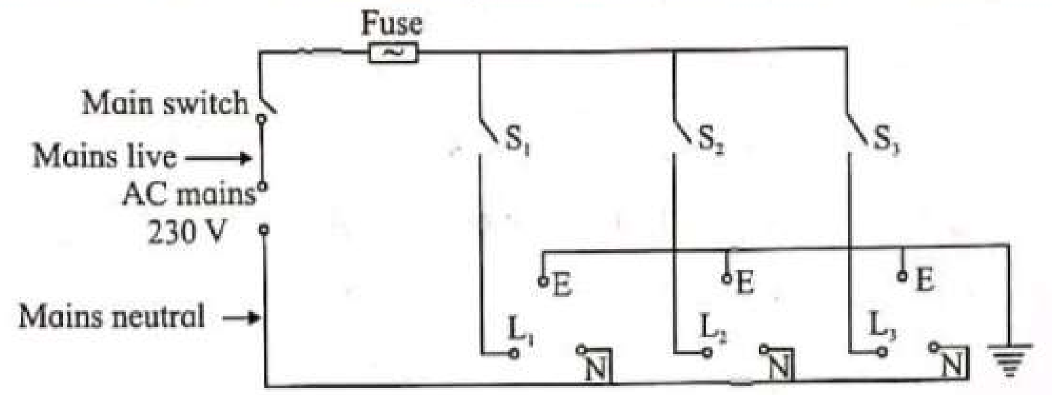
Remark and sign of teacher :

ACTIVITY NO. 6
HOUSEHOLD CIRCUIT

Aim : To design, build and demonstrate a simple house hold electrical circuit .

Apparatus : - ON-Off switches, three pin sockets, flexible connecting wires, bulbs, fuse, power supply etc.

Diagram :



Black View

S_1, S_2, S_3- ON-Off switches, L_1, L_2, L_3- Live terminals, N- Neutral terminals, E- Earthing

Procedure :

1. Connect the live wires L_1, L_2, L_3 in series with the switches S_1, S_2, S_3 respectively.
2. Connect each set of Live wire and switch in parallel combination with each other as shown in circuit diagram.
3. Connect the fuse in series with main switch and A.C. mains.
4. Join all neutral wires together and connect to the neutral terminal of AC mains.
5. Similarly join all earthing wires together and give it to the earthing connection.
6. Check the circuit once again to ensure that household circuit is complete.

Result: Household circuit is verified.

Precautions :

1. Live wire and neutral wire should be well separated.
2. While making connection do not connect the wire of A.C. mains.
3. All connections should be tight.

Questions

1.What is household circuit?

Household circuit is an electrical system that basically controls the flows of electricity at our house. In our house the more things that are turned on the more current is requested.

2. How are the circuits wired in houses?

Circuits in houses are generally wired in parallel, which allows you to operate each light or power point independently of the others.

3. What is the importance of earthing in household circuit?

Earthing is used to protect you from an electric shock. It does this by providing a path for a fault current to flow to earth.

Earthing is as important as the fuses in the wiring circuits i.e. in the case of short circuits or over loads. the heavy current flows through the wires and fitting etc.

4. Explain the role of fuse in household circuit.

An electric fuse is a safety device used to limit the current in an electric circuit. The use of a fuse is to safeguard the electric circuit and the electric appliances connected in the electric appliances connected in the electric circuit from being damaged.

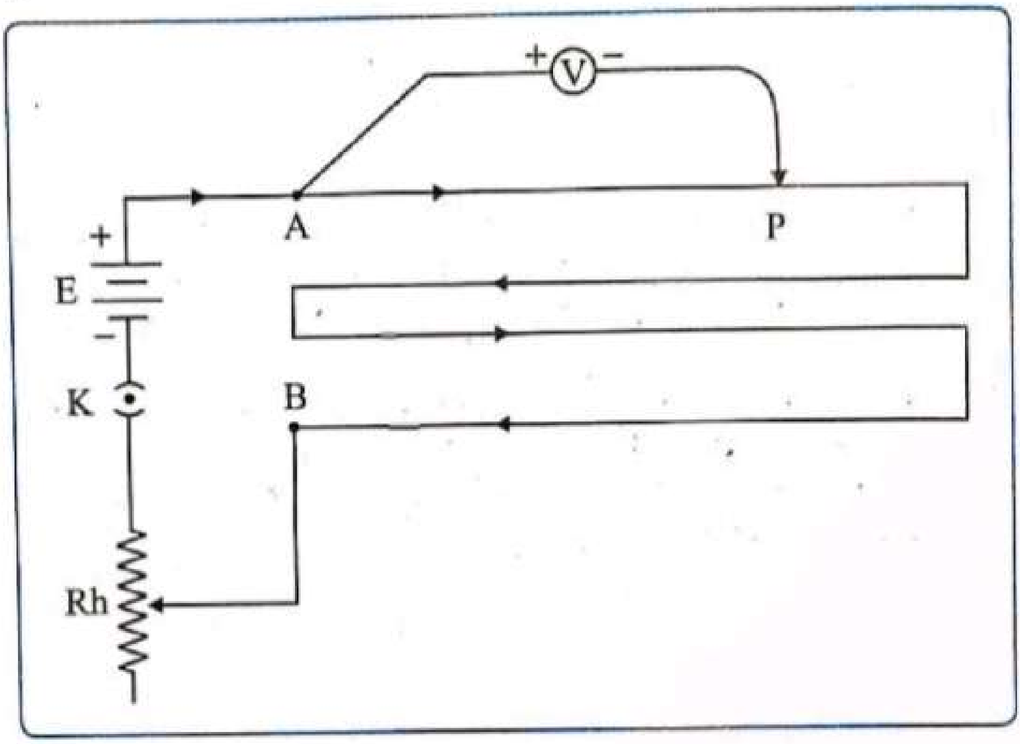
Remark and sign of teacher :

ACTIVITY NO. 7
VARIATION OF POTENTIAL DROP WITH LENGTH OF WIRE

Aim: To study the variation in potential drop with length of a wire for a steady current.

Apparatus : Potentiometer, battery (or driving cell), plug key, voltmeter, rheostat, jockey, connecting wires.

Circuit diagram :



Formula : For a potentiometer wire of uniform density and cross-sectional area carrying a steady current, potential drop (V) is proportional to length (ℓ) of the wire.
Potential gradient $k = V/\ell$

Procedure :

1. Arrange and connect the circuit as shown in the circuit diagram Close the key K.
2. Touch the jockey at length 60 cm of the wire from end A. Note down the voltmeter reading.
3. Touch the jockey at different length such as, 120 cm, 180cm, 240cm of the wire from end A and note the voltmeter reading in each case.

Observations :

Least count of voltmeter = 0.5 V

Ob. No.	Length of potentiometer wire 'ℓ' cm	Voltmeter Reading 'V' volt	Ratio $\frac{V}{\ell}$ V/cm
1	50	0.15	0.003
2	100	0.35	0.003
3	150	0.55	0.003

Calculations :

$$\frac{V}{L} = \frac{0.15}{50} = 0.003$$

$$\frac{V}{L} = \frac{0.35}{100} = 0.003$$

$$\frac{V}{L} = \frac{0.55}{150} = 0.003$$

Result :

Potential gradient V/L= 0.003 = constant,

Precautions :

1. All the connections should be tight.
2. By closing the key 'K' adjust the rheostat so that the voltmeter gives full scale deflection.

Questions

1. Define potential gradient.

A potential gradient is the rate of change of the potential with respect to displacement.

2. What is advantage of potentiometer over voltmeter?

The advantages of a potentiometer over the voltmeter is that the potentiometer doesn't draw any current from the circuit in which it is used for the measurment.

Whereas the voltmeter draws some amount of current in case of high voltages. which results in some errors in the measurments done using a voltmeter.

Remark and sign of teacher :

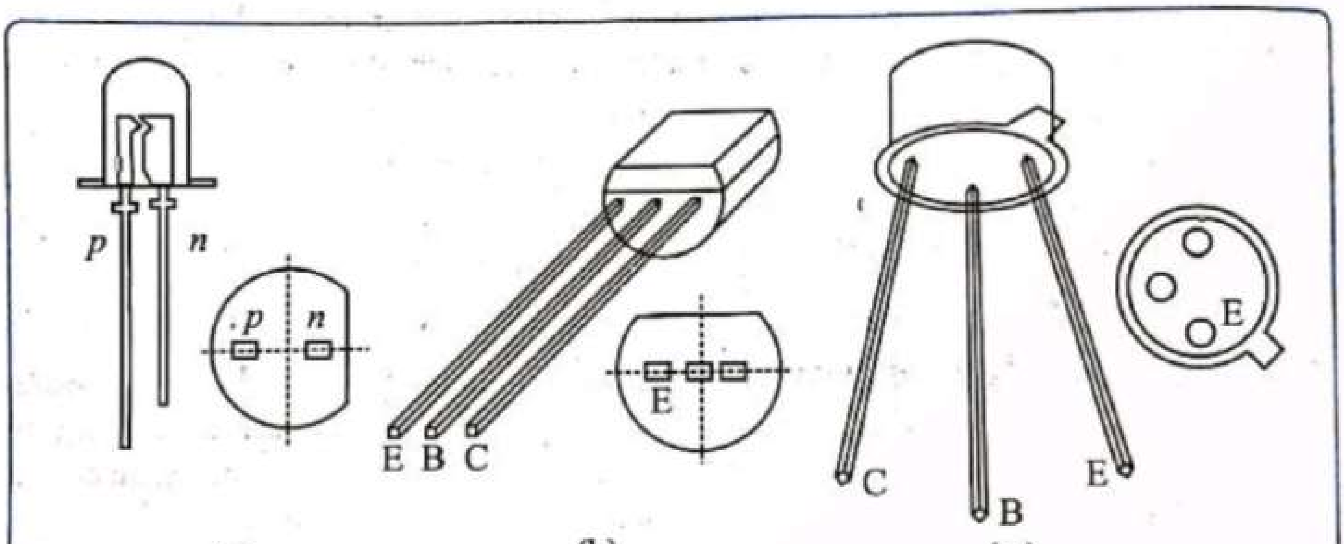
ACTIVITY NO. 8
USE OF MULTIMETER

Aim : Use of multimeter to check working of various components.

Apparatus : Multimeter, transistor (npn and pnp), diode, LED.

Diagram :

Package TO92		Package TO5,T018	
npn	pnp	npn	pnp
BC547	BC577	BC107	BC177
2N4402	2N44O2	2N706	BC187
2N3903		2N2369	2N2904



(a) (b) (c)

Procedure :

i)To identify base of a transistor

ii)To distinguish between npn and pnp type transistors.

1. Make sure that red (positive) and black (negative) probes of DMM are in proper positions.
2. Select the diode-check range of DMM.

Terminology used

a) **Forward Bias :** When positive of DMM is connected to p-terminal and negative of DMM is connected to n-terminal of a component, with selection of diode-check range of DMM, the reading shown in DMM will be between 0.3 V and 0.8 V, indicating forward bias.

b) **Reverse Bias :** When positive of DMM is connected to n-terminal and negative of DMM is connected to p-terminal of a component with selection of diode-check range of DMM, there will be no reading shown in DMM. it will indicate open circuit by vertical line (J) which is reverse bias.

c) **npn transistor :** When positive probe of DMM is connected to base terminal and negative probe of DMM is connected to eitler collector terminal or emitter terminal, it will show forward bias.

d) pnp transistor :when negative probe of DMM is connected to base terminal and positive probe of DMM is connected to either collector terminal or emitter terminal, it will show forward bias.

3) Connect the positive probe of DMM to the centre terminal of any transistor (npnorpnp)
4) Connect the negative probe in turn to other two terminals. If both the times forward bias shown, it is an npn transistor and the centre terminal is 'base'
5) If the above condition is not satisfied, repeat with other two terminals until you find the 'base'
6) If none of the three terminals satisfy the test for 'base' terminal, then this may be a pnp transistor.
7) Connect the negative probe of DMM to the centre terminal of the transistor and positive probe of 0MM to remaining terminals in turn.
8) If both the times forward bias is shown, then the selected centre terminal is 'base' and it is the pnp transistor. If the above condition is not satisfied, repeat with other two terminals, until you find the 'base'.

iii) To see the unidirectional flow of current in case of a diode and an LED.
1) Select the diode-check range of DMM.
2) Connect the two probes of DMM to two terminals of a diode/an LED.

In case of a diode -

When the negative probe of DMM is connected to the cathode (i.e. (n) terminal adjacent to ring marked on diode) it will show forward bias. Thus current (lows through diode. When the DMM probes are interchanged, it will show reverse bias or open circuit. That is, no current flows through diode. Thus there is unidirectional flow of current in a diode.

In case of an LED-

When positive probe of DMM is connected to anode (long terminal of LED) andnegative probe of DMM is connected to cathode (short terminal of LED) DMM will show forward bias. LED lights up indicating flow of current.
When DMM probes are interchanged, DMM will show reverse bias. LED does notlight up, indicating no flow of current. Thus, there is unidirectional flow of current inLED.

iv) To check whether a given electronic component (diode, transistor) is in workingorder.
1. Test the component using the above procedure.
2.Diode/LED must satisfy both forward bias and reverse bias tests, it is in working order.
3.In case of a transistor, 'base' identification test should be checked, so that it is in workin order If base' is not identified, then transistor is not working order.

Observation Table :

Sr. No	Transistor	Forward Bias		Reverse Bias		Type of Transistor
		CB	BE	CB	BE	
1	2N3904	0.7	0.7	OL	OL	NPN
2	2N3906	OL	OL	0.7	0.7	PNP

Result :

1. Transistor is ..N.P.N... type
2. Transistor is ..P.N.P.... type
3. Diode is Zener.. type

Precautions:

1. Turn the function knob of the DMM/Multimeter gently so as not to wear out its contact points inside.
2. Switch off the Multimeter. (i.e. turn its function knob to the OFF position) when not using.

Questions

1. Which type of error is present in multimeter?

Absolute accuracy is the error of measurment compared to the perfect measurement. Relative accuracy is the error of the measurment compared to the device used to calibrate the multimeter. most multimeter datasheets provide relative accuracy.

2. Can we distinguish between zener diode and rectifier diode using multimeter?

Although they are both called diodes they have very different uses.

If we use 5.1 V zener diode in circuit we were to use a multimeter across Vout then we would measure 5.1 V all other voltage is dropped across the other component in the circuit in this case use 1 k resistor

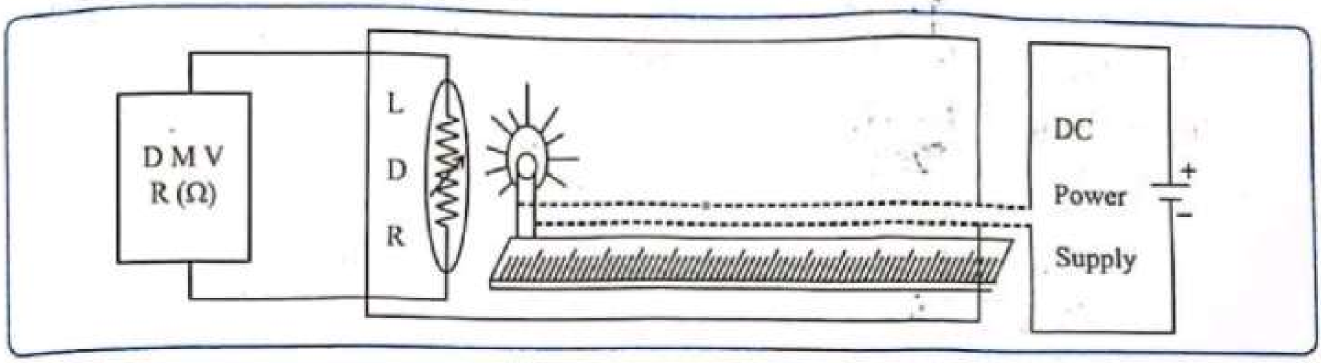
Remark and sign of teacher :

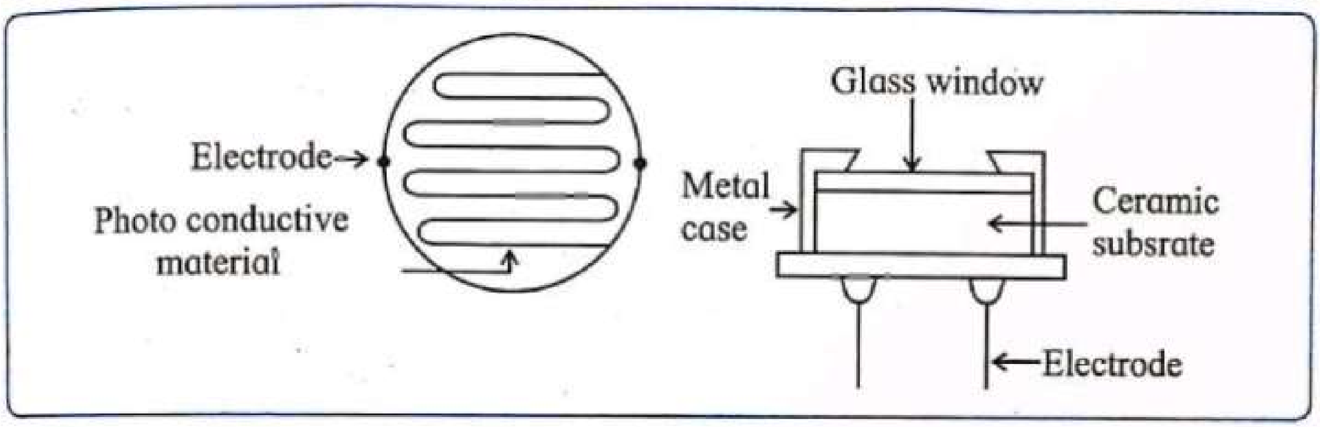
ACTIVITY NO. 9
LIGHT DEPENDENT RESISTOR

Aim : To study the effect of intensity of light on light dependent resistor (L.D.R.)

Apparatus : L.D.R., filament lamp (16V, 3W), meter scale, D.C. power supply, Digital multimeter. (DMM)

Circuit Diagram :





Theory :

The photo conductive cell is a two terminal semiconductor device whose resistance varies with the intensity of the incident light i.e. the resistance of the material decreases with exposure to light. Hence it is also called Light Dependent Resistor (LDR).

Light Dependent Resistors are fabricated from semiconductor materials, e.g. cadmium sulphide (CdS), cadmium selenide (Cd Se), cadmium - sulpho selenide (Cd_2S Se), lead sulphide (PbS).

When energy ($E = h\nu$) of the incident photon is greater than the energy band gap (Φ) between the valence band and the conduction band, electrons will be excited from the valence band to the conduction band. Electron - hole pairs thus generated will serve as charge carriers. Since conductivity of the material increases, its resistance decreases.

Procedure :

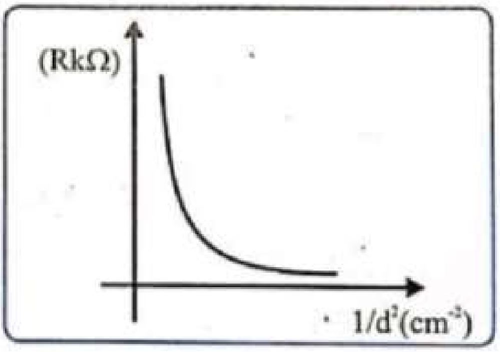
1. The given enclosed box consists of LDR fitted at its one end.
2. A filament bulb is fitted at one end of a movable half meter scale in line with LDR.
3. Connect the circuit as shown in the diagram
4. Keep the power supply knob on 10V, and switch ON the power supply.
5. Initially keep the lamp and the LDR very close to each other, measure the distance 'd' between the LDR and the lamp. Note down the corresponding resistance on DMM.

6. Increase distance 'd' by 3 cm each time and note down the corresponding resistance.
7. Plot a graph of R against $1/d^2$

Observations:

Obs. No	R (kΩ)	d (cm)	d^2 (cm^2)	$1/d^2$ (cm^{-2})
1	0.45	6	36	0.02778
2	0.71	10	100	0.01000
3	1.00	15	225	0.00400
4	1.35	20	400	0.00250
5	1.66	25	625	0.00160
6	2.06	30	900	0.001100
7	2.55	35	1225	0.00080
8	3.00	40	1600	0.00063
9	3.36	44	1936	0.00052
10	3.76	50	2500	0.00040

Graph: A graph of R aginst $1/d^2$



Conclusion:

1. The intensity of light is inversely proportional to the square of distance.
2. As the intensity of light decreases, the resistance of LDR increases. The graph of R against $1/d^2$ shows the exponential decrease.

Precautions :

1. The light from outside should not fall on the LDR.
2. The box is blackened from inside, so that light scattered or reflected from interior of enclosure does not fall on LDR.

Questions

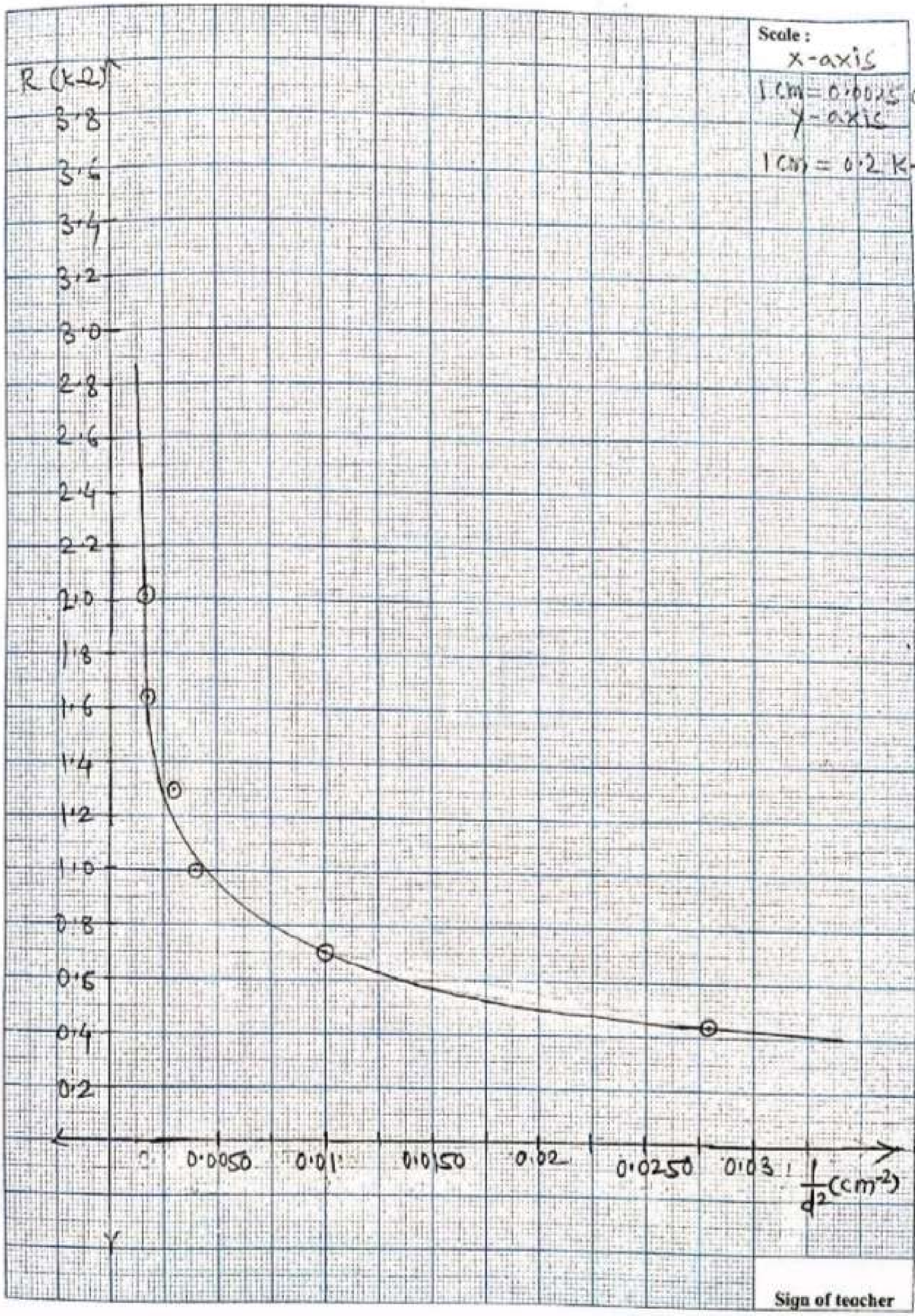
1) What is the relationship between intensity of light and resistance ?

Resistance decreases as the light intensity increases.

2) State the applications of LDR

LDR used in smoke detectors. It is used in optical coding. It is used in sequrity alarm. It is used in proximity switch

Remark and sign of teacher :



R (kΩ)
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0050
0.01
0.0150
0.02
0.0250
0.03
1/d² (cm⁻²)
Scale :
X-axis
1 cm = 0.0025 cm⁻²
Y-axis
1 cm = 0.2 kΩ
Sign of teacher

6. Measure distance between two knife edges which is the vibrating length of wire. Take on more reading for the same tension. Find the mean value of vibrating length (ℓ).
7. Repeat the same procedure with increasing tension by 500 gm applied to the wire. Note the corresponding vibrating length.
8. Calculate $\frac{T}{\ell^2}$ in each case. Plot a graph of ℓ^2 against T .
9. Determine the unknown mass by calculation and graph.
10. Determine the linear density by calculation.

Observation : g = 980cm/s² **Frequency of tuning fork** n ..328...Hz

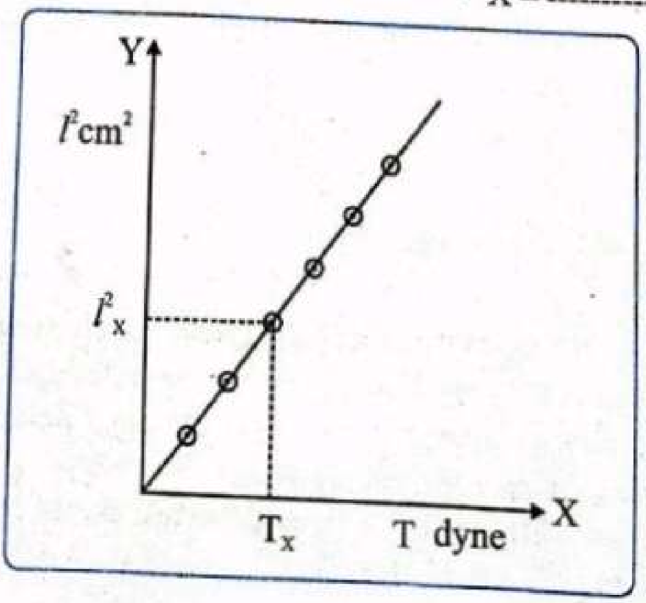
Obs. No.	Mass attached to the wire including hange Mgm	Tension T = Mg dyne	Vibrating length of wire			ℓ^2 Cm²	T/ℓ^2 dyne / cm²
			$\ell_1$cm	$\ell_2$cm	Mean ℓcm		
1	500	490×10³	4·0	6·0	5·0	25·00	19600·0
2	1000	980×10³	6·2	7·1	6·65	44·22	22160·0
3	1500	1470×10³	7·7	9·3	8·5	72·25	20350·0
4	2000	1960×10³	8·8	10·2	9·5	90·25	21720·0
5	Unknown	T_x 1250×10³			ℓ_x 7·7		

Calculations :

Ob. No.	1	2	3	4	5
log T = a	5·6902	5·9912	6·1674	6·2923	
log ℓ^2 = b	1·3979	1·6456	1·8588	1·9554	
a-b=c	4·2923	4·3456	4·3086	4·3369	
Antilog c = T/ℓ^2	19600·0	22160·0	20350·0	21720·0	

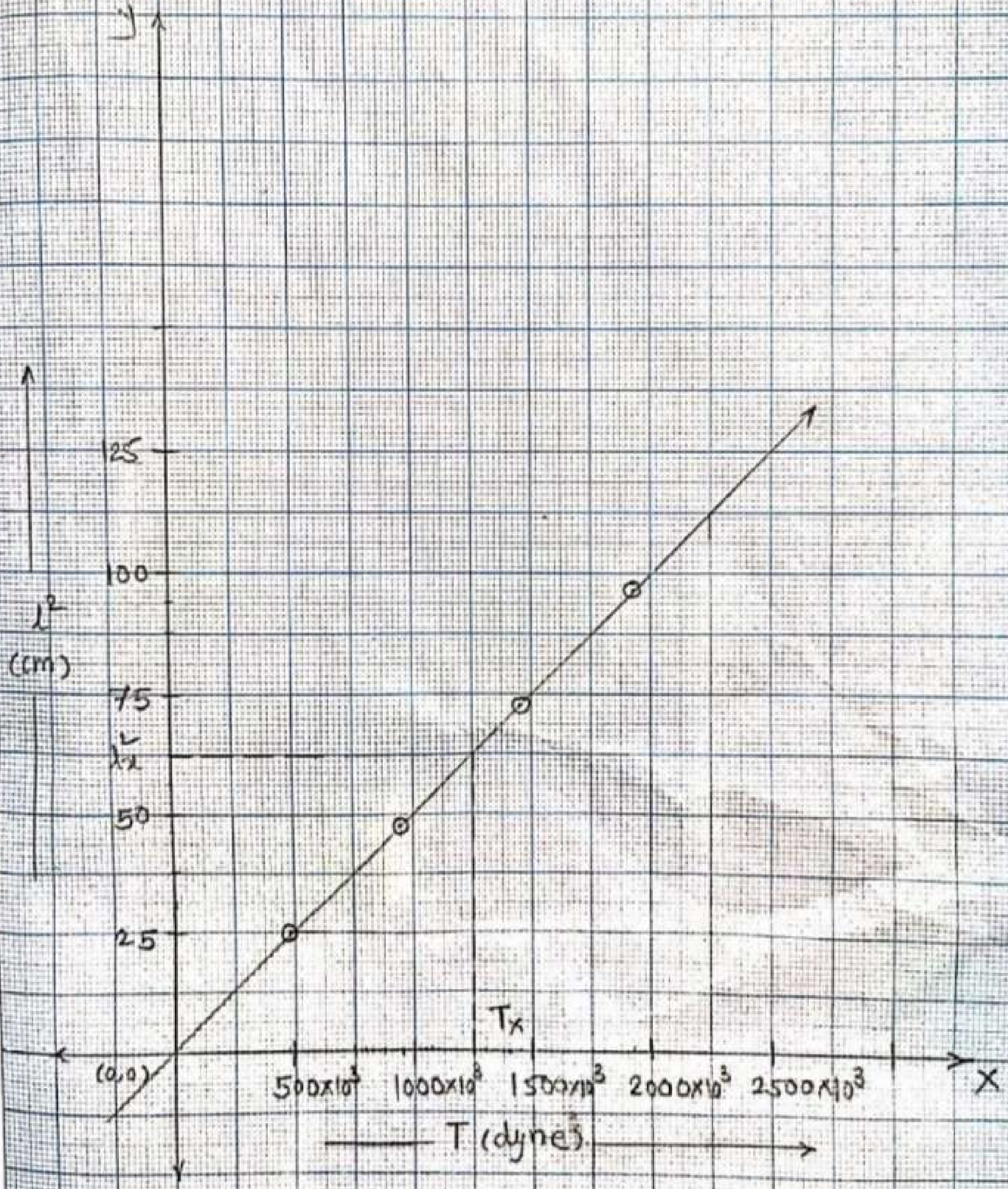
Graph : A graph of l^2 against T

Scale Y = ---------------cm²
X = ---------------dyne



A Graph of l^2 against T

Scale :
$Y = 2cm = 25cm^2$
$X = 2cm = 500 \times 10^3$ dyne



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