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Experiment-1

Aim- To understand the phenomenon Photoelectric effect and plot a graph between photocurrent & potential to determine stopping potential.

Theory -

The photoelectric effect is an instantaneous phenomenon. There is no time delay b/w the incidence of light and emission of photo electrons.

The no. of photoelectrons emitted is proportional to the of incident light. Also, energy of ~~incident light~~ photoelectron is independent of incident light

The energy of emitted photoelectrons is directly proportional to the frequency of light.

It has been observed that there must be a minimum energy needed for electrons to escape from a particular metal surface and is called work function 'W'

$$W = h\nu_0$$

acc. to Einstien Photoelectric effect equation

$$h\nu = KE + W$$

$$KE_{max} = h(\nu - \nu_0)$$

If we increase the reverse potential, the photocurrent gradually decreases and becomes zero, this is the min^m applied reverse potential called stopping potential V_0.

$$KE_{max} = eV_0$$

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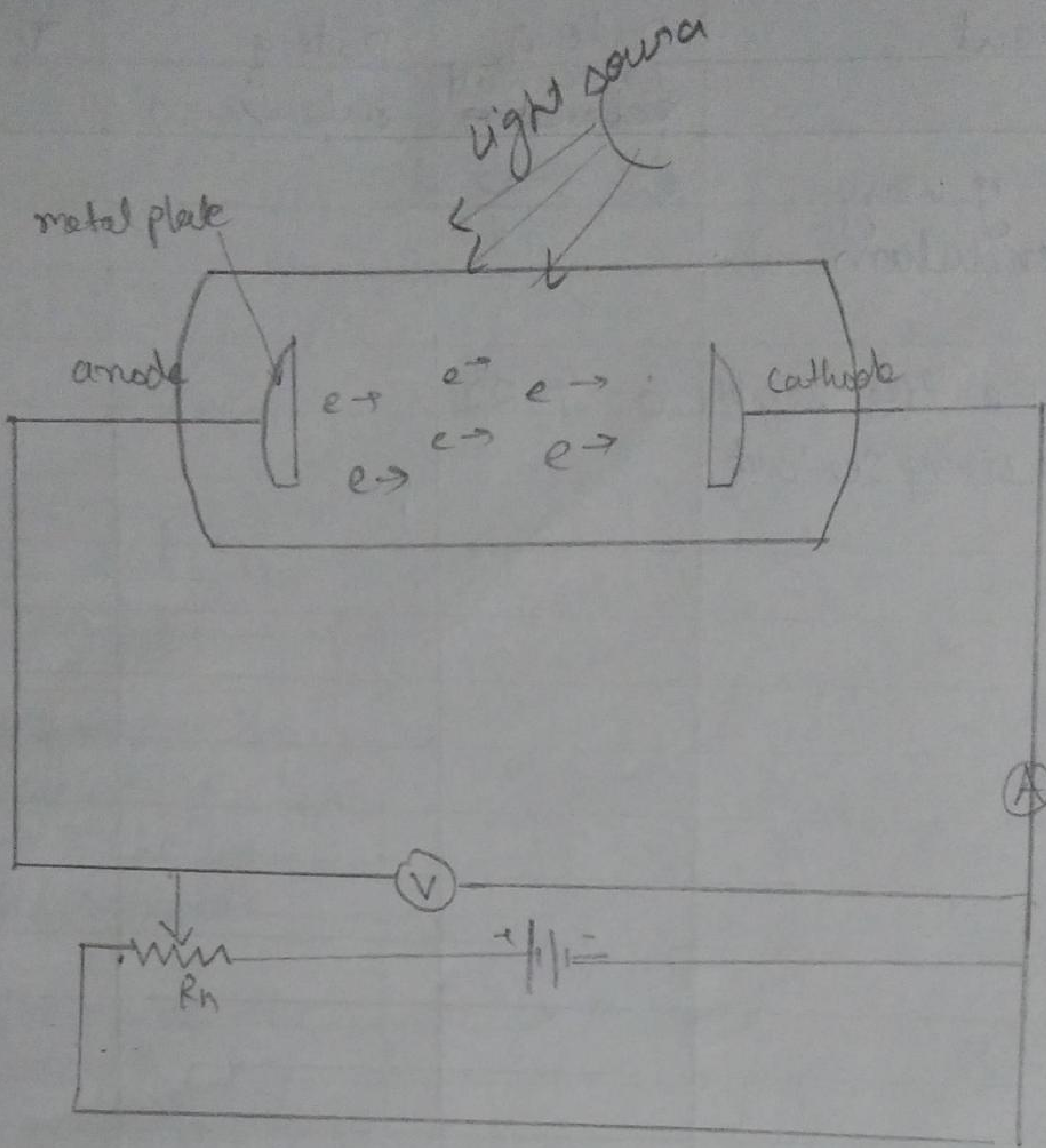

Set up for
Photoelectric Effect

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Procedure-

1. Select the material for studying photoelectric current
2. Select the area of the material, wavelength, intensity of incident light.
3. Switch on the light source
4. Measure the reverse current for various reverse voltage
5. Plot the current-voltage graph and determine the threshold voltage.
6. Repeat the experiment by varying the intensity for a particular wavelength of incident light.
7. Repeat the experiment by varying the wavelength for a particular intensity of the incident light.

Result-

Metal used - Copper

Threshold ~~voltage~~ frequency = 1.1×10^{15} Hz

Stopping potential = -7.8 V

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Observations-

Constant intensity ($I = 5\ W/m^2$) different wavelength

Cu

λ = 100nm		λ = 150 nm		λ = 200nm	
V	Ip (μA)	V	Ip (μA)	V	Ip (μA)
-7.8	0	-3.6	0	-1.6	0
-7	1.79	-3	1.44	-1	1.27
-6	4.29	-2.5	2.69	-0.5	2.52
-5	6.79	-2	3.94	0	3.77
-4	9.29	-1.5	5.19		
-3	11.79	-1	6.44		
-2	14.29	0	8.94		
-1	16.79				
0	19.29				

for constant wavelength λ = 100nm variable intensity

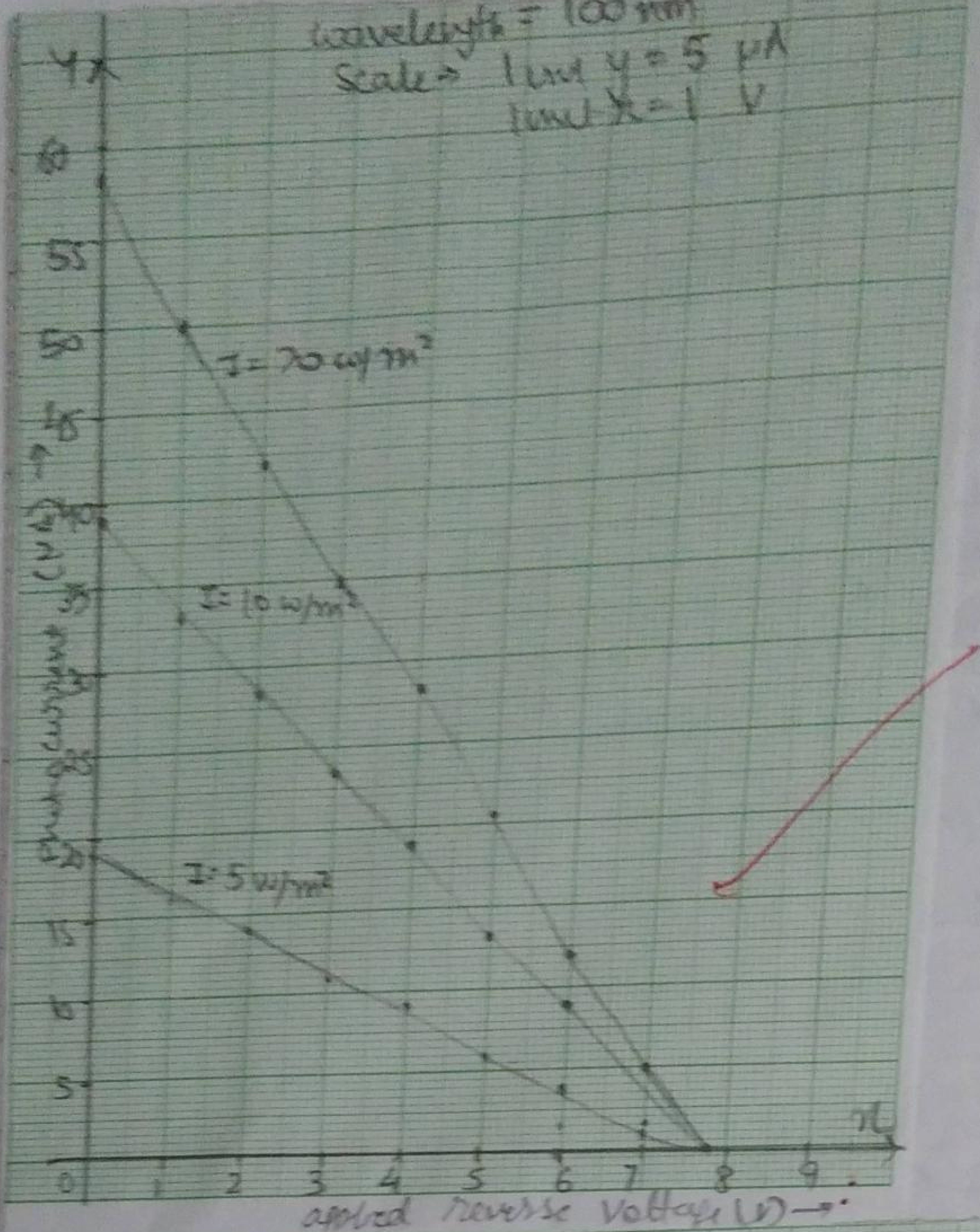
Intensity = 5 W/m²		Intensity = 10 W/m²		Intensity = 15 W/m²	
0	19.29	0	38.58	0	57.87
-1	16.79	-1	33.58	-1	50.37
-2	14.29	-2	28.58	-2	42.87
-3	11.79	-3	23.58	-3	35.37
-4	9.29	-4	18.58	-4	27.87
-5	6.79	-5	13.58	5	20.37
-6	4.29	-6	8.58	6	17.87
-7	1.79	-7	3.58	-7	5.37
-7.8	0	-7.8	0	-7.8	0

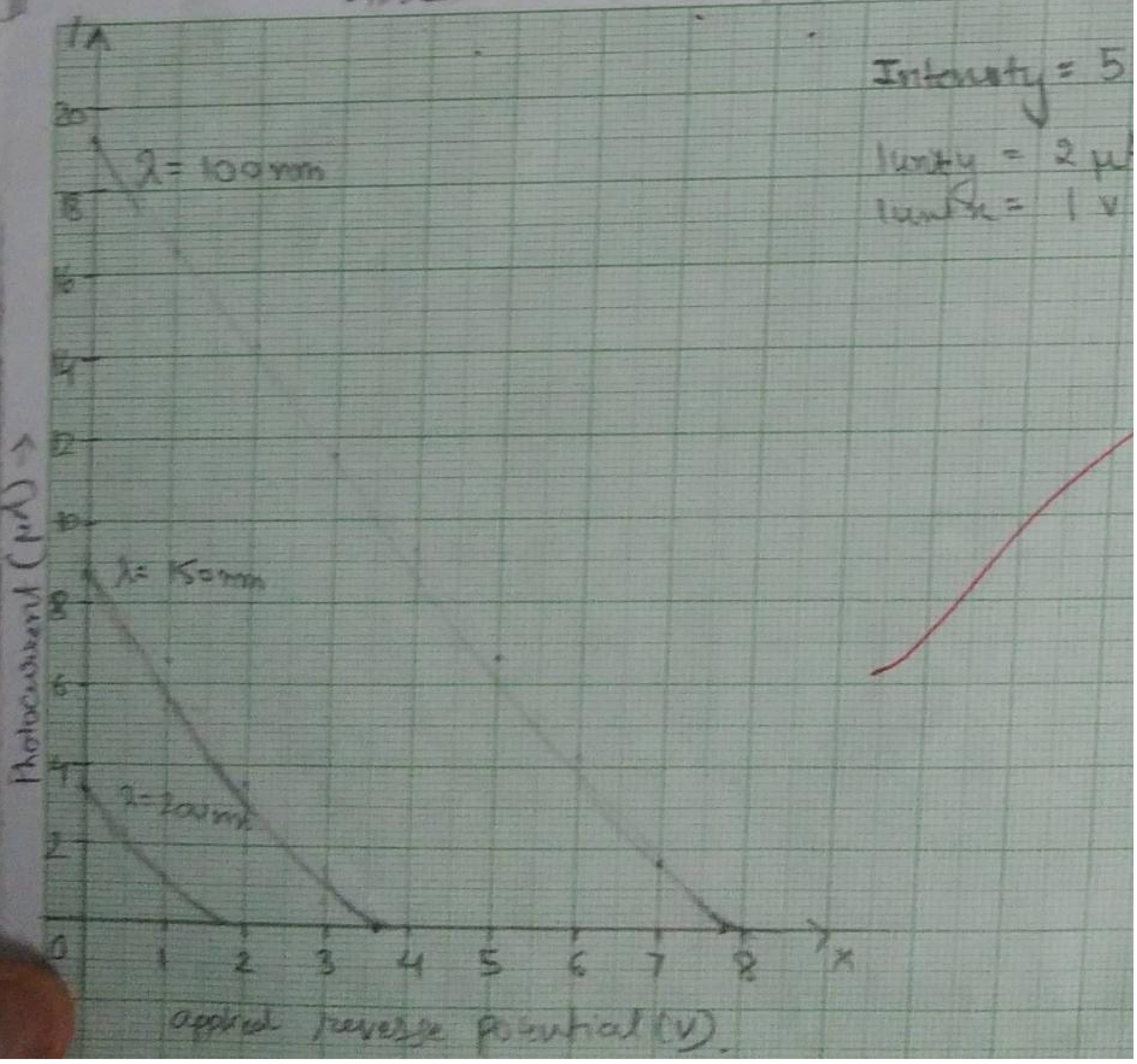
Calculations- $E = W_0 + KE \rightarrow \frac{hc}{\lambda} = W_0 + eV_0$

$$W_0 = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{10^{-7}} - (1.6 \times 10^{-19})(7.8)$$

$$W_0 = 7.32 \times 10^{-19} J = 4.57 eV$$

$$\nu_0 = \frac{7.32 \times 10^{-19}}{6.6 \times 10^{-34}} = 1.1 \times 10^{15}\ Hz$$


wavelength = 100 nm
Scale → 1 unit y = 5 μA
1 unit x = 1 V
I = 20 w/m²
I = 10 w/m²
I = 5 w/m²
applied reverse voltage (V) →


Intensity = 5
1 unit y = 2 μ
1 unit x = 1 V
λ = 100 nm
λ = 150 nm
λ = 200 nm
Photocurrent (μA) →
applied reverse potential (V)

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Experiment - 2

Aim- To determine the specific heat of Copper, lead and glass.

Materials Required-
Dewar flask, steam generator, heating chamber, beaker, metal samples, Silicon tube,

Theory-
Heat capacity C of an object is defined as $C = \frac{\Delta Q}{\Delta T}$, where ΔQ is the amount of heat required to change the temperature of object by ΔT. specific heat is the heat capacity per unit mass.

$$c = \frac{C}{m} = \frac{\Delta Q}{m \Delta T}$$

$$\Delta Q = cm \Delta T$$

According to conservation of energy -

$$\Delta Q_{gained} = \Delta Q_{lost}$$

$$m_2 c_2 (T_6 - T_2) = m_1 c_1 (T_1 - T_6)$$

for this experiment, the system consist of mixing a given mass m_1 of a hot metal with specific heat c_1 at temperature T_1 and a known mass m_2 of water with specific heat c_2 at a lower temperature T_2 contained in calorimeter of mass m_3, c_3 - specific heat of calorimeter, initial temperature T_2. Let final temp be T_6.

$$\Delta Q_{lost}(metal) = \Delta Q_{gained}(water) + \Delta Q_{gained}(calorimeter)$$

$$m_1 c_1 (T_1 - T_6) = m_2 c_2 (T_6 - T_2) + m_3 c_3 (T_6 - T_2)$$

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$$m_{pb} c_1 (t_s - t_f) = (M_w + W)(t_f - t_2)$$

W = water equivalent - It is the mass of water which absorb the same amount of heat as absorbed by flask to raise its temp by 1°C.

We will consider a metal specimen heated to a high temperature is dropped into water contained in a calorimeter at a lower temperature. The specific heat can be obtained by equating the heat loss by the metal heat gained by both calorimeter and water

Procedure -

1. The experiment setup is placed
2. Open the top of steam generator by turning it anticlockwise and add sufficient water so that heater element is well dipped into water
3. Connect the heating chamber to the steam generator using Silicon tube.
4. Attach silicone tubing to the bottom hose connection of the heating chamber and hang the other end in the beaker. See that the silicone tubing is securely seated at all connections
5. Fill the sample chamber of the heating chamber with a weighed quantity of lead shots and seal it with stopper.
6. Switch on the steam generator to generate steam and heat the shots for about 20-30 minutes in the heating chamber.

Determination of specific heat

1. Empty the dewar flask and place it in water so that it regain its normal temperature.
2. Open the cover of the dewar vessel and shift below the heat chamber and drop the shots at 100°c into the dewar flask.
3. Stir the mixture gently by rotating the flask clockwise and anti-clockwise with hand.

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Observation-

Determination of water equivalent of dewas flask-

1. Mass of flask (M_1) =
2. M_2 (mass of cold water (M_2) + mass of flask (M_1)) =
3. Mass of cold water (M_c) = $M_2 - M_1$ =
4. Temp of cold water (T_c) =
5. Temp of hot water (T_h) =
6. M_3 (cold water + flask + hot water) =
7. Mass of hot water = M_h = $M_3 - M_2$ =
8. Temp of mixture = T_m =

heat lost = heat gained

$$M_h (T_h - T_m) = M_c (T_m - T_c) + w (T_m - T_c)$$

w =

Determination of the specific heat-

(i) Sample result for lead-

initial temperature of water (T_2) =

final temperature of water (T_f) =

mass of lead shots, m_{pb} =

m_w (mass of water in flask in water with lead shot) =

water equivalent =

t_s = temp of steam =

$$m_{pb} C_1 (t_s - t_f) = (M_w + W)(T_f - t_2)$$

Literature value = 0.129 $kJ\,k^{-1}/g^{-1}$

error =

4. Read the temperature of the mixture when the temperature of the water stop rising and use eqn-6 to find specific heat.
5. Rearrange the experiment with copper and glass shots.

Result

Specific heat of lead=
Specific heat of Copper=
Specific heat of Glass=

(ii) Sample result for Copper-

initial temp of water (T_2) =

final temp of water (T_f) =

mass of Cu Shots, M_{cu} =

M_w = mass of water + Cu =

Water equivalent W =

t_s = temp of steam

$$m_{cu} C_2 (t_s - t_f) = (M_w + W)(T_f - T_2)$$

C_2 =

Literature Value =

error =

(iii) Sample result for glass -

initial temp of water (T_2) =

final temp of water (T_f) =

mass of glass shots, M_{glass}

M_w =

W =

t_s =

$$M_{glass} C_3 (t_s - t_f) = (M_w - W)(T_f - T_2)$$

C_3 =

Literature value =

error =

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Experiment - 3

Aim -

To determine the wave length of a laser using the Michelson interferometer

Apparatus -

Laser light source, Michelson interferometer kit, optical bench, meter scale

Theory -

In Michelson interferometer, coherent beams are obtained by splitting a beam ~~of~~ of light using beam splitter. The rays falling on mirror M_1 and M_2 reflect and interfere on screen. Two virtual images are formed S_1 due to reflection at M_1 and S_2 due to reflection at M_2 separated by a distance 2d

Using Michelson interferometer, wavelength of light is determined by

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

Procedure -

1. The laser beam must strike at the center of movable mirror and should be reflected directly back into the laser aperture
2. Adjust the position of beam splitter so that the beam is reflected the fixed mirror.
3. Adjust the angle of the beam splitter to make the two sets of spots as close together as possible.
4. With the screws on the back of the adjustable mirror adjust the mirror's tilt until the two sets of spots coincide
5. Expand the the laser beam slowly rotating the collimating lens in front of laser

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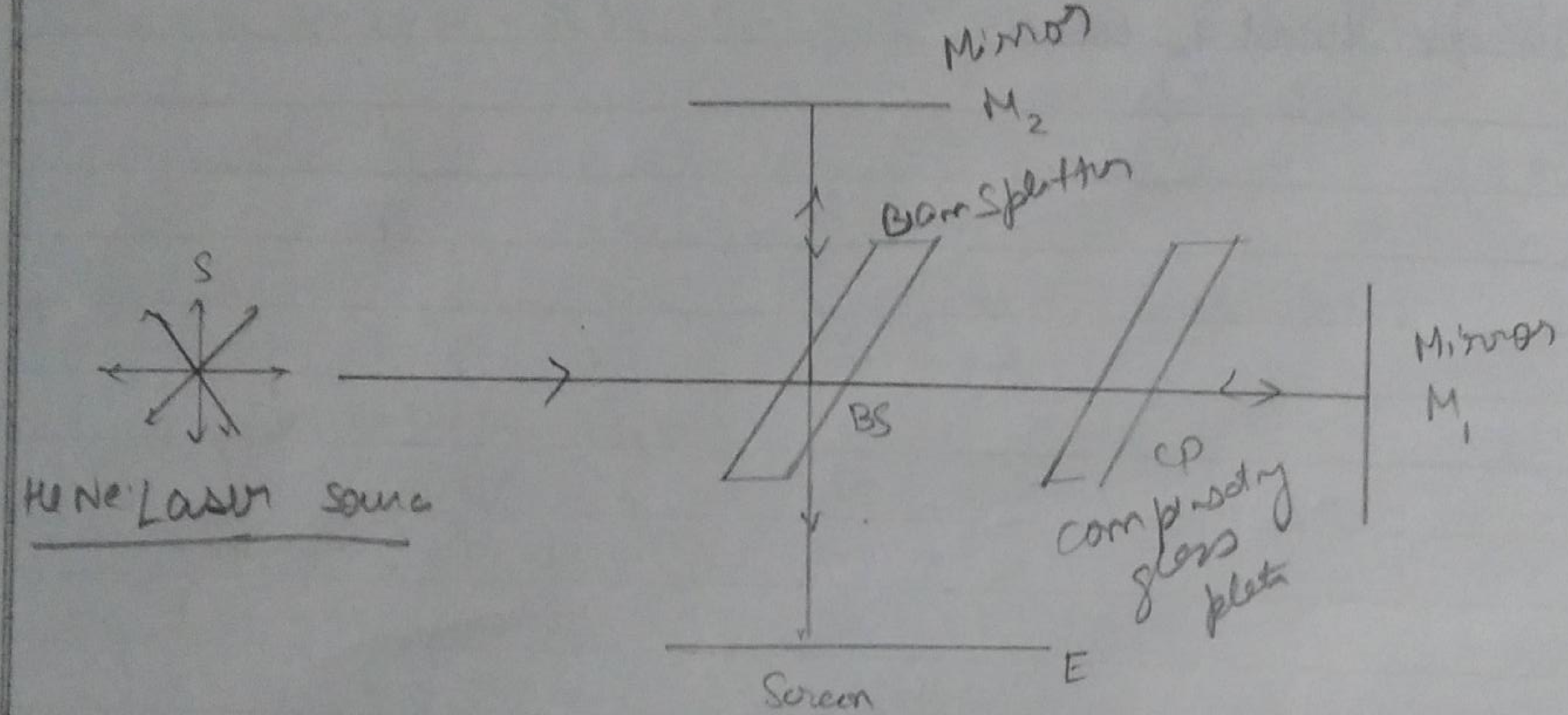

Michelson Interferometer

6. Allign the laser with the interferometer and make certain that the fringes are moving when the micrometers screw is turned.
7. Make a point on the screen and note the micrometer reading.
8. Calculate the distance d, repeat the procedure to take average distance.
9. With a known wavelength, $d = N\lambda/2$ is Calculated.
10. Unknown wavelength is Calculated.

Result -

The observed wavelength of the given light source ~~diode laser~~ is 550 nm.

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Observation-

Least count VSR = 0.0001 mm   L.C. CSR = 0.01mm

Distance moved for N fringes d = 10

S.No	CSR (mm)	VSR (mm)	Distance d (mm)	Difference Δd (mm)
1	90 × 0.0001	0.5 × 0.01	0.0140	
2	59 × 0.0001	0.5 × 0.01	0.0109	0.0031
3	30 × 0.0001	0.5 × 0.01	0.0080	0.0029
4	12 × 0.0001	0.4 × 0.01	0.0052	0.0028
5	0 × 0.0001	0.3 × 0.01	0.0030	0.0022

Calculation-

$$\text{mean} = \Delta d = \frac{0.0031 + 0.0029 + 0.0028 + 0.0022}{4}$$

$$= 0.00275$$

$$\lambda = \frac{2d}{N} = \frac{2(0.00275)}{10} = 0.00055 \text{ mm}$$

$$= 550 \text{ nm}$$

Error · $\frac{620 - 550}{620}$ nm $=$ 11% error

Experiment-4

Aim-
To determine the wavelength of laser light using diffraction grating.

Theory- Diffraction of light occurs as it passes through a slit, the angle to the minima in the diffraction pattern is given by-

$$a \sin\theta = m\lambda$$

where, a = slit width
θ = angle from the centre of pattern to the m^{th} minima.
λ = wavelength of the light and
m = order.

Since, the angles are usually small, it can be assumed that

$$\tan\theta = \frac{y}{D}$$

where, y = distance on the screen from the centre of the pattern to the m^{th} minimum
D = distance from the slit to the screen

$\therefore$ Slit width $a = \frac{m\lambda D}{y}$ $(m = 1, 2, 3 \cdots)$

Procedure- 1 Set up the diode laser at the end of the optical bench and place the slit holder about 5 cm in front of laser.
2 Put the photo-detector at the other end of the ~~[illegible]~~ optical bench adjust the vertical and horizontal position and laser so that beam falls at the centre of the pin hole.
3 Connect the multimeter to the detector.
4 Mount the single slit in slit holder and adjust the position of laser beam from left to right and up and down until the beam is centered on the slit.

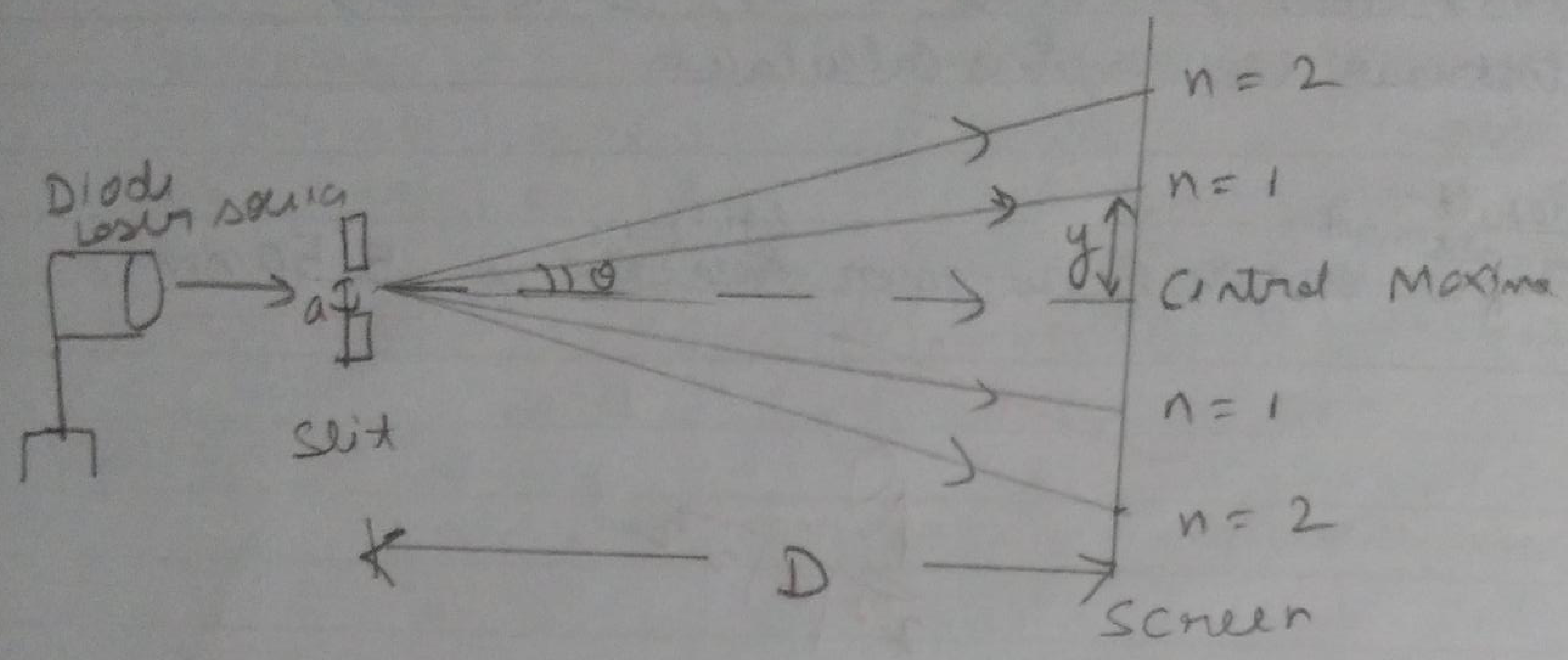

Figure. Diffraction grating setup.

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5 Determine the distance b/w slit and detector

6 Record the intensity at closed intervals by traversing the detector through the crosssection.

7 Diode laser is mounted on the saddle

8 A plane transmitting grating is mounted on an upright next to laser.

9 The position of x of the spot of 1st order on either side of central maxima is marked

10 The distance D b/w the grating and screen is measured

11 Calculate $\sin\theta = \frac{x}{\sqrt{x^2+D^2}}$

12 Grating element d for grating lines per mm

$$= \frac{1}{x10 \times 100}$$

Result -

The wavelength of the given laser beam = 642.75 nm

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Observations

for n=0 D = 31 cm

S.no.	order (m)	left (mm)	right (mm)	y (mean)	D (cm)
		N = 300 lines/mm			
1	1	10.55	10.5	0.025	11
2	2	7.74	7.81	0.035	9
		N = 80 lines/mm			
3	1	10	10.4	0.2	23.7
4	2	24.615	25.20	0.375	23.7

Calculations -

$\lambda = \frac{N(y)}{mD}$; $\lambda_1 = \frac{(300)(0.025)}{(1)(11)} = 681$ nm

$\lambda_2 = \frac{(300)(0.035)}{(2)(9)} = 583$ nm

$\lambda_3 = \frac{(80)(0.2)}{(1)(23.7)} = 675$ nm

$\lambda_4 = \frac{(80)(0.375)}{(2)(23.7)} = 632$ nm

Mean $\lambda = \frac{\lambda_1+\lambda_2+\lambda_3+\lambda_4}{4} = 642.75$ nm

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Experiment - 5
(virtual)

Aim -
To determine the resistivity of semiconductors by four probe method.

Apparatus -
four probe arrangement, Sample, oven 0-200°c, constant current generator, oven power supply, digital panel meter.

Theory -
Resistance - $R = \rho \frac{L}{A}$ where ρ is resistivity

~~Resistivity of material is uniform in the area of measurement. If there is a minority carrier injection into the semiconductor by the current carrying electrode, they recombine so that effect on conductivity is less.~~

A semiconductor has electrical conductivity intermediate in magnitude. In case of intrinsic semiconductors, the Fermi level lies in between conduction and valence band, at 0K resistance is infinite. As temperature increases, the occupancy of conduction band goes up and results in decrease in electrical resistivity of semiconductor.

$$\rho = \frac{\rho_0}{G(W/S)} \qquad \rho_0 = \frac{V}{I} 2\pi S \qquad S = \text{spacing b/w probes}$$

Procedure -
1. Select the semiconductor material from the combo box.
2. Select the source current from the slider. Restrict the slider based on current range.
3. Select the range of oven from the combo box
4. Set the temperature from the slider

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5. Click on the Run button to start heating the oven on a particular interval, from the default 28°C to the temp that we set and then stop heating when temperature is reached
6. Measure to display the temp in the oven.
7. Select range of voltmeter and measure voltage
8. Calculate the resistivity of semiconductor in eV for given temperature.
9. Temperature vs resistivity graph is plotted

Result -

The resistivity of the given semiconductor = 6.204 ohm cm

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Observations -

Temperature T, (K)	Voltage V (mV)	Current I (mA)	Resistivity ρ (Ohm cm)
25	87.24	3	6.204
30	84.65	3	6.020
35	82.22	3	5.845
40	79.94	3	5.683
45	77.78	3	5.530
50	75.75	3	5.385
55	73.83	3	5.249
60	72.01	3	5.119
65	70.30	3	4.998
70	68.67	3	4.882

Calculations

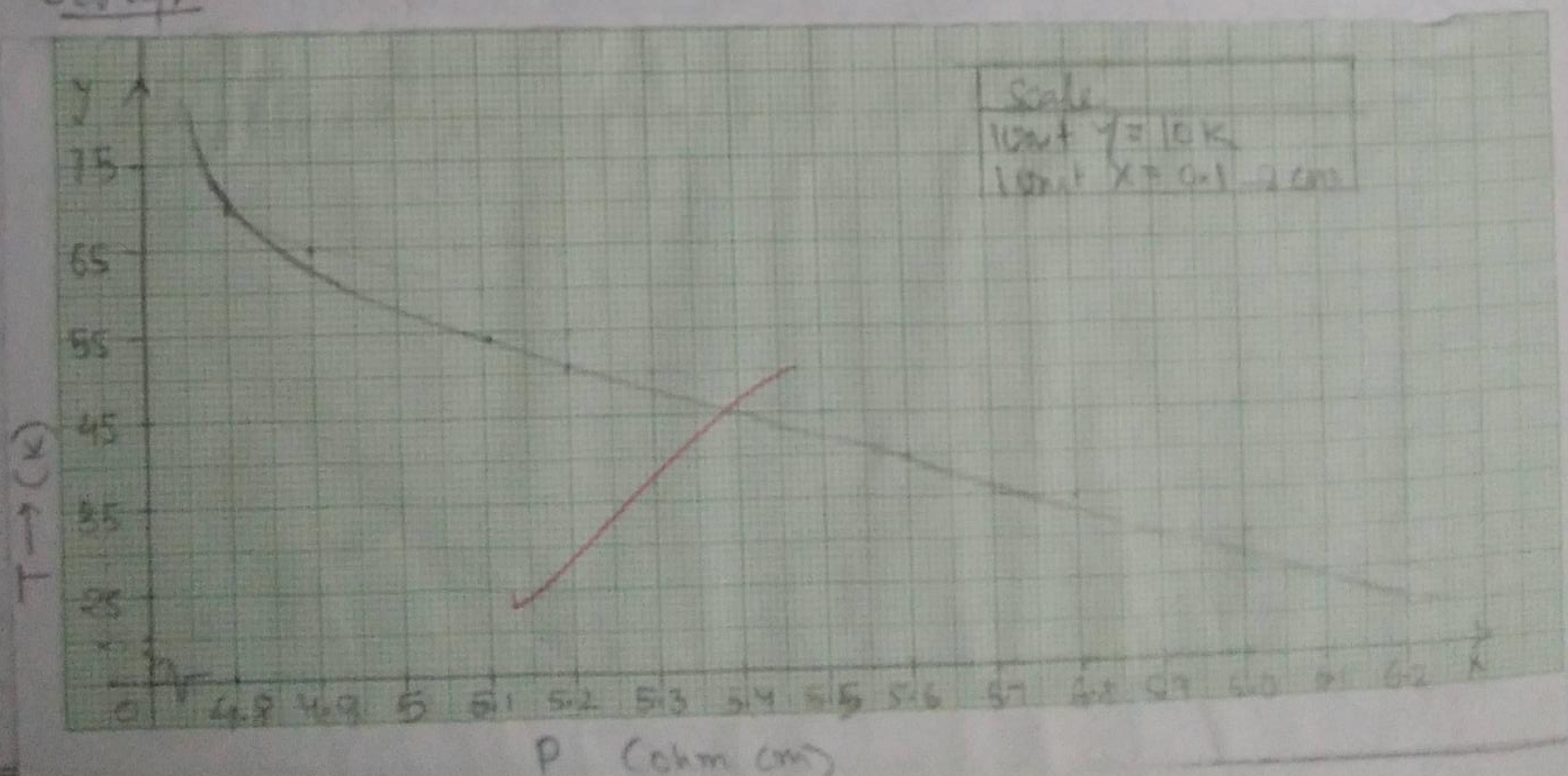
Distance between probes ; S = 0.2 cm

Thickness of sample ; W = 0.05 cm

from standard table $f(W/S) = 5.89$

$\rho_0 = \frac{V}{I} 2\pi S = 36.54\ \Omega\,cm$ $\quad \rho = \frac{\rho_0}{f(W/S)} = 6.204\ \Omega\,cm$

Graph -



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Experiment-6

Aim-

To find the numerical apperture of a given optic fibre and hence to find its acceptance angle

Materials required

Optical fibre cable, emitter, output unit, screen,

Theory-

Numerical aperture of any optical system is a measure of how much light can be collected by optical system. It is product of refractive index of incident medium and sine of maximum ray angle.

$$NA = n_i \sin\theta_{max};\ n_i \text{ for air is } 1$$

hence $N.A = \sin\theta_{max}$

for a step index fibre, as in present case, numerical aperture is given by

$$N = \sqrt{n^2_{core} - n^2_{cladding}}$$

for very small difference in refractive indices, equation reduces to

$$N.A = n_{core}\sqrt{2\Delta}$$

where Δ is fractional difference in refractive indices.

The fibre may refer to specification of PMMA fibre and record manufacturer's N A, n_{core}, $n_{cladding}$.

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Procedure-

1 Connect one end of cable 1 to FO LED in fibre optic LED driver section of FO and other end to N A jig.

2 Switch on trainer. Light should appear to end of fibre on NA jig. Turn set Pout knob clockwise to set to maximum Po. The light intensity should by increased.

3 Hold white screen with ~~concentric~~ concentric circles vertically at a suitable distance to make red spot from emitting fibre coincide with 10 mm circle. Note that circumference of circle must coincide with light. Record 'L' distance of screen from fibre end and note diameter of spot.

4 Compute N.A from formula-

$$N.A = \sin\theta_{max} = \frac{w}{\sqrt{4L^2 + w^2}}$$

5 In case fibre is under filled, intensity within spot may not be evenly distribution. To ensure even distribution of light in fibre, first remove twists on fibre and then wind 5 turns of fibre on to mandreal.

Result-

Numerical aperture of given wire is = 0.69 radian

Observation -

S. no.	L (cm) (length)	W (cm) diameter	$\sin\theta$ (N.A)
1	1	1.7	0.640
2	2	2.9	0.587
3	5	6.4	0. 530
4	8	7.8	0.870
5	10	10.4	0.460

mean of N.A = 0.61

N.A = 0.64

θ_{max} = 0.69 radian

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Experiment-7

Aim- To determine wavelength of sodium light by newton rings.

Apparatus required- Plano-Convex lens of large radius of curvature, optical arrangement for Newton's rings, plane glass plate, sodium lamp, and travelling microscope.

Theory-

Due to air film formed by glass plate & the plano convex lens of large radius of curvature, interference fringes are formed which are observed directly through travelling microscope. Rings are concentric circles

path difference : $\Delta x = 2\pi \lambda \Delta\phi$

~~radius~~ of circles

using formula: $\lambda = \dfrac{D^2_{m+n} - D^2_n}{4mR}$

- $D_{m+n} \rightarrow$ diameter of $(n+m)^{th}$ ~~circle~~ ring
- $D_n \rightarrow$ diameter of n^{th} ring
- $m \rightarrow$ an integer of no. of rings
- $R \rightarrow$ radius of curvature of plano-convex lens
- $n \rightarrow$ order of ring

~~Theo~~

Procedure-

1. After the experimental arrangement, the glass plate is inclined at an angle 45° to the horizontal. The glass plate reflects light from the source vertically downwards and falls normally on the convex lens

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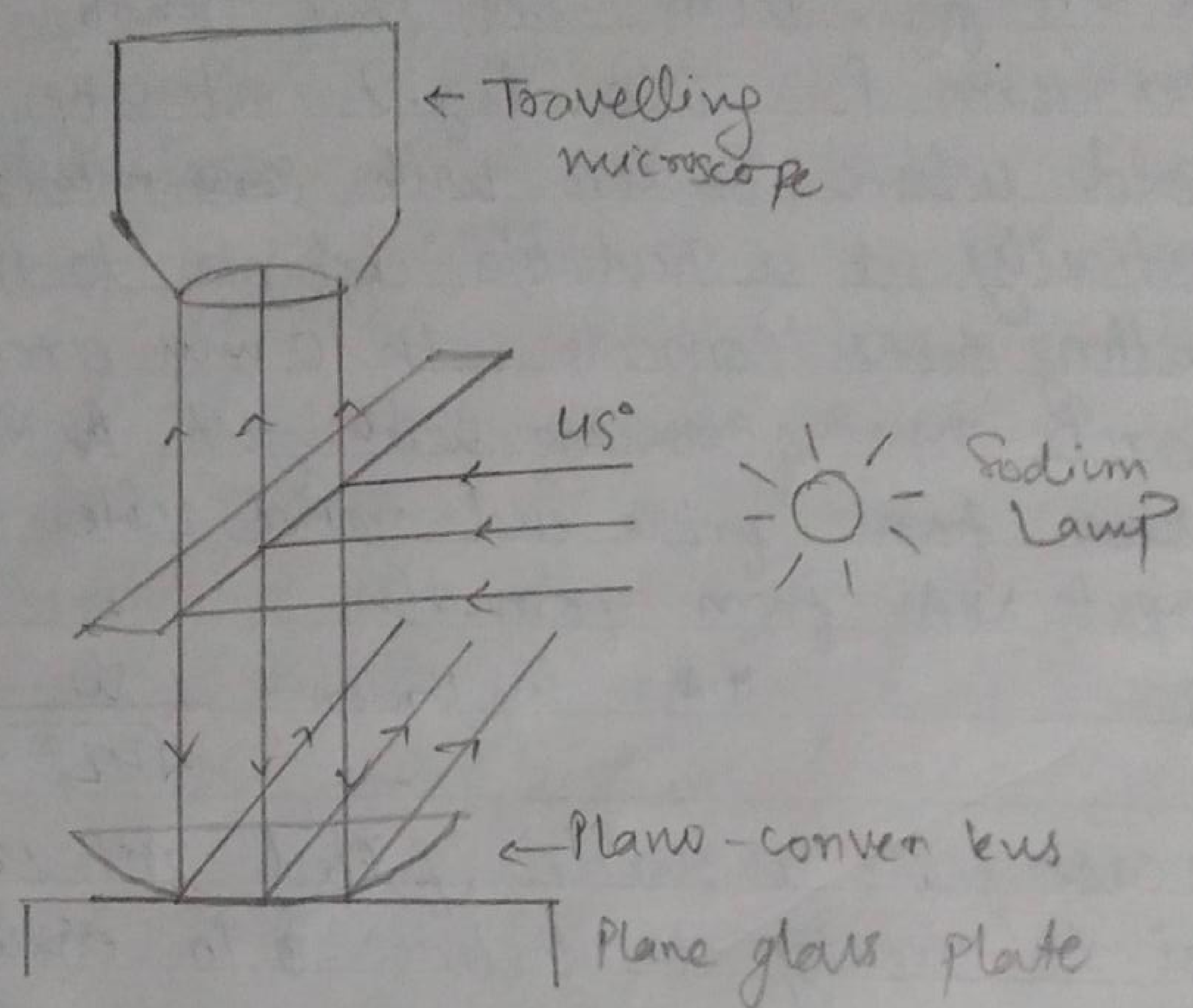

apparatus for newton rings

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2. Newton's rings are seen using a long focus microscope, focussed on the air film. The ~~cr~~ Crosswire microscope is made tangential to the 1^{st} ring on the left side of the centre. The reading of Main scale and vernier scale are noted.

3. Then it is seen through right side from the centre and observation are taken. Similarly readings for 2^{nd}, 3^{rd}, 4^{th} etc. rings are taken.

4. Diameter of rings is found out by subtracting readings on the left and right sides. The squares of diameters and hence $D_n^2 - D_{n+m}^2$ are found out. Wavelength for individual rings were calculated and their mean was found.

Result -

~~Observed~~ Wavelength of Sodium lamp is = 542 nm

~~Stand~~ Calculated value of wavelength = 589 nm

Percentage error = 7.9%

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Observations -

R = 60 cm

Order of ring (p)	Micrometer reading		Diameter D_p (mm) left - right	D_p^2 (mm²)	$D_{m+p}^2 - D_p^2$ (mm²) m = 2	$\lambda = \frac{D_{m+p}^2 - D_p^2}{4pR}$ (nm)
	Left	Right				
1	10.365	10.60	-0.235	0.055225	0.01775	369
2	10.60	10.24	0.36	0.1296	0.994	207
3	10.315	10.06	0.755	0.57	1.3621	283
4	10.99	9.93	1.06	1.1236	14846	309
5	11.14	9.75	1.39	1.9321	6.1335	1277
6	11.23	9.65	1.615	2.608225	6.3617	1325
7	11.33	8.49	2.84	8.0656	1.4433	300
8	11.415	8.42	2.995	8.97	1.9861	413
9	11.49	8.32	3.17	10.0489	2.1312	444
10	11.55	8.24	3.31	10.9561	2.3664	493
11	11.65	8.16	3.49	12.1801		
12	11.76	8.11	3.65	13.3225		

Calculation

$$\lambda_{mean} = \frac{5420}{10} = 542 \text{ nm}$$

$$\text{Error} \Rightarrow \frac{589 - 542}{589} \times 100 = 7.9\%$$

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Experiment - 8

Aim- To determine the value of g, the acceleration due to gravity at a particular location using kater pendulum.

Apparatus required-
Kater's pendulum, stopwatch, meter scale, weights, wooden and metal knife edges.

Theory-
We consider the force of gravity to be acting at G. If h_i is the distance to G from the suspension point O_i at the knife edge K_i

$$I_i \ddot{\theta} = -Mgh_i \sin\theta$$

where I_i is moment of inertia.
Comparing to the motion of simple pendulum

$$M I_i^2 \ddot{\theta} = -Mg\, l_i \sin\theta$$

$$Mg h_i / I_i = g / l_i \quad -(1)$$

or

$$I_i = MK_i^2$$

$$k_i^2 = h_i l_i \quad -(2)$$

If I_g is the moment of inertia of pendulum about G, radius of gyration is $I_g = MK_g^2$

$$l_i = \frac{h_i^2 + k_g^2}{h_i} \quad \text{using (2)}$$

time period $T_i = 2\pi\sqrt{\frac{l_i}{g}} = 2\pi\sqrt{\frac{h_i^2 + k_g^2}{g h_i}} \quad -(3)$

Squaring (3) and calculate g

$$g = 8\pi^2 \left[\frac{T_1^2 + T_2^2}{h_1 + h_2} + \frac{T_1^2 - T_2^2}{h_1 - h_2} \right]^{-1}$$

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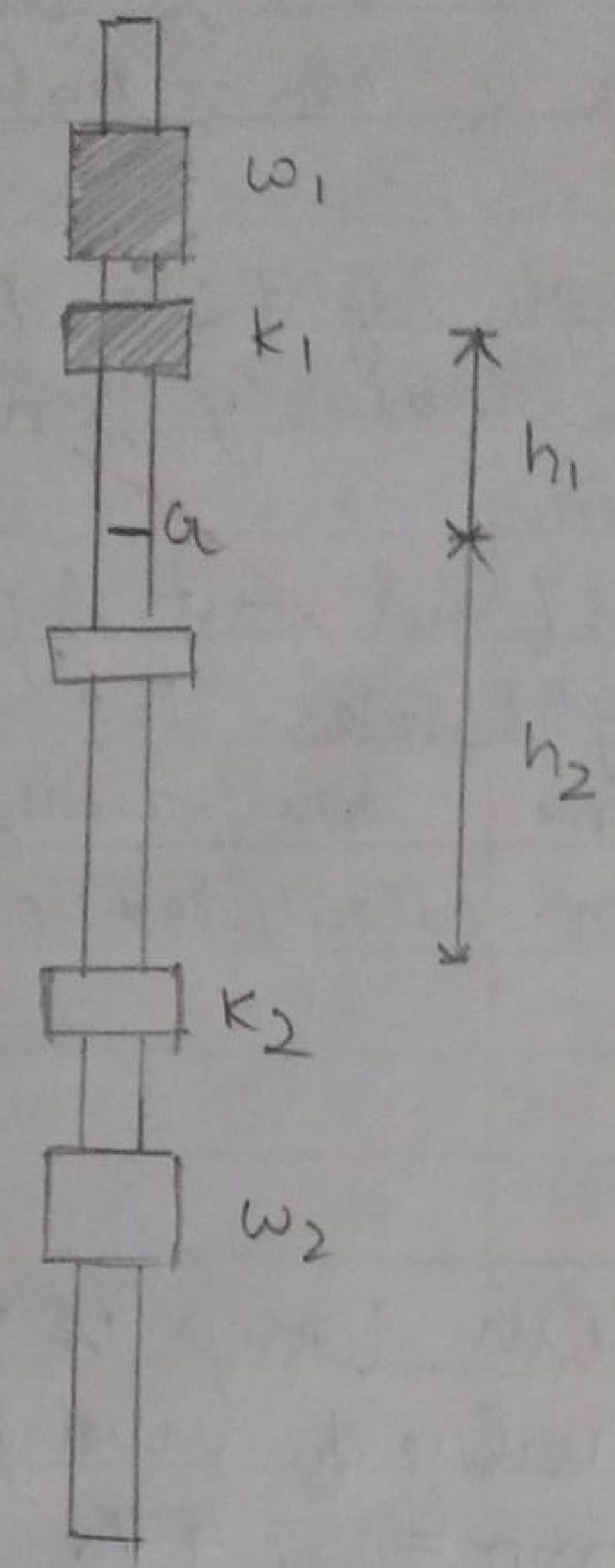
Experimental Setup for Kater's Pendulum



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Procedure -

1. Choose a desired environment from pendulum.
2. Shift the weight w, to one end of Kater's pendulum and fix it. Fix the knife edge K_1 just below it. Keep
3. the knife edge K_2 at the other end. Keep the small weight W near to centre.

4. Suspend the pendulum about the knife edge and take the time for about 10 oscillations. Note the time t_1 using a stopwatch and calculate its time period using $T_1 = t_1/10$.
5. Now suspend about knife edge K_2 by inverting the pendulum and note the time t_2 for 10 oscillation. Calculate T_2.
6. If $T_2 \neq T_1$ adjust the position of knife edge K_2 so that $T_2 \simeq T_1$.
7. Balance the pendulum on a sharp edge and work the position of its centre of gravity. Measure the distance of the knife edge K_1 and h_1 and that of K_2 as h_2 from G.

Result

The accn due to gravity at a given place is found ~~to be~~ $= 10.38\ ms^{-2}$

Percentage error $= 5.91\%$

Teacher's Signature :

Observation -

S.no	Distance (L_1+L_2)	t_1 period	T_1	t_2 period	T_2	g
1	79.5	17.28	1.728	17.48	1.748	10.38

Calculations -

$T_1 \approx T_2$

$$g = \frac{8\pi^2 (L_1 + L_2)}{(T_1^2 + T_2^2)}$$

$$= \frac{8 \times (3.14)^2 \times 79.5}{2.988 + 3.055}$$

$$= \frac{6270.7}{6.040}$$

$$= 1038 \ cm/s^2 = 10.38 \ m/s^2$$

Error -

$$\frac{10.38 - 9.8}{9.8} \times 100 = 5.91\% \text{ error}$$

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Experiment-9

Aim -
To measure the height of window using Sextant

Materials Required
Sextant, measuring tape, rigid clamp stand

Theory -
height of accessible object -
let h = height
θ = angle made by PQ at O
$\therefore h = d\tan\theta$
d = OP measured using measuring tape.

determination of height of inaccessible object -
measure angle θ_1 and θ_2 at R and S, using sextant
$h = PQ =$
$\therefore \cot\theta_1 = \frac{RP}{h}$ $\quad \cot\theta_2 = \frac{SP}{h}$
$\cos\theta_2 - \cot\theta_1 = \frac{SR}{h} = \frac{d}{h}$

$h = d / (\cot\theta_2 - \cot\theta_1)$

determination of height of a tall object -
height of object = QP − SP
$= d\tan\theta_2 - d\tan\theta_1$
$QS = h' = d(\tan\theta_2 - \tan\theta_1)$ —(1)

Teacher's Signature :

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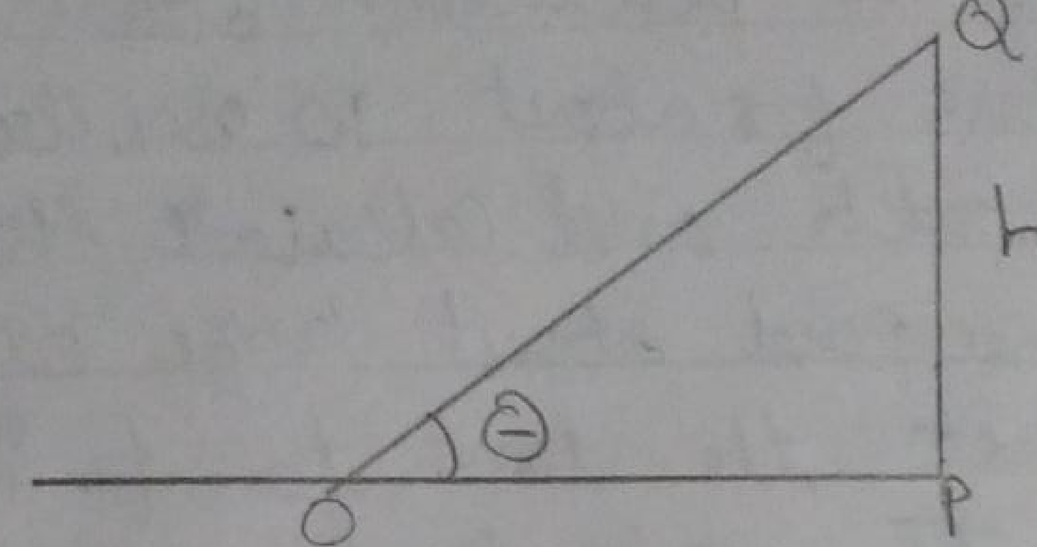
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h
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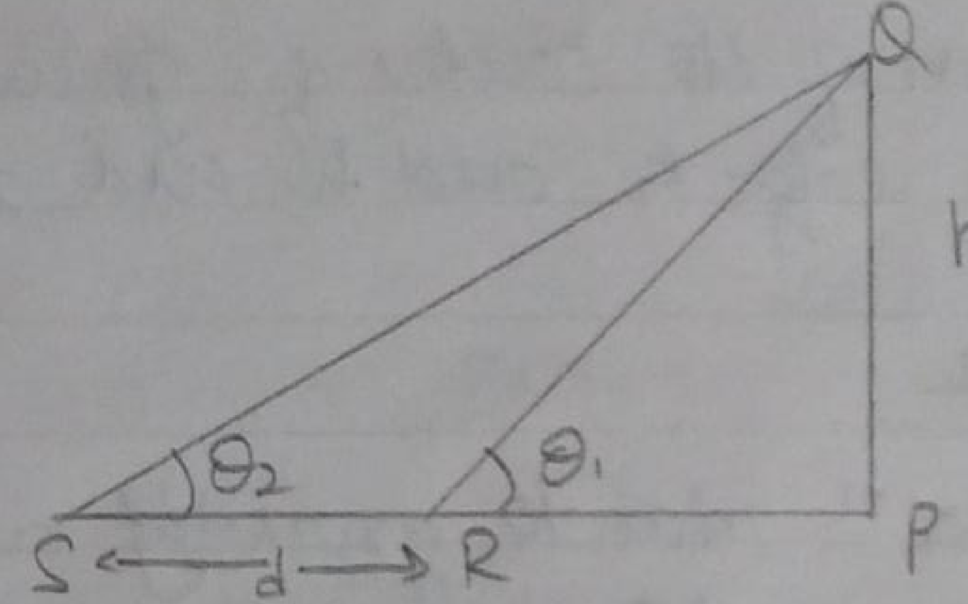
Q
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θ2
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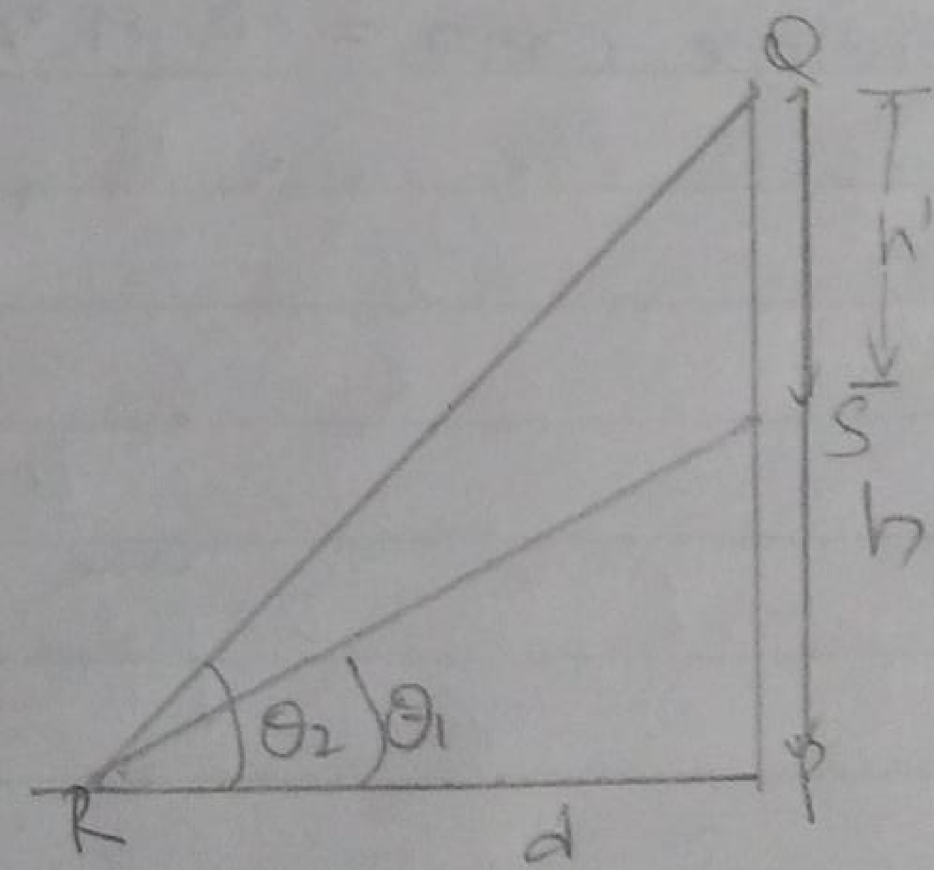
Q
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R
d
P

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Procedure-

1. Find the vernier constant of scale
2. In the level of your eye, mark a horizontal line on the tower. Place the sextant at a large distance from source.
3. Observe the horizontal line and observe its one image directly and other by two reflections at M_1 & M_2. Now rotate the movable arm, such that the horizontal line is seen continuous. If there is no zero error, zero reading should coincide with zero of mainscale. If not, record the zero error with proper sign.
4. Now turn the movable arm slowly till the image of top coincide with the image of line. Record this reading also. The difference of two reading is the angular elevation θ_1.
5. From this point of observation move the sextant to about 3.05 m away.
6. Repeat the step 4 & 5 find angle θ_2.
7. Using eqn 1 to find the height of the window. Also measure the distance of horizontal line from the ground. Add this in the calculation of actual height.

Result-

height of window calculated using measuring tape = 135 cm
height of window calculated using sextant = 139.24 cm
Percentage error = 3%

Teacher's Signature :

Observations-

$D = 387.35$ cm

LC of main Scale $= 1^\circ$

LC of circular Scale $= \left(\frac{1}{60}\right)^\circ = 1'$

Vernier Constant Calculation:

$$4\,CSD = 5\,VSD$$

$$1\,VSD = \frac{4}{5}\,CSD = \frac{4}{5}\left(\frac{1}{60}\right)^\circ$$

$$VC = 1 - VSD = \left(1-\frac{4}{5}\right)\left(\frac{1}{60}\right)^\circ = \left(\frac{1}{5}\right)\left(\frac{1}{60}\right) = \left(\frac{1}{300}\right)^\circ = 12'$$

LC of Vernier Scale $= \left(\frac{1}{300}\right)^\circ$

S.No	MSR	CSR	VSR	θ (deg)
1	14	$15 \times \frac{1}{60} = 0.25$	$4 \times \frac{1}{300} = 0.0133$	14.2633
2	31	$27 \times \frac{1}{60} = 0.45$	$5 \times \frac{1}{300} = 0.0166$	31.4666

Calculations

$$h = D(\tan\theta_2 - \tan\theta_1)$$

$$= 387.35(\tan(31.46) - \tan(14.26))$$

$$= 139.24 \text{ cm}$$

Error $\rightarrow$ $\frac{139.24 - 135}{135} \times 100 = 3\%$