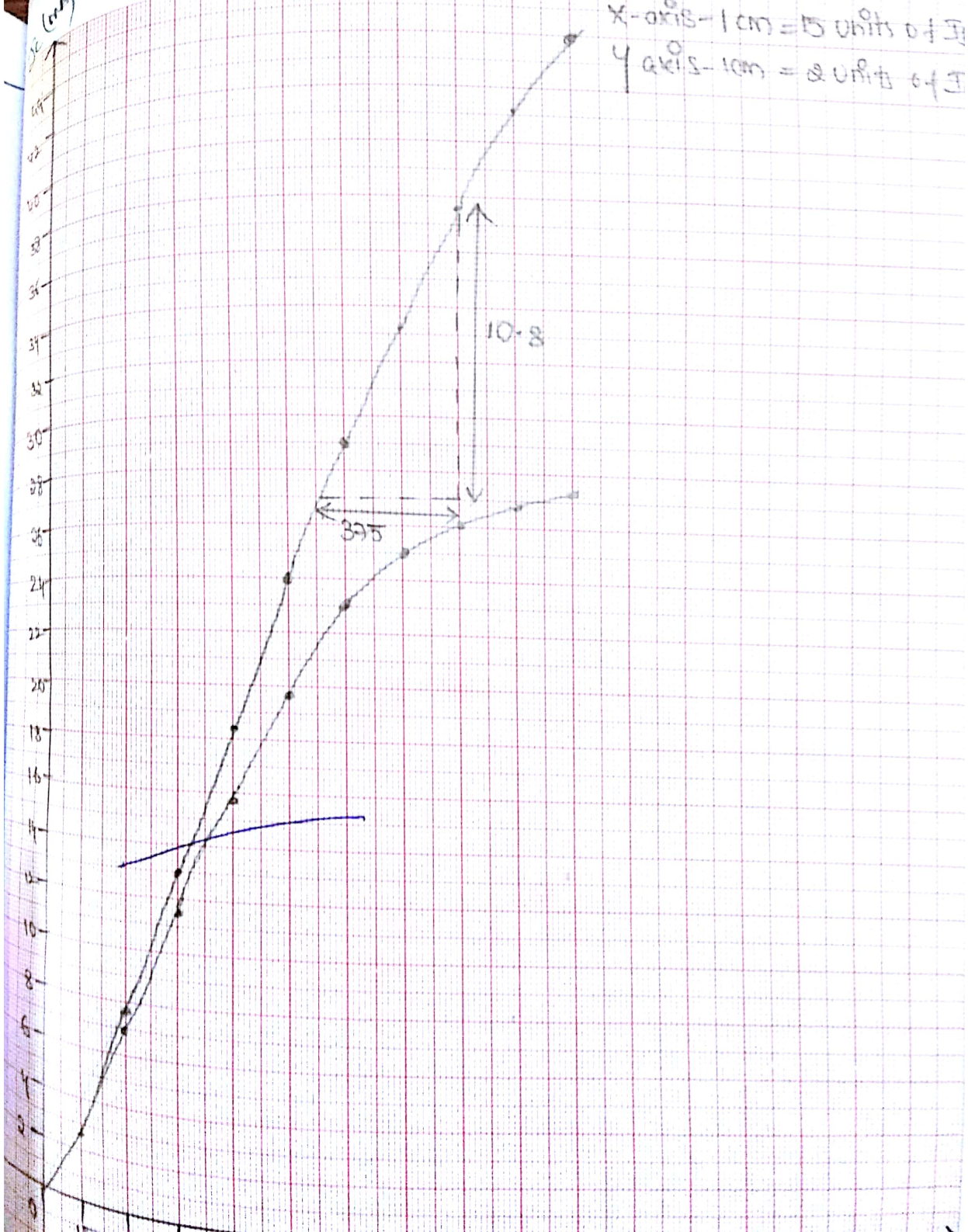


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Slope of the Graph $= \frac{\Delta I_C}{\Delta I_B}$

$= \frac{10.8 \times 10^{-3}}{37.5 \times 10^{-6}}$

$= 0.288 \times 10^{3}$

Current gain $= \beta = 288$

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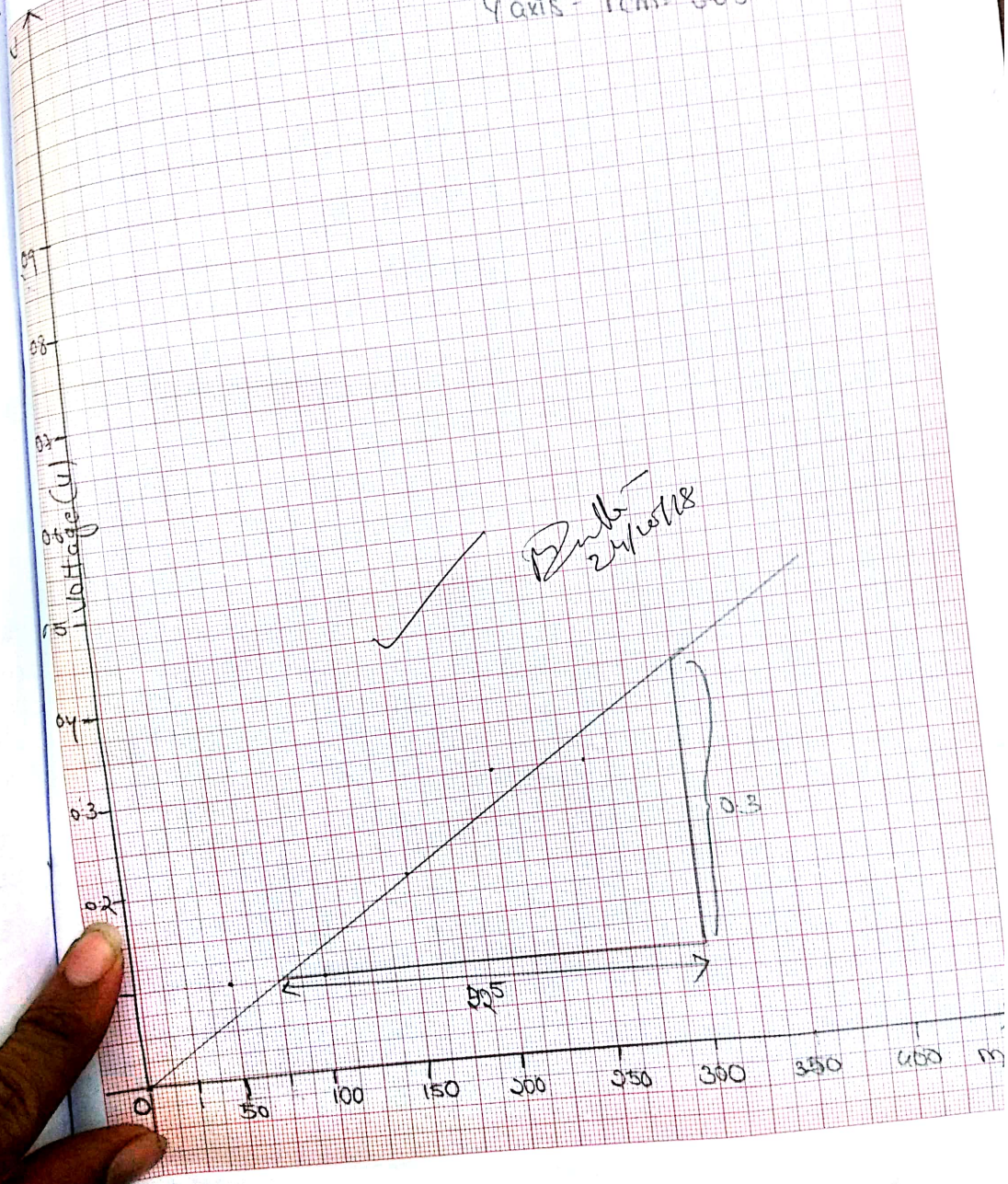
Scale:

X axis - 1 cm = 25 units of m

Y axis - 1 cm = 0.05 units of V

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Youngs Modulus Of Wood Using A Strain Gauge

Slope Of the Graph

$$= \frac{\Delta V}{\Delta m}$$

$$= \frac{0.3 \times 10^{-3}}{225 \times 10^{-3}}$$

$$= \cancel{0.06 \times 10^{3}}\ V/kg$$

$$= 1.3 \times 10^{-3}\ V/kg$$

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Slope of the Graph = $\frac{\Delta I_c}{\Delta V_{CE}}$

$= \frac{2.5 \times 10^{-3}}{6} \Omega^{-1}$

$= 0.416 \times 10^{-3} \Omega^{-1}$

Resistance = $\frac{1}{\text{Slope}}$

$= 2.4 k\Omega$

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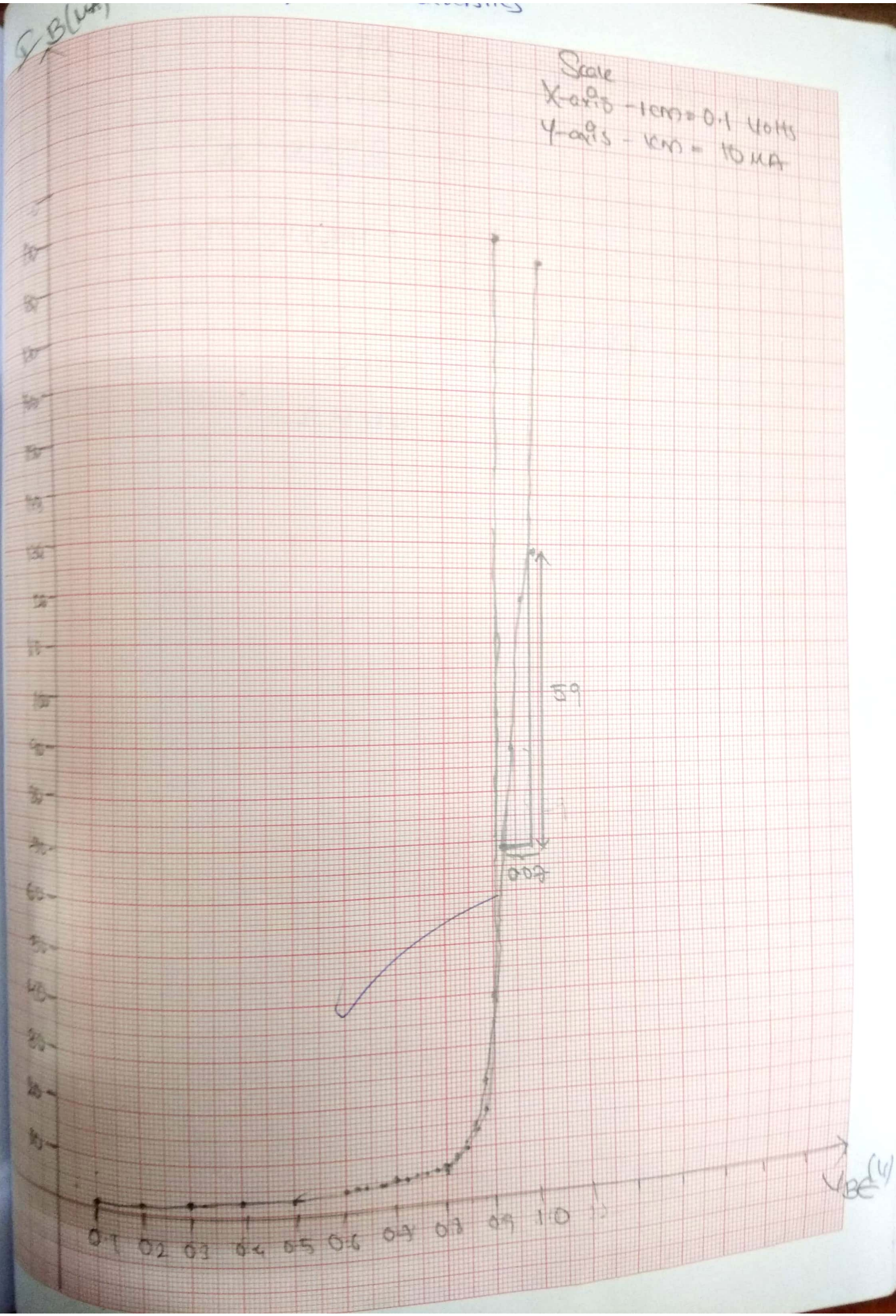


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## Input Characterstics

Slope of the Graph $= \frac{\Delta I_B}{\Delta V_{CE}}$

$= \frac{59 \times 10^{-6}}{0.07}$

$= 842 \times 10^{-6}\ \Omega^{-1}$

Resistance $= \frac{1}{\text{slope}} = \frac{10^6}{842}$

$= 1187.6\ \Omega$

$= 1.1876\ k\Omega$

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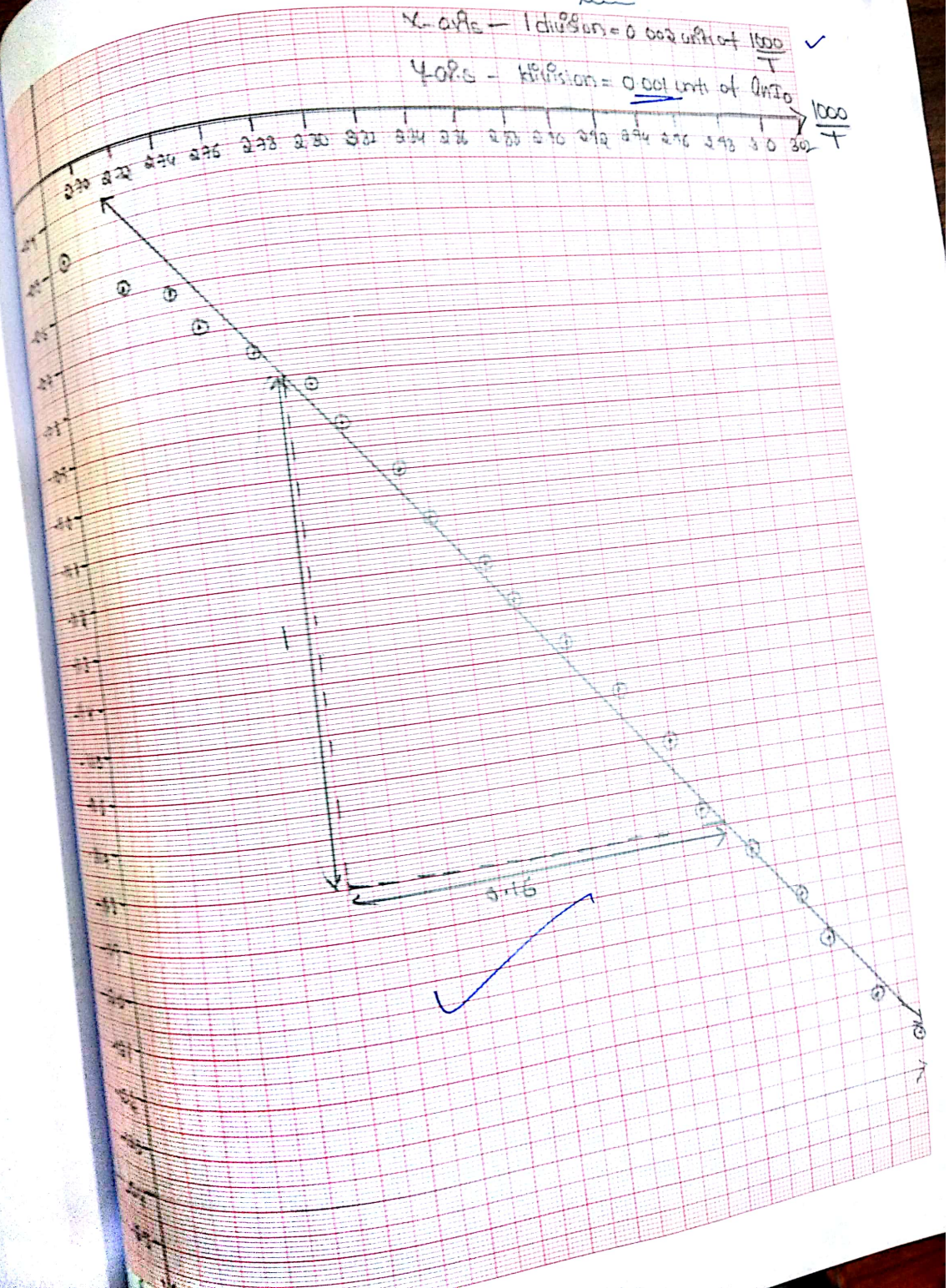
Scale:

X-axis — 1 division = 0.002 unit of $\frac{1000}{T}$

Y-axis — division = 0.001 unit of $\ln I_0$

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# Determination Of Energy Gap Of Semi Conductor

Slope of Graph $= \frac{y_2 - y_1}{x_2 - x_1} = \cancel{\frac{\Delta \ln I}{\Delta \frac{1000}{T}}}$

$= \frac{\Delta \ln I}{\Delta \frac{1000}{T}} \Rightarrow \frac{-11.2+10.2}{5.92-2.92}$

$= \frac{1}{0.16}$

$= 6.25$

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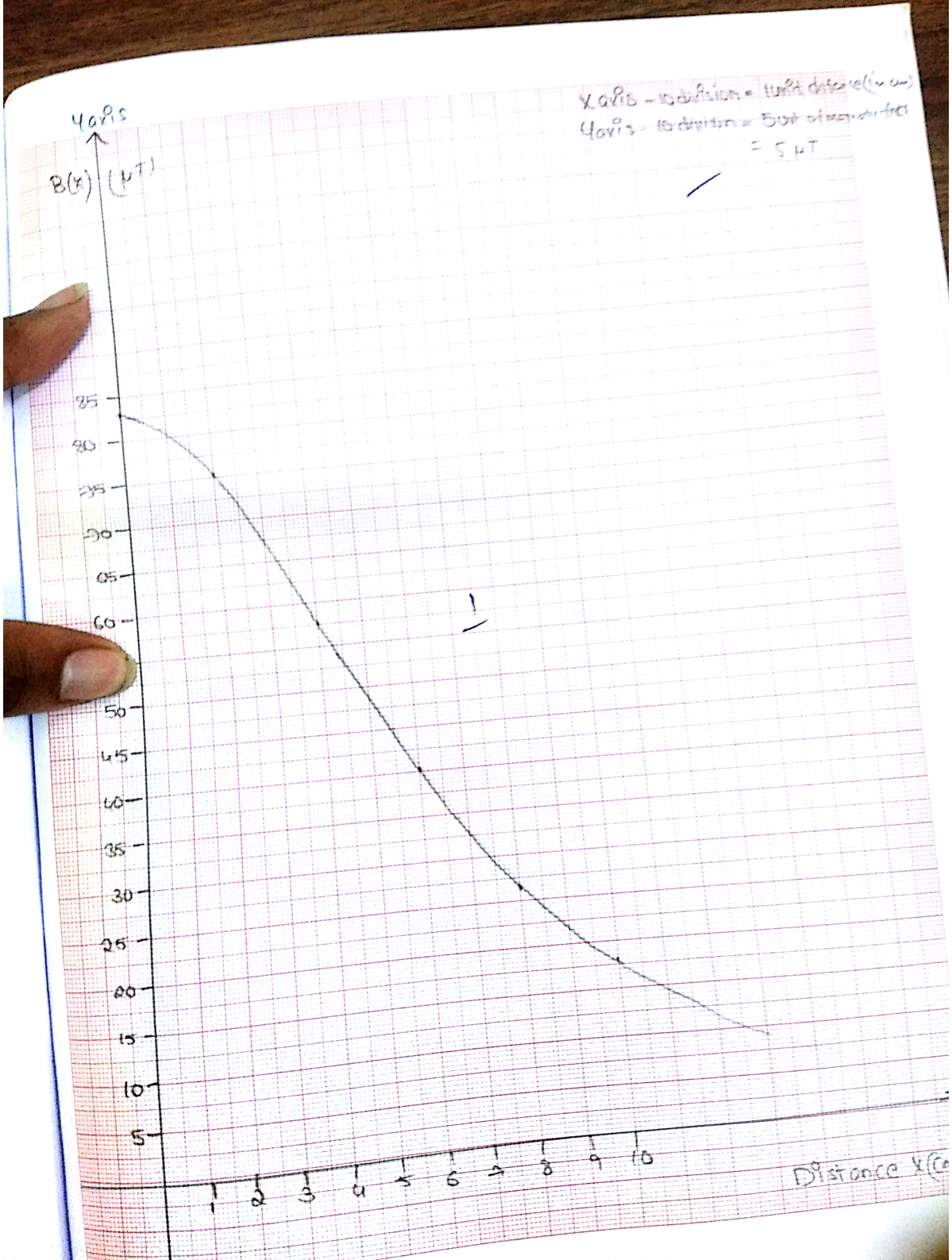


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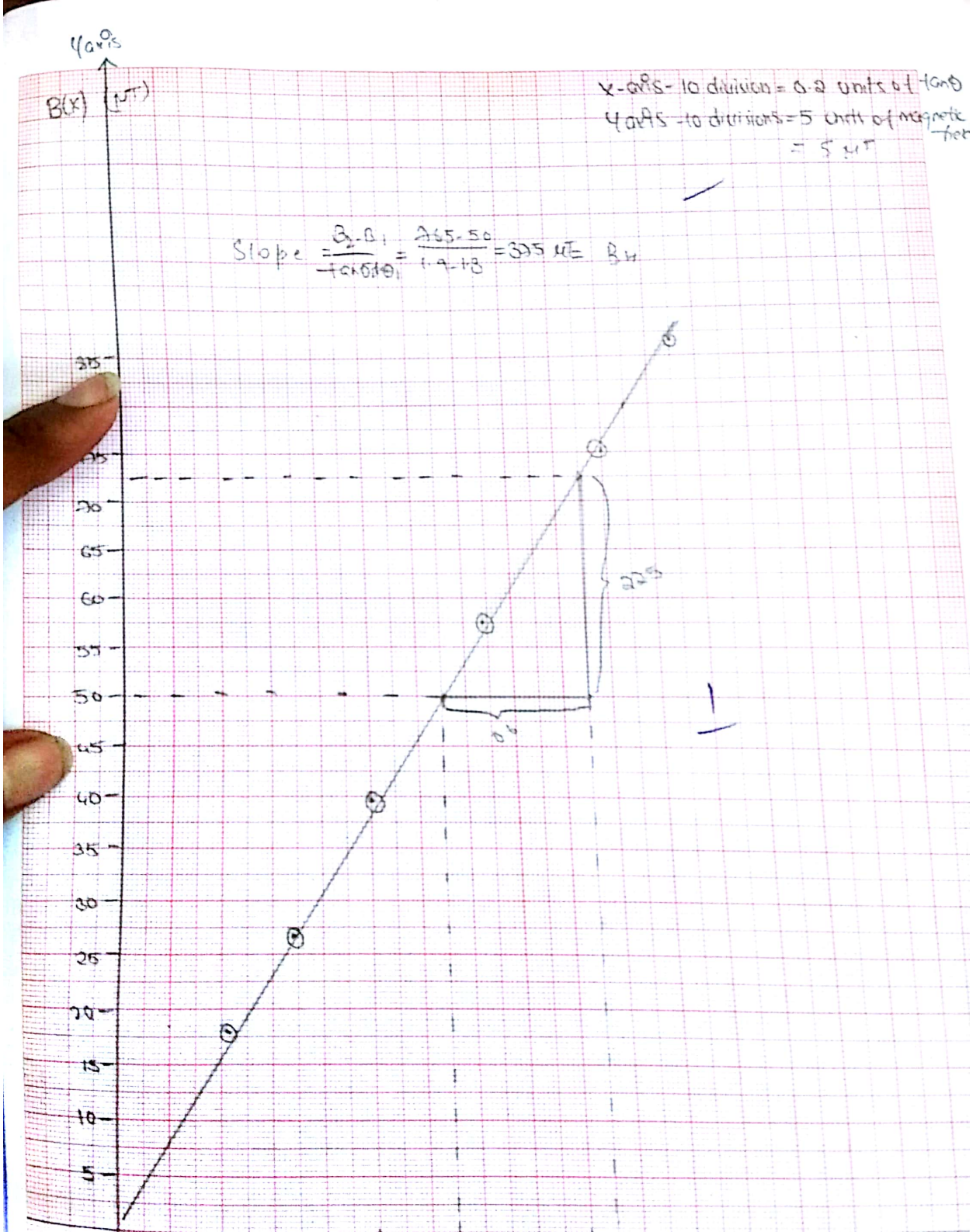


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Determination of wavelength of light by studying Newton's — From A Scale

| m | $y_m^2$ ($cm^2$) |
|---|---|
| 1 | 14.44 |
| 2 | 23.04 |
| 3 | 30.25 |
| 4. | 40.96 |
| 5. | 49 |
| 6. | 57.76 |
| 7 | 67.24 |

$$\text{Slope} = \frac{y_{m_2}^2 - y_{m_1}^2}{m_2 - m_1} = \frac{49 - 30.25}{2} = 9.375\ cm^2$$

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Determination Of Radius Of Curvature Of A plano Convex lens Using Newtons Ring Method.

From the Graph

$$\text{Slope of the graph} = \frac{D_2^2 - D_1^2}{n_2 - n_1}$$

$$= \frac{155 - 9}{7 - 4}$$

$$= \frac{6.5}{3}$$

$$= 2.16$$

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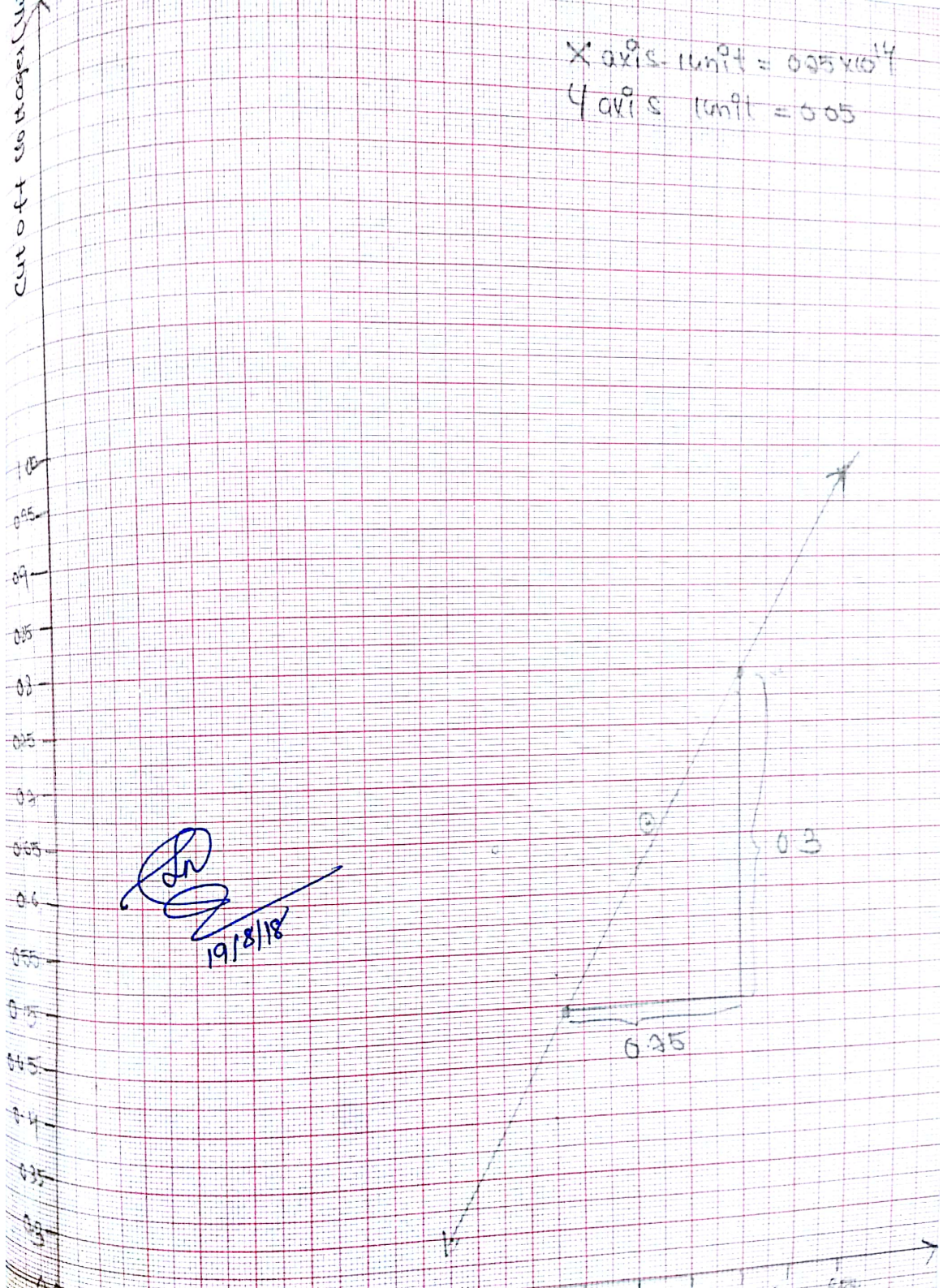


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# Clerification of planck's Constant

Slope of the graph $= \frac{(V_0)_2 - (V_0)_1}{\nu_2 - \nu_1}$

$= \frac{0.49 - 0.30}{(5.2 - 4.7) \times 10^{14}}$

$= 0.38 \times 10^{-14}$

From the equation

$V_0 = \frac{h\nu}{e} - f \quad = y = mx + c$

Slope $= h/e$

$\Rightarrow h/e = 0.38 \times 10^{-14}$

$\Rightarrow h = 0.38 \times 10^{-14} \times 1.6 \times 10^{-19}$

$\boxed{h = 6.9 \times 10^{-34}}$

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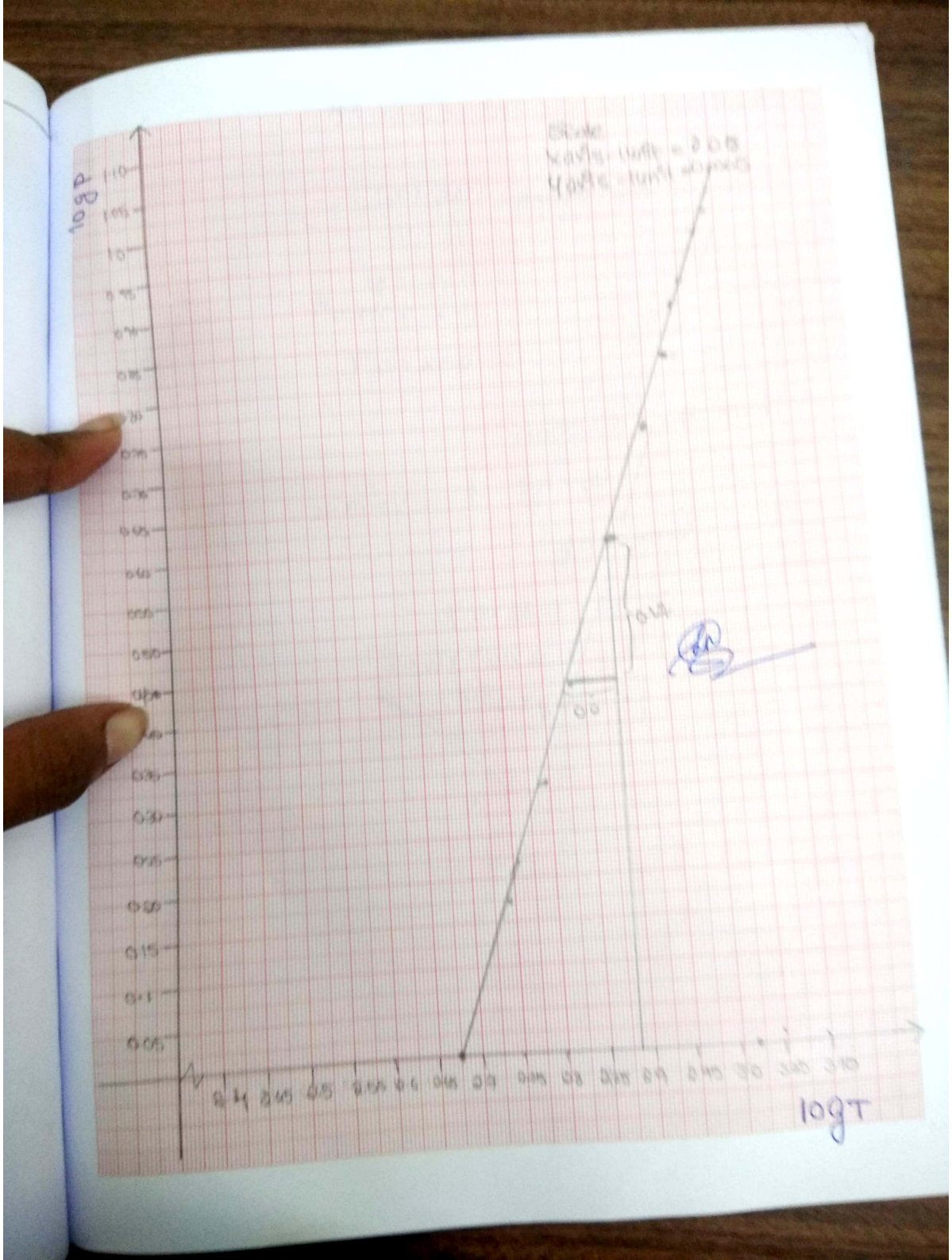


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Verification of Stephans law ~~and~~

Slope of the graph $= \frac{\log P_2 - \log P_1}{\log T_2 - \log T_1}$

$= \frac{0.75 - 0.6}{2.94 - 2.90}$

$= \frac{0.15}{0.04}$

$= 3.75 = n$

From the equation $\log P = n \log T + C$

Slope of graph $= n = 3.75$.

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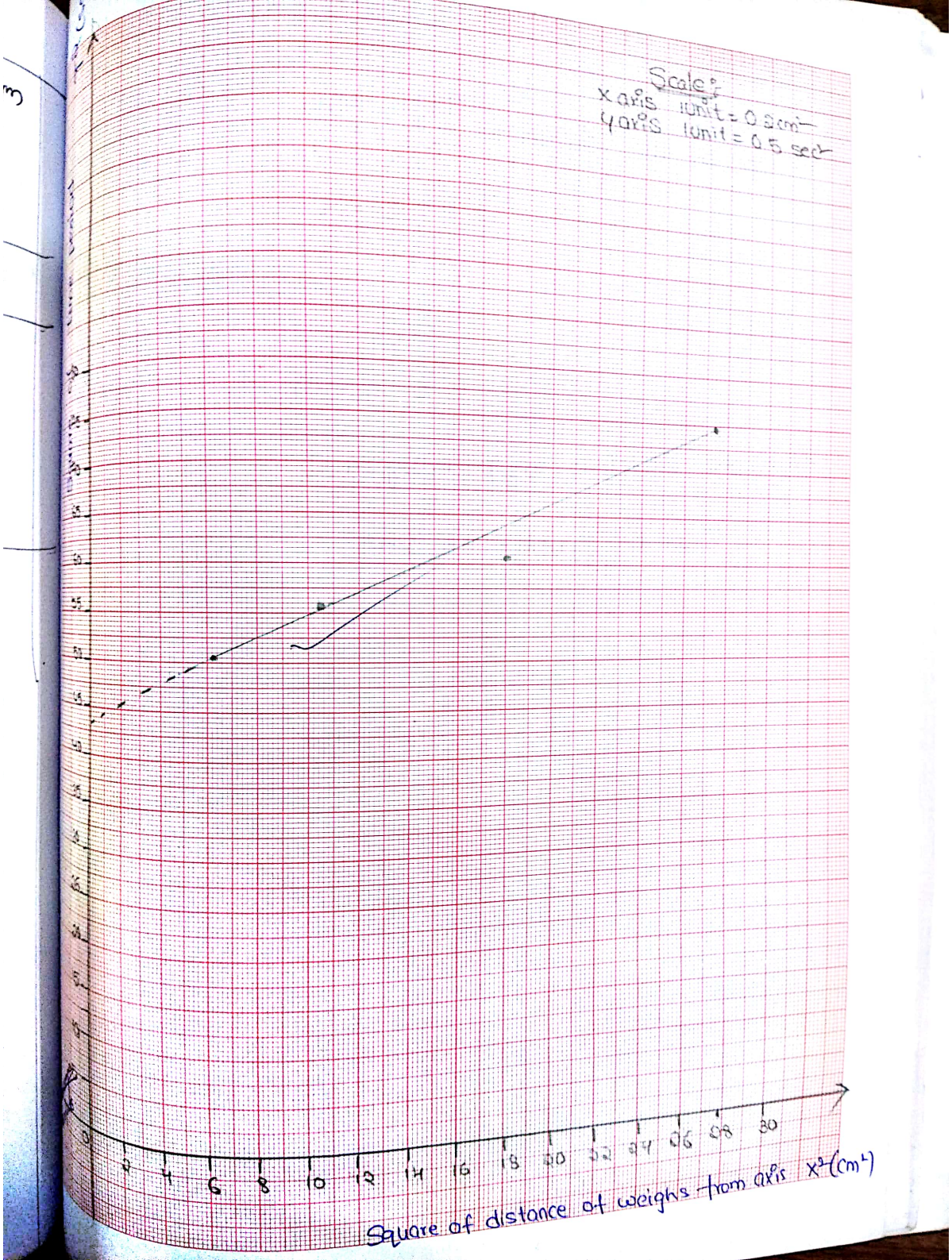


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Rigidity Modulus of Wire Using Torsional Pendulum

| Serial no | $x^2$ - Square of Distance of weight from axis | $T^2$ - Time period Square |
|---|---|---|
| 1. | 6.25 $cm^2$ | 53.29 $sec^2$ |
| 2. | 10.56 $cm^2$ | 56.25 $sec^2$ |
| 3. | 12.46 $cm^2$ | 60.84 $sec^2$ |
| 4. | 17.56 $cm^2$ | 68.9 $sec^2$ |

From the graph slope $= \frac{56.25 - 53.29}{10.56 - 6.25} = 0.68 \frac{sec^2}{cm^2}$

$$\boxed{\text{Slope} = 0.68 \times 10^4 \frac{sec^2}{m^2}}$$

From the graph by extending the line the y intercept $\boxed{T_{x_0}^2 = 43.5 \ sec^2}$

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Result:

The youngs modulus of the wood scale by the strain gauge is $1.05 \times 10^{10} \pm 0.3765 \times 10^{10}$ N/m²

24/05/18

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Result :

The youngs modulus of the wood scale by the Strain gauge is $1.05 \times 10^{10} \pm 0.3765 \times 10^{10}$ N/m²

1/12/18

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Relative Error in $y = 0.3586$

Error in $Y = 0.3586 \times y$

$= 0.3586 \times 1.05 \times 10^{10}$

$= 0.37653 \times 10^{10}$ N/m²

Discussion:-

* Here in this Experiment we find the youngs modulus of wood using instrument named Strain Gauge.

* With the help of transducer which measures any change in physical properties of the body we measure Longitudanal strain in Wooden scale.

* Here we use the ~~prin~~ wheatson bridge principle.

* As the length of wooden scale increases Resistance of the transducer also increases as $\frac{\Delta L}{L} \propto \frac{\Delta R}{R}$ hence we can find change in length of wooden scale.

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M.S.R = 6

C.S.R = 17

After Correction C.S.R = 17+20 = 37

Total Reading = 6+ 37(0.01) = 6.37 mm.

Thickness of Scale = 6.35 mm

Calculations:

$$Y = \frac{6Lg\lambda R l}{bd^2(1+R/P)(dV/m)}$$

$$= \frac{6 \times 2.511\times10^{-2} \times 19.8 \times 2 \times 120.8 \times 1.025\times10^{-3}}{2.511\times10^{-2} \times 40.3225\times10^{-6} \times \left(1+\frac{120.8}{100}\right) \times 1.3\times10^{-3}}$$

$$= 1.05\times10^{10} \ N/m^2$$

Youngs modulus of the bar = $1.05\times10^{10}$ N/m²

Error Analysis

$$\frac{\Delta y}{y} = \frac{\Delta b}{b} + 2\times\frac{\Delta d}{d} + \frac{\Delta x}{x} + \frac{\Delta y}{y}$$

$$= \frac{0.002}{2.514} + 2\times\frac{0.01}{6.35} + \frac{25}{225} + \frac{0.05}{0.3}$$

$$= 7.96\times10^{-4} + 3\times10^{-3} + 0.11 + 0.166$$

$$= 0.3586$$

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Note:

Resistance of the strain gauge = 120.8

Width Of Scale:

| M.S.R(cm) | V.S.R(mm) | T.R(cm) | Mean(cm) |
|---|---|---|---|
| 2.5 | 7 | 2.514 | |
| 2.5 | 3 | 2.506 | 2.511 |
| 2.5 | 7 | 2.514 | |

Least Count of Vernier Callipers $= 1 - \frac{49}{50} = 0.02$ mm

Main Scale reading = 2.5

Vernier Scale reading = 7

Total Reading = M.S.R + (V.S.R) L.C = (2.5 + 7(0.002)) cm

= 2.514 cm

width of scale = 2.511 cm

Thickness Of Scale:

| M.S.R(mm) | V.S.R(mm) +20 | T.R(mm) | Mean (mm) |
|---|---|---|---|
| 6 | 17+20 | 6.17+(0.2) | |
| 6 | 5+20 | 6.05+(0.2) | 6.35 |
| 6 | 23+20 | 6.23+(0.2) | |

Least Count of Screw gauge = 0.01 mm

Negative Error in Screw gauge = −(0.01) mm

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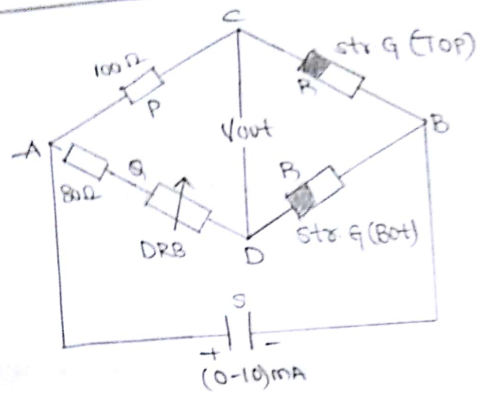


Wheatson bridge circuit diagram

$$Y = \frac{6Lg\lambda BI}{bd^2(1+R/P)(dV/m)}$$

g = Acceleration due to gravity

λ = gauge factor

I = Output current from source (S)

R = Resistance of the strain gauge

m = 50 gm

Tabulations:

| Load/g → | 0 | m | 2m | 3m | 4m | 5m |
|---|---|---|---|---|---|---|
| DMM reading (mV) ↓ | | | | | | |
| Loading ($V_1$) | 0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 |
| Unloading ($V_2$) | 0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 |
| Mean of ($V_1+V_2$) | 0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 |

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# Young's Modulus Of Wood Using A Strain Gauge

**Aim:-** To determine the young's Modulus of a wooden scale using a strain gauge

**Required Apparatus:-**

A half meter scale with two identical strain gauge fixed to one end of the scale One strain gauge at the top and the other at the bottom length wise, a clamp, a circuit board with appropriate terminals to constitute a wheatson bridge network, hanger and slotted weights, digital multimeter, Vernier ~~to constitute a~~ wheatson Callipers, Screw gauge, Decade Resistance Box(DRB) Constant current source connecting wires.

**Formulae:-**

$$Y = \frac{F/A}{\Delta L/L}$$

Y = youngs modulus of the bar.

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* While taking first Input characterstics make sure $V_{CE}$ is constant through out the readings and $I_B$ during output characteristic and $V_{CE}$ during transfer characterstic

* Donot take the fluctuating values make them stop and note the reading

Result:

Input resistance $= \frac{\Delta V_{BE}}{\Delta I_B}$ at $V_{CE}$ constant

$= 1.18 K\Omega$

Output resistance $= \frac{\Delta V_{CE}}{\Delta I_C}$ at $I_B$ constant

$= 2.4 K\Omega$

Current gain $\beta = \frac{\Delta I_C}{\Delta I_B}$ at $V_{CE}$ Constant

$= 288$

9.8/10

V.N. Sravanthi

Discussion:-

* In this Experiment we find the Input Resistance, Output Resistance and Current gain of NPN transistor.
* The Output Resistance is seem to be greater than input resistance
* The Bipolar Junction Transistor is used in amplyfying or switching applications.
* It is an three terminal device Constructed with doped semi conductor material.
* The Current gain β gives the increase in the Output Current to the given input Current.

Precautions and Source of Error:-

* Make sure that there are no loose Connections
* Increase the Input voltage knob slowly and smoothly

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Transfer characteristics:-

| SNO | $V_{CE} = 5V$ | | $V_{CE} = 10V$ | |
|---|---|---|---|---|
| | $I_B$ (μA) | $I_C$ (mA) | $I_B$ (μA) | $I_C$ (mA) |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 15 | 2.6 | 15 | 2.6 |
| 3 | 30 | 6.9 | 30 | 6.9 |
| 4 | 45 | 11.5 | 45 | 11.5 |
| 5 | 60 | 15.8 | 60 | 15.8 |
| 6 | 75 | 19.7 | 75 | 19.7 |
| 7 | 90 | 23.1 | 90 | 23.1 |
| 8 | 105 | 25.2 | 105 | 25.2 |
| 9 | 120 | 26.1 | 120 | 26.1 |
| 10 | 135 | 26.3 | 135 | 26.3 |
| 11 | 150 | 27.4 | 150 | 27.4 |

From the Graph:-

Input Resistance = 1.18 kΩ

Output Resistance = 2.4 kΩ

Current gain (β) = 288.

| | | | | |
|---|---|---|---|---|
| 16 | 0.78 | 61 | 0.78 | 61 |
| 17 | 0.80 | 69 | 0.8 | 67 |
| 18 | 0.82 | 82 | 0.82 | 83 |
| 19 | 0.84 | 10.0 | 0.84 | 104 |
| 20 | 0.86 | 13.6 | 0.86 | 144 |
| 21 | 0.88 | 19.5 | 0.88 | 229 |
| 22 | 0.90 | 28.2 | 0.90 | 396 |
| 23 | 0.91 | 190.7 | 0.92 | 682 |

b) Output Characteristics

| SNo | $I_B = 20\mu A$ | | $I_B = 40\mu A$ | |
|---|---|---|---|---|
| | $V_{CE}$ (V) | $I_C$ (mA) | $V_{CE}$ (V) | $I_C$ (mA) |
| | 0 | 0 | 0 | 0 |
| | 1 | 3.6 | 1 | 5.2 |
| | 2 | 3.8 | 2 | 9.0 |
| | 3 | 3.9 | 3 | 9.5 |
| | 4 | 4.0 | 4 | 9.7 |
| | 5 | 4.0 | 5 | 9.9 |
| | 6 | 4.2 | 6 | 10.1 |
| | 7 | 4.2 | 7 | 10.4 |
| | 8 | 4.3 | 8 | 10.2 |
| | 9 | 4.4 | 9 | 11.0 |
| | 10 | 4.5 | 10 | 11.4 |

Transf

| SNo |
|---|
| 1 |
| 2 |
| 3 |
| 4 |
| 5 |
| 6 |
| 7 |
| 8 |
| 9 |
| 10 |
| 11 |

Fro

Inp

Outp

Ou

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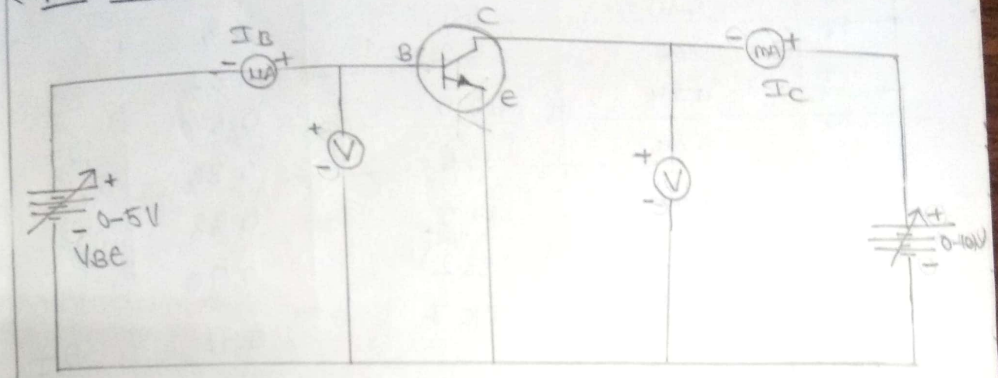
Transistor:




Input Characterstics:

| S.No | Vce = 1V | | Vce = 5V | |
|---|---|---|---|---|
| | VBE (V) | IB (μA) | VBE (V) | IB (μA) |
| 1) | 0 | 0 | 0 | 0 |
| 2) | 0.1 | +0.6 | 0.1 | 0.6 |
| 3) | 0.2 | +1.3 | 0.2 | 1.4 |
| 4) | 0.3 | 2.0 | 0.3 | 2.0 |
| 5 | 0.4 | 2.7 | 0.4 | 2.7 |
| 6. | 0.5 | 3.4 | 0.5 | 3.4 |
| 7. | 0.6 | 4.1 | 0.6 | 4.0 |
| 8 | 0.62 | 4.2 | 0.62 | 4.2 |
| 9 | 0.64 | 4.3 | 0.64 | 4.3 |
| 10 | 0.66 | 4.5 | 0.66 | 4.5 |
| 11 | 0.68 | 4.6 | 0.68 | 4.6 |
| 12 | 0.70 | 4.8 | 0.70 | 4.8 |
| 13 | 0.72 | 5.0 | 0.72 | 5.0 |
| 14 | 0.74 | 5.2 | 0.74 | 5.2 |
| 15 | 0.76 | 5.5 | 0.76 | 5.5 |

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## Aim:

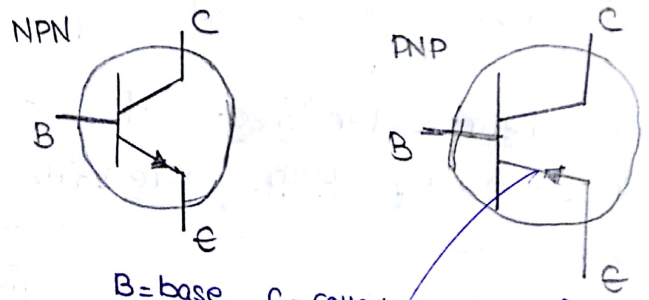
To study the input and output Characteristics of a bipolar Junction Transistor (BJT) and Calculate the input dynamic resistance from input characterstics and output dynamic resistance from output characterstics and current gain from transfer charcterstics.

## Apparatus:

Bipolar Junction Transistor (kit), Connecting wires

## Introduction:

### Transistor:




B = base C = collector E = emitter.

i) $V_{BE}$ - Base to emmitter voltage

ii) $V_{CE}$ - Collector to emitter voltage

iii) $I_B$ - Base current

iv) $I_C$ - Collector current

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too high for semiconductors it is 1-3eV

(ii) The Energy gap is called Forbidden Energy gap.

(iii) The Semiconductors of two types intrinsic and Extrinsic. intrinsic are pure and Extrinsic are doped one. The flow of current is due to electrons and holes.

(iv) These Extrinsic are divided to P-type and N-type. In P-type majority carriers are holes and in N-type majority are electrons.

Precautions:

i) Stop the oven at the 50° of the thermometer Or else the temparature reaches higher values and takes too much time to cool

ii) If the thermometer breaks donot touch the glass or mercury with bare skin.

9.8/10

24/10/18

## Discussion :

i) In this Experiment we find Energy gap of Semiconductor by using property of semiconductor ie Current increases with increase in temparature due to increase in thermal agitation in the Semiconductor.

ii) Here the semiconductor is ~~conducted~~ connected in reverse bias so that the less current is noted in semi conductor if we use forward bias large current appears for which the Equation $I_0 = [Const] e^{-\frac{E_g q}{\eta k_B T}}$ is not applicable then we can't find the energy gap of semi conductor.

iii) The Current in semiconductor increases with increase in temparature ie due to increase in thermal agitation most of electrons in conduction band gains energy and jumps to valency band

iv) The Energy gap of Semi Conductor is the Energy difference between conduction band and valency band.

v) The Energy gap between conduction band and valence band for metals is almost zero ie they overlap. For Non conductors the gap is

## Calculations:

Slope from the graph = 6.25

The Energy gap of the SemiConductor = (0.1725 × Slope) eV

$= (0.1725 \times 6.25)$

$= 1.07\ eV$

## Error Analysis:

$$\frac{\Delta E_g}{E_g} = \frac{\Delta x}{x} + \frac{\Delta y}{y}$$

$$= \frac{0.002}{0.16} + \frac{0.001}{1}$$

$$= 0.0126$$

$$\% \text{ Error} = \frac{\Delta E_g}{E_g} \times 100 = 1.26\%$$

$$\Delta E_g = 1.26\% \times \frac{1.07}{100} = 0.134 = 0.0134\ eV$$

## Result:

The Energy gap of the SemiConductor $= E_g \pm \Delta E_g$

$= \cancel{0.013}\ 1.07\ eV \pm 0.013\ eV$

This semiconductor is Si.

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The Current Reading reaches a Saturation point.
Now Note the Recording of Current for every 2° decrease in temperature.

Tabulations:

| S.No | Temperature (°C) | Temperature (K) | 1000/T | $I_0$ (μA) | $\ln I_0$ |
|---|---|---|---|---|---|
| 1. | 96° | 369 | 2.71 | 28 | -10.41 |
| | 94° | 367 | 2.72 | 25.5 | -10.57 |
| | 92° | 365 | 2.74 | 24.4 | -10.62 |
| | 90° | 363 | 2.75 | 22.8 | -10.68 |
| | 88° | 361 | 2.77 | 21.4 | -10.75 |
| | 86° | 359 | 2.79 | 19.8 | -10.83 |
| | 84° | 357 | 2.80 | 18.3 | -10.90 |
| | 82° | 355 | 2.82 | 16.6 | -11.00 |
| | 80° | 353 | 2.83 | 15 | -11.10 |
| | 78° | 351 | 2.85 | 13.6 | -11.20 |
| | 76° | 349 | 2.86 | 12.5 | -11.29 |
| | 74° | 347 | 2.88 | 11.4 | -11.38 |
| | 72° | 345 | 2.90 | 10.2 | -11.49 |
| | 70° | 343 | 2.92 | 9.0 | -11.61 |
| | 68° | 341 | 2.93 | 7.8 | -11.76 |
| | 66° | 339 | 2.95 | 7.0 | -11.86 |
| | 64° | 337 | 2.97 | 6.4 | -11.96 |
| | 62° | 335 | 2.98 | 5.7 | -12.07 |
| | 60° | 333 | 3.00 | 5.0 | -12.21 |
| | 58° | 331 | | | |

Calculations:

Slope from

The Ene

Error

$\frac{\Delta E_g}{E_g}$

% Erro

$\Delta E_g$

Result:

The

This

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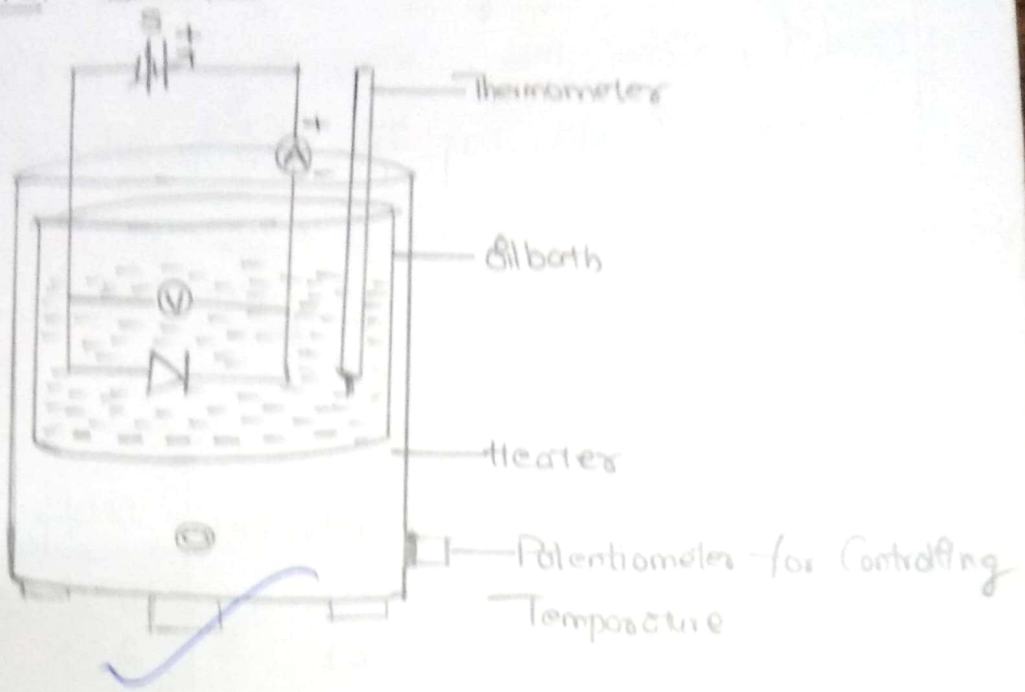
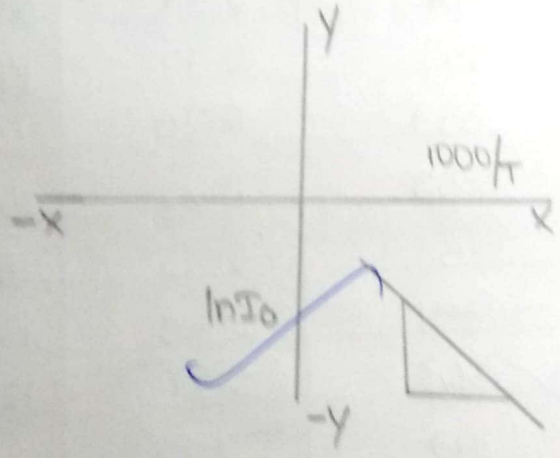
## Experimental Setup:




## Model graph: $\ln I_0$ Vs $1000/T$




## Procedure of Recording:

i) The Oven is used to heat the oil and wait till the temperature reaches 96° of oil. The temperature is checked with the help of thermometer.

ii) After the oil temperature is 96° place the semi conductor in the oil in reverse bias and wait till

Aim:

To determine the energy gap of given semiconductor

Apparatus:

A semi conductor diode, a low voltage power supply an oven to heat the semiconductor diode, an oil bath, thermometer.

Mathamatical Formulae:

$$I_0 = [Const]\, e^{-\frac{E_g q}{\eta K_B T}}$$

$$E_g = (0.1205 \times \text{slope})\, eV$$

$$\text{Slope} = \frac{\ln I_0}{1000/T}$$

where,

$I_0$ is reverse saturation current

$K_B$ is Boltzmann const $1.3806 \times 10^{-23}\, m^2 kg\, s^{-2} K^{-1}$

$E_g$ is Energy band gap in electron volts.

$\eta$ is Junction constant

$q$ is Charge of electron $(1.6 \times 10^{-19} C)$

$T$ is temperature in kelvin.

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The Error in the result may due to the

i) Deflections in current.

ii) Human error.

iii) zero error in magnetic compass.

2

Precautions:

i) Don't pass higher current through the coil

ii) If the power supply shows the overload switch the power supply and minimize your input current value or increase the load by using more number of turns.

iii) Make sure there is no magnetic material near the deflection magnetometer.

iv) Carefully connect the commutator and plug key in the circuit such a way that the current source terminal should not be shorted.

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$$\% \text{ Error} = \frac{\Delta B_H}{B_H} \times 100$$

$$= 0.05 \times 100$$

$$= 12.5\%$$

## Result:

The horizontal component of the earth's magnetic field $B_H = 33.54$ T

## Discussion:

- In the first graph i.e $B(n)$ vs $\tan\theta$ we get the straight line passing through the origin this is due to relationship between $B_H$ & $\tan\theta$ i.e $B_H = B_H \tan\theta$ in the form $y = mx$ Hence slope of graph gives $B_H$
- In the second graph $B(n)$ vs $x$ we can observe that $B(n)$ decreases with increase in the distance from centre of coil due to $B(n) \propto \frac{1}{(\text{distance})^2}$ Hence as $x$ is decreasing and graph is smooth hand curve.

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$$B(x) = \frac{\mu_0 n I a^2}{2(a^2+x^2)^{3/2}} = \frac{4\pi\times10^{-7} \times 2.67\times0.32(0.04)^2}{2\,(0.04^2+(0.02)^2\times10^{-4})^{3/2}}$$

$$= 1.8\times10^{-5} \text{ tesla}$$

Slope of graph B(x) Vs tanθ :

$$= \frac{B_2 - B_1}{\tan\theta_2 - \tan\theta_1}$$

$$= \frac{22.5-50}{9.9-9.3}$$

$$= \frac{22.5}{0.6}$$

$$= 37.5\mu = B_H$$

From the formulae $B(x) = B_H \tan\theta$

$$y = mx$$

$$\text{Slope} = B_H$$

$$\Rightarrow B_H = 37.5\mu \text{ tesla.}$$

Error Analysis :

$$\text{Error in } B_H = \frac{|\text{Exact value} - \text{Experimental}|}{\text{Exact Value}} \times 100$$

$$= \frac{42.9 - 37.5}{42.9}$$

$$= 0.125$$

0.69×10^5

Calculations:

1st Reading:

$$B(x) = \frac{\mu_0 n I a^2}{2(a^2+x^2)^{3/2}} \Rightarrow \frac{4\pi\times10^{-7}\times 20\times 0.5\times(7.48)^2\times10^{-4}}{2\left((7.43)^2+(0)^2\times10^{-4}\right)^{3/2}}$$

$$= 8.3\times10^{-5} \text{ tesla.}$$

2nd Reading:

$$B(x) = \frac{\mu_0 n I a^2}{2(a^2+x^2)^{3/2}} = \frac{4\pi\times10^{-7}\times 20\times 0.5\times(7.48)^2\times10^{-4}}{2\times\left((7.48)^2+(4)^2\times10^{-4}\right)^{3/2}}$$

$$= 7.56\times10^{-5} \text{ tesla.}$$

3rd

$$B(x) = \frac{\mu_0 n I a^2}{2(a^2+x^2)^{3/2}} = \frac{4\pi\times10^{-7}\times 20\times 0.5\times(7.43)^2}{2\times\left((7.43)^2+(4)^2\times10^{-4}\right)^{3/2}}$$

$$= 5.7\times10^{-5} \text{ tesla.}$$

4th

$$B(x) = \frac{\mu_0 n I a^2}{2(a^2+x^2)^{3/2}} = \frac{4\pi\times10^{-7}\times 20\times 0.5\times(7.43)^2}{2\times\left((7.43)^2+(6)^2\times10^{-4}\right)^{3/2}}$$

$$= 3.98\times10^{-5} \text{ tesla.}$$

5th

$$B(x) = \frac{\mu_0 n I a^2}{2(a^2+x^2)^{3/2}} = \frac{4\pi\times10^{-7}\times 20\times 0.5\times(7.48)^2}{2\times\left((7.48)^2+(8)^2\times10^{-4}\right)^{3/2}} = 2.67\times10^{-5}$$

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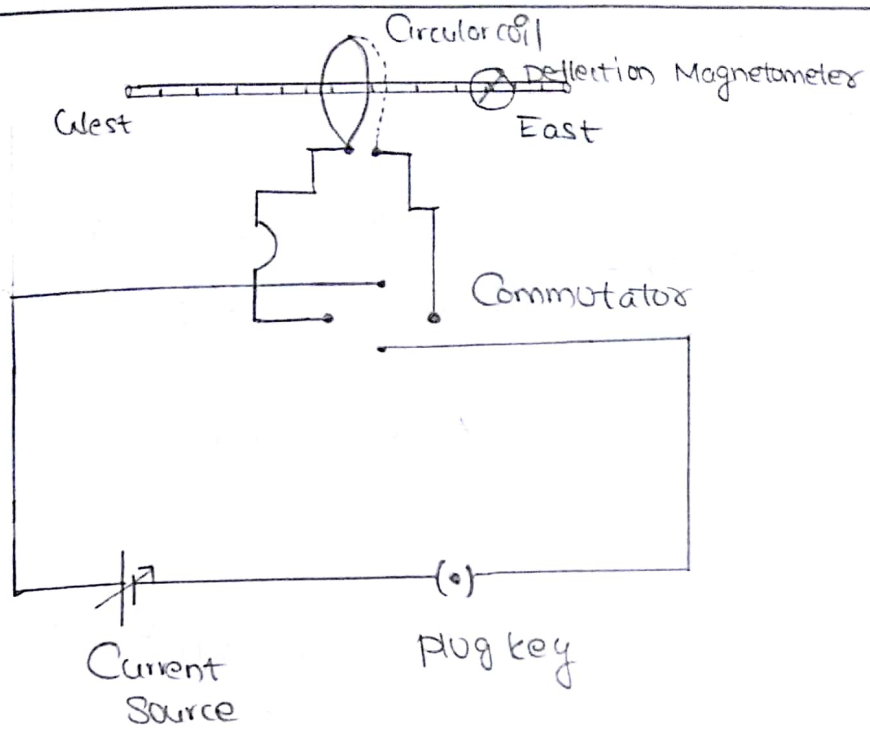
2/




Tabulations And Observations.

| S No | Distance (x) cm | Deflection (θ) degrees | | | | | Magnetic field B(x) | Tanθ |
|---|---|---|---|---|---|---|---|---|
| | | $\theta_1$ | $\theta_2$ | $\theta_3$ | $\theta_4$ | Mean θ | | |
| 1. | 0 | 68 | 69 | 65 | 65 | 66.75° | $8.3\times10^{-5}$ tesla | 2.327 |
| 2. | 2 cm | 65 | 65 | 62 | 63 | 63.75° | $7.56\times10^{-5}$ tesla | 2.02 |
| 3. | 4cm | 56° | 58° | 55° | 55° | 56 | $5.75\times10^{-5}$ tesla | 1.48 |
| 4. | 6 cm | 44° | 44° | 45° | 48° | 45.25 | $3.98\times10^{-5}$ tesla | 1.00 |
| 5. | 8 cm | 30° | 28° | 35° | 35° | 32° | $2.67\times10^{-5}$ tesla | 0.68 |
| 6 | 10cm | 22° | 25° | 25° | 23° | 23.5° | $1.8\times10^{-5}$ tesla | 0.43 |

i) No of turns of Coil n = 20 /

ii) Radius of Coil r = 7.48 cm /

iii) Current in Coil I = 0.5 amp /

iv) Magnetic permeability of the free space $\mu_0 = 4\pi\times10^{-7}$ tesla

# 8. Magnetic Field Along The Axis Of A Circular Coil

## Aim:

To measure the magnetic field along the axis of a circular coil carrying current and to calculate Horizontal component of the Earth's magnetic field

## Apparatus:

Stewart & Gee's apparatus, D.C power supply ammeter, Commutator, Plug key, Connecting wires etc.

## Mathematical Formulae:

$$B(x) = \frac{\mu_0 I r^2}{2(r^2+x^2)^{3/2}}$$

$\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$

$r$ = Radius of circular loop of wire

B in tesla $HAm^{-2}$

If n loops then

$$B(x) = \frac{\mu_0 n I r^2}{2(r^2+x^2)^{3/2}}$$

$$B(x) = B_H \tan\theta$$

$B_H$ = Horizontal Component of magnetic field.

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measurement of $\theta_0$ & $\theta_6$

Result:

The wavelength of light used for diffraction is $\lambda \pm \Delta\lambda$

648 nm ± 18.8 nm

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Percentage error = $\frac{\Delta\lambda}{\lambda} \times 100 =$ ~~35.638~~ 2.9%

~~$\Delta\lambda$ = [illegible] = 35.395 nm~~

$\Delta\lambda = 0.029 \times 648.000 = 18.792$ nm

Discussion:

* In this experiment we are able calculate the wavelength of light used by using diffraction property of light

* When the laser light incident on the division of steel scale the divisions acts as slits and they produce secondary wavelets. These secondary wavelets acts as source again and produces another wavelets. These undergo constructive and destructive interface. The constructive interface produces bright spots.

* The intensity of brightness of spots decreases as we go

Source of Error

* Parallax Error
* Human Error
* The diffraction pattern should be ~~areas~~ obtained neat and clean.

measurement

Result:

The wavel

648 nm ± 1

9.6/10

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th order
hori-
cale
the
nd the
s.
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d with
ys

70 = 85

$= \frac{52}{2} = 26$ cm

| m | $y_m^2$ cm$^2$ |
|---|---|
| -26 -8 | 14.44 |
| 4.8 | 23.04 |

| | | | | |
|---|---|---|---|---|
| 5. | m=3 | 31.5 | $y_3 = y_3 - y_0 = 31.5 - 26 = 5.5$ | 30.25 |
| 6. | m=4 | 32.4 | $y_4 = y_4 - y_0 = 32.4 - 26 = 6.4$ | 40.96 |
| 7. | m=5 | 33 | $y_5 = y_5 - y_0 = 33 - 26 = 7$ | 49 |
| 8. | m=6 | 33.6 | $y_6 = y_6 - y_0 = 33.6 - 26 = 7.6$ | 57.76 |
| 9. | m=7 | 34.2 | $y_7 = y_7 - y_0 = 34.2 - 26 = 8.2$ | 67.24 |

From the graph slope = 9.375

$$\lambda = \frac{d}{2D^2}(\text{slope}) = \frac{0.1\times10^{-2}\,(9.375)}{2\times(85\times10^{-2})^2}$$

$$= 6.48\times10^{-7}$$

$$= 648\ \text{nm}$$

Error Analysis:-

$$\lambda = \frac{d}{2D^2}\left(\frac{\Delta y_m^2}{\Delta m^2}\right)$$

$$\frac{\Delta\lambda}{d} = 2\times\frac{\Delta D}{D} + \frac{\Delta y_m}{y_m}$$

$$= \frac{2\times10^{-3}}{0.85} + \frac{0.5}{18.75}$$

$$= \cancel{0.0556} = 0.0290$$

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The distances $y_m$ of the position of mth order diffraction spot are measured from the horizontal plane (ie the plane in which the scale lies). For this purpose the position of the direct beam is marked on the screen, and the distances of the various diffraction orders.

The distance between $z_0$ between the point of incidence and screen is measured with a meterscale or measuring tape. The data is tabulated as given below.

Observations:-

Least Count of metal scale $d = 0.1$ cm

Distance between meterscale to screen $z_0 = 85$

$$y_0 = \frac{y_{0+} - (y_0)}{2} = \frac{23.7 + 28.3}{2} = \frac{52}{2} = 26 \text{ cm}$$

Tabulations:-

| Observations S.No | Order of fringes (m) | Position ($y_m$) cm | $y_M = (y_m - y_0)$ Reduced Position cm | $y_m^2$ cm$^2$ |
|---|---|---|---|---|
| 1 | Direct beam | $-y_0 = 23.7$ | | |
| 2. | m=0 | $y_0 = 28.3$ | | |
| 3. | m=1 | $y_1 = 29.8$ | $Y_1 = y_1 - y_0 = 29.8 - 26 = 3.8$ | 14.44 |
| 4. | m=2 | $y_2 =$ | | |

5.

6.

7.

8.

9.

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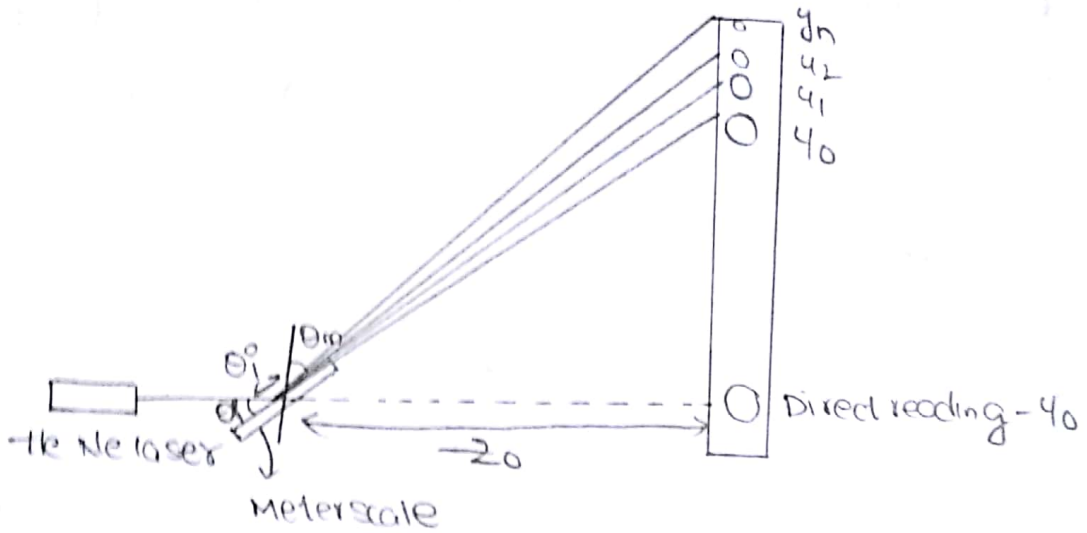


The laser beam is incident at grazing incidence on the table. The diffraction pattern is observed at large distances from the scale. This is called fraunhofer diffraction. The pattern arises due to diffraction at engraving of the scale and is governed by following equation.

$$d(\sin\theta_i - \sin\theta_m) = m\lambda$$

where d is the engraving separation, $\lambda$ is the wavelength of light, $\theta_i$ is angle of incidence and $\theta_m$ is the angle of diffraction for $m^{th}$ order. For $m=0$ the beam is specularly reflected.

## Procedure;

The metal scale is placed on the optical bench and aligned so that beam is falling at grazing incidence. Well defined diffraction pattern is observed on the screen.

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# Determination Of Wavelength Of Light By Studying Diffraction From A Scale.

## Aim:

To determine the wavelength of the light beam using diffraction from a scale.

## Apparatus

A laser source (He-Ne laser), a stainless steel scale preferably graduated in millimeters, Optic bench wooden scale.

## Theory

The diffraction grating is an array of N parallel equidistant slits.

When a beam of monochromatic light of wave length ($\lambda$) falls on a grating an intensity pattern results, consists of series of Interference fringes The angular separation of these fringes are determined by the ratio($\lambda/d$), where d is the spacing between the centres of adjacent slits. The relative intensities of the fringes are determined by diffraction pattern of single grating slit, which depends on ratio $\lambda/a$ where a is slit width.

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* If we use the normal light for experiment then we can see rings of different colours upto some extent and after that all rings overlap no rings visible.

* This is due to normal light contains different wavelengths of light and each wavelength forms their respective rings of different diametre hence these rings overlaps.

* Precautions:-

* The error occurance due to the parallax error and back lash error.

* While counting the $X_{Right}$ of 10th ~~right~~ ring start moving the microscope from the 15th ring so that the back lash error is avoided.

Result:-

The radius of curvature of plano convex lens 91 (cm) $\pm 0.015$ cm

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$\Rightarrow \frac{0.1}{6.5} + 0$

$\Rightarrow \frac{\Delta R}{R} = 0.015$

Relative error in R = $\frac{\Delta R}{R} = 0.015$

Percentage error in R = $\frac{\Delta R}{R} \times 100 = 0.015 \times 100 = 1.5\%$

Discussion:-

* In this experiment we are calculating the radius of curvature of ~~light~~ convex lens using interferance property of light.
* Interferance is the superposition of light rays in coherance i.e of same phase difference between light rays.
* Here in the experiment the rays are reflected from glass plate surface and newton rings due to constructive and destructive interferance of light.
* Dark fringes due to destructive interferance and Bright fringes due to constructive interferance.
* If we use monochromatic light of another wavelength the diameter of rings varies accordingly so that Radius of curvature not changes.

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Diameter = $X_{Right} - X_{left}$

Calculation:-

We know that = Radius of curvature = $\frac{D_{m+m}^2 - D_m^2}{4\lambda n}$

$$\Rightarrow \frac{\text{Slope}}{4\lambda}$$

$$\text{Slope} = \frac{D_{m+m}^2 - D_m^2}{n}$$

From the graph slope = 2.16 $mm^2$

$\lambda$ = wavelength of light used = 589.3 nm

Hence Radius of Curvature of plano convex lens

$$= \frac{\text{Slope}}{4\lambda} = \frac{2.16\ mm^2}{4 \times 589.3\ nm}$$

$$= 0.91\ m$$

$$= 91\ cm$$

Error Analysis:-

$$R = \frac{\text{slope}}{4\lambda} \Rightarrow \frac{\Delta R}{R} = \frac{\Delta x}{x} + \frac{\Delta y}{y}$$

$$\Rightarrow \frac{\Delta R}{R} = \frac{\Delta D^2}{D^2} + \frac{\Delta n}{n}$$

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## Formulae:

$$R = \frac{D_{n+m}^2 - D_m^2}{4\lambda n}$$

R = Radius of curvature of Convex lens

$\lambda$ = wavelength of light used

n = nth ring

$D_{n+m}$ = Diameter of $(n+m)^{th}$ Ring

$D_m$ = Diameter of $m^{th}$ Ring

## Data collection - Tabulations:

| Order Of Ring | X left | X Right | Diameter | (Diameter)$^2$ $d^2$ |
|---|---|---|---|---|
| 1 | 38.9 | 40.5 | 1.4 | 1.96 |
| 2 | 38.62 | 40.83 | 2.21 | 4.88 |
| 3 | 38.39 | 41.05 | 2.64 | 6.96 |
| 4 | 38.19 | 41.23 | 3.04 | 11.22 |
| 5 | 38.04 | 41.39 | 3.35 | 13.32 |
| 6 | 37.9 | 41.55 | 3.65 | 15.60 |
| 7 | 37.74 | 41.69 | 3.95 | 17.80 |
| 8 | 37.6 | 41.82 | 4.22 | 17.80 |
| 9 | 37.47 | 41.93 | 4.46 | 19.8 |
| 10 | 37.37 | 42.04 | 4.67 | 21.80 |

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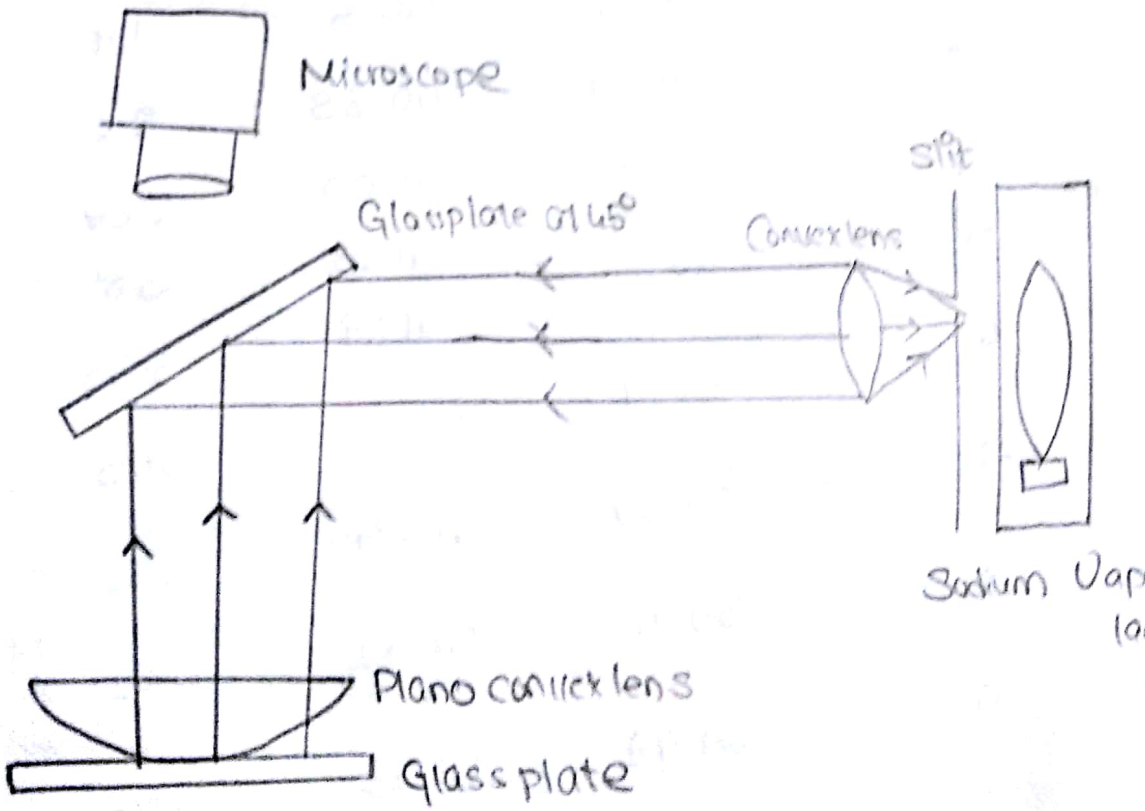
# Determination Of The Radius Of Curvature Of A Plano Convex Lens Using Newton's Rings Method

## Aim:

To determine the radius of curvature of the plano convex lens by forming Newton's rings method.

## Apparatus:

Plano-convex lens of focal length, glass plate, mono chromatic light source and travelling microscope.

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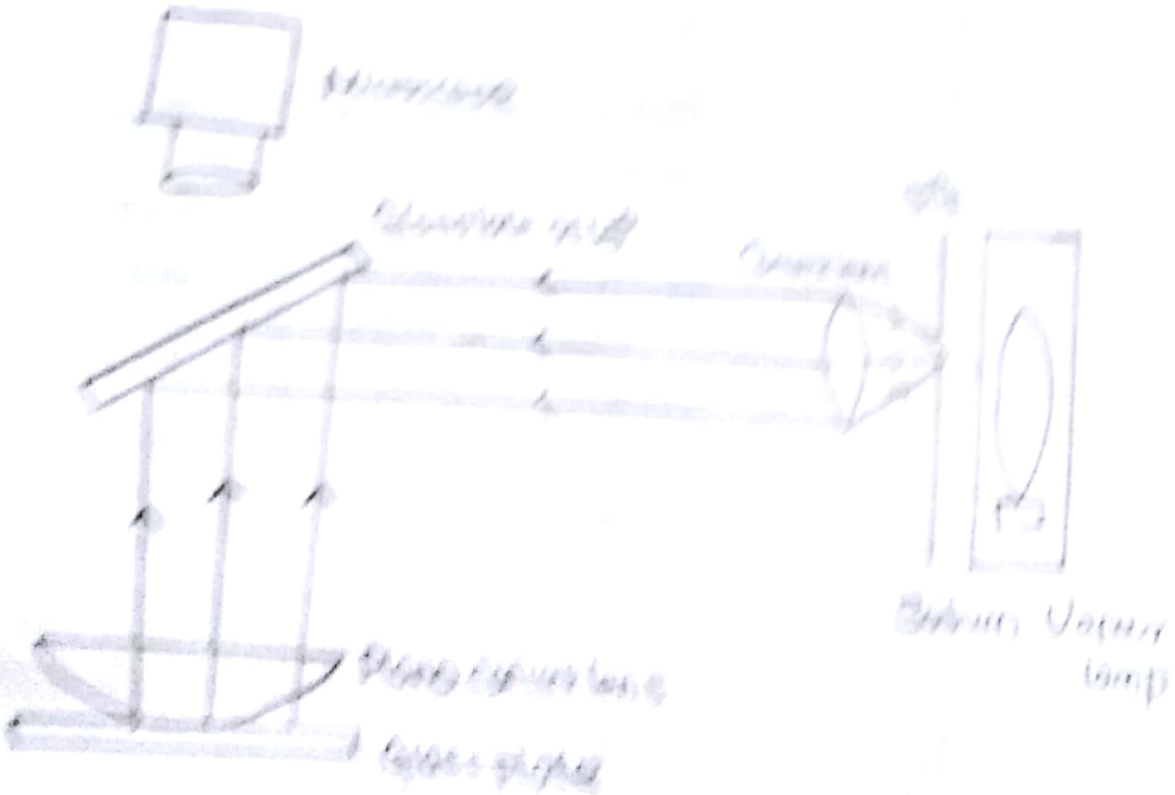
# Determination of the Radius of Curvature of a Plano Convex lens using Newton's Ring Method

## Aim

To determine the radius of curvature of the plano convex lens by finding Newton's Ring method

## Apparatus

Plano convex lens of focal length, glass plate, monochromatic light source and travelling microscope



* The height of prism table must be adjusted to the collimator and telescope

* Note down the readings carefully. Don't interchange the vernier-1, Vernier-2 readings

Result:

1. Angle of Prism = 59°. 30'34"
2. The refractive index of the material of a given prism (μ) = 1.66

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Deviation (i.e $L_i = L_e$) when the slit light just moves in opposite direction.

* Here for the reference we have taken yellow light as it is a mean of all wavelengths of colours in VIBGYOR.

* The Refractive index of prism changes with the refrence colour taken.

~~Sources Of Error~~;

* We can see different colours in prism due to the different wavelengths of colours the deviation of colours are different hence they are separated and visible

* The angle of deviation first decreases till we reach the Angle of minimum deviation and if we move further the Angle of deviation increases again.

## Sources Of Error:

* The error may occur due to the uncleaned smooth surfaces.

* The focuss of telescope may not done prope

* Parallax Errors during the measurement.

* Least Count Error of measuring device.

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## Error Calculation:

$$du = \frac{du}{dD_m} dD_m$$

$$\Rightarrow du = \frac{\cos\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} \cdot \frac{1}{2} (dD_m)$$

$dD_m$ = least Count = $20''$

$$= \frac{\cos\left(\frac{35^\circ 20' 20'' + 40^\circ 20' 20''}{2}\right)}{\sin\left(\frac{35^\circ 20' 20''}{2}\right)} \cdot \frac{1}{2} \times \frac{20''}{60 \times 60 \times 180/\pi}$$

$du = 3.4 \times 10^{-5}$

Relative Error in $\mu$

$$= \frac{du}{\mu}$$

$$= 3.4 \times 10^{-5}$$

$$\% \text{ Error} = \frac{du}{\mu} \times 100$$

$$= 3.4 \times 10^{-3} \%$$

## Discussion:

1) Calith the help of Experiment we use the to find the refractive Index of prism with the help of Spectrometre and angle of prism

2) We use this to find the angle of minimum

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Mean $= \frac{A+A}{2} = \frac{60^\circ 0' 48'' + 59^\circ 0' 20''}{2}$

$$\boxed{A = 59^\circ 30' 34''}$$

## Minimum Deviation:-

$D_M = \theta_{1Dir} - \theta_{1ref}$

$= 270^\circ 10' - 220^\circ 10'$

$= 50^\circ$

$D_M = \theta_{2Dir} - \theta_{2ref}$

$= 90^\circ 6' 36'' - 40^\circ 10'$

$= 49^\circ 56' 24''$

$= 49^\circ 56' 24''$

$$\boxed{\text{Mean } D_M = 49^\circ 28' 12''}$$

## Refractive Index of the material of the prism

$$\mu = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin(A/2)}$$

$$= \frac{\sin\left(\frac{59^\circ 30' 34'' + 49^\circ 28' 12''}{2}\right)}{\sin\left(\frac{59^\circ 30' 34''}{2}\right)}$$

$$= \frac{0.814}{0.49}$$

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Vernier-2

M.S.R = 220°

V.S.R = 5

Total Reading = M.S.R + (V.S.R) · L.C

= 220° + 5 · 20''

= 220° 16'

= 220° 1' 36''

Face-2

Vernier-1

M.S.R = 280

V.S.R = 5

Total Reading = 280 + 5 × 20''

= 280 · 16'

= 280° 1' 36''

Vernier-2

M.S.R = 100

V.S.R = 60

Total Reading = 100° + 60 × 20''

= 100° . 20'

$$A = \frac{\theta_1 - \theta_2}{2} = \frac{400° 3' 18'' - 280° 1' 36''}{2}$$

$$= 60° . 0' . 48''$$

$$A = \frac{\theta_1 - \theta_2}{2} = \frac{220° 1' 36'' - 100° . 20'}{2}$$

$$= 59° . 0' . 20''$$

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| Prism Angle A | | Angle of Minimum Deviation D | |
|---|---|---|---|
| Observer 1 | Observer 2 | Observer 1 | Observer 2 |
| $\theta_2 = 270^\circ 0' 30''$ Face 2 | $\theta_4 = 100^\circ 30'$ Face 4 | $\theta_1 = 240^\circ 0'$ Reported | $\theta_3 = 90^\circ 0' 30''$ Reported |
| $A_1 = \frac{\theta_1 - \theta_2}{2} = 60^\circ 29' 45''$ | $A_2 = \frac{\theta_3 - \theta_4}{2} = 59^\circ 29' 30''$ | Minimum deviation $D_{m1} = \theta_{min1} - \theta_{ref} = 30^\circ$ | $D_{m2} = \theta_{min2} - \theta_{ref} = 59^\circ 30' 30''$ |
| Mean $A = 59^\circ 30' 30''$ | | Mean $D_m = 44^\circ 29' 45''$ | |

Calculations:-

Refractive index of the material of prism is

$$\boxed{\mu = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}}$$

Table-1:-

Observer-1

MSR = $40^\circ + 30^\circ$

CSR = 10

Total Reading = MSR + (CSR) LC

$= (40^\circ + 30^\circ) + 10 \times 30''$

$= 400^\circ 30''$

$= 400^\circ 3' 18''$

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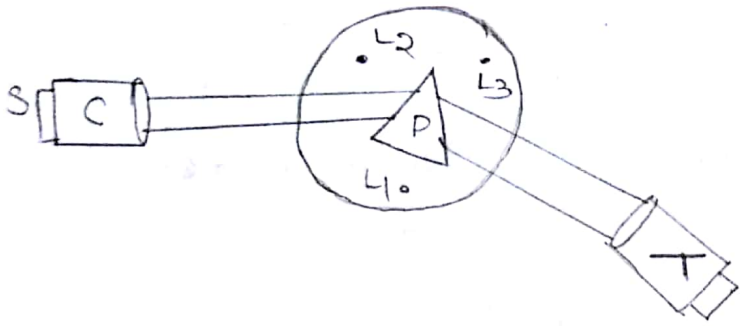


Adjustment of Spectrometer for Observing dipresion of light.

## Least Count of Spectrometer:

One main Scale division (N) = 20 minute

Number of divisons on Vernier (V) = 60

L.C of = $\frac{N}{V}$ = 20 Sec.

## Tabulations:-

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# 5. Refractive Index Of A Prism Using Spectrometer

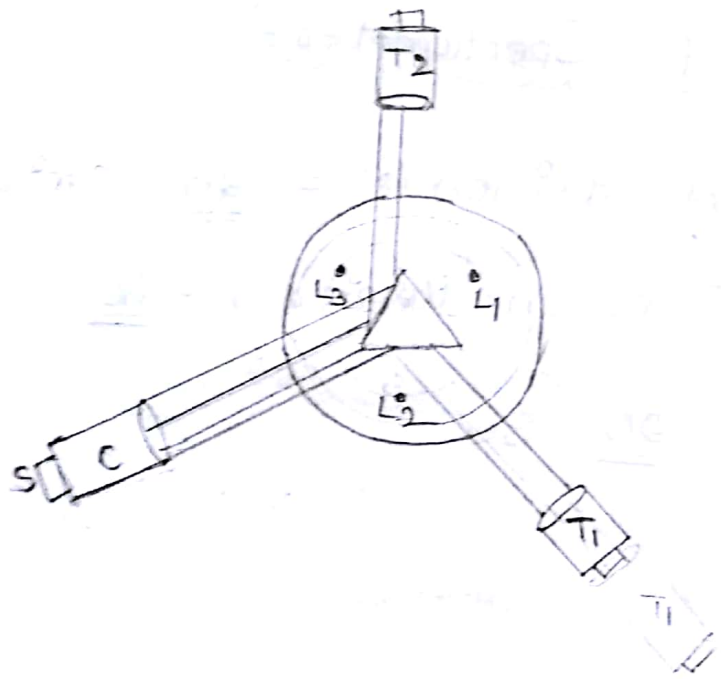
**Aim:-**

To determine the refractive index of the material of a given prism using a spectrometer.

**Apparatus:-**

Spectrometer, Spirit level, glassprism, mercury vapour lamp, reading lens, reading light

**Diagrams:-**




S- Source

T- Telescope

C- Collimator.

**Adjustments of Spectrometer for measuring angle of prism.**

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## Measurement of the phase difference:

| SNo | Frequency (Hz) | R(Ω) | C(μf) | tan ϕ | ϕ Calculated | A | B | Sin ϕ | ϕ Measured |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 2500 | 1KΩ | 0.1 | 0.6369 | 32.4 | 85.39 | | 0.615 | 37.9 |
| 2 | 2600 | 1kΩ | 0.1 | 0.612 | 31.46 | 54 | 32 | 0.59 | 36.15 |
| 3 | 3000 | 1kΩ | 0.1 | 0.53 | 27.9 | 56 | 3 | 0.53 | 32.00 |

## Group Discussion:-

* In this experiment we come to know some of properties of sine, square, Triangular waves with the help of CRO. we have also calculated $V_{rms}$ with CRO and with DMM. These $V_{rms}$ values vary for CRO and DMM because DMM is only designed to measure sin function.
* we have also drawn Lissajous pattern by keeping simple ratio we havent gone for high ratio because the patterns become more complex. The patterns are continuosly moving because of CRO.
* In 3rd experiment we cannot get measurement for lower frequency as the ellipse is so much disorted. we can get good result after H.F of 2500

1.8 +
3 +
4.5 +
9.3/10

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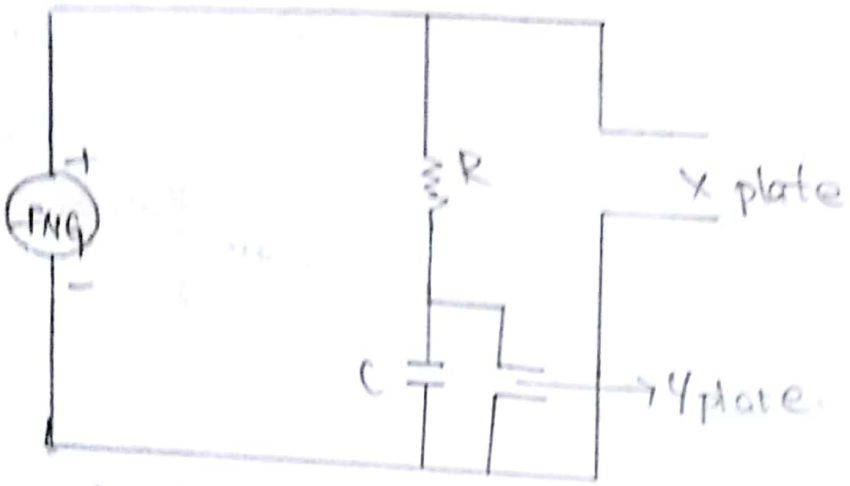
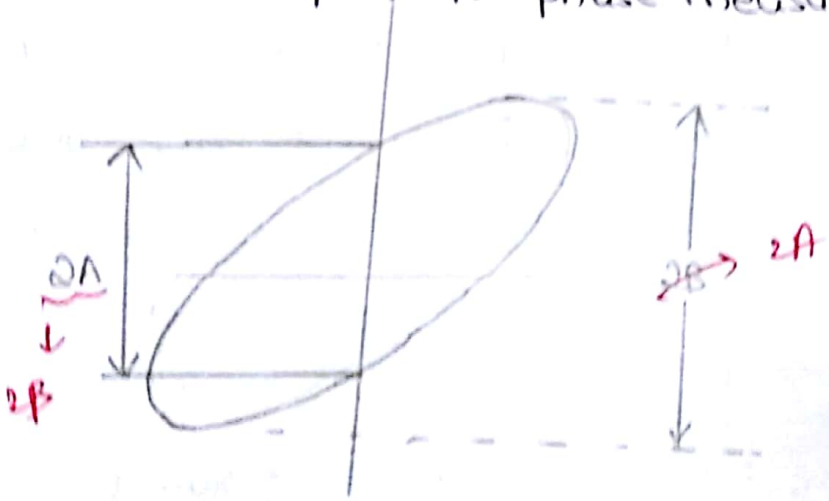
Phase measurement using C.R.O :-

Circuit Diagram :-




Circuit diagram for phase measurement.




Phase Diagram.

Formulae :-

* $\tan\phi = \frac{1}{\omega CR}$ $(\omega = 2\pi f)$

$\sin\phi = B/A$ where f = frequency

ω = Angular frequency

C = Capacitance

R = Resistance

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| S.No | FNS,1 | FNS,2 | Figure (Dimensionless figure) | Ratio |
|---|---|---|---|---|
| 1 | 1000 | 1000 | | 1:1 |
| 2 | 1000 | 2000 | | 1:2 |
| 3 | 2000 | 2000 | | 2:1 |
| 4 | 2000 | 2000 | | 2:2 |

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The voltage sensitivity is read from the knob position of CH-1 (Y) in V/div.

For sine wave $V_{rms} = V_p/\sqrt{2}$

For Triangular wave

$$\therefore V_{rms} = \frac{V_p}{\sqrt{3}}$$

For SQUARE waves

$$\therefore V_{rms} = V_p$$

Table-1 Measurement of AC voltages

| SNo | Shape of the wave | Not divisons | $V_p$ | $V_{rms}$ (C.R.O) | $V_{RMS}$ (DMM) |
|---|---|---|---|---|---|
| 1 | Sine | 5.2 (2) | 5.2 | 3.67 | 3.99 |
| 2 | | 4 (5) | 10 | 7.07 | 7.80 |
| 1 | Square | 4.6 (2) | 4.6 | 4.6 | 5.96 |
| 2 | | 3.6 (5) | 9 | 9 | 11.66 |
| 1 | Triangle. | 4.6 (2) | 4.6 | 2.65 | 2.89 |
| 2 | | 3.6 (5) | 9 | 5.19 | 5.40 |

Lissajous pattern and superposition principle.

Measurement of frequency using Lisajous patterns.

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# Super Position Principle Using Cathode Ray Oscillioscope

(C.R.O)

Aim:-

To study the voltage measurements, wave shapes, Lissajous patterns and phase measurement using a C.R.O

Apparatus:

A Cathode ray oscillioscope, function generators, BNC (Bayonet Neill- Concelman) Connectors, R-C networks arrangement for phase measurement

Measurement of A.C Voltages of different wave-forms:-

1. The magnitude of the line is proportional to the peak to peak voltage of the applied wave ($V_{pp}$). Calculate the peak voltage of the Sinusoid using formulae.

$$V_p = \frac{\text{Number of divisions} \times \text{Voltage sensitivity}}{2}$$

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## Discussion:

In this Experiment we find the planck's constant 'h' by plotting graph b/w the cutoff voltage and frequency of light that falls on the planck's constant measuring instrument. The Error is due to the unusual radiation on the instrument and may be of not cleaned filters.

## Error Analysis:

$$\frac{\Delta h}{h} = \frac{\Delta x}{x} + \frac{\Delta y}{y}$$

$$= \frac{0.005}{0.35} + \frac{0.005}{0.5}$$

$$= 0.049$$

4.9%

$$\frac{\Delta h}{h} \times 100 = 4.9\%$$

$$\Delta h = 0.049 \times 6.2 \times 10^{-34}$$

$$= 0.303 \times 10^{-34}$$

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$$h = 6.2 \times 10^{-34}\ J\,s$$

**Error Analysis:-**

we got planck's constant $h = 6.2 \times 10^{-34}$ but actually it is $6.6 \times 10^{-34}\ J \cdot s$

$$\text{Error \%} = \frac{6.6 \times 10^{-34} - 6.2 \times 10^{-34}}{6.6 \times 10^{-34}} \times 100$$

$$= \frac{0.4}{6.6} \times 100$$

$$= 6\%$$

$$\Delta h = 0.4 \times 10^{-34}$$

% Error in $h = 6\%$

**Precautions:-**

* Make sure that no other radiation fall on planck's constant measuring instrument.
* keep the filter free from dust.

**Result:-**

The planck's constant $h = (6.2 \times 10^{-34} \pm 0.3 \times 10^{-34})\ J\,s$

$h = h \pm \Delta h$

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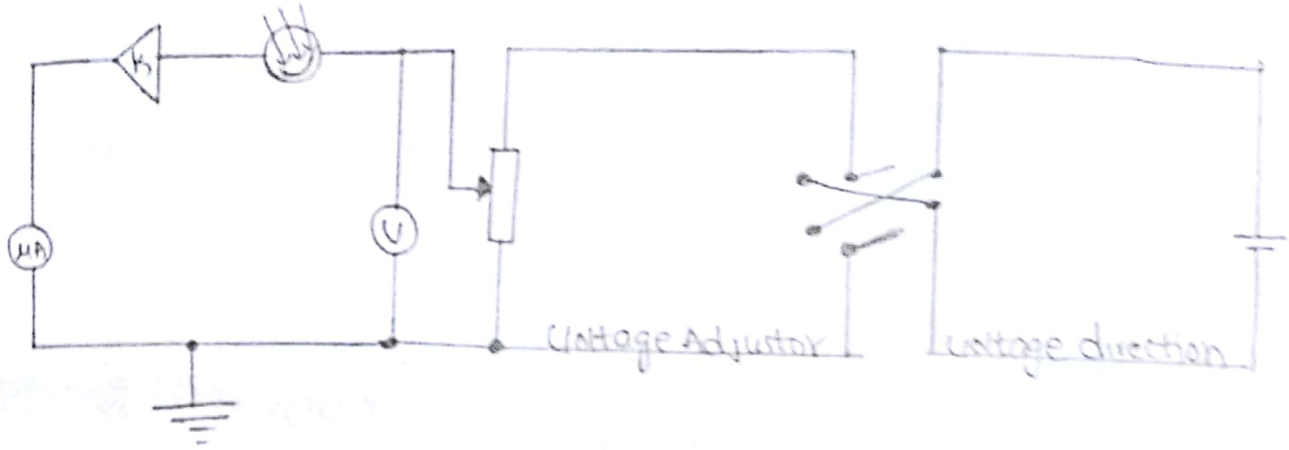
## Circuit Diagram:-




## Tabular Form:-

Distance of source = 20cm

| SNo | ~~Voltage~~ wavelength of colour filter (λ) nm | Frequency $(\nu = \frac{c}{\lambda})$ Hz | Cutoff Voltage ($V_0$) Volts |
|---|---|---|---|
| 1 | 465 nm | $6.49 \times 10^{14}$ | −0.96 |
| 2 | 500 nm | $6 \times 10^{14}$ | −0.77 |
| 3 | 540 nm | $5.5 \times 10^{14}$ | −0.66 |
| 4 | 575 nm | $5.2 \times 10^{14}$ | −0.49 |
| 5 | 635 nm | $4.7 \times 10^{14}$ | −0.30 |

## Calculation:-

Frequency $= c/\lambda = \frac{3 \times 10^8}{465 \times 10^{-9}} = 6.4 \times 10^{14}$ Hz

From the graph we get the slope $= h/e = 0.38 \times 10^{-14}$

$\Rightarrow h = 0.38 \times 10^{-14} \times 1.6 \times 10^{-19}$

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Formulae:

$$\boxed{E = h\nu}$$

$E$ = energy of electromagnetic field
$h$ = Planck's Constant
$\nu$ = frequency of Radiation.

Also $\boxed{h\nu = \frac{1}{2} mv^2 + ef}$

$h$ = planck's Constant
$\nu$ = frequency of Radiation
$m$ = mass of electron
$v$ = velocity of electron
$e$ = Charge of electron
$f$ = work function.

The kinetic energy of the emmited electron can be calculated by retarding potential technique if $V_0$ is the potential then the kinetic energy of electron given by

$$E_e = \frac{1}{2} mv^2 = eV_0 \text{ and}$$

$$\boxed{V_0 = \frac{h\nu}{e} - f}$$

$V_0$ = cutoff voltage | $h$ = planck's Contant
$\nu$ = frequency | $e$ = charge of electron

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B) Verification of Planck's Constant

Aim:

To determine the planck's constant

Apparatus:

Photo Sensitive Device, Light source, Tungsten lamp 12V/35

Color filters: 635 nm, 570nm, 540 nm, 500 nm, 460 nm

Regulated Voltage Power Supply, Digital ammeter.

Explanation:

Most of the metals emit electrons under the influence of radiation. This phenomenon was termed as photoelectric emmission.

1. The emission process depends strongly on frequency of radiation.
2. For each metal there exists a critical frequency such that light of lower frequency is unable to liberate electrons, while light of higher frequency always does
3. number of electrons emmited is proportional to intensity of this radiation.

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$= 0.1294$

$\frac{\Delta n}{n} = 0.1294$

Percentage error $= 12.94\%$

$\Delta n = 0.1294 \times 3.75$

$= 0.45$

~~Power~~

9.8/10

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From the graph n = 3.5 but actually it is 4

$$\text{Error \%} = \frac{4-3.5}{4} \times 100$$

$$= 6.25\% = \frac{\Delta n}{n} \times 100 \Rightarrow \Delta n = 0.25$$

Error % in n = 6.25%

## Discussion:-

In the Experiment we get power radiated by a body is directly proportional to $T^{3.95}$ but it is actually $T^4$. The error is due to the loose connections and may due to lack of accurate measurement.

## Result:-

The power radiated by a black body is directly proportional to $T^{3.95}$

$$\boxed{n = 3.95 \pm 0.25} = n \pm \Delta n$$

## Error Analysis:-

$$\frac{\Delta n}{n} = \frac{\Delta x}{x} + \frac{\Delta y}{y}$$

$$= \frac{0.005}{0.05} + \frac{0.0005}{0.12}$$

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | 3 | 0.9 | 3.33 | 2.7 | 689 | 0.43 | 2.83 |
| 7 | 3.5 | 0.96 | 3.64 | 3.36 | 748 | 0.52 | 2.87 |
| 8 | 4 | 1.01 | 3.96 | 3.99 | 809 | 0.6 | 2.90 |
| 9. | 4.5 | 1.08 | 4.16 | 4.86 | 847 | 0.68 | 2.92 |
| 10. | 5.0 | 1.14 | 4.38 | 5.7 | 890 | 0.75 | 2.94 |
| 11. | 5.5 | 1.19 | 4.32 | 6.54 | 924 | 0.81 | 2.98 |
| 12. | 6 | 1.24 | 4.83 | 7.44 | 976 | 0.87 | 2.99 |
| 13 | 6.5 | 1.29 | 5.03 | 8.38 | 1014.3 | 0.92 | 3.00 |
| 14. | 7 | 1.34 | 5.22 | 9.38 | 1050 | 0.97 | 3.02 |
| 15. | 7.5 | 1.39 | 5.39 | 10.05 | 1083 | 1.00 | 3.03 |
| 16. | 8 | 1.44 | 5.55 | 11.52 | 1113 | 1.06 | 3.04 |

## Calculation:-

i) $R_t = R_0(1+\alpha t)$ $\Rightarrow 1.72 = 1.16(1+0.0045[t])$

$\Rightarrow t = 107^\circ C$

$t_K = 107 + 273 = 380 K$

$R = \frac{V}{I} = \frac{1}{0.58} = 1.72$

Power $= VI = 1 \times 0.58 = 0.58$

## Error Analysis:-

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(ii) Calculate corresponding power.

Formulae

(i) $R_T = R_0(1+\alpha T)$

$R_0$ Resistance of filament at 0°C

$R_T$ Resistance at temparature T

$\alpha$ - temparature coefficient of Resistance

$P = (Const)T^n$

$\log P = \log(Const) + n \log T$

$y = c + mx$

## Precautions :-

1. Donot increase the voltage beyond 10V
2. Reduce the voltage to zero after the reading are taken and switch off the kit

## Tabulation :-

| SNO | Voltage(V) | Current(I) | Resistance $R = \frac{V}{I}(\Omega)$ | Power $P = VI$ | temp (K) | logP | logT |
|---|---|---|---|---|---|---|---|
| 1 | 05 | 0.43 | 1.16 | 0.215 | 273 | -0.66 | 2.4 |
| 2 | 1 | ~~3.86~~ 0.58 | 1.72 | 0.58 | 380 | -0.23 | 2.57 |
| 3 | 1.5 | 0.67 | 2.23 | 1.005 | 478 | 0 | 2.67 |
| 4 | 2 | 0.75 | 2.66 | 1.5 | 560 | 0.18 | 2.74 |
| 5 | 2.5 | 0.83 | 3.01 | 2.07 | 627 | 0.31 | 2.79 |

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Circuit diagrams :

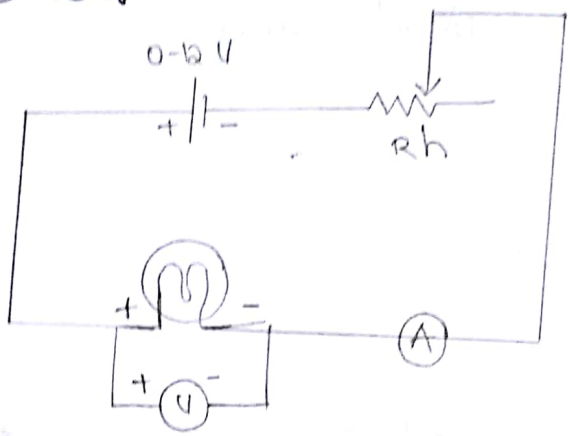


fig 3.1. Circuit diagram for verification of Stephan's law.

Procedure :

i) Make the connections of circuit diagram as shown in fig 3.1

ii) Switch on the DC source adjust voltage, so that the voltmeter (V) reads 0.5 V. Read out corresponding current (I) through the bulb and record the voltage and current in tabular column.

iii) Calculate resistance of filament $\left(\frac{V}{I}\right)$ and use it as $R_0$

iv) Now increase voltage by 1V and find the corresponding current (Max 10V)

v) Calculate resistance of filament for various readings taken as step iv

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# Verification Of Stephan's Law And Planck's Constant

## (A) Verification of Stephan's Law.

**Aim:**

To verify the stephan's Law.

**Apparatus:**

A kit comprising of a DC voltage source and meters to measure voltage and current through a circuit

**Introduction:**

The rate of heat loss to the surroundings depends on the temparature of the body as well as the area of the body. It is also known that the rate of loss of heat is given by the stephan's law

$$\boxed{P = Ae\sigma T^4}$$

where

e is the emmisivity of the surface of the radiating body

$\sigma$ is Stephan's Constant

A is area of the radiating surface

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Please write values with pen
Answer 31/09/2018

## Result:-

The rigidity modulus of wire is = $3.2 \pm 1.056 \times 10^{9}$ N/m²

9.5/10

Also write discussion about experiment in 2 to 3 lines

## Group Discussion:-

This experiment is done with the torisional pendulum to determine the Rigidity modulus of a wire. Here we should give small angular displacements to torisional pendulum so that the result is accurate.

* The Error of the Experiment can be reduced by taking more number of reading.
* Donot the disturb the system while counting the time period of Oscillations.
* Whilte taking the reading of diametre of wire first see the error in screw gauge.
* Make sure that pendulum makes only rotational oscillations.

9.7/10

19/09/2018.

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$$\boxed{\eta = 32 \times 10^{10} \ N/m^2}$$

## Error Calculation:-

$$\frac{\Delta\eta}{\eta} = \frac{\Delta l}{l} + \frac{\Delta c}{c} + 4\frac{\Delta r}{r}$$

$$\Rightarrow \frac{0.001}{0.43} + \frac{\Delta c}{c} + 4 \times \frac{0.01}{0.33}$$

$$c = 8\pi^2 m_s\left(\frac{\Delta x^2}{\Delta T^2}\right) \Rightarrow \frac{8\pi^2 m_s}{\text{slope}} \Rightarrow \frac{k_s}{y/x} \Rightarrow$$

$$\frac{\Delta c}{c} = \frac{\Delta y}{y} + \frac{\Delta x}{x}$$

$$= \frac{0.5}{2.96} + \frac{0.2}{4.31}$$

$$\frac{\Delta\eta}{\eta} = 0.33 \Rightarrow \Delta\eta = 0.33 \times 3.2 \times 10^{10} \Rightarrow 1.056 \times 10^{10} \ N/m^2$$

$$\Rightarrow \boxed{\Delta\eta = 1.056 \times 10^{10} \ N/m^2}$$

## Precautions:

i) The Suspension wire should be free from kinks

ii) The disc should be horizontal always

iii) Solid weights must be identical

iv) Oscillations should be purely rotational

v) The wire should not be twisted beyond elastic lim

vi) The time period should be noted carefully taking average of about ten periods.

vii) Make sure that angular displacements are small.

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Caluculation of Couple per unit twist of suspension wire (C):-

formulae:-

$$C = 8\pi^2 m_s \left(\frac{\Delta x^2}{\Delta T^2}\right)$$

$m_s$ = mass of weight suspended on disc = 0.2 kg

$\frac{\Delta T^2}{\Delta x^2}$ = slope of graph between $T^2$ and $x^2$ = $0.68 \times 10^4 \frac{sec}{m^2}$

$$C = \frac{8 \times (3.14)^2 \times 0.2 \times}{0.68 \times 10^4} = 23.19 \times 10^{-4} \frac{kgm^2}{sec^2}$$

* Determination of $I_0$ and $I_s$:-

$I_0$ = moment of inertia of larger disc = $2 m_s x^2 \frac{T_0^2}{T_x^2 - T_{x0}^2}$

$$= \frac{2 m_s T_0^2}{slope}$$

$$= \frac{2 \times 0.2 \times (6.6)^2}{0.68 \times 10^4}$$

$$\boxed{I_0 = 25.7 \times 10^{-4}\ kgm^2}$$

$$I_s = m_s x^2 \frac{T_{x0}^2 - T_0^2}{T_x^2 - T_{x0}^2} = m_s \frac{T_{x0}^2 - T_0^2}{slope}$$

$$\boxed{I_s = 0.24 \times 10^{-4}\ kgm^2}$$

Calculation of Rigidity modulus:-

$$C = \frac{\pi \eta r^4}{2l} \Rightarrow \eta = \frac{2lC}{\pi r^4} \Rightarrow \frac{2 \times 43.5 \times 23.19 \times 10^{-4} \times 10^2}{3.14 \times (0.33 \times 10^{-3})^4}$$

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$$T_0 = \frac{t_{01} + t_{02} + t_3}{3}$$

$$= \frac{6.6 + 6.7 + 6.7}{3}$$

$$\boxed{T_0 = 6.6 \text{ sec}}$$

## Measurement and tabulation:-

| Distance of weight from axis of twist (cm) | $x^2$ in ($cm^2$) | No. of oscillations (n) | Time taken t (in sec) | Period T = t/n (sec) | $T^2$ ($sec^2$) |
|---|---|---|---|---|---|
| $x_1$ = 2.5 cm | 6.25 $cm^2$ | 10 | 73 | 7.3 | 53.29 |
| $x_2$ = 3.25 cm | 10.56 $cm^2$ | 10 | 75 | 7.5 | 56.25 |
| $x_3$ = 4.25 cm | 18.06 $cm^2$ | 10 | 78 | 7.8 | 60.84 |
| $x_4$ = 5.25 cm | 27.56 $cm^2$ | 10 | 83 | 8.3 | 68.90 |

## Determination of Radius of wire:-

| | P.S.R | H.S.R | zero error | Corrected H.S.R | PSR + (HSR ± ze) |
|---|---|---|---|---|---|
| | 0 | 60 | −6 | 66 | 0 + (60+6) 0.01 mm = 0.66 mm |
| | 0 | 61 | −6 | 67 | 0 + (61+6) 0.01 mm = 0.67 mm |
| | 0 | 60 | −6 | 66 | 0 + (60+6) 0.01 mm = 0.66 mm |

$$\text{Least Count} = \frac{\text{Pitch}}{\text{No. division on H.S}} = \frac{1}{100} = 0.01 \text{ mm}$$

Average diametre of wire = 0.663 mm

Average Radius = 0.33 mm

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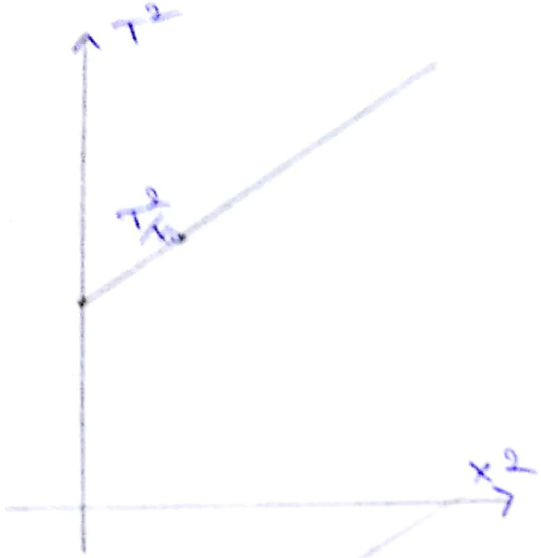
Graph b/w $T^2$ and $x^2$

model graph:




$$C = 8\pi^2 m_s \left[\frac{\Delta x^2}{\Delta T^2}\right]$$

Determination of $I_0$ and $I_s$:

$$I_0 = 2m_s x^2 \frac{T_0^2}{T_x^2 - T_{x0}^2} = \frac{2m_s T_0^2}{\text{slope}}$$

$$I_s = m_s x^2 \frac{T_{x0}^2 - T_0^2}{T_x^2 - T_{x0}^2} = m_s \frac{T_{x0}^2 - T_0^2}{\text{slope}}$$

Observations:

1) Mass of each identical added weight $m_s$ = 0.2 kg
2) Time period of disc with no masses $T_0$ = 6.6 sec
3) y intercept from $T_{x0}^2$ = 4.35 $sec^2$
4) The length of the wire = 43 cm

Calculation of $T_0$:

| No. of Oscillation | Time taken (t) (sec) | Period $T = t/n$ (sec) |
|---|---|---|
| 10 | 66 | $\frac{66}{10} = 6.6$ (t1) |
| 10 | 67 | $\frac{67}{10} = 6.7$ (t2) |
| 10 | 67 | 67 [illegible] |

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# Rigidity Modulus Of A Wire Using Torsional Pendulum

## Aim:

To determine the rigidity modulus of wire using a torisional pendulum.

## Requirements:-

Circular disc, metal wire, two similar weights, a stop watch, meter scale, screw gauge.

## Formulae:-

$$T = 2\pi\sqrt{\frac{I_{total}}{C}} = 2\pi\sqrt{\frac{I_0 + 2I_s + 2m_s x^2}{C}}$$

where

$I_0$ = moment of Inertia of larger disc

$I_s$ = moment of Inertia of ~~disc~~ weights about an axis passing through their own centre of mass parallel to its length.

$m_s$ = mass of each solid cylinder

$x$ = Distance of each weight from axis of suspension

$C$ = Torsional rigidity of suspension wire.

Squaring equation we get

$$T^2 = \frac{4\pi^2}{C}[I_0 + 2I_s + 2m_s x^2]$$

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$$(f_s)_x = (-\mu_k M g)$$

$$\Rightarrow -f_{sx} + \underbrace{f_{bx}}_{0} = \frac{\partial}{\partial t}\int_{CV} \underbrace{\rho u_x}_{0}\, dV + \int_{CS} \rho \vec{u}_x (\vec{u}_{rel} \cdot d\vec{A})$$

$$- \int_{CS} \rho u_{rel} \cdot dA \rightarrow 0$$

$$\Rightarrow -\mu_k M g = \rho (V-u)(V-u)(0.005)\frac{\cos\pi}{(-1)} \quad \text{(opp. direction)}$$

$$\Rightarrow (V-u)^2 = \frac{\mu_k M g}{\rho A_{rea}}$$

$$\Rightarrow V-u = \pm\sqrt{\frac{0.3 \times 30 \times 9.8}{999 \times 0.005}}$$

We should only (+) because velocity of vane cannot be greather than velocity of liquid

$$\Rightarrow V-u = \sqrt{17.65} = 4.20$$

$$\Rightarrow u = V - 4.20210 \Rightarrow 20 - 4.20210$$

$$\Rightarrow 15.7978 \text{ m/s toward right}$$

Terminal velocity of vane = 15.7978 m/s

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- Area of cross section = 0.005 $m^2$
- Mass of vane (m) = 30 kg
- Coefficient of kinetic friction $\mu_k = 0.3$

**To find**

Terminal speed of vane

**Assumption**

i) Flow is steady
ii) Uniform
iii) non deformable CV
iv) Vertical forces are balanced as no displacement in vertical direction
v) no incompressible liquid
vi) Finally the terminal velocity is constant.

**Governing Equation :-**

$$-F_s + F_B - \int_{CV} \vec{a}_{rel}\, dm = \frac{d}{dt}\int_{CV} (\rho u_x\, d\forall) + \int_{CS} \rho u_x (\vec{V}\cdot\vec{dA})$$

$u_x$ = Velocity of fluid with respect to vane

**Solution**

$\therefore a_{rel} = \frac{du}{dt} = 0$ as u constant

$\frac{d}{dt}\int_{CV} \rho u_x\, d\forall = 0$ (Steady flow)

$F_{Bx} = 0$ No Body force along x axis

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$f = \mu_k M g$

## Given:

Crane moves under the influe
as shown.

$\rho$ = density of liquid = 999 kg/m³

Velocity of liquid $u$ = 20 m/s

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