RESHMA. A
I Sem. BE

ENGINEERING PHYSICS

Neha. A
II Sem BE

Practical Manual
cum
Observation Book

Rs : 55

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CALCULATION OF LEAST COUNT FOR VARIOUS MEASURING INSTRUMENTS :

1. Vernier calipers :

$$L.C = \frac{\text{Value of 1MSD}}{\text{No,of divisions on vernier scale}}$$

Value of 1 MSD $= \frac{1}{10}$ cm $= 0.1$ cm

No. of divisions on vernier scale = 10

$\therefore$ L.C $= \frac{0.1}{10}$ cm.

$\therefore$ **L.C = 0.01 cm**

$\frac{1}{10} = 0.1$ cm.

L.C $= \frac{0.1}{10} = 0.01$

(Alternate method)

L.C = Value of 1 MSD – Value of 1 VSD

Value of 1 MSD $= \frac{1}{10}$ cm

10 Vernier scale divisions = 9 MSD

$\therefore$ 1 VSD $= \frac{9}{10}$ MSD $= \frac{9}{10} \times \frac{1}{10} = \frac{9}{100}$ cm

L.C = 1MSD – 1VSD

$= \frac{1}{10}$ cm $- \frac{9}{100}$ cm

L.C $= \frac{10-9}{100} = \frac{1}{100}$ cm

$\therefore$ **L.C = 0.01 cm**

2. Screw gauge :

$$L.C = \frac{\text{Pitch}}{\text{No.of divisions on head scale}}$$

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{No.of rotations given to the head scale}}$$

No.of rotations given to the screw head = 4

Distance moved on pitch scale = 4mm

No. of divisions on head scale = 100

$$\text{Pitch} = \frac{\text{Distance moved}}{\text{No. of rotations given}} = \frac{4mm}{4} = 1mm$$

$$L.C = \frac{\text{Pitch}}{\text{No.of divisions on head scale}} = \frac{1mm}{100}$$

$\therefore$ **L.C = 0.01 mm**

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3. **Travelling microscope :**

$$L.C = \frac{\text{Value of 1MSD}}{\text{No.of divisions on vernier scale}}$$

Value of 1 MSD $= \frac{1\text{ cm}}{20} = 0.05$ cm

No. of divisions on vernier scale = 50.

$$L.C = \frac{0.05\text{cm}}{50} \qquad \therefore \text{ L.C} = 0.001\text{cm.}$$

(Alternate method)

$$L.C = \text{Value of 1MSD} - \text{Value of 1VSD}$$

$\frac{1}{50}$ $\frac{0.05}{50}$ $= 0.001$cm

Value of 1 MSD $= \frac{1}{20}$ cm

$\frac{1\text{cm}}{20}$

50 vernier scale divisions = 49 MSD

$$\therefore \text{1VSD} = \frac{49}{50}\text{ MSD} = \frac{49}{50} \times \frac{1}{20} = \frac{49}{1000}\text{ cm}$$

$\frac{1}{20} = \frac{0.05}{50.}$

$= 0.001$

L.C = 1 MSD − 1VSD

$$= \frac{1}{20} - \frac{49}{1000} = \frac{50-49}{1000} = \frac{1\text{ cm}}{1000}$$

$\therefore$ **L.C = 0.001cm.**

4. **Spectrometer :**

$$L.C = \frac{\text{Value of 1MSD}}{\text{No.of divisions on vernier scale}}$$

Value of 1MSD $= \frac{10^\circ}{20} = \frac{1^\circ}{2} = 30$ minutes.

Number of vernier scale divisions = 30

$$L.C = \frac{30\text{ minutes}}{30} \qquad \therefore \text{ L.C} = 1\text{ minute } (1')$$

(Alternate method)

L.C = Value of 1 MSD − Value of 1 VSD.

Value of 1MSD $= \frac{10^\circ}{20} = \frac{1^\circ}{2}$

30 vernier scale divisions = 29 MSD

$$\therefore 1\text{ VSD} = \frac{29}{30}\text{ MSD} = \frac{29}{30} \times \frac{1^\circ}{2} = \frac{29^\circ}{60}$$

$$L.C = 1\text{ MSD} - 1\text{ VSD} = \frac{1^\circ}{2} - \frac{29^\circ}{60}$$

$$L.C = \frac{30^\circ - 29^\circ}{60} = \frac{1^\circ}{60} = \frac{60'}{60}$$

$\therefore$ **L.C = 1'**

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Part B

Aim : To dertermine the width of the given single slit.

Apparatus : Single slit, He-Ne laser, screen

Formula : The width of the single slit is given by $d = \frac{n\lambda}{\sin\theta}$ m

where, n = order of the fringe (n=1,for 1st order)

λ = wavelength of the laser light = 6328 Å

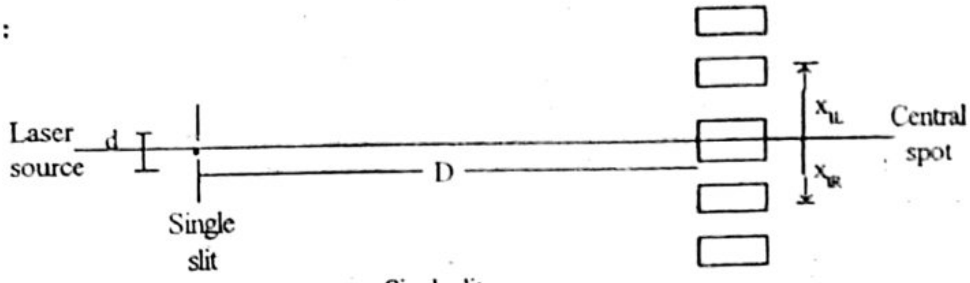
$$\sin\theta = \frac{x}{\sqrt{D^2 + x^2}}$$

where x = distance between central spot and 1st dark fringe, m

D = distance between the slit and the screen, m

Principle : When laser light is made to fall on the single slit which form coherent sources, alternate bright and dark fringes are formed due to constructive and destructive interference.

Figure :



Single slit

Procedure : Replace the double slit by single slit and adjust the position of single slit to obtain the diffraction pattern as shown in the figure.

The position of the first maxima, both on the right and left side of the central spot is noted and the mean distance of the first maxima from the central spot is calculated. Sine of the angle of deviation is calculated using the formula ,

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

Then the width of the given single slit is calculated using the formula,

$$d = \frac{n\lambda}{\sin\theta}$$

Observartions : D = ...

x_{1R} = ... x_{1L} = ...

$$x_1 = \frac{x_{1L} + x_{1R}}{2}$$

Result : The width of the given slit (single slit) is found to be_______________.

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Part C

Aim : To determine the grating constant of the given student grating.

Apparatus : He-Ne laser, student grating, screen.

Formula : The grating constant of the student grating is given by,

$$C = \frac{n\lambda}{\sin\theta} \ \text{m}$$

where

n = order of the fringe (n=1, for 1st order)
λ = wavelength of the laser light = 6328 Å

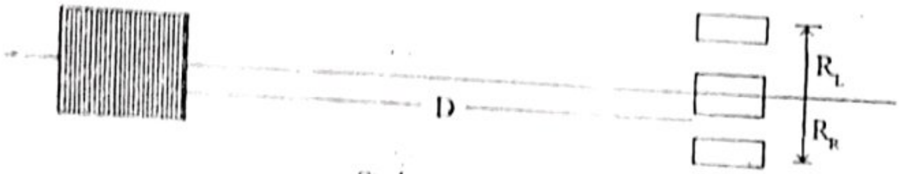
$$\sin\theta = \frac{x}{\sqrt{D^2 + x^2}}$$

where

x = distance between central spot and 1st dark fringe, m
D = distance between the slit and the screen, m

Principle : When laser light is passed through the given student grating, alternate bright and dark fringes are formed due to interference such that a large central spot and smaller bright fringes are formed on either side as shown in the figure.

Figure :



StudentGrating

Procedure: The single slit is replaced by the given student grating to obtain diffraction pattern. The readings corresponding to the first order maxima on the left side, RL and the right side RR is noted and the mean distance of the first maxima from the central spot is calculated. Then, knowing the wavelength of the laser and sine of the angle of deviation, the grating constant of the given student grating is calculated using the formula,

$$C = \frac{n\lambda}{\sin\theta}$$

Observations :

Trial no.	D in m	R_L in m	R_R in m	$x = \frac{R_L + R_R}{2}$ in m	$\sin\theta = \frac{x}{\sqrt{D^2 + x^2}}$
1	8.3 cm	5.5 cm	5.5 cm		
[illegible]	[illegible]	6.3	8.4		
3	10	8.5	[illegible]		

$(\sin\theta)_{mean}$ =...............

Result : The grating constant of the given student grating is found to be __________.

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5.1

DENSITY OF GLASS

AIM : TO DETERMINE THE DENSITY OF THE MATERIAL OF THE CAPILLARY TUBE USING A TRAVELLING MICROSCOPE.

APPARATUS : Capillary tube, travelling microscope, stand, physical balance etc.,

FORMULA : The density of the material of the capillary tube is given by

$$\rho = \frac{M}{\pi (R^2 - r^2) L} \ \text{kg/m}^3$$

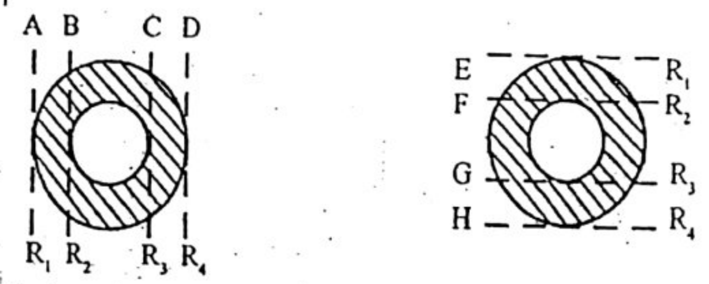
where M = Mass of the capillary tube, kg

R = External radius of the capillary tube, m

r = Internal radius of the capillary tube, m

L = Length of the capillary tube, m

FIGURE :



Horizontal Traverse   Vertical Traverse

PROCEDURE : The given capillary tube is placed horizontally on a stand and is kept in position by means of wax. The travelling microscope is focussed on the capillary tube such that the image of the cross-section of the tube is clearly seen. The microscope is adjusted such that the vertical crosswire is tangential to the cross-section of the capillary tube at the point A and the reading R_1 is taken on the horizontal scale. Similarly the readings R_2, R_3 and R_4 corresponding to the points B, C and D are taken on the horizontal scale. The travelling microscope is then adjusted for vertical traverse and the readings R_1,R_2,R_3 and R_4 corresponding to the points E,F,G and H are taken on the vertical scale. The readings are tabulated and the mean external and internal radius of the capillary tube is calculated.

The length L of the capillary tube is measured by coinciding the point of intersection of the cross wires with the ends of the tube. The

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mass M of the capillary tube is determined using a physical balance. The density of the material of the capillary tube is then calculated using the formula

$$\rho = \frac{M}{\pi (R^2 - r^2) L}$$

OBSERVATIONS :

Least count of the travelling microscope : $\frac{1}{20}$

Value of one main scale division = ------- cm

No. of vernier scale divisions = ---50---------

$$L.C. = \frac{\text{Value of 1 M.S.D.}}{\text{Total number of V.S.D.}} = \text{---0.001---} \text{ cm}$$

To determine external radius R and internal radius r :

Position of TM	TM Readings in cm	External diameter $D = R_4 \sim R_1$ in cm	Internal diameter $d = R_3 \sim R_2$ in cm	External Radius $R = D/2$ in cm	Internal Radius $r = d/2$ in cm
Horizontal Traverse	R_1 = [illegible] R_2 = [illegible] R_3 = [illegible] R_4 = [illegible]	[illegible]	[illegible]		
Vertical Traverse	R_1 = [illegible] R_2 = [illegible] R_3 = [illegible] R_4 = [illegible]	[illegible]	[illegible]		

R_{mean}= .... cm r_{mean}=.......cm

R = [illegible]----x10^{-2}m r =-----x10^{-2}m

To determine length L of the tube :

Trial No.	Reading at one end of the tube 'a' in cm	Reading at the other end of the tube 'b' in cm	Length of the tube L = a ~ b in cm

Mean Length L = [illegible]----------- cm

L = ---------- x 10^{-2}m

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Mass of the capillary tube M = 7.56 gm

M = -------- x 10^{-3} kg

RESULT : The density of the material of the given capillary tube

= ----------- kg/m³

MSR

8.5 , VD: 25

TR = 8.5 [illegible]

8.40, 45,

8.05, 39

7.9 47.

8911.08

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VOLUME RESONATOR

AIM : TO DETERMINE THE UNKNOWN FREQUENCY OF A TUNING FORK USING A VOLUME RESONATOR.

APPARATUS : Aspirator bottle, tuning forks, beaker, measuring jar, rubber pad etc.,

FORMULA : The unknown frequency of the tuning fork is given by

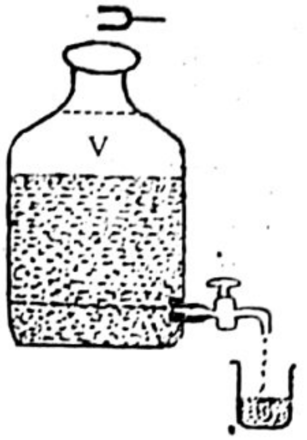
$$n_x = \sqrt{\frac{(n^2V)_{mean}}{V_x}} \text{ Hertz}$$

where n = Frequency of known tuning forks, Hz.

V = Volume of air cavity/water of the resonator corresponding to tuning fork of known frequency, m^3

V_x = Volume of air cavity/water of the resonator corresponding to tuning fork of unknown frequency, m^3.

FIGURE :



PROCEDURE : The apparatus is set up as shown in the figure. The aspirator bottle is filled with water upto the neck. A tuning fork of known frequency is excited by striking it gently on a rubber pad. The excited tuning fork is held near the mouth of the aspirator bottle. At the same time, by opening the pinch cock, water is allowed to flow out gradually into a beaker until resonance occurs and a maximum sound is heard. The volume 'V' of water collected in the beaker is measured using a measuring jar. This volume of water gives the volume of the air in the bottle which resonates with the tuning fork. Water is poured back to the aspirator bottle upto the neck. The above procedure is repeated again and the mean value of volume 'V' is found. The experiment is repeated with other tuning forks of known frequency and in each case n^2V is calculated.

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The experiment is then performed with the tuning fork whose frequency is to be determined. Let the mean value of the volume of water collected in this case be V_x. The unknown frequency of the tuning fork is then calculated using the formula

$$n_x = \sqrt{\frac{(n^2V)_{mean}}{V_x}}$$

OBSERVATIONS :

	Frequency of the tuning fork 'n' in Hertz	Volume of water collected 'V' in m³ $\times 10^{-6}$			n^2V
		Trial 1	Trial 2	Mean	
4.3	480	105	103	104	23.96
5.49	426.6	143	143	143	26.02
12.05	288	309	305	307	25.46
15.25	256	392	394	393	25.15
	$n_x =$	221	223	$V_x = 222$	

$(n^2V)_{mean} = 24.70$

RESULT : Frequency of the given tuning fork = ---------- Hertz

$$n_x = \sqrt{\frac{(n^2v)_{mean}}{V_x}}$$

$$= \sqrt{\frac{24.70}{222 \times 10^{-6}}}$$

$$= \sqrt{\frac{24.91 \times 10^{+6}}{222}}$$

Graphically $n_x = 333.55$ Hz

$$n_x = \sqrt{\frac{slope}{V_x + V_c}} \quad , V_c = 0$$

$$= \sqrt{}$$

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DIFFRACTION GRATING
Minimum Deviation Method

AIM : TO DETERMINE THE WAVELENGTH OF THE PROMINENT SPECTRAL LINES OF A MERCURY VAPOUR LAMP USING A DIFFRACTION GRATING BY MINIMUM DEVIATION METHOD.

APPARATUS : Diffraction grating, spectrometer, mercury vapour lamp, condensing lens etc.,

FORMULA : The grating constant is given by

$$C = \frac{2.54 \times 10^{-2}}{N} \text{ m}$$

where N = No. of lines ruled per inch in the grating

Also: $$C = \frac{n\lambda_g}{2 \sin D_g/2} \text{ m}$$

where n = Order of spectrum (n = 1 for first order)

λ_g = Wavelength of the green light

= 5461×10^{-10} m

D_g = Angle of minimum deviation for green line.

The wavelength of the particular spectral line is given by

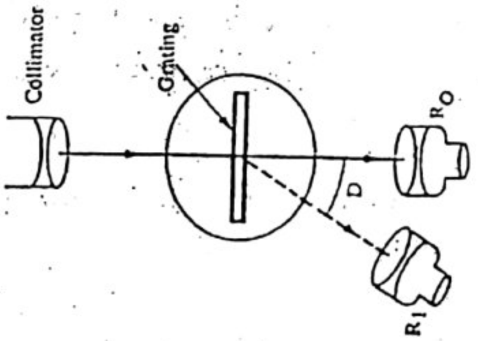
$$\lambda = \frac{2C \sin D/2}{n} \text{ m}$$

where C = Grating constant

D = Angle of minimum deviation of the corresponding colour.

n = Order of spectrum

FIGURE :



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PROCEDURE : To begin with, the following preliminary adjustments are made with the spectrometer :

(i) The telescope is turned towards a white wall and the position of the eyepiece is adjusted (the eyepiece can be moved in or out for this purpose) such that the crosswires are clearly seen.

(ii) The telescope is turned towards a distant object and by using its rack and pinion motion the distant object is made to see in the eyepiece of the telescope distinctly.

(iii) The prism table is levelled using a spirit level.

(iv) The slit is illuminated using a condensing lens. The image of the slit is viewed through the telescope and the collimator is adjusted till the image of the slit is clearly seen.

After the preliminary adjustments are made the grating is mounted on the prism table using the grating stand such that the lines engraved on the grating are vertical. The collimator slit is illuminated with the light from a mercury vapour lamp. The telescope is now turned in one direction to view the first order spectrum. Looking at one of the lines say the yellow, the prism table is slowly rotated in such a direction that the spectral lines move towards the axis of the collimator and return. At this position, the prism table is fixed. Now the colours of the spectrum are in minimum deviation position. The telescope is fixed by means of the tangential screw, the vertical crosswire is made to coincide with each spectral line starting from yellow and the corresponding readings are noted. The telescope is then brought in line with the collimator and the reading R_0 (called the direct reading) is taken when the direct image of the slit coincides with the vertical crosswire. The difference between the direct reading and the reading of the minimum deviation position gives the angle of minimum deviation "D" of that particular colour.

The grating constant "C" is calculated as follows ;

(i) By knowing the number of lines ruled per inch in the grating.

(ii) By assuming the wavelength of one of the lines in the spectrum.

If the grating contains 15,000 lines per inch then,

$$C = \frac{2.54 \times 10^{-2}}{15,000} \text{ m} = 1.6933 \times 10^{-6}$$

Assuming $\lambda = 5461 \times 10^{-10}$ m, the grating constant is calculated using the relation

$$C = \frac{5461 \times 10^{-10}}{2 \sin D_g/2} \text{ m} = 1.6544 \times 10^{-6}$$

where D_g is the angle of minimum deviation for the green line.

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Having known the grating constant, the wavelength of the various spectral lines are calculated using the formula,

$$\lambda = 2\,C \sin D/2$$

OBSERVATIONS:

Least count of the spectrometer :

Value of one main scale division = ------------------ degree

Total number of vernier scale divisions = -----------

$$\text{Least count} = \frac{\text{Value of 1 M.S.D.}}{\text{Total number of V.S.D.}}$$

L.C.= ------------------- minute

Colour of the Spectral line	Reading at min. Dev. Position R in Deg.	Direct Reading R_0 in Deg.	Angle of min. Dev. "D" in Deg. $D = (R_0 \sim R)$	Wavelength "λ" in m. $\lambda = 2\,C \sin D/2$	
				Method 1	Method 2
Yellow 1	41.5	21	20.5	6026	5878
Yellow 2	41.5		20.5	6026	5878
Green	40		19	5589	5461
Blue	38.5		17.5	5152	5033
Violet	36.5		15.5	4567	4462

RESULT : The wavelength of the various spectral lines of the mercury vapour lamp are tabulated in the tabular column.

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FREQUENCY OF AC USING SONOMETER

AIM : TO DETERMINE THE FREQUENCY OF THE ALTERNATING CURRENT BY USING SONOMETER

APPARATUS : Sonometer, step-down transformer, rheostat, two bar magnets, weights etc.,

FORMULA : The frequency of AC supply is given by

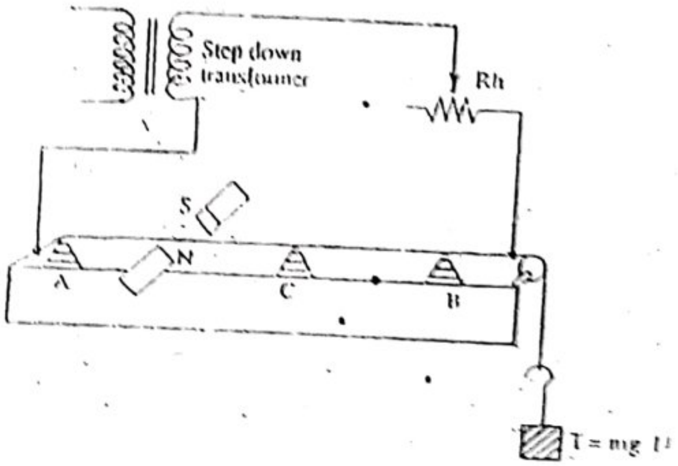
$$n = \frac{1}{2\sqrt{m}} \left[\frac{\sqrt{T}}{l}\right]_{mean} \quad \text{Hertz}$$

where T = Tension in the wire, Newtons.

m = Mass per unit length of the wire, kg/m.

l = Length of the vibrating segment, m.

FIGURE :



PROCEDURE : The electrical connections are made as shown in the figure. The two bar magnets are placed between the fixed bridge A and the movable bridge C on the sonometer such that their opposite poles face each other. To start with, a suitable load is attached to the weight hanger and the position of the movable bridge is adjusted till the segment AC vibrates with maximum amplitude. The length of the vibrating segment AC is measured using a meter scale. Knowing the mass of the load (including the weight hanger) the tension in the wire is calculated. The experiment is repeated for different tension "T" by adding different masses in the weight hanger and in each case the length of the vibrating segment is measured. The readings are tabulated and the mean value of $\sqrt{T}/l$ is calculated. The mass per unit length of the sonometer wire is found out by finding the mass of a known length of the wire. The frequency of AC supply is calculated using the formula,

$$n = \frac{1}{2\sqrt{m}} \left[\frac{\sqrt{T}}{l}\right]_{mean}$$

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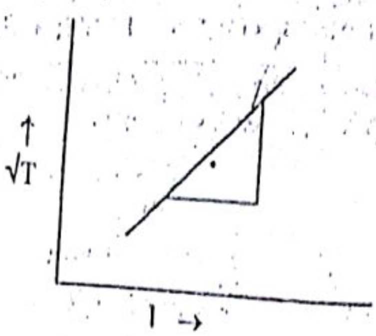
GRAPHICAL METHOD :



A graph is drawn by plotting "$\sqrt{T}$" along the y-axis and "l" along the x-axis. The slope of the straight line ($\sqrt{T}/l$) is calculated. Knowing the value of the slope, the frequency of AC supply is calculated using the formula,

$$n = \frac{1}{2\sqrt{m}} \times \text{slope}$$

OBSERVATIONS:

To determine $\sqrt{T}/l$:

Trial No.	Mass in the Weight Hanger "M" in kg.	Tension T=Mxg in Newtons	Length of the Vibrating Segment "l" in m.	$\sqrt{T}$	$\sqrt{T}/l$ in Newton/m
1	69.46×10⁻³	681.40×10⁻³			
2	119.46×10⁻³	1171.9×10⁻³	42 23	82.5×10⁻²	1.96
3	169.46×10⁻³	1662.4×10⁻³	49 29	108.25×10⁻²	2.20
4	219.46×10⁻³	2152.90×10⁻³	40	128.9×10⁻²	2.13
5	269.46×10⁻³	2643.40×10⁻³	45	146.7×10⁻²	2.22
6	319.46×10⁻³	3133.90×10⁻³	50	162.58×10⁻²	2.15
			55	177.0×10⁻²	2.15

mass of plate = 19.97 gm.

Mean ($\sqrt{T}/l$) = 2.135 N/m

Mass of the wire = 0.8 gms = ... $\times 10^{-3}$ kg.

Length of the wire = 1 m. cms = ... $\times 10^{-2}$ m.

Mass/unit length of the wire, m = $\frac{\text{Mass of the wire}}{\text{Length of the wire}}$ = $\frac{1.38\times10^{-3}}{100\times10^{-2}}$ = 1.38×10^{-3}

= .... kg/m

RESULT : The frequency of the AC supply by

(i) Formula method = ... Hz.

(ii) Graphical method = ... Hz.

68.1 / 16.

55 63.5 65 85

3.75 3.38 2.68 2.60 2.70 2.85 2.06

3.2 3.26 3.21 3.24

53.7 / 13

63.2 / 17

53.3

14.4 / 35

109.9 − 84.7 / 28 − 21.5

25.3 / 6.7

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ALTERNATE METHOD

AIM : TO DETERMINE THE FREQUENCY OF THE ALTERNATING CURRENT BY USING SONOMETER.

APPARATUS : Sonometer, step-down transformer, electro magnet, weights, etc.,

FORMULA : The frequency of the sonometer wire is given by

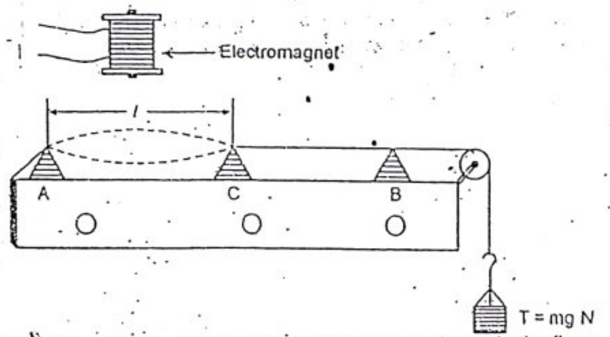
$$N = \frac{1}{2\sqrt{m}}\left[\frac{\sqrt{T}}{l}\right]_{mean} \text{ Hertz}$$

$\therefore$ Frequency of AC supply $n = \frac{N}{2}$

$$\text{ie., } n = \frac{1}{4\sqrt{m}}\left[\frac{\sqrt{T}}{l}\right]_{mean} \text{ Hertz}$$

where T = Tension in the wire, N
m = Mass per unit length of the wire, kg/m
l = Length of the vibrating segment, m

FIGURE :



PROCEDURE : The electrical connections are made as shown in the figure. The electro magnet is clamped to a stand so that it is just above the sonometer wire, between the movable bridges A and C. To start with, a suitable load is attached to the weight hanger and the distance between the bridges is adjusted till the segment AC vibrates with maximum amplitude. The length of the vibrating segment AC is measured using a metre scale. Knowing the mass of the load (including the weight hanger) the tension in the wire is calculated. The experiment is repeated for different tension T by adding different masses in the weight hanger and in each case the length of the vibrating segment l is measured. The readings are tabulated and the mean value of $\sqrt{T}/l$ is calculated. The mass per unit length of the sonometer wire is found out by finding the mass of a known length of the wire. The frequency of AC supply is calculated using the formula

$$n = \frac{1}{4\sqrt{m}}\left[\frac{\sqrt{T}}{l}\right]_{mean} \text{ Hertz}$$

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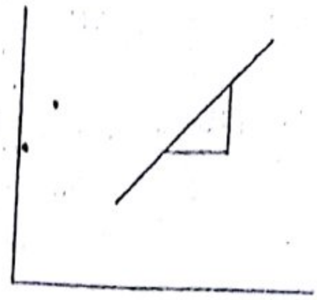
GRAPHICAL METHOD :



A graph is drawn by plotting "$\sqrt{T}$" along the y - axis and "l" along the x - axis. The slope of the straight line is calculated. Knowing the value of the slope, the frequency of AC supply is calculated using the formula,

$$n = \frac{1}{4\sqrt{m}} \times \text{slope}$$

OBSERVATIONS :

To determine $\sqrt{T}/l$:

Trial No.	Mass in the weight hanger M in kg	Tension T = M x g in newtons	Length of the vibrating segment : l in m	$\sqrt{T}$	$\sqrt{T}/l$ in Newton/m
1					
2					
3					
4					
5					
6					

Mean ($\sqrt{T}/l$) = ... N/m

Mass of the wire = ... gms = ... $\times 10^{-3}$ kg.

Length of the wire = ... cms = ... $\times 10^{-2}$ m.

Mass / unit length of the wire, m = $\frac{\text{Mass of the wire}}{\text{Length of the wire}}$

= .... kg/m

RESULT : The frequency of the AC supply by :

(i) Formula method = ... Hz

(ii) Graphical method = ... Hz

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AIM : TO DETERMINE THE THICKNESS OF A PAPER STRIP BY PRODUCING INTERFERENCE PATTERN.

APPARATUS : Two optically plano glass plates, reflecting glass plate fixed to a stand, sodium vapour lamp, travelling microscope, small piece of paper, reading lens etc.,

FORMULA : The thickness of the paper is given by

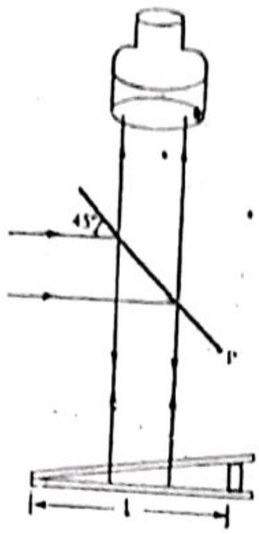
$$t = \frac{\lambda l}{2\beta} \text{ m}$$

where λ = Wavelength of sodium light = 5893×10^{-10} m

l = Distance between the paper and the point of contact of the two glass plates, m.

β = Average fringe width, m.

FIGURE :



PROCEDURE : The given piece of paper whose thickness is to be determined is placed between the two glass plates so that a thin film of air is formed in the form of a wedge between the plates. This is kept below an inclined glass plate. The travelling microscope is placed such that its objective is directly above the optically flat glass plates. The inclined glass plate is tilted such that the field of view is brightly illuminated by monochromatic light from a sodium vapour lamp. The focus of the travelling microscope is adjusted such that a series of alternate dark and bright fringes is clearly seen in the field of view of the microscope. With the help of the tangential screw, the cross-wire of the microscope is made to coincide with any one of the dark fringe taken as the n^{th} fringe and the microscope reading is taken. Again by means of the tangential screw, the cross-wire is made to coincide with every alternate dark fringe upto the $(n+18)^{th}$ fringe and the corresponding microscope readings are noted. The readings

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are tabulated as shown in the tabular column and the average fringe width is calculated.

The distance between the piece of paper and the line of contact of the two glass plates is measured with the help of a meter scale. Knowing the wavelength of sodium light, the thickness of the given paper piece is calculated using the relation

$$t = \frac{\lambda l}{2\beta}$$

OBSERVATIONS :

Least count of the travelling microscope :

Value of one main scale division = ---------------- cm

No. of vernier scale divisions = ----------------

$\therefore$ L.C. = $\frac{\text{Value of 1 M.S.D.}}{\text{Total number of V.S.D.}}$ = ---------------- cm

To determine fringe width "β" :

Fringe No.	TM Readings R_1 in cm	Fringe No.	TM Readings R_2 in cm	Width of 10 Fringes $R_1 \sim R_2$ in cm	Fringe Width $\beta = (R_1 \sim R_2)/10$ in cm
n		n+10			
n+2		n+12			
n+4		n+14			
n+6		n+16			
n+8		n+18			

Average fringe width, β = ------- x 10^{-2} m

Distance between the paper and the point of contact of the glass plate, l = -------------------- m

RESULT : The thickness of the given paper = ------------ m.

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AIM : TO DETERMINE THE RADIUS OF CURVATURE OF A PLANOCONVEX LENS BY NEWTON'S RINGS METHOD.

APPARATUS : Newton's rings apparatus, travelling microscope, sodium vapour lamp etc.

FORMULA : The radius of curvature of the surface of the lens is given by

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

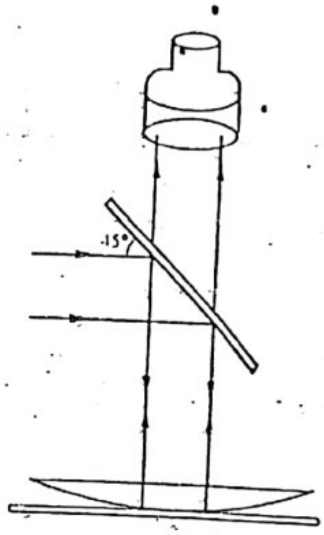
where D_m = Diameter of the m^{th} dark ring, m

D_n = Diameter of the n^{th} dark ring, m

$(m-n)$ = Difference between the m^{th} and n^{th} dark rings.

λ = Wavelength of sodium light = 5893×10^{-10} m.

FIGURE :



PROCEDURE : The apparatus is set up as shown in the figure. The travelling microscope is placed such that its objective is directly above the plano-convex lens. The inclined glass plate is tilted so that the light rays from the sodium vapour lamp are reflected on the plane glass plate and the field of view is brightly illuminated. The focus of the microscope is adjusted such that Newton's rings are clearly seen. The travelling microscope is adjusted such that the point of intersection of the crosswires coincides with the centre of the ring system. The microscope is moved towards the left such that the vertical cross wire is tangential to the 8^{th} dark ring and the reading of microscope is taken. The microscope is now moved towards right and the reading of every ring is noted down till the 8^{th} dark ring on the other side is reached. The readings are entered in the tabular column and the mean vlaue of $(D_m^2 - D_n^2)$ is calculated. Knowing the

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wavelength of sodium light, the radius of curvature of the plano convex lens is calculated using the formula,

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

OBSERVATIONS:

Least Count of the travelling microscope :

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{No. of rotations given to the head scale}} = \text{--------------} \ mm$$

$$\text{L.C.} = \frac{\text{Pitch}}{\text{No. of divisions on the head scale}} = \text{--------------} \ mm$$

To determine $D_m^2 - D_n^2$:

Ring No. "m"	TM Readings in mm		Diameter D_m in mm	D_m^2 in mm^2	Ring No. "n"	TM Readings in mm		Diameter D_n in mm	D_n^2 in mm^2	$D_m^2 - D_n^2$ in mm^2
	Left Lm	Right Rm	D_m = Lm - Rm			Left Ln	Right Rn	D_n = Ln - Rn		
8					4					
7					3					
6					2					
5					1					

Here (m-n) = 4

Mean $(D_m^2 - D_n^2)$ = ---------- mm^2

= ---------- $\times 10^{-6} m^2$

RESULT : The radius of curvature of the given plano-convex lens = ------------------ m

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12. RIGIDITY MODULUS BY DYNAMIC METHOD

AIM : TO DETERMINE THE RIGIDITY MODULUS OF THE MATERIAL OF A WIRE BY DYNAMIC METHOD.

APPARATUS : Given wire, uniform rectangular bar, two identical slotted weights, stand, stop clock, screw gauge, pointer etc.,

FORMULA : The rigidity modulus of the material of a wire is given by

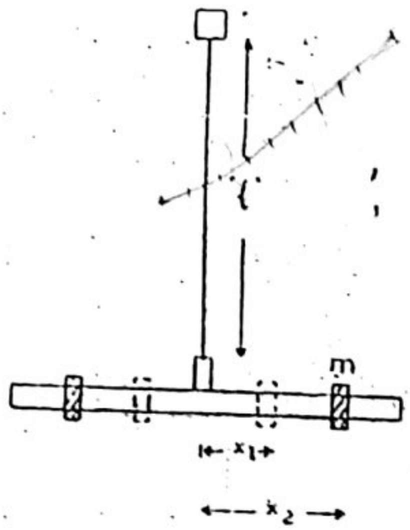
$$n = \frac{16\pi lm\,(x_2^2 - x_1^2)}{r^4(T_2^2 - T_1^2)}\ \mathrm{N/m^2}$$ Replace formulae.

where

	L	=	Length of the wire between the two chucknuts, m
	m	=	Mass of one of the slotted weight, kg
	x_1, x_2	=	Distance of the slotted weights from the axis of suspension, m
	r	=	Mean radius of the wire, m
	T_1	=	Time period when the slotted weight is at a distance x_1 from the axis of suspension, secs.
	T_2	=	Time period when the slotted weight is at a distance x_2 from the axis of suspension, secs.

FIGURE :

$$\frac{16\pi L m}{r^4}\left(\frac{\frac{x_2^2-x_1^2}{T_2^2-T_1^2}+\frac{(x_1^2-x_3^2)}{(T_1^2-T_3^2)}+\frac{(x_3^2-x_2^2)}{(T_3^2-T_1^2)}}{3}\right)$$



PROCEDURE : The given wire whose rigidity modulus is to be determined is taken and their free ends are connected to the chucknuts. One end of the chucknut is rigidly clamped to a stand and the other end of the chucknut is clamped to the centre of the rectangular bar as shown in the figure. Two slotted weights each of mass 100 gms are placed on the rectanguair bar at equal distances (x_1 = 5 cms) from the centre of the bar. The chucknut screwed to the rectangular bar is rotated through a small angle so that the bar

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executes torsional oscillations. Using a stop clock the time taken for 10 oscillations is noted down thrice and the time period T_1 is calculated. The experiment is repeated by changing the distance of the symmetrical masses from the suspension wire to x_2 (say 10 cms) and the corresponding time period T_2 is found out. The length 'l' of the wire between the two chucknuts is measured using a metre scale. The radius of the wire is determined using a screw gauge. The rigidity modulus of the material of the wire is then calculated using the formula

$$n = \frac{16 \pi l m (x_2^2 - x_1^2)}{r^4 (T_2^2 - T_1^2)}$$ replace formulae

OBSERVATIONS :

Mass of one of the slotted weight, m = ------------ kg

Length of the wire between the two chucknuts, l = ------------ m

Distance of the slotted weights in metres	Time for 10 oscillations in secs				Period T in secs
	Trial 1	Trial 2	Trial 3	Mean	
X_1 = 5 cm					T_1 =
X_2 =					T_2 =

To determine radius of the wire : (using screw gauge)

Pitch = $\frac{\text{Distance moved on the pitch scale}}{\text{No. of rotations given to the head scale}}$ = -------- mm

L.C. = $\frac{\text{Pitch}}{\text{No. of divisions on the head scale}}$ = -------- mm

Zero error = -------------------- divisions

Zero correction = -------------- divisions

Trial No.	P.S.R.	H.S.R.	Corrected HSR C.H.S.R.	Diameter in mm d = PSR + (CHSR x LC)
1.				
2.				
3.				
4.				

Mean diameter 'd' = ------------ mm

Radius of the wire r = $\frac{d}{2}$ = ------- mm = ------------ x 10^{-3} m

RESULT : The rigidity modulus of the material of the given wire = ----------- N/m^2

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SINGLE CANTILEVER

AIM : TO DETERMINE THE YOUNG'S MODULUS OF THE MATERIAL OF A BAR BY USING IT AS A SINGLE CANTILEVER

APPARATUS : A uniform rectangular bar, travelling microscope, scale pan, slide calipers, screw gauge etc.,

FORMULA : The Young's modulus of the material of a bar is given by

$$q = \frac{4 m g l^3}{b d^3 s} \text{ N/m}^2$$

where m = Mass for which depression is found, kg

g = Acceleration due to gravity = 9.8 m/sec²

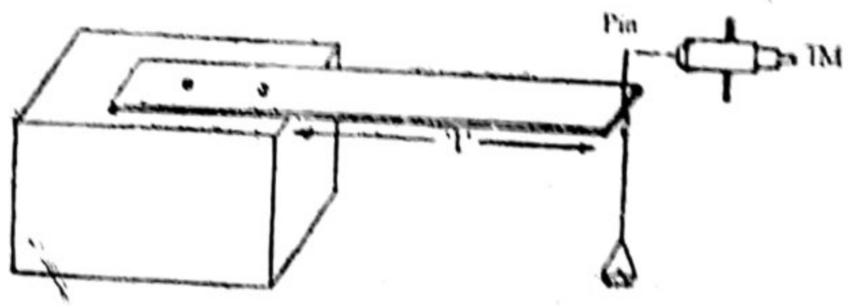
l = Length of the cantilever from the point of projection to the point where the pin is fixed, m

b = Breadth of the bar, m

d = Thickness of the bar, m

s = Mean depression for load of m kg, m

FIGURE :



PROCEDURE : One end of a given rectangular bar is fixed firmly to a heavy wooden block and a scale pan is suspended from the other end. A pin is fixed vertically to the bar such that it is exactly above the point where the scale pan is hung. A load of 10 gms is added to the scale pan. A travelling microscope is focussed on the tip of the pin such that a clear image of the tip of the pin is seen. The microscope is adjusted such that the image of the tip of the pin coincides with the point of intersection of the cross wires and the reading is taken. The load in the scale pan is increased in steps of 10 gms till a maximum load of 60 gms is reached and the corresponding readings are noted down in each case. The

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experiment is repeated by decreasing the load in steps of 10 gms and the corresponding readings are noted down. The readings are tabulated and the mean depression for a load of 30 gms is calculated.

The length of the cantilever from the point of projection to the point where scale pan is hung is measured using a meter scale. The breadth 'b' and the thickness 'd' of the bar are measured using a slide caliper and screw gauge respectively. The Young's modulus of the material of the bar is then calculated using the formula

$$q = \frac{4\,mg\,l^3}{b\,d^3 s}$$

OBSERVATIONS :

Least count of the travelling microscope : 1/50

Value of one main scale division = --------------- cm

No. of vernier scale divisions = 50

$$\text{L.C.} = \frac{\text{Value of 1 M.S.D.}}{\text{Total number of V.S.D.}} = \frac{1/20}{50} \text{ cm}$$

To determine the depression s :

Load in gms	TM Readings in cm: load increasing	load decreasing	mean R1	Load in gms	TM Readings in cm: load increasing	load decreasing	mean R2	Depression s for 30 gms in cm $s = (R_1 - R_2)$
10	6.887	[illegible]	[illegible]	40	6.735	6.719	[illegible]	
20	6.899	6.853	[illegible]	50	6.565	[illegible]	[illegible]	
30	[illegible]	6.770	[illegible]	60	6.690	6.[illegible]	[illegible]	

Mean depression s = [illegible] cm

s = [illegible] × 10^{-2} m

Length of the cantilever l = 8.8 × 10^{-2}m

Mass for which depression is found m = 15 × 10^{-3} kg

To determine breadth 'b' : (using slide calipers)

Least count of slide calipers :

$$\text{L. C.} = \frac{\text{Value of 1 M.S.D.}}{\text{Total no. of vernier scale divisions}}$$

L.C. = 0.1 cm

Trial No.	M.S.R.	C.V.S.D.	Breadth 'b' in cms b = MSR + (CVSD x LC)
1.	1.2	2	1.22
2.	1.2	2	1.22
3.	1.2	1	1.21
4.	1.2	2	

Mean breadth 'b' = 1.2[illegible] × 10^{-2} m

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To determine thickness 'd' : (using screw gauge)

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{No. of rotations given to the head scale}} = \text{1 mm}$$

$$\text{L.C.} = \frac{\text{Pitch}}{\text{No. of divisions on the head scale}} = \text{0.01 mm}$$

Zero error = 20 divisions

Zero correction = 20 divisions

Trial No.	P.S.R.	H.S.R.	Corrected HSR C.H.S.R.	Thickness in mm d = PSR + (CHSR x LC)
1.	0	51	71	0.71
2.		51	71	0.71
3.		52	72	0.72
4.		53	73	0.73

Mean thickness 'd' = 0.715 mm

= 0.715 $\times 10^{-3}$ m

RESULT : The Young's modulus of the material of the given bar = ------------ N/m^2

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YOUNG'S MODULUS BY UNIFORM BENDING

AIM : TO DETERMINE THE YOUNG'S MODULUS OF THE MATERIAL OF A BAR BY UNIFORM BENDING METHOD.

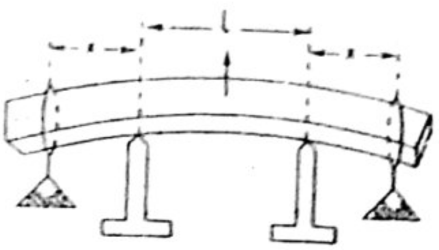
APPARATUS : A uniform wooden bar about 1 meter long, two knife-edges, two weight hangers, travelling microscope, slide calipers, screw gauge etc.,

FORMULA : The Young's modulus of the material of a bar is given by

$$q = \frac{3\, m g\, l^2 x}{2\, b\, d^3 \delta} \quad N/m^2$$

where
- m = Mass for which the elevation is found, kg
- g = Acceleration due to gravity = 9.8 m/sec^2
- x = Distance between weight hanger and nearer knife-edge, m.
- l = Distance between the knife edges, m.
- b = Breadth of the bar, m
- d = Thickness of the bar, m
- δ = Mean elevation for load of m kg, m.

FIGURE :



PROCEDURE : The given wooden bar (meter scale) is placed symmetrically on the two knife edges such that about one-fourth of the bar projects beyond each knife edge. Two scale pans are suspended at each end of the scale such that the distances from the knife edge are equal. A pin is fixed vertically at the centre of the scale by means of wax. A load of 20 gms is added to each of the scale pan. A travelling microscope is focussed on the tip of the pin such that a clear image of the tip of the pin is seen. The microscope is adjusted such that the image of the tip of the pin coincides with the point of intersection of the cross wires and the reading is taken. The load in each of the scale pan is increased in steps of 20 gms till a maximum load of 120 gms is reached and the corresponding readings are noted down in each case. The experiment is repeated by

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decreasing the load in steps of 20 gms and the corresponding readings are noted down. The readings are tabulated and the mean elevation for a load of 60 gms is calculated.

The distance between the knife edges 'l' and the distance between the weight hanger and the nearest knife edge 'x' is measured using a meter scale. The breadth 'b' and the thickness 'd' of the bar are measured using a slide caliper and screw gauge respectively. The Young's modulus of the material of the bar is then calculated using the formula

$$q = \frac{3\,mg\,l^2\,x}{2\,b\,d^3\,\delta}$$

OBSERVATIONS:

Least count of the travelling microscope :

$$L.C. = \frac{\text{Value of 1 M.S.D.}}{\text{Total number of V.S.D.}} = \text{------------------ cm}$$

To derternine the elevation δ :

Load in gms	TM Readings in cm			Load in gms	TM Readings in cm			Elevation 'δ' for 60 gms in cm
	load increasing	load decreasing	mean R_1		load increasing	load decreasing	mean R_2	$\delta = (R_1 - R_2)$
20				80				
40				100				
60				120				

Mean elevation, δ = -------- cm

= -------- $\times 10^{-2}$m

Distance between the knife edges, l = --------- $\times 10^{-2}$m

Distance between the weight and the nearer knife edge, x = --------------- $\times 10^{-2}$ m

Mass for which elevation is found, m = --------- $\times 10^{-3}$ kg

To determine breadth "b" : (using slide calipers)

Least count of slide calipers :

$$L.C. = \frac{\text{Value of 1 M.S.D.}}{\text{Total no. of vernier scale divisions}}$$

L.C. = --------- cm

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Trial No.	M.S.R. in cm	C.V.S.D.	Breadth 'b' in cms $b = MSR + (CVSD \times LC)$
1.			
2.			
3.			
4.			

Mean breadth 'b' = --------- cms

= -------- $\times 10^{-2}$ m

To determine thickness 'd' : (using screw gauge)

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{No. of rotations given to the head scale}} = \text{--------- mm}$$

$$\text{L.C.} = \frac{\text{Pitch}}{\text{No. of divisions on the head scale}} = \text{--------- mm}$$

Zero error = -------------------- divisions

Zero correction = --------------- divisions

Trial No.	P.S.R. in mm	H.S.R.	Corrected HSR C.H.S.R.	Thickness in mm $d = PSR + (CHSR \times LC)$
1.				
2.				
3.				
4.				

Mean thickness 'd' = ---------- mm

= ----------- $\times 10^{-3}$ m

RESULT : The Young's modulus of the material of the given bar = ----------- N/m^2

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