* Observations

Case (i)
At frequency = 2.503 kHz

n	y (cm)
1	77
2	138
3	213
4	279
5	349
6	421
7	500

Case (ii)
At frequency = 3.006 kHz

n	y (cm)
1	40
2	94
3	145
4	206
5	262
6	332
7	387

Graph at the back.

Date 21/01/19

Expt. No. 01. Page No. 01.

Velocity of sound using Kundt's Tube

* **Objective of the experiment**

To determine velocity of sound in air at room temperature & calculate γ for air

* **Apparatus**

Brass tube containing loud speaker & microphone audio signal generator oscilloscope & frequency counter

* **Principle**

$$V = \nu\lambda$$

where V = velocity, ν = frequency, λ = wavelength

$$V = \sqrt{\frac{\gamma RT}{M}}$$

where $\gamma = C_p / C_v$, $R = 8.32$ J/mole K, M = molecular weight in kg

* **Calculations**

using $V = \sqrt{\frac{\gamma RT}{M}} \Rightarrow \gamma = \frac{V^2 M}{RT}$

$$= \frac{(330)^2 (28.88)}{(8.32)(303)} \times \frac{1}{1000}$$

$$\gamma = \frac{1247.553}{1000} = 1.247$$

* **Result**

The γ of air is ~~1247.553~~ 1.247

Teacher's Signature :

Using Least square fitting method

Frequency = 2.5 KHz

x^2	xy
1	77
4	276
9	639
16	1116
25	1745
36	2526
49	3500

A = 28

B = 140

C = 1977

D = 9179

m = 70.3928

c = 0.85714

$y = 70.3928x + 0.85714$

Frequency = 3.0 KHz

x^2	xy
1	40
4	188
9	435
16	824
25	1310
36	1992
49	2709

A = 28

B = 140

C = 1466

D = 7498

m = 58.35714

c = -23.9999

$y = 58.35714x - 23.9999$

Expt. No. 01.

Date 21/01/19

Page No. 02.

Teacher's Signature :

* Observations

Sl. no.	Temperature (°C)	Time (sec)
1.	46.4	3360
2.	46.2	3660
3.	44.9	3960
4.	43.7	4260

couldn't complete the readings as there was power cut for few min.

Thermal conductivity by Lee's method

* Objectives of the experiment

To determine the thermal conductivity of a bad conductor (glass, wood, nylon) in the form of a disk using Lee's method

* Apparatus

Lee's apparatus & the experimental specimen in the form of disk, weighing balance, heater

* Principle

$$H = \frac{KA(T_2 - T_3)}{x} \quad \text{--- (1)}$$

where H = steady state rate of heat transfer, K = thermal conductivity, A = cross sectional area, x = thickness of sample, $T_2 - T_3$ = temp. difference across the sample

* Calculations

$$H = ms\frac{dT}{dt} \quad \text{--- (2)}$$

m = mass of lower disk, s = specific heat of lower disk
$\frac{dT}{dt}$ = rate of cooling, H = heat radiated per second.

from (1) & (2), we get

$$K = \frac{ms\frac{dT}{dt}x}{A(T_2 - T_3)} \quad \text{--- (3)}$$

* Calculations

- Rate of cooling

$$\frac{dT}{dt} = \frac{(46.2 - 46.4)^\circ C}{600 \text{ sec}} = -3.33 \times 10^{-4} \; ^\circ C/\text{sec}$$

- Thermal conductivity

$$\frac{mS \frac{dT}{dt} x}{A(T_2 - T_3)} = \frac{0.885 \times 375 \times (-3.33 \times 10^{-4})(4 \times 10^{-3})}{4.5364 \times 10^{-3} (-0.7)}$$

$$= 0.1393$$

* Calculations

Mass of metal disk = 885 gm

Specific heat capacity of metal disk = 375 J/kg

Radius of metal disk r = 38mm

Contact area of metal disc $A = \pi r^2 = 4.5364 \times 10^{-3} \; m^2$

Height of metal disk h = 23.1mm = 23.1×10^{-3} m

Thickness of sample x = 4mm = 4×10^{-3} m

Temperature of heating disk T_2 = 45.5 °C

Temperature of Lee's disk T_3 = 46.2 °C

Temperature difference $T_2 - T_3$ = -0.7 °C

Rate of cooling of Lee's Disk dT/dt from graph = -3.33×10^{-4} °C/s

Thermal conductivity, $k = 0.1393 \; Wm^{-1}K^{-1}$

* Results

Thermal conductivity of sample = $0.1393 \; Wm^{-1}K^{-1}$

* Observations

Sl. no.	m_1 (g)	v_1 (m/s)	a m/s^2	a (theoretical)
1.	4	0.352	0.185	0.420
2.	4	0.540	0.378	0.420
3.	4	0.496	0.385	0.420
4.	4	0.548	0.377	0.420.

* Calculations

$$a_{Th} = \frac{mg}{M+m}$$

$$= \frac{4 \times 9.8}{4 + 89.2}$$

$$= \frac{39.2}{93.2}$$

$$= 0.420\ m/s^2$$

Date 04/02/19

Expt. No. 03.

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Momentum in Elastic & Non elastic collision

* Aim

1. To calculate velocities before & after collisions in case of both elastic & inelastic collisions
2. To verify law of conservation of momenta & energies

* Theory

$$mg = (M+m)a$$

$$a = \frac{mg}{M+m}$$

a = acceleration of mass M+m, M = mass of slider, m = mass of hanging obj. over pulley

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2$$

where m_1 = net mass over slider 1, m_2 = net mass over slider 2, v_1 = velocity of slider 1, v_2 = velocity of slider 2.

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$$

others be being the same, v' = final velocity of system of mass $(m_1 + m_2)$.

Teacher's Signature :

* Observations

For elastic collisions

Sl.no.	v_1 m/s	v_2 m/s	v_1' m/s	v_2' m/s	$v'_{1\,Th}$ m/s	$v'_{2\,Th}$ m/s
1.	0.405	0.361	0.315	0.347	0.361	0.405
2.	0.394	0.409	0.368	0.356	0.408	0.395
3.	0.492	0.450	0.413	0.444	0.450	0.492
4.	0.304	0.263	0.209	0.263	0.263	0.304
5	0.414	0.296	0.255	0.368	0.294	0.414

For Inelastic collisions

Sl.no	v_1 m/s	v_2 m/s	v_1' m/s	v_2' m/s	$v'_{1\,Th}$ m/s	$v'_{2\,Th}$ m/s
1.	0.422	0.141	0.144	0.172	0.281	0.281
2.	0.454	0.304	0.097	0.140	0.379	0.379
3.	0.349	0.291	0.087	0.133	0.320	0.320
4.	0.373	0.205	0.095	0.1377	0.289	0.289

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- % difference b/t therotical & experimental values of v_1'

$$\frac{v'_{1\,Th} - v_1'}{v'_{1\,Th}} \times 100 = 12.74\%$$

- % difference b/t therotical & experimental values of v_2'

$$\frac{v'_{2\,Th} - v_2'}{v'_{2\,Th}} \times 100 = 14.3\%$$

- % difference b/t therotical & experimental values of v'

$$\frac{v'_{Th} - v'}{v'_{Th}} \times 100 = 13.2\%$$

Teacher's Signature : ______

* Observations & Calculations

Height, h (cm)	Time, t (s)	Time, Δt (ms)	Velocity, v (m/s)	Inertia, I (kg/m²)
35	4.209	37.930	0.083155	1.7658
30	4.011	41.707	0.074793	1.8710
25	3.639	45.302	0.06870	1.8480
20.	3.278	50.154	0.0610128	1.8744
15	2.815	58.530	0.0532	1.8431

Diameter of the disk = 12.8 cm = 0.128 m

Mass of the disk = 0.435 kg

Moment of inertia = 1.84046 kg/m²

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Maxwell's wheel

* Objective of the experiment

1. Determination of M.I of maxwell's wheel
2. Verify the transformation of P.E into translational & rotational energy.
3. Validate concept of conservation of energy.

* Theory

$$PE = KE_{Trans} + KE_{Rot}$$

$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$$

where

I = M.I of wheel
m = mass of wheel
r = radius of spindle
v = velocity of wheel
g = acc. due to gravity
h = height position
ω = angular velocity

$v = r\omega$ $v = \frac{\Delta s}{\Delta t}$ ~~$v = \frac{h}{t}$~~

$$v = r.\omega$$

$$I = mr^2\left(\frac{2gh}{v^2} - 1\right)$$

* Result

The M.I of the disk is ~~[illegible] kg/m²~~ 1.84046 kg/m²

Teacher's Signature :

* Observation

	Time, Δt s	Direction	Rest frequency, f_0 Hz	Frequency, f Hz	Δf	
v_1	3.53	Right	40049	40085	36	35
	3.34	Left	40041	40015	34	
v_2	3.75	Right	40046	40082	36	35
	3.29	Left	40039	40005	34	
v_3	3.62	Right	40039	40073		
	3.29	Left	40033	40001		
v_4	4.29	Right	40037	40067		
	3.59	Left	40031	40000		

	velocity v, $\Delta s/\Delta t$ m/s	$\Delta f = f - f_0$ Hz		
v_1	0.2911	31	5	35
v_2	0.2841	35	1	35
v_3	0.2894	33	1	34
v_4	0.2538	30.5	1	

Doppler Effect

* Objectives of the experiment

- To determine velocity of moving trolley
- Measuring change of freq. percieved by observer at rest as a f° of velocity of source of ultrasonic waves.
- Validating proportionality b/t change of freq. & velocity of the source of ultrasonic waves.
- Determining velocity of sound 'c' in air.

* Theory

$$v = \frac{\Delta s}{\Delta t}$$

where,

v = velocity of moving transducer

Δt = time in which trolley covers a particular distance

Δs = distance covered.

$$\Delta f = f - f_0$$

$$= f_0 \left(\frac{v}{c}\right)$$

where,

Δf = change in frequency

f_0 = rest frequency

f = moving frequency

c = velocity of sound wave.

* Calculations

Using "fitting a st. line to a set of data" method,

x	x^2	y	xy
0.2911	0.08474	31	9.0241
0.2841	0.08071	35	9.9435
0.2894	0.08375	33	9.5502
0.2538	0.06441	30.5	7.7409

N = 4

A = 1.1184

B = 0.31361

C = 129.5

D = 36.2587

$$m = \frac{AC - DN}{A^2 - NB} = 55.77891$$

$$c = \frac{C - mA}{N} = 16.72921$$

$\therefore$ eq^n of line $\Rightarrow$ $y = 55.77891x + 16.72921$

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From the graph,

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{[illegible] - [illegible]}{0.2994 - 0.2894}$$

$= \cancel{[illegible]}\ 55.8823$

But slope $= \dfrac{f_0}{c}$

$\cancel{[illegible]}\ 55.8823 = \dfrac{40039.375}{c}$

Teacher's Signature :

* Measurements
  - First set

(1) $m = 49.4$ gms (with no mass attached)

$d = 10$ cm

pivot point : 2nd hole from top

$g = 9.8\ m/s^2$

$T_{A_1} = 0.813$ sec

using : $T = 2\pi\sqrt{\frac{I}{mgd}}$ => $\frac{T^2}{4\pi^2} \cdot mgd = I$

$$\boxed{I_{exp} = 8.105 \times 10^{-4}\ kg/m^2}$$

→ Theoretical value

$$I_{Th} = \frac{m}{3(x_1+x_2)} x_1^3 + \frac{m}{3(x_1+x_2)} x_2^3 = \boxed{8.645 \times 10^{-4}\ kg/m^2}$$

(2) $m = (52 + 49.4)$ gms $= 101.4$ gms

$d = 15$ cm

pivot point : end (with one mass attached)

$g = 9.8\ m/s^2$

$T_{A_2} = 0.989$ s

$$\boxed{I_{exp} = 3.693 \times 10^{-3}\ kg/m^2}$$

Simple pendulum

* Objectives
  - To measure the time period of a pendulum
  - Dependence of 'T' of pendulum oscillations as a f^n of distance b/t COM & rotation axis.
  - To determine 'g' from 'T'
  - Dependence of 'T' as a function of oscillations amplitude.

* Theory

$$\tau = mgd\sin\theta$$

where τ = restoring torque

θ = angle when pendulum is displaced from eq^n

m = overall mass of pendulum

g = acceleration due to gravity

d = distance from pivot to COM

$$\frac{d^2\theta}{dt^2} = -\left(\frac{mgd}{I}\right)\theta$$

$$\theta = \theta_0 \sin(\omega t + \phi)$$

$$\omega = \sqrt{\frac{mgd}{I}}$$

where ωT = time period

I = moment of inertia

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{I}{mgd}}$$

→ Theoretical value

$$I_{Th} = \frac{m}{3(x_1+x_2)}\left[x_1^3 + x_2^3\right]$$

$= 0.003042$ kg/m²

$$\boxed{I_{Th} = 3.042 \times 10^{-3}\ kg/m^2}$$

① Simple.

→ Theoretical value

$$\boxed{I_{Th} = \frac{ML^2}{3} = 3.042 \times 10^{-3}\ kg/m^2}$$

③

$m = (104 + 49.4)$ gms $= 153.4$ gms

$d = 10$ cm (with two masses attached).

pivot pt : 2^{nd} pt. from top

$g = 9.8\ m/s^2$

$T_{A_3} = 1.009$ sec

$$\boxed{I_{exp} = 3.8079 \times 10^{-3}\ kg/m^2}$$

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$$I = I_0 + md^2$$

where I_0 = momentum of inertia when COM = origin.

$$T = 2\pi\sqrt{\frac{I_0 + md^2}{mgd}}$$

* **Result**

I (no mass) $= 8.105 \times 10^{-4}$ kg/m²

I (one mass) $= 3.693 \times 10^{-3}$ kg/m²

I (two mass) $= 3.8079 \times 10^{-3}$ kg/m² //.

Teacher's Signature :

→ Theoretical value

$$\frac{m}{3(r_1 + r_2)} \left[r_1^3 + r_2^3 \right]$$

$$= \boxed{I_{Th} = 2.6845 \times 10^{-3} \ kg/m^2}$$

Good

25/2/15

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Teacher's Signature :

* Observations

Mass of weight (W_0) = 100g = 0.1 kg

Reading corresponding to no mass = 266 cms

* Table

Trial no.	Distance b/t		Mass hung	Scale reading			Shift
	Scale & optical lever D (m)	Knife edges l (m)	m (kg)	Load (cm)	Unload (cm)	Mean (cm) $x - x_0$	y_i
1.	0.7	0.0205	0	266	266	$\frac{0+0}{2}$	0
2.	0.7	0.0205	0.1	270	270	$\frac{4+4}{2}$	4
3.	0.7	0.0205	0.2	273	273	$\frac{7+7}{2}$	7
4.	0.7	0.0205	0.3	276	276	$\frac{10+10}{2}$	10
5.	0.7	0.0205	0.4	279	279	$\frac{13+13}{2}$	13

D = 70cm b = 5.0cm p = 17.6 cm

l = 20.5cm d = 0.2cm x = 4.6cm

Young's Modulus

* Objective of the experiment

To determine the young's modulus of material of bar subjected to uniform bending by measuring elevation at center point using optic lever.

* Theory

$$Z = \frac{MgPL^2}{8Y\left(\frac{bd^3}{12}\right)}$$

where, Z = elevation at midpoint
d = thickness of bar
b = breadth of bar
L = dist. b/t two knives
p = load b/t mass M from each edge

$$q = \frac{Z}{x}$$

where, x = perpendicular dist. to legs of optical lever

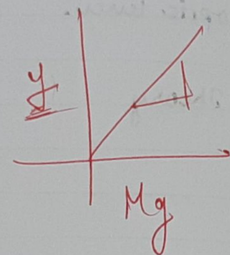
$$q = \frac{Y}{2D}$$

where, y = shift on scale at dist. D from optical lever

$$Z = \frac{xy}{2D}$$

* Fitting a st. line to a set of data

x	x^2	y	xy
0	0	0	0
0.98	0.9604	0.04	0.0392
1.96	3.8416	0.07	0.1372
2.94	8.6436	0.10	0.2940
3.92	15.3664	0.13	0.5096
Σ = 9.8	28.812	0.34	0.98
A	B	C	D



$$m = \frac{y}{Mg}$$

$$Y = \frac{3}{x}\frac{1}{m}\frac{\rho D L^2}{b d^3}$$

$$m = \frac{AC - DN}{A^2 - NB} = 0.03265$$

$$c = \frac{C - mA}{N} = 0.004$$

eq^n ⇒

$$y = 0.03265x + 0.004$$

x	y_{new}
0	0.004
0.98	0.035997
1.96	0.067994
2.94	0.099991
3.92	0.131988

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$$\cancel{Y = \frac{3Mg\rho DL^2}{xy\, bd^3}}$$

$$y = \frac{3Mg\rho DL^2}{xY bd^3}$$

$$y = \frac{3\rho DL^2}{xYbd^3}\,\frac{Mg}{(x)}$$

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \cancel{\frac{1.96 - 0.98}{0.06}} \quad \frac{0.067994 - 0.035997}{1.96 - 0.98}$$

slope = 0.03265

$$\text{slope} = \frac{3\rho DL^2}{xYbd^3}$$

$$0.03265 = \frac{3(0.176)(0.7)(0.205)^2}{(0.046)\,Y\,(0.05)(0.002)^3}$$

$$Y = \frac{3(0.176)(0.7)(0.205)^2}{(0.046)(0.05)(0.002)^3(0.03265)}$$

$$Y = 2.5854 \times 10^{10}\ N/m^2$$

* Result

d = 2mm, b = 5 cm, $Y = 2.5854 \times 10^{10}\ N/m^2$

Teacher's Signature: 11/3/15

* Observations

no. of antinodes (N)	frequency, f (Hz)
1	23.5
2	46.64
3	53.02
4	71.32
5	92.42

* Fitting given data into a straight line.

x	y	x^2	xy
1	23.5	1	23.5
2	46.64	4	93.28
3	53.02	9	159.06
4	71.32	16	285.28
5	92.42	25	462.10

Date 25/03/19

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Vibrating string

* **Objectives**

1. To generate standing waves on an elastic string as a f' of freq.
2. To deduce wave velocity 'v' of string.

* **Theory**

$$S = \frac{n\lambda_n}{2}$$

$n = 1, 2, 3 \ldots$

where, S = length of string
n = no. of oscillation antinodes

$$v = f_n \lambda_n$$

where, v = velocity
λ = wavelength
f = frequency

$$f_n = \frac{vn}{2S}$$

where, v = phase velocity.

* **Result**

The phase velocity 'v' of the string is 24.378 m/s

Teacher's Signature :

N = 5

A = Σx = 15

B = Σx^2 = 55

C = Σy = 286.9

D = Σxy = 1023.22

$$m = \frac{AC - DN}{A^2 - NB} = 16.252$$

$$c = \frac{C - mA}{N} = 8.624$$

$$y = 16.252x + 8.624$$

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★ Calculations

$$\text{slope from graph} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{73.632 - 41.128}{4 - 2}$$

$$= 16.252$$

$m = \frac{f_n}{n}$.

$$v = 2s\frac{f_n}{n}$$ = $v = 2sm$

= m/s

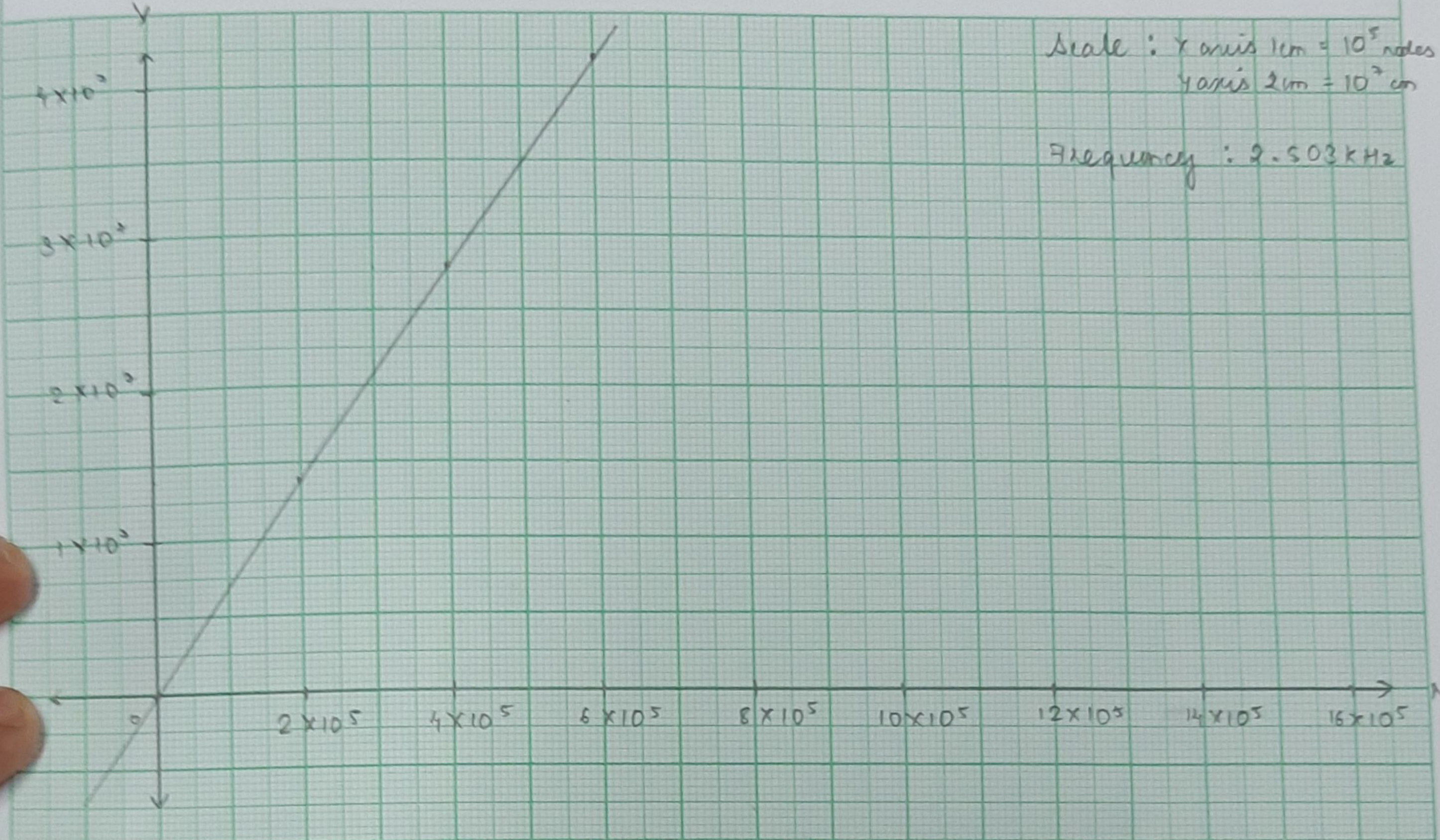
N	n	f/n
[illegible]	1	[illegible]
[illegible]	2	41.128
[illegible]	3	[illegible]
[illegible]	4	73.632
[illegible]	5	[illegible]

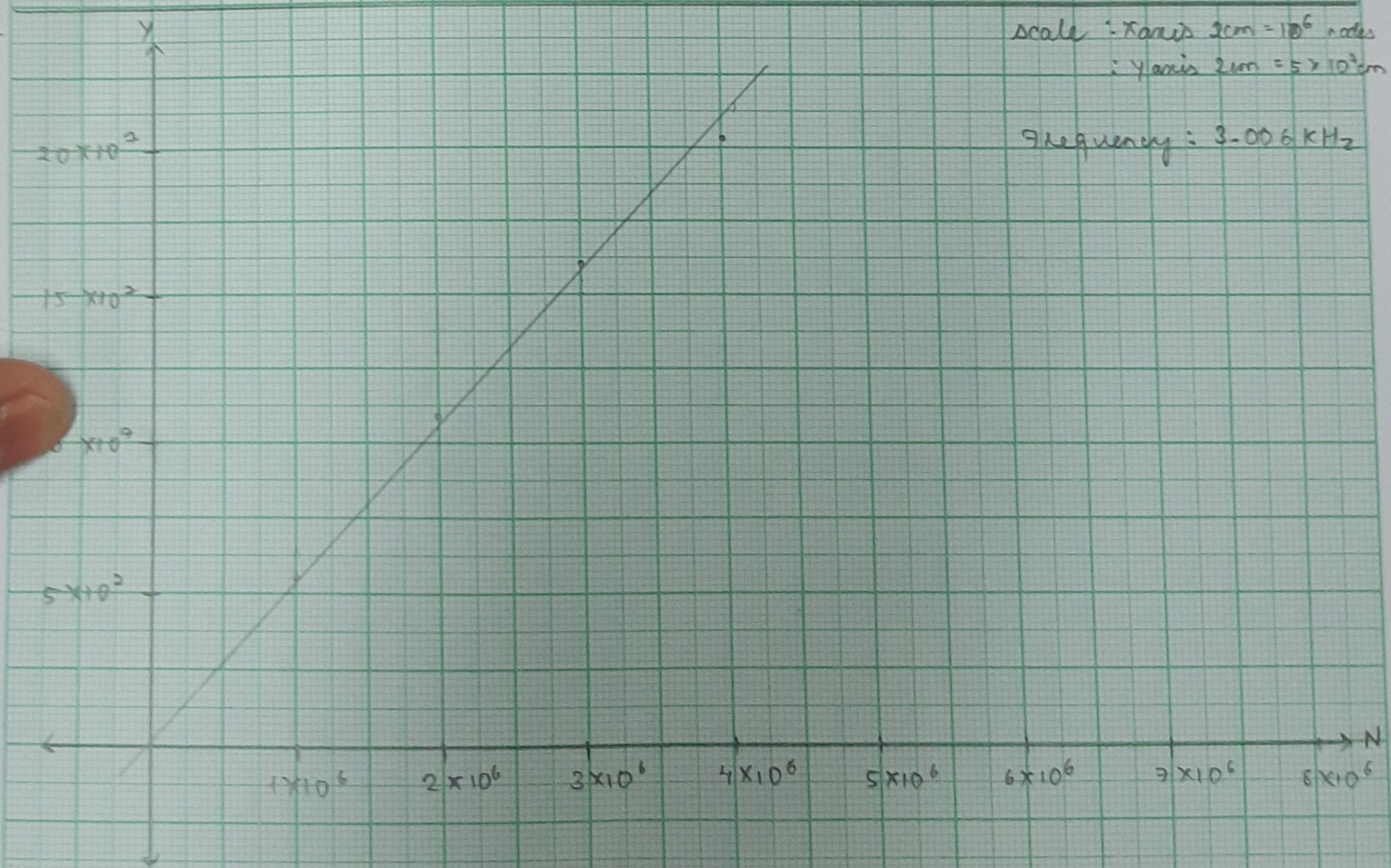
$$\boxed{v = 2(0.75)(16.252) = 24.378\,m/s}$$

25/3/19

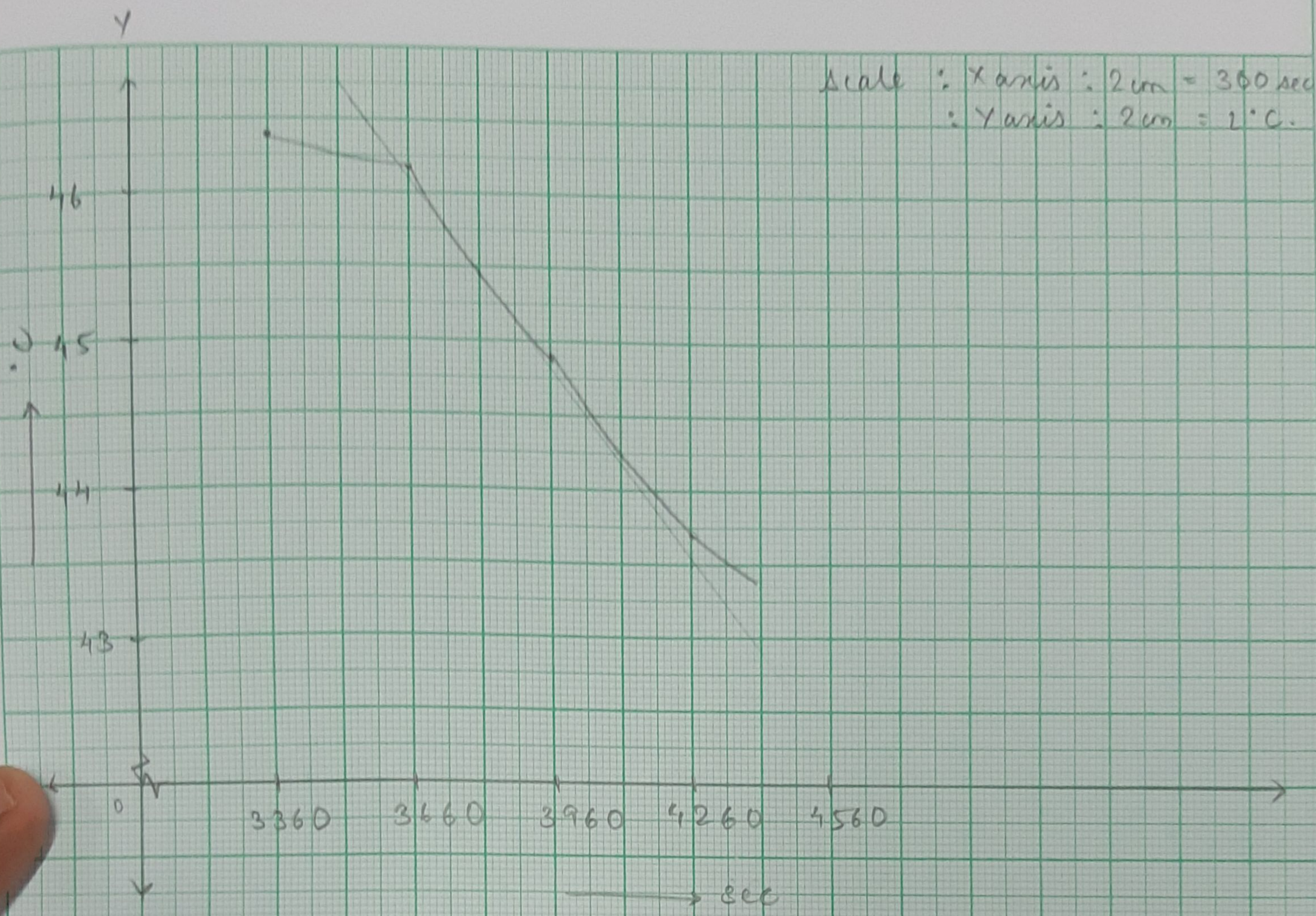
Teacher's Signature :

1. Exp : Kundt's Tube

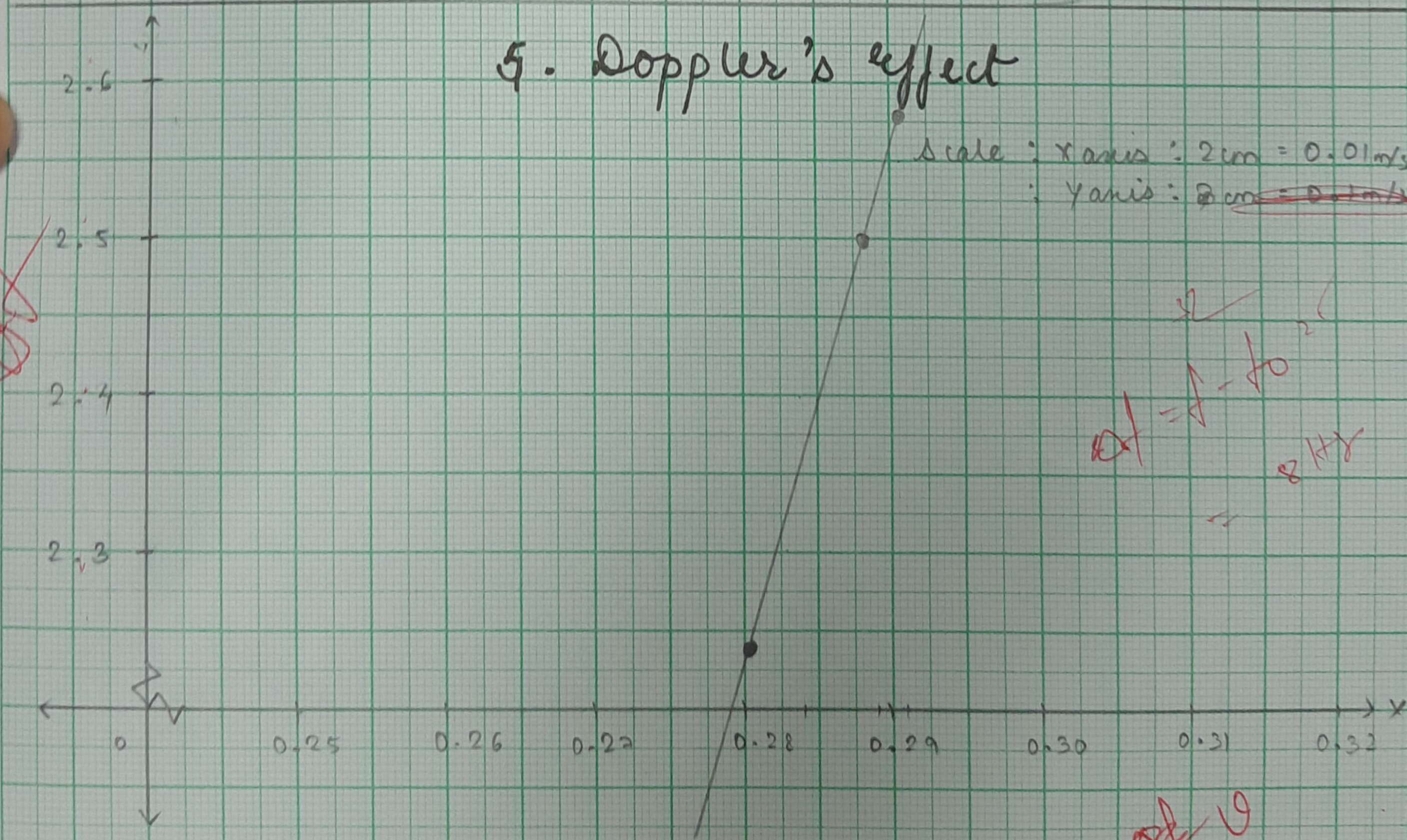




2. Lee's Disk

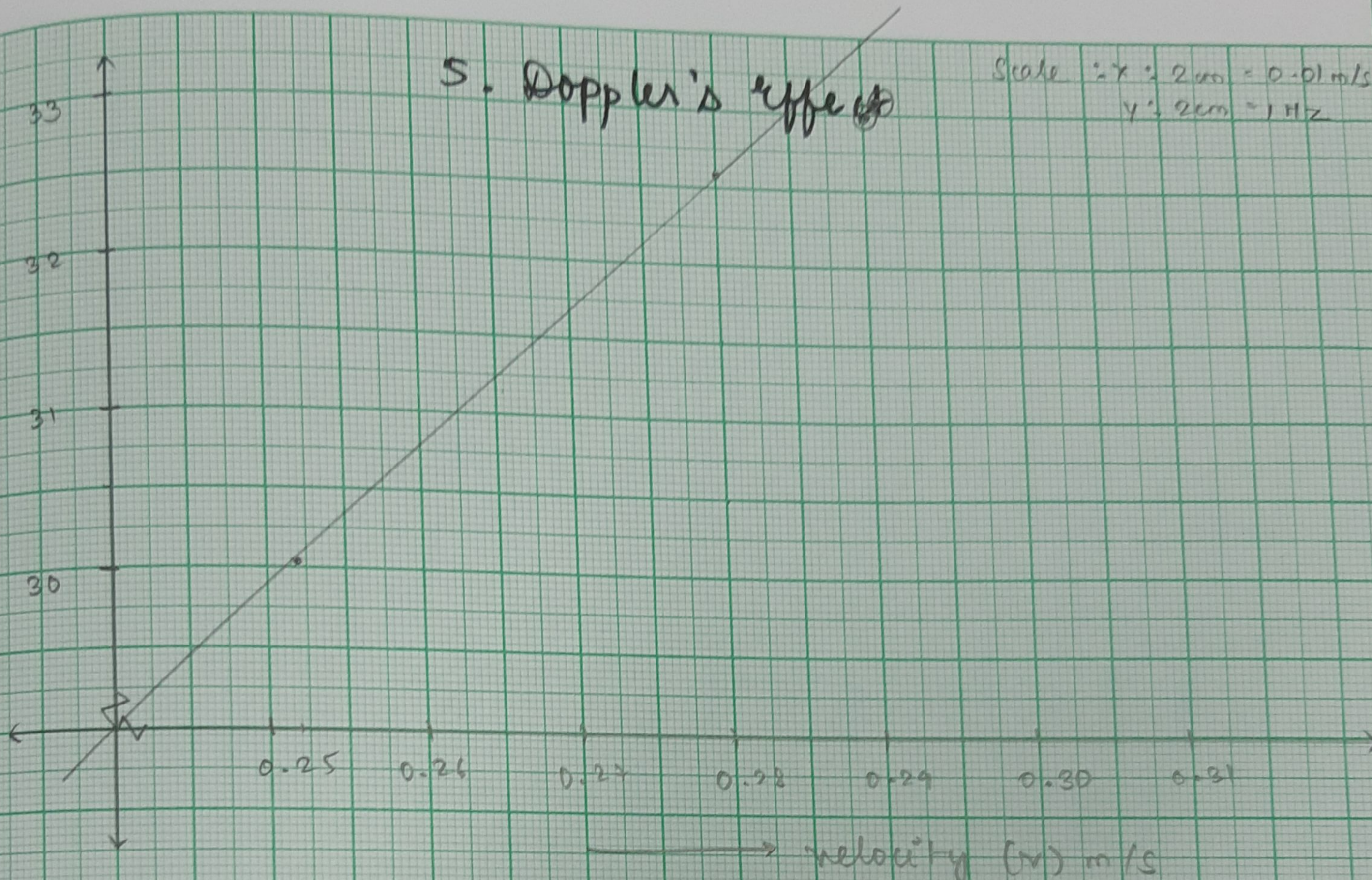


5. Doppler's effect

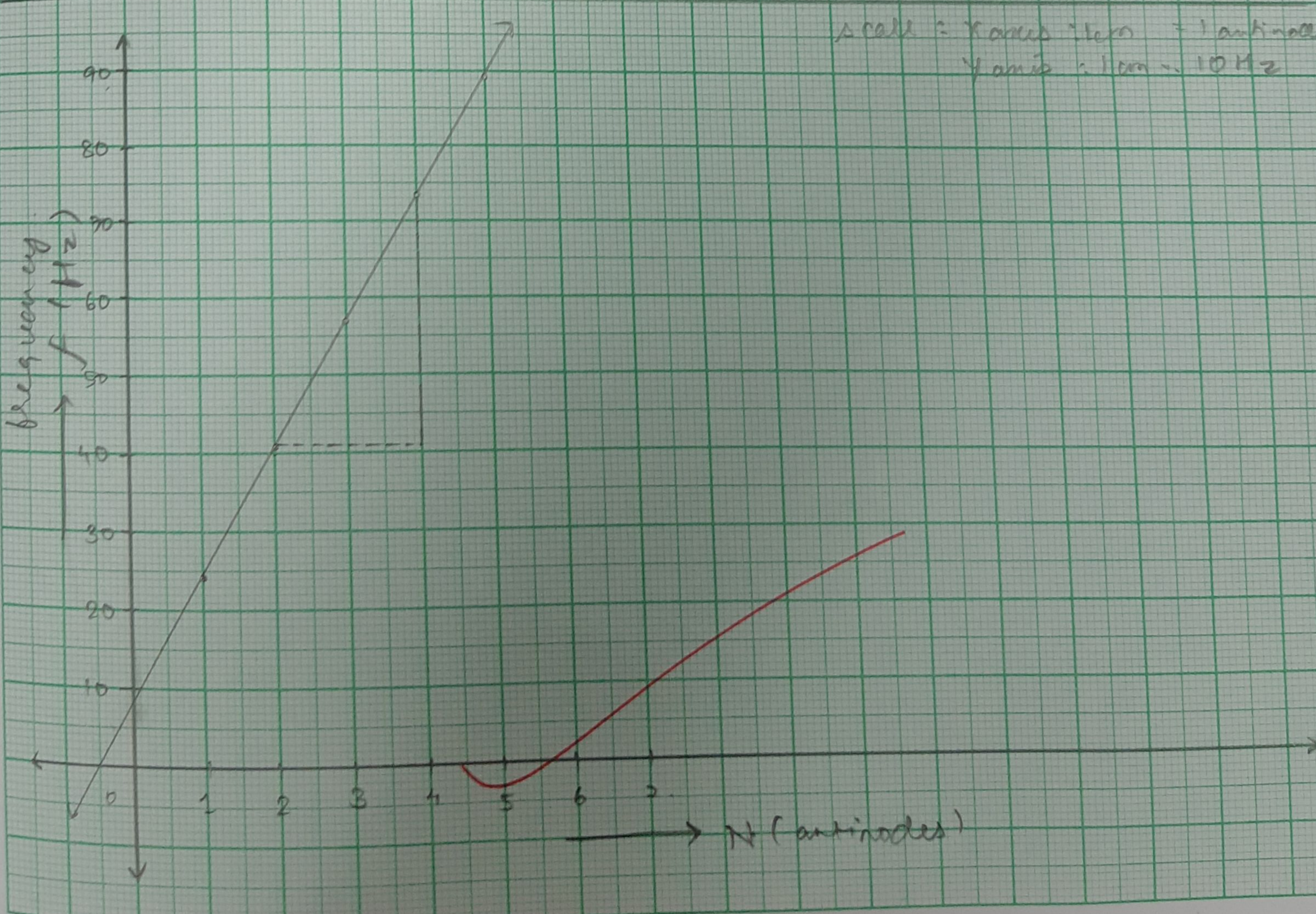


5. Doppler's effect

Scale : x : 2cm = 0.01 m/s
y : 2cm = 1 Hz



Scale : X axis : 1cm = 1 antinode
Y axis : 1cm = 10 Hz



Young's Modulus