Karnatak University's

Karnatak Science College Dharwad

Department of Physics

LABORATORY MANUAL

B.Sc. FIRST SEMESTER

Karnataka Science College Dharwad
Department of physics
BSc FIRST SEMESTER

Estimation of Errors

Aim: Estimate Average deviation, Standard deviation and Probable error in the experimental determination of physical quantities like diameter, in addition, fit the acceleration due to gravity data to a straight-line graph from a least square fit method.

Theory:

Errors: There is some error or the other in every measurement we make. The errors are of two kinds;

a) Errors due to known causes (Systematic errors).
b) Errors due to unknown causes (Random errors).

a) Systematic errors: Systematic errors are due to

i) The temperature of the measuring scale being different from that at which it was graduated.

ii) Radiation loss or gain in calorimeter measurement.

iii) Error in measuring time with a stop watch, the watch running either too slow or too fast.

b) Random error: If an observation is repeated a number of times by the same person under similar conditions, it's found that every time a different reading is obtained, even though the instrument used is very sensitive and accurate and the observer is an experienced one. These errors are not due to any definite cause. We, therefore, cannot depend upon a single observation. The precision with which a physical quantity is measured depends inversely upon the deviation or dispersion of the set of measured values(X_i) about their mean value ($\bar{X}$). If the values are widely dispersed or the observed values have a large deviation from the true value, the precision is said to be low.

The deviation $\delta_i = X_i - \bar{X}$

Average Deviation: The average value of the deviation of all the individual measurements from the arithmetic mean is known as average deviation.

Standard deviation: The square root of the mean square deviation for an infinite set of measurements is known as standard deviation and is denoted by σ.

Standard error: The quantity $(\sigma/\sqrt{n})$ is known as standard error is denoted by σ_m

Probable error: The probable error is a quantity 'e' such that it is an even chance whether true value of the quantity measured differs from the mean value by an amount greater or less than 'e'

OBSERVATIONS AND CALCULATIONS:

A. Estimation of error in the measurement of diameter of the given wire using given Screw Gauge data:

Least count of the screw gauge = 0.01 mm

Zero Error = -5

Tabular column-3:

S.NO	Pitch scale reading (PSR) (mm)	Head scale reading (HSR)	$T.R = PSR + (HSR \pm ZE)LC$ X_i	Deviation $\delta_i = X_i - \bar{X}$	δ_i^2
1	2	41	X_1=	δ_1=	δ_1^2=
2	2	39	X_2=	δ_2=	δ_2^2=
3	2	40	X_3=	δ_3=	δ_3^2 =
4	2	41	X_4=	δ_4=	δ_4^2=
5	2	42	X_5=	δ_5=	δ_5^2=
6	2	39	X_6=	δ_6=	δ_6^2=
7	2	38	X_7=	δ_7=	δ_7^2=
8	2	40	X_8=	δ_8=	δ_8^2=
9	2	42	X_9=	δ_9=	δ_9^2=
10	2	41	X_{10}=	δ_{10}=	δ_{10}^2=
			Mean $\bar{X}=\frac{\sum x_i}{n}$		$\sum \delta_i^2$

Standard deviation

$$\sigma = \sqrt{\frac{\sum \delta_i^2}{n-1}}$$

Standard error

$$\sigma_m = \sqrt{\frac{\sum \delta_i^2}{n(n-1)}}$$

Probable error

$$e = \pm 0.6745\sqrt{\frac{\sum \delta^2}{n(n-1)}}$$

B. Estimation of errors in the measurement of Diameter of Bob.

Least count of the Vernier Calipers:

Total number of observations = n = 10

Tabular Calumn-1:

S.No	Main scale reading (MSR)	Coinciding Vernier Division (CVD)	Diameter of Bob Total reading X_i=MSR+(CVD x LC)	Deviation $\delta_i = X_i - \bar{X}$	δ_i^2
1			X_1=	δ_1=	δ_1^2=
2			X_2=	δ_2=	δ_2^2=
3			X_3=	δ_3=	δ_3^2 =
4			X_4=	δ_4=	δ_4^2=
5			X_5=	δ_5=	δ_5^2=
6			X_6=	δ_6=	δ_6^2=
7			X_7=	δ_7=	δ_7^2=
8			X_8=	δ_8=	δ_8^2=
9			X_9=	δ_9=	δ_9^2=
10			X_{10}=	δ_{10}=	δ_{10}^2=
				Mean $\bar{X}=\frac{\sum x_i}{n}$	$\sum \delta_i^2$

Standard deviation

$$\sigma = \sqrt{\frac{\sum \delta_i^2}{n-1}}$$

Standard error

$$\sigma_m = \sqrt{\frac{\sum \delta_i^2}{n(n-1)}}$$

Probable error

$$e = \pm 0.6745\sqrt{\frac{\sum \delta^2}{n(n-1)}}$$

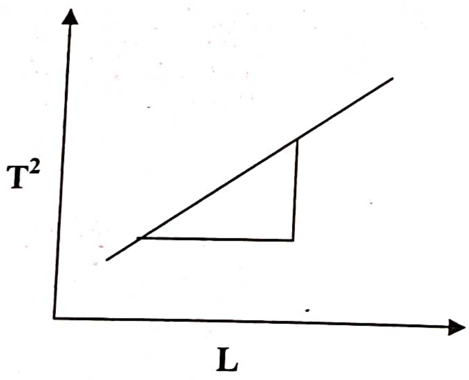
C. Estimation of error in the measurement of acceleration due to gravity using simple pendulum:

Experimental data for the determination for acceleration due gravity (g) by simple pendulum.

Tabular column-1:

No.	Length $L = l + r$ (in cm)	Time for 10 oscillations (in seconds)	Time period $T = t/10$ (in seconds)	T^2 (in $seconds^2$)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Nature of Graph



$$g = \frac{4\pi^2}{Slope}$$

Acceleration due to gravity (from experimental data) g =

Experimental data for the determination for acceleration due gravity (g) using simple pendulum plotting L vs T^2 graph by using least square fit method.

Tabular column-3:

Length 'L' (in cm) X_i	**T^2 (Y_i)**	**$X_i\ Y_i$**	**X_i^2**
X_1	Y_1		X_1^2
X_2	Y_2		X_2^2
X_3	Y_3		X_3^2
X_4	Y_4		X_4^2
X_5	Y_5		X_5^2
X_6	Y_6		X_6^2
X_7	Y_7		X_7^2
X_8	Y_8		X_8^2
X_9	Y_9		X_9^9
X_{10}	Y_{10}		X_{10}^2
$\sum X_i =$	$\sum Y_i =$	$\sum X_i Y_i$	$\sum X_i^2=$

No of observation(n)=

m= slope of the line.

$$m = \frac{n\sum Xi\ Yi - \sum Xi\ \sum Yi}{n\sum X_i^2 - (\sum X_i)^2}$$

b= intercept of the line

$$b = \frac{\sum Y_i - m\sum X_i}{n}$$

Length of the thread L in cm x_i	**Least square fit values of T^2 $y_i = mx_i + b$**

Plot the Yi versus X_i graph and find out the acceleration due to gravity.

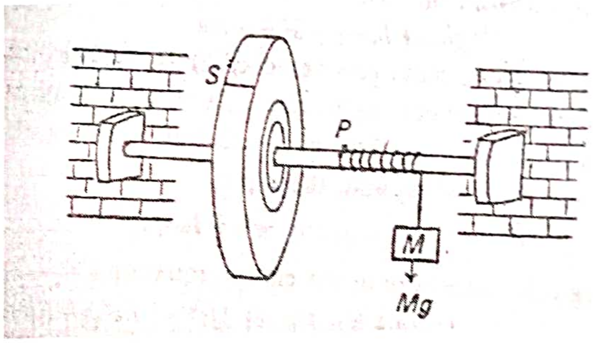
KARNATAK SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. -- I Semister

FLY WHEEL

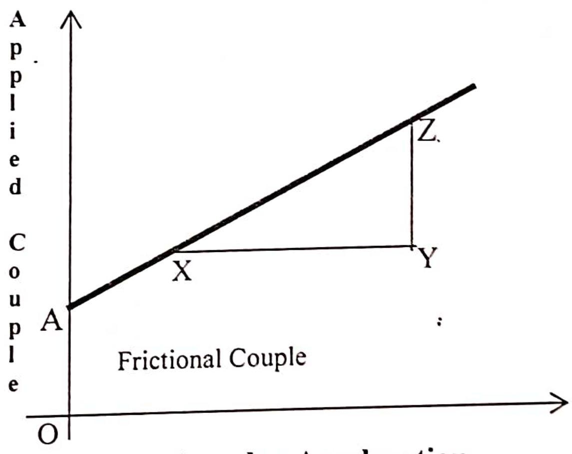
AIM: **Determine the moment of inertia of the fly wheel from the graph of applied couple against angular acceleration. Calculate frictional couple.**

APPARATUS: Fly Wheel, weight pan, weight Box, Stop watch, vernier calipers.

Schematic Diagram:



NATURE OF THE GRAPH :



Formula:

From the graph,

Slope = ZY / XY = M.I. (Moment of Inertia) of fly wheel

= ... Kgm^2

Intercept = Frictional Couple

= OA

= ________Newton meter

OBSERVATIONS:

Least count of vernier calliperse =

1) Diameter of the axle

Trial 1. ______ cm
Trial 2. ______ cm
Trial 3. ______ cm

2) Mean diameter of the axle (2r) = ______ cm
3) Radius of the axle (r) = ______cm = -----------m

4) Total number of windings of thread on axle $n_1 = 10$
5) Mass of the pan = P_0 = ______ kg

6) Acceleration due to gravity = g = 9.8 m/s^2

No. of obns	Total mass = M (P$_0$ + Mass added to pan) Kg	Applied couple (Mgr) in N-m	No. of revolutions after detachment of mass(n_2)			Time taken for n_2 rotations 't' in sec			Mean n_2	Mean of 't' in sec	Angular acceleration
			I	II	III	I	II	III			
1	P_0+0.005 =										
2	P_0+0.010 =										
3	P_0+0.015 =										
4	P_0+0.020 =										
5	P_0+0.025 =										
6	P_0+0.030 =										

PROCEDURE:

1) Slip one end of the string on to the pin on the axle and add a mass of 5 gms to the pan attached to the other end of the string.
2) Raise the mass through a height 'h' by rotating the fly wheel through n_1 turns (n_1 = the number of windings of the thread on the axle=10).
3) Release the fly wheel without any jerk to the pan. When the sting just detaches from the pin, start the stop watch. When the fly wheel just comes to rest, stop the stop watch. Note down the number of revolutions (n_2) made by the fly wheel and time taken (t_2 seconds).
4) Repeat the experiment for different masses.

Result:

Slope = M.I. of fly wheel = ____________ kg-m^2

Intercept = Frictional couple = OA = ________ Nm.

KATER'S PENDULUM

AIM: To determine the value of 'g' using a Kater's Pendulum (reversible pendulum).

APPARATUS: A Kater's Pendulum, knife edges, support stands,stop watch,measuring tape/scale.

Theory:

Kater's pendulum, shown in Fig. 1, is a physical pendulum composed of a metal rod 1.20 m in length, upon which are mounted a sliding metal weight W_1, a sliding wooden weight W_2, a small sliding metal cylinder w, and two sliding knife edges K_1 and K_2 that face each other. Each of the sliding objects can be clamped in place on the rod. The pendulum can suspended and set swinging by resting either knife edge on a flat, level surface. The wooden weight W_2 is the same size and shape as the metal weight W_1. Its function is to provide as near equal air resistance to swinging as possible in either suspension, which happens if W_1 and W_2, and separately K_1 and K_2, are constrained to be equidistant from the ends of the metal rod. The centre of mass G can be located by balancing the pendulum on an external knife edge. Due to the difference in mass between the metal and wooden weights W_1 and W_2, G is not at the centre of the rod, and the distances h_1 and h_2 from G to the suspension points O_1 and O_2 at the knife edges K_1 and K_2 are not equal. Fine adjustments in the position of G, and thus in h_1 and h_2, can be made by moving the small metal cylinder w.

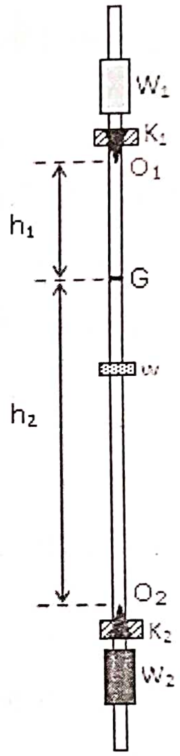


Figure 1

In Fig. 1, we consider the force of gravity to be acting at G. If h_i is the distance to G from the suspension point O_i at the knife edge K_i, the equation of motion of the pendulum is

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

where I_i is the moment of inertia of the pendulum about the suspension point O_i, and i can be 1 or 2. Comparing to the equation of motion for a simple pendulum

$$Ml_i^2\ddot{\theta} = -Mgl_i \sin\theta$$

we see that the two equations of motion are the same if we take

$$Mgh_i / I_i = g / l_i \qquad (1)$$

It is convenient to define the radius of gyration of a compound pendulum such that if all its mass M were at a distance from O_i, the moment of inertia about O_i would be I_i, which we do by writing

$$I_i = Mk_i^2$$

Inserting this definition into equation (1) shows that

$$k_i^2 = h_i l_i \qquad (2)$$

If I_G is the moment of inertia of the pendulum about its centre of mass G, we can also define the radius of gyration about the centre of mass by writing

$$I_G = Mk_G^2$$

The parallel axis theorem gives us

$$k_i^2 = h_i^2 + k_G^2,$$

so that, using (2), we have

$$l_i = \frac{h_i^2 + k_G^2}{h_i}$$

The period of the pendulum from either suspension point is then

$$T_1 = 2\pi\sqrt{\frac{l_1}{g}} = 2\pi\sqrt{\frac{h_1^2 + k_G^2}{gh_1}} \qquad (3)$$

Squaring (3), one can show that

$$h_1T_1^2 - h_2T_2^2 = \frac{4\pi^2}{g}\left(h_1^2 - h_2^2\right)$$

and in turn,

$$\frac{4\pi^2}{g} = \frac{h_1T_1^2 - h_2T_2^2}{(h_1+h_2)(h_1-h_2)} = \frac{T_1^2 + T_2^2}{2(h_1+h_2)} + \frac{T_1^2 - T_2^2}{2(h_1-h_2)}$$

which allows us to calculate g,

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

$$g = \frac{8\pi^2}{\frac{T_1^2 + T_2^2}{h_1+h_2} + \frac{T_1^2 - T_2^2}{h_1-h_2'}} \qquad \text{..........(4)}$$

Procedure:

1. The knife edges must be fixed at the same height so as to make sure the mass of the pendulum will be distributed evenly over both bearing points. Make sure that the table and the stage supporting the knife edges do not move 'with the pendulum. The geometrical length of the rod used as reversible pendulum is 75 cm to which the bearing can be screwed at a desired position. The time period T of the pendulum is determined for small oscillating amplitudes.

2. In this experiment in order to find g, first we need to determine the height of the sleeve W1 and W2 from the center of gravity.

3. Throughout the experiment sleeve W1(metal) is fixed at a distance of 7 – 10 cm from one end of the pendulum. Position of sleeveW2(wooden) can be varied.

4. Adjust the bearing sleeve W2 . Now find the center of gravity for this system and measure the distance between W1 to center of gravity and note as h_1.Simillarly measure h_2. Make sleeve W1 as the pivot point and record the time period T_1 about W1.

5. Now turn the pendulum upside down and make sleeve W2 as the pivot point. Measure the time period T_2 by varying the position of sleeve W2 (keeping position of sleeve W1 fixed)

6. Repeat the above steps i.e. vary the position of W2, find the center of gravity for this new system. Measure h_1 and h_2 from th center of gravity.

7. Now to determine the value of g using the equation (4).

TABULAR COLUMN -1:

S. No.	Distance between sleeve W1 and center of gravity (h_1) cm	Distance between sleeve W2 and center of gravity (h_2) cm	Time for 20 oscillation pendulum when sleeve W1 as the pivot point **t_1 (sec)**	Time period of a pendulum when sleeve W1 as the pivot point **T1 (sec)**	Time for 20 oscillation pendulum when sleeve W2 as the pivot point **t_2 (sec)**	Time period of a pendulum when sleeve W2 as the pivot point **T2 (sec)**	g (cm/s^2)

KARNATAK SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. – I Semister

Parallel Axes Theorem Of Moment of Inertia

Aim: To verify Parallel Axes Theorem Of Moment of Inertia using bar pendulum.

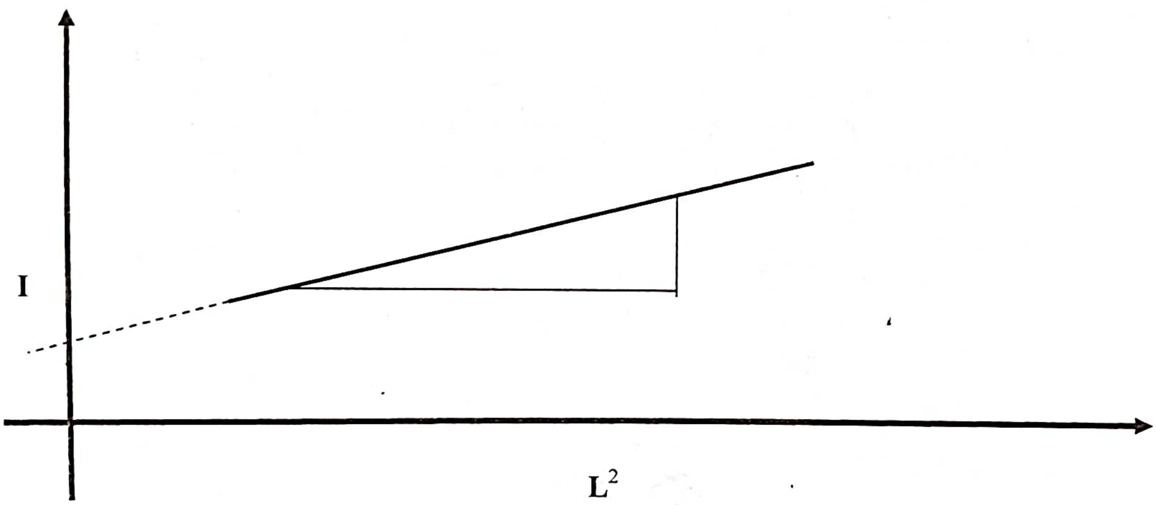
Apparatus: Bar pendulum, Knife Edge, Telescope, wax, pin Clock, Thread, Scale.

Formula:

(I) Moment of Inertia (M.I) of Rectangular body about an axis parallel to the axis passing through C.G is $I = I_{CG} + ML^2$

where $I = MgLT^2/(4\pi^2)$
I_{CG} = *M.I of rectangular body about CG*
M= Mass of the bar(rectangular body)
L= distance between two parallel axes
(or distance of the hole from CG)

Nature of the graph:



Observations:

1) Mass of the bar Pendulum= kg

2)Total Length of the bar pendulum= X= m

3) Breadth of the bar pendulum = Y= m

Tabular Column:

Sl. No.	Distance of the hole from CG L	Time for 20 oscillations t in s		Time period T=t/20 s	L^2	LT^2	M.I I
		i	ii				
1							
2							
3							
4							
5							
6							
7							

Theoretical calculation of I_{CG} :

$$I_{CG} = M(X^2 + Y^2) / 12$$

Result: I_{CG} (from graph) = -------------------- $kg\ m^2$

I_{CG} (from formula) = -------------------- $kg\ m^2$

KARNATAK SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. – I Semister

YOUNG'S MODULUS USING CANTILEVER

AIM: Determine Young's modulus of given material with the cantilever beam arrangement.

APPARATUS: Travelling Microscope, Wooden/steel/plastic scales, Weight box and Screw Gauge.

INTRODUCTION:

Young's modulus:

It is defined as the ratio of stress to longitudinal strain within elastic limit. The longitudinal strain is measured by observing the change in length per unit length. If 'L' is the length of a wire and an increase in length 'l' produced by a force F, then,

Strain = (l/L) and Youngs modulus = Y = (Stress/ Strain) = (F/a) x (L/l)

Young's modulus can be used to predict elongation or compression of an object as long as the stress is less than the yield strength of the material.

Cantilever: It is a beam fixed horizontally at one end and loaded at the other.

FORMULA:

$$\textbf{Young's Modulus} = Y = \frac{4gl^3}{bd^3} \times \left(\frac{m}{e}\right) \quad \textbf{(N/m}^2\textbf{)}$$

Where 'g' is the acceleration due to gravity, 'l' is the length of the cantilever, 'b' is the width of the Wooden/steel/plastic scales, 'd' is the thickness of the Wooden/steel/plastic scales, 'm' is the mass suspended and 'e' is the depression.

OBSERVATIONS:

1. Thickness of the Steel scale $=d_s$ =........................cm. =................meters
2. Width of the Steel scale $=b_s$ =........................cm. =................meters

TABULAR COLUMN:

For Steel Scale:

Projected Length = l = ...cm. = ... meters.

Least count of the given Travelling Microscope = ... cm.

S.No.	Mass suspended (kg) 'm'	Microscope Reading		Mean Reading (cm)	Depression 'e' in meters
		Load increasing(cm)	Load decreasing(cm)		
1				a_0	
2				a_1	$a_0 - a_1$
3				a_2	$a_0 - a_2$
4				a_3	$a_0 - a_3$
5				a_4	$a_0 - a_4$
6				a_5	$a_0 - a_5$

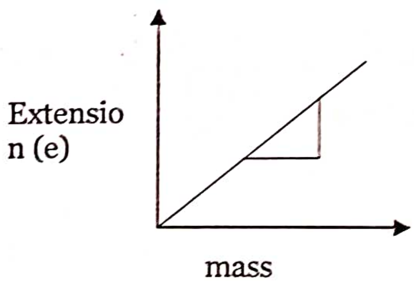
GRAPH: Plot 'e' versus 'm' graph and find the slope of the graph.

Slope = (e/m) = ... m/kg

CALCULATIONS:

$$\textbf{Young's Modulus} = Y = \frac{4gl^3}{bd^3} \times \left(\frac{1}{slope}\right)$$

NATURE OF THE GRAPH:



Result: The Young's modulus of given material is =

KARNATAKA SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. Part- I (SEMESTER-I)

MAXWELL'S NEEDLE

AIM: Determine the modulus of rigidity of the material of the given wire using Maxwell's Needle. Take at least three lengths of the wire.

APPARATUS: Maxwell's Needle, wire, fixed support with torsion head, lamp and scale arrangement, stopwatch (stop clock), micrometer screw, balance, and meter rod.

THEORY: Maxwell's needle consists of a hollow cylindrical tube in which two hollow and two solid cylinders of the same diameter and equal length can be fitted. The needle is suspended from a rigid support by the given wire. If T1 is the period of torsional oscillations when the solid cylinders are at the end (system I), C is the couple per unit twist of the wire, then

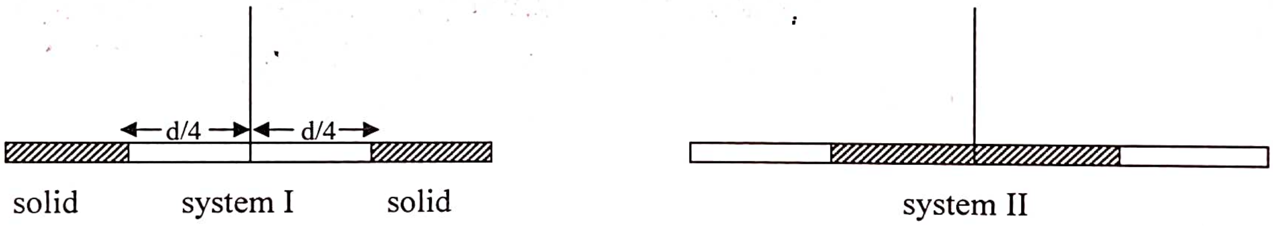
$$T_1 = 2\Pi\sqrt{(I_1/C)} \qquad (1)$$

where I_1 = M.I of system - I about wire.

Similarly if T_2 is the period of torsional oscillations when solid cylinders are at the center (system II).

$$T_2 = 2\Pi\sqrt{(I_2/C)} \qquad ....(2)$$

where I_2/C = M.I of system - II about wire



From (1) and (2) $T_1^2 - T_2^2 = \frac{4\Pi^2 (I_1 - I_2)}{C}$ ......(3)

Now $I_1 = I_0 + 2m_2\left(\frac{d}{8}\right)^2 + 2m_1\left(\frac{3d}{8}\right)^2$

$I_2 = I_0 + 2m_2\left(\frac{3d}{8}\right)^2 + 2m_1\left(\frac{d}{8}\right)^2$

where I_0 = M.I of the needle about the wire
m_1 = Mass of either solid cylinder
m_2 = Mass of either hollow cylinder
d = Length of the needle

Hence $I_1 - I_2 = \frac{d^2}{4}(m_1 - m_2)$ ....(4)

Further $C = \frac{n \Pi r^4}{2L}$ where n = modulus of rigidity
r = radius of wire
L = Length of wire ,
Hence (3) becomes $T_1^2 - T_2^2 = 2\Pi d^2 L\ (m_1 - m_2)$ and So

$$n = \frac{2\Pi m d^2}{r^4} \left\{ \frac{L}{T_1^2 - T_2^2} \right\}$$

where $m = m_1 - m_2$

PROCEDURE :

1. Measure the length (d) of the needle by meter rod. Determine the mass of both solid cylinders ($2m_1$) and that of hollow cylinders ($2m_2$) by a balance.
2. Measure the diameter of the wire accurately at several places with micrometer screw.
3. Arrange the lamp and scale at a suitable distance from the needle.
4. Find the time for 10 oscillations when the solid cylinders are at the end and determine T_1, similarly calculate T_2, (the needle should not vibrate up and down)
5. Measure length (L) of wire from point of suspension to the point where it is attached to the needle.
6. Repeat the experiment with 2 more lengths of the wire.

OBSERVATIONS:

1. Length of Maxwell's Needle = d = ...cm = ...m
2. Mass of two solid cylinders ($2m_1$) = ...gm = ...kg
3. Mass of two hollow cylinders ($2m_2$) = ...gm = ...kg
4. Mass of one solid cylinder = m_1 = ...kg
5. Mass of one hollow cylinder = m_2 = ...kg
6. Mass $m = m_1 - m_2$ = ...kg
7. Diameter of the wire = i) ....mm ii) ....mm
   iii) ....mm iv) ....mm v) ....mm
   Mean = ...mm = ...m = 2r
8. Mean radius of the wire = r =........m

No. of obs	Length of Wire L meter	Time for 10 oscillations when solid cylinders are at end (secs)				Period T_1 secs	Time for 10 oscillations when solid cylinders are at the centre (secs)				Period T_2 secs	$\frac{L}{T_1^2-T_2^2}$
		I	II	III	Mean		I	II	III	Mean		
1												
2												
3												

Mean =

CALCULATIONS: Modulus of rigidity $n = \frac{2\Gamma I m d^2}{r^4}\left\{\frac{L}{T_1^2 - T_2^2}\right\}$

Karnataka Science College Dharwad
Department of physics
B.Sc. FIRST SEMESTER

Poisson's Ratio

Determination of Different Coefficient of Elasticity and Poisson's Ratio using Searle's Apparatus.

Aim: To determine the Young's Modulus, Bulk Modulus and Modulus of Rigidity of wire, and hence the Poisson's Ratio using Searle's Apparatus.

Apparatus: Searle's apparatus, rectangular bar, wire, thread, candle, match box, stop watch etc.

Formula:

Young's Modulus: $Y = \frac{8\pi l I}{T_1^2 r^4}$

Modulus of Rigidity: $\eta = \frac{8\pi l I}{T_2^2 r^4}$

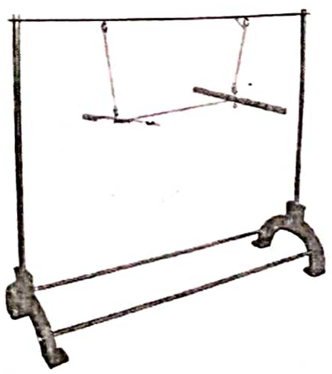
Poisson's ratio: $\sigma = \frac{T_2^2}{2T_1^2} - 1$

Bulk Modulus: $K = \frac{Y}{3(1-2\sigma)}$

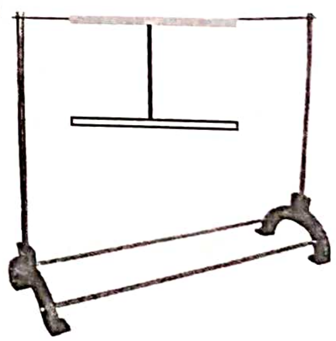
Moment of inertia: $I = M\left(\frac{L^2+b^2}{12}\right)$

where l: length of the wire, r is radius of the wire, M is mass of the bar, b is breadth of the bar, L is length of the bar, T_1 time period for horizontal configuration and T_2 time period for vertical configuration.

Experimental Arrangement



Horizontal Configuration of wire



Vertical Configuration of wire

Observations:

Mass of the bar M= gm= kg

Length of the bar L= cm= m

Breadth of the Bar (b)

i) ii) iii) mean b= cm= m

Radius of the wire (r)

i) ii) iii) mean diameter d= mm= m

Radius of wire r= d/2= mm= m

Tabular Column

Configuration	Time for 10 oscillation t (s)					Time Period T T=t/10 (s)
	t1	t2	t3	t4	Mean t (s)	
Horizontal						T_1=
Vertical						T_2=

Calculation:

Moment of inertia: $I = M\left(\frac{L^2+b^2}{12}\right)$

Young's Modulus: $Y = \frac{8\pi l I}{T_1^2 r^4}$

Modulus of Rigidity: $\eta = \frac{8\pi l I}{T_2^2 r^4}$

Poisson's ratio: $\sigma = \frac{T_2^2}{2T_1^2} - 1$

Bulk Modulus: $K = \frac{Y}{3(1-2\sigma)}$

Result:

Young's Modulus of wire = ... N/m^2

Modulus of Rigidity of wire =............ N/m^2

Bulk Modulus of wire =......... N/m^2

Poisson's ratio of wire =

KARNATAK SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. – I SEMISTER

Bifilar Suspension

Aim: To determine the moment of inertia of the regular object (Rectangular object) by bifilar suspension method. Compare the experimentally determined value of M.I with theoretical value.

Apparatus: Wooden block (Regular shaped object), Frame, Thread, Timer, telescope, scale, caliperse etc.

Formula:

$$I = \frac{Mgdd'}{4\pi^2}(T^2/l) \quad \text{kg-m}^2$$

where
M= mass of the regular body
g = Acceleration due to gravity
d =(Separation between points of suspension)/2= AB/2
d'= (Distance between hooks on regular body)/2 = CD/2
T=Time period
l = length of the thread =AC=BD

Theoretical Formula for M.I:

$$I = M(L^2+B^2)/12$$

where
M= mass of the regular object(Rectangular block)
L = Length of the block
B = Breadth of the block

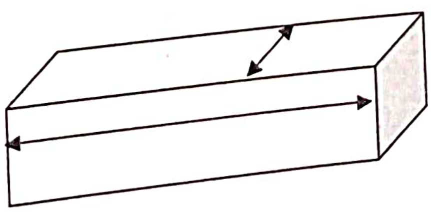
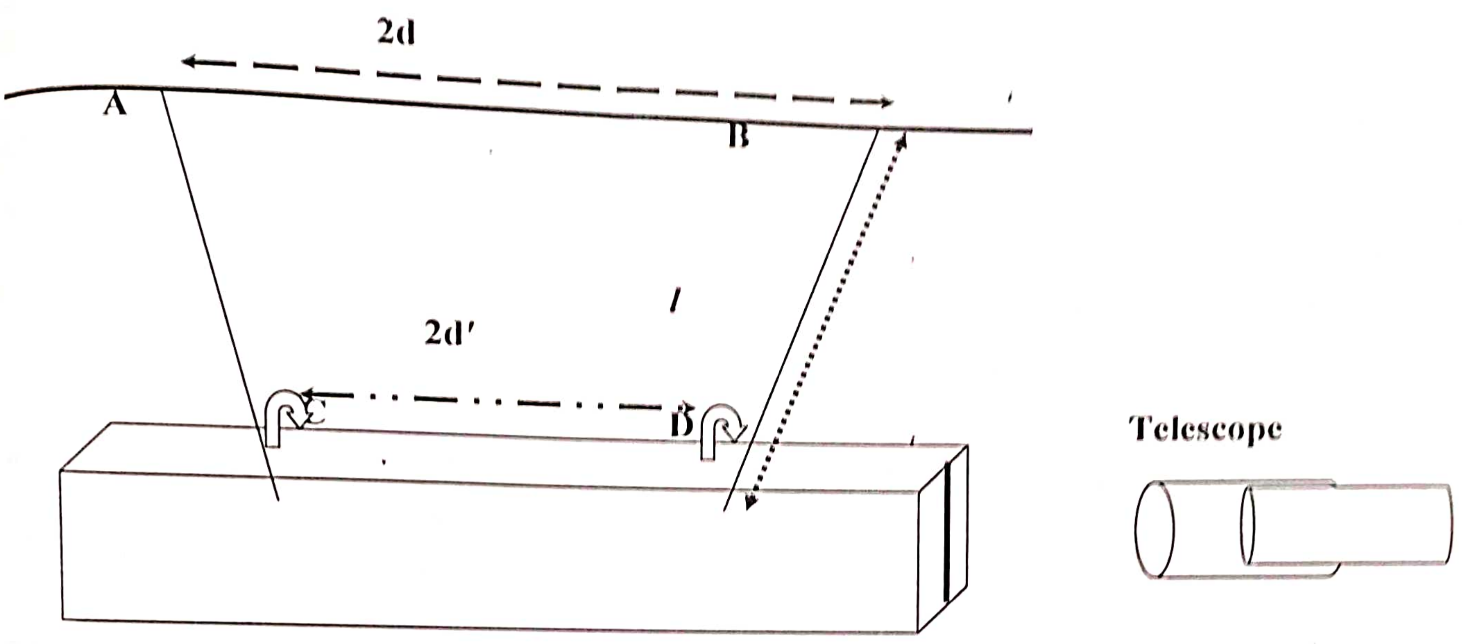


Diagram:



Observations:

1) Mass of the regular object= M = kg

2) Length of the object = L = m

3 Breadth of the object= B = m

Trial No.	Length l (m)	AB=2d	d m	CD=2d'	d' m	Time for 30 Oscillations I s	Ii s	Ii s	Mean t in s	Time Period s	Momet of inertia I Kg-m²
1											
2											
3											
4											
5											
6											

Average I=

Result:

Measured Moment of inertia of given regular object about vertical axis	=	$kg\text{-}m^2$
Theoretically calculated M.I of given regular object about same vertical axis	=	$kg\text{-}m^2$

KARNATAKA SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. I SEMESTER

Volume Resonator

Aim: Obtain experimentally the volume of air in resonator that would resonate with each of the five tuning forks of frequency N. Plot a graph of V vs $1/N^2$ and hence determine the frequency of the unknown tuning fork, the neck correction and natural frequency of the resonator

Apparatus: Resonator filled with water on stand , tuning forks, pinchcock , rubber pad and measuring cylinder

Theory: As the water flows out of the resonator , the volume of the air inside it increases. The air in the neck moves back and forth like a piston when the vibrating tuning fork is held over the mouth of the resonator. For a certain volume of air in a resonator, a loud sound is heard indicating that the air inside resonates. The frequency of vibration of air-piston in the neck equal to the frequency of the tunning fork is given by

$$N = \frac{1}{2\pi}\sqrt{\frac{\gamma p a^2}{m v}}$$

where $\gamma = \frac{C_p}{C_v}$ p is pressure inside , a is area of cross section of the neck v is volume of air in the resonator and m is mass of the air in the neck.

Since velocity of sound $v = \sqrt{\frac{rP}{\rho}}$ $\quad\quad rP = v^2\,\rho$

Hence $N = \frac{1}{2\pi} v\sqrt{\frac{a}{lV}}$. $\quad$ and $\quad N^2 V = \frac{v^2\, a}{4\pi^2 l} = constant$

L is length of the neck and ρ is density of air

However the relation experimentally found is
$N^2 = (V + v_0) =$ constant v_0 is called neck correction.

Procedure:

1. Fill the resonator to the base of the neck. Arrange the given forks in descending order of the frequency
2. Set the tuning fork of the highest frequency into vibration and hold it just above the mouth of the resonator. Allow the water to flow out at slow rate till a sound heard. Measure the volume of the collected water with the help of measuring cylinder. Repeat this three times and find the mean volume of the resonating air.
3. Repeat the above process for the remaining four forks and also for the unknown fork.
4. Plot the graph of V vs $1/N^2$ and from the graph calculate the neck correction, frequency of the unknown tuning fork and the natural frequency of the resonator.

Observations:

Volume of the bottle V_r=...........cc

No. of Observations.	Frequency of the fork N	Volume of the water collected out from the Volume resonator V in cc			Mean V	$1/N^2$
1						
2						
3						
4						
5						
6	Unknown				V_x	

KARNATAKA SCIENCE COLLEGE, DHARWAD
DEPARTMENT OF PHYSICS
B.Sc. I SEMESTER

Frequency of A.C. by Sonometer

Aim: To determine the frequency of AC source using Sonometer
Apparatus: Sonometer strong magnets, AC ammeter, rheostat, plug key, wire etc.

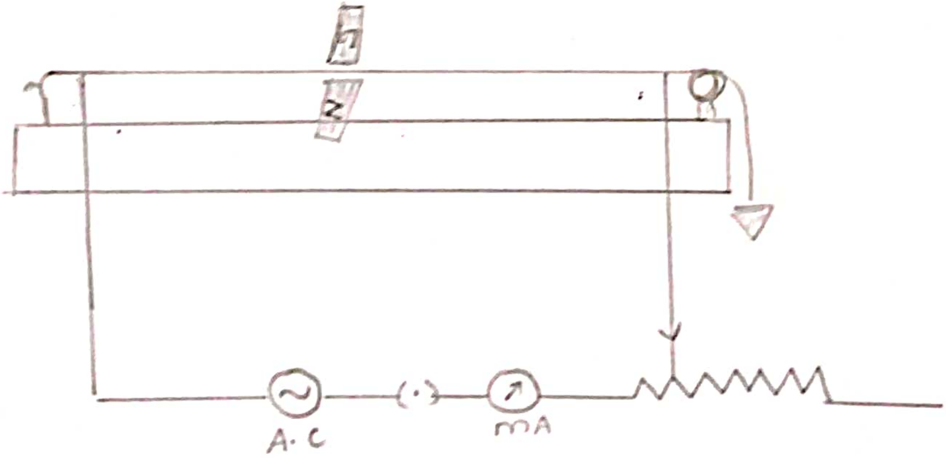
Principle:
The frequency of vibrating string is given by

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}} \quad \text{Hz}$$

where *l is* vibrating length T is Tension and M is mass per unit length of the string

Principle: The AC from 6 V transformer is passed through the sonometer wire with rheostat and AC ammeter in series as shown in figure. Two strong magnets with N and S poles symmetrically placed on the two sides of the wire are arranged to produced magnetic field perpendicular to the direction of the current. The wire will experience a force perpendicular to the plane of paper. Setting the wire to vibrate with the frequency of AC, the wedges are adjusted till the amplitude of vibration is maximum. The frequency of vibration of the wire will then be equal to the frequency of AC.

Circuit Diagram:



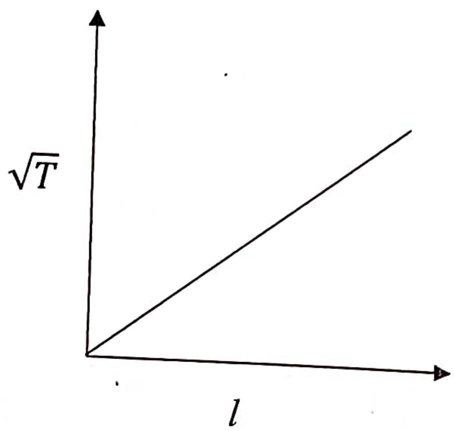
Observation:

1. Mass per unit length (m)= …….kg/m
2. Mass of the pan (M_o)=……..gm=……..kg

Tabular Column:

No. Observation	Load applied $M= M_o+M'$ (kg)	Tension $T=M \times g$ (N)	Length of the vibrating loop l (m)	$\sqrt{\frac{T}{l}}$	Frequency of AC $n = \frac{1}{2l}\sqrt{\frac{T}{m}}$

Graph:



From the graph obtain slope

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

Procedure:

1. Make the electrical connections shown in the circuit diagram. Keep N and S poles of two magnets close but symmetrically with respect to the wire.
2. For weights 5 gm, 10gm,15 gm and so on in the pan, adjust the wedges such that a loop of maximum amplitude is observed. Note the distance (l) between the wedges in each case. Calculate T=Mg in each case.
3. Calculate the frequency n in each case using the formula
4. Plot the graph and determine slope. Using slope determine the frequency.