KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)
(Established Under Section 3 of UGC Act 1956)
COIMBATORE-21
(For the candidates admitted from 2019 onwards)

DEPARTMENT OF PHYSICS

SUBJECT: PROPERTIES OF MATTER AND ACOUSTICS PRACTICAL
SEMESTER: I
SUB.CODE:19PHP112 **CLASS: I B.Sc PHYSICS**

Course Objective

1. To be able to identify solids, liquids and gases, and their main properties.
2. To be able to identify changes of state.
3. To be able to discuss changes of state in terms of the energy of molecules

Course Outcomes (COs)

1. Study the elastic behavior and working of torsional pendulum.
2. Study the bending behavior of beams and analyse the expression for young's modulus.
3. Understand about the surface tension and viscosity of fluid.

ANY SIX EXPERIMENTS

1. To determine the Young's Modulus of the wooden by Optical Lever Method.
2. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
3. To determine the Young's modulus of the bar using pin and microscope – Non-uniform method.
4. To determine the Young's modulus of the bar using cantilever – Non-uniform method.
5. To determine the surface tension of water – capillary rise method
6. To determine the coefficient of viscosity by Stoke's method
7. Verification of laws of transverse vibration and frequency of tuning fork – Sonometer
8. Rigidity modulus – Torison pendulum
9. To determine the Young's modulus of the bar – Koenig's method
10. To determine the coefficient of viscosity of the liquid – Poiseuille's method

SUGGESTED READINGS

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. Elements of Properties of Matter by D.S. Mathur, S.Chand & Co.

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3. To determine the Young's modulus of the bar using cantilever – Non-uniform method.
4. To determine the surface tension of water – capillary rise method
5. To determine the coefficient of viscosity by Stoke's method
6. Rigidity modulus – Torison pendulum

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YOUNG'S MODULUS BY NON-UNIFORM BENDING

Expt No:

Date:

Aim

To determine the Young's modulus of the material of the given beam by non uniform bending.

Apparatus required

Travelling microscope, two knife edge supports, weight hanger with set of weights, pin, meter scale, vernier calipers and screw gauge.

Formula

The Young's modulus of the material of the beam (meter scale) is

$$E = \frac{Mgl^3}{4bd^3y} \quad N/m^2$$

Where

E =Young's Modulus of the material of the beam (N/m^2)

y =depression at the center of the beam (m)

M=Mass suspended at the center of the beam (Kg)

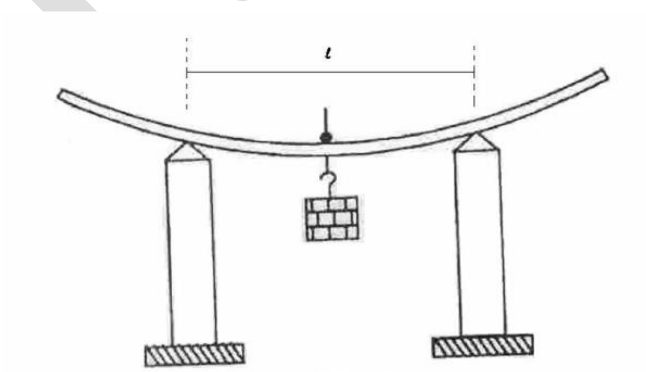
g = acceleration due to gravity (9.8 m/s^2)

l =distance between the two knife edges (m)

b = breadth of the beam (m)

d = thickness of the beam (m)

Experimental Procedure



- Using two knife edges, the meter scale is placed horizontally.

- Exactly midway between the knife edges, a pin index using clay is affixed such that its tip is facing upwards. At that point a weight hanger is suspended.
- The microscope is adjusted such that the tip of the image of the pin is exactly at the centre of the cross wires.
- The loads are added to the hangers in steps of 50 gm and the microscope is adjusted so that the tip of the image of the pin just coincides with the horizontal cross wires in each case and the microscope readings are noted.
- After reaching the maximum load, the hanger is unloaded in the same steps of 50 gm and the microscope readings are noted again.
- The experiment is repeated for the different lengths of beam.
- Finally the breadth of the scale is measured using vernier calipers and the thickness using screw gauge respectively at different points on the beam and mean value is taken.

Observations:

Least count of Traveling microscope (L.C) = 0.001cm (or) 0.001 x10^{-2}m

V.S.R = V.S.C x L.C T.R = M.S.R+ V.S.R

Distance between the two knife edges (l) = __________ x10^{-2}m

To find the average value of M/Y

S.No	Load M x10^{-3} kg	Microscope readings						Mean x10^{-2}m	Average depression Y (for M=50g) x10^{-2}m	M/Y x10^{-1} Kg/m
		During increasing load			During Decreasing load					
		MSR x10^{-2}m	VSR x10^{-2}m	TR x10^{-2}m	MSR x10^{-2}m	VSR X10^{-2}m	TR x10^{-2}m			
1	50									
2	100									
3	150									
4	200									

Mean M/Y = __________________ Kg/m

To find the breadth of the beam using vernier caliper

Least count of vernier caliper (L.C) = 0.01cm or 0.01 x10^{-2}m

Zero error (Z.E) =) ______divisions

Zero correction (Z.C) = (Z.E x L.C) =________x10^{-2}m

S.No	M.S.R $x10^{-2}$m	V.S.C Divisions	V.S.R = V.S.C x L.C $x10^{-2}$m	Breadth = M.S.R + V.S.R + Z.C $x10^{-2}$m
1				
2				
3				
4				
5				

Mean Breadth of the beam (b) = ______$x10^{-3}$ m

To find the Thickness of the beam using Screw Gauge

Least Count of Screw Gauge (L.C) = 0.01 mm (or) 0.01 x 10^{-3}m

Zero Error (Z.E) = _______ Divisions

Zero Correction (Z.C) = (Z.E x L.C) = ______ x 10^{-3} m

S .No	P.S.R x 10^{-3}m	H.S.C divisions	H.S.R(= H.S.C XL.C) X 10^{-3}m	Thickness = (P.S.R + H.S.R+Z.C) X 10^{-3}m
1				
2				
3				
4				
5				

Mean Thickness of the beam (d) = ______$x10^{-3}$ m

Calculation:

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

Distance between the two knife edges l = _____________ x 10^{-2} m

Breadth of the beam b = _____________ x 10^{-2} m

Thickness of the beam d = _____________ x 10^{-3} m

Average value of M/y = _____________ kg/m

Young's modulus of the material of the beam (meter scale)

$$E = \frac{Mgl^3}{4bd^3y} \quad N/m^2$$

Result:

Young's modulus of the material of the beam is ---------N/m^2

VIVA QUESTIONS

1] Define modulus of elasticity.
2] State Hooke's law.
3] Define elastic limit.
4] Define young's modulus

YOUNG'S MODULUS - NONUNIFORM BENDING (CANTILEVER METHOD)

Expt No:
Date:

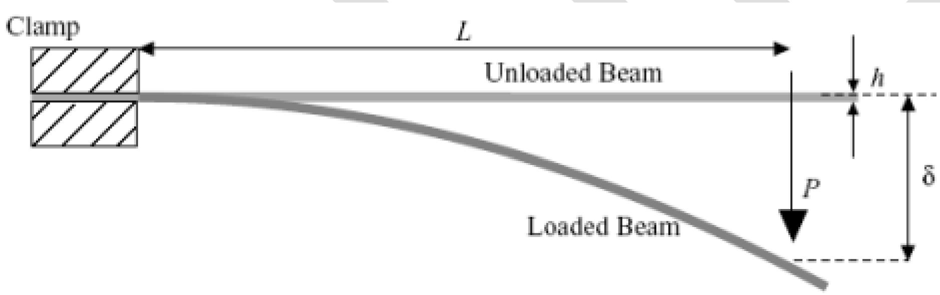
Aim:

To determine Young's modulus of the given beam by cantilever method

Apparatus/Materials:

Meter rule, A half-meter rule, A G-clamp, stand and clamp, Thread, A50 g slotted mass hanger, Telescope

Experimental Procedure



- The average thickness of the meter rule is measured using a vernier caliper and the reading is recorded.
- By using a micrometer screw gauge, the average width of the meter rule is measured and the reading is recorded.
- The apparatus is set up as shown in figure 1.
  A10gofslottedmass is hung and the length of the deflection is observed.
- The reading obtained is tabulated in a table.
- Step4 and 5is repeated using a slotted mass of20 g, 30 g, 40g, 50 gand60 g.

Observations and Calculations of Non-Uniform Bending

Value of 1 m.s.d = 1/20

Number of divisions on the vernier, n = 50

Least count of microscope = 1 m.s.d/n = 1/1000 = 0.001 cm

No	Distance of the knife edges , l (cm)	Load M(kg)	Telescope reading			depression for load 4m, e (cm)	Mean e (cm)	$\frac{l^3}{e}$ (cm^3)	Mean $\frac{l^3}{e}$ (cm^3)
			Loading (cm)	unloading (cm)	mean (cm)				
1		Wo			Xo	X4-X0			
		Wo+m			X1	X5-X1			
		Wo+2m			X2	X6-X2			
		Wo+3m			X3	X7-X3			
		Wo+4m			X4				
		Wo+5m			X5				
		Wo+6m			X6				
		Wo+7m			X7				

To find the breadth of the beam using vernier caliper

Least count of vernier caliper (L.C) = 0.01cm or 0.01 x10^{-2}m

Zero error (Z.E) =) ______divisions

Zero correction (Z.C) = (Z.E x L.C) =________x10^{-2}m

S.No	M.S.R x10^{-2}m	V.S.C Divisions	V.S.R = V.S.C x L.C x10^{-2}m	Breadth = M.S.R + V.S.R + Z.C x10^{-2}m
1				
2				
3				
4				
5				

Mean Breadth of the beam (b) = ______x10^{-3} m

To find the Thickness of the beam using Screw Gauge

Least Count of Screw Gauge (L.C) = 0.01 mm (or) 0.01 x 10^{-3}m

Zero Error (Z.E) = _______ Divisions

Zero Correction (Z.C) = (Z.E x L.C) = ______ x 10^{-3} m

S .No	P.S.R x 10^{-3}m	H.S.C divisions	H.S.R(= H.S.C XL.C) X 10^{-3}m	Thickness = (P.S.R + H.S.R+Z.C) X 10^{-3}m
1				
2				
3				
4				
5				

Mean Thickness of the beam (d) = _______x10^{-3} m

Calculation:

Thickness of the material bar "d" = ……………………….. mm.

Breadth of the material bar "b" = ……………………………cm.

Mean value of l^3/e = …………………………m.

Load applied for depression "e" = ………………………… m.

Result

Young's modulus of the given material using cantilever =.............Nm^{-2}

VIVA QUESTIONS

1] Define modulus of elasticity.

2] State Hooke's law.

3] Define elastic limit.

4] Define young's modules.

5] Give SI unit of young's modulus.

SURFACE TENSION OF WATER –CAPILLARY RISE METHOD

Expt No:

Date:

Aim

To determine of the surface tension of a liquid by capillary rise method

Apparatus Required

Capillary tube, Experimental liquid (water), Beaker, Travelling microscope, Glass plate to fix the tubes, A needle

Formula used

$$T = \frac{r(h + \frac{r}{3})\rho g}{2cos\theta}$$

T - Surface tension of water N/m

ρ - Density of water at observed temperature, kg/m^3

g is the acceleration due to gravity

Experimental Procedure

- Fix the supplied capillary tube. The lower ends of the tubes, which are to be immersed in water, should be nearly at the same level. Fix the needle at about 1 cm away from the capillary tubes.
- Clamp the glass plate to the support stand and check that the tubes remain perfectly vertical.
- Keep the beaker filled with water on the support base. Bring the clamp stand near the beaker. Let the tube immerse in water. Adjust the needle such that the lower tip just touches the water surface.
- Determine the vernier constant of the travelling microscope to be used.

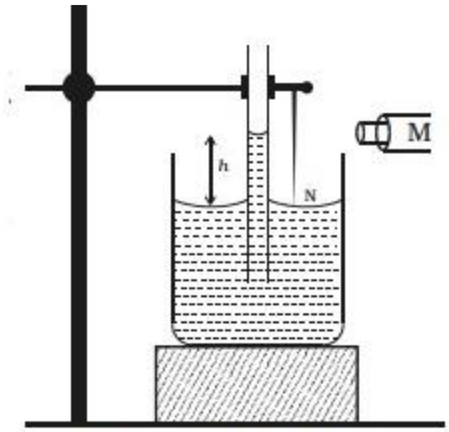


Fig. Surface tension by capillary rise method

- Focus the travelling microscope so that you can see the inverted (convex) meniscus of water. Adjust the horizontal crosswire to be tangential to the convex liquid surface. Note down the readings (say R1) on the vertical scale.
- Turn the microscope screws in horizontal direction to view the next capillary tube and follow the above step to note the position of liquid surface.
- After noting the positions of liquid surface, move the microscope further horizontally and focus to the needle. Now move the microscope vertically and let the lower tip of the needle be focused at the point of intersection of the two cross wires. Note down the readings on the vertical scale (say R).
- Thus the height of the liquid can be calculated from the difference of the two readings noted above, e.g. (R1-R).
- Now to find the radius of the tube, lower the height of the support base and remove the beaker. Carefully rotate the glass plate with the tubes so that the immersed lower ends face towards you.
- Focus one of the tubes using travelling microscope to clearly see the inner walls of the tube. Let the vertical crosswire coincide with the left side inner wall of the tube. Note down the reading (say L1). Turn the microscope screws in horizontal direction to view the right side inner wall of the tube. Note down the reading (say R1). Thus the radius of the tube can be calculated as ½(L1~R1).
- Turn the microscope screws in horizontal direction to view the next capillary tubes and follow the above step to find the radius of each tube.

- Finally calculate the surface tension.

Height of the liquid, *h*

Tube #	Microscope reading for the position of lower meniscus of liquid			Microscope reading for the position of lower tip of the needle			Height of the liquid ***h***
	Main scale reading	Vernier scale reading	Total reading	Main scale reading	Vernier scale reading	Total reading	
1							
2							
3							

Radii of the capillary tube, *r*

Tube #	Microscope reading for the position of inner left wall of the tube			Microscope reading for the position of inner right wall of the tube			Radius of the capillary tube ***r***
	Main scale reading	Vernier scale reading	Total reading	Main scale reading	Vernier scale reading	Total reading	
1							

Calculation

Result:

Surface tension of water is ………………… N/m

CO-EFFICIENT OF VISCOSITY - STOKE'S METHOD

Expt No:

Date:

Aim

To determine the coefficient of viscosity of a known fluid using Stokes' method.

Apparatus Required

A long cylindrical glass jar, Transparent viscous fluid, Metre scale, Spherical ball, Screw gauge, Stop clock

Formula Used

Coefficient of viscosity,

$$\eta = \frac{2}{9}\frac{r^2(\rho - \sigma)g}{v}$$

η - coefficient of viscosity of the given liquid, Nsm^{-2}

g- acceleration due to gravity, m

ρ - Density of the liquid, kg/m^3

σ - Density of the sphere, kg/m^3

r – radius of the sphere, m

Experimental Procedure

- Find the least count and zero correction of the given screw guage.
- Find the diameter (d) of the ball using the screw gauge. Now, the radius(r) of ball can be calculated as ; r = d/2
- Clean the glass jar and fill it with the viscous fluid.
- Place a meter scale vertically beside the jar.
- Mark two reference points A and B on the jar using two threads. The marking A is made well below the free surface of liquid, so that by the time when the ball reaches A, it would have acquired terminal velocity v.
- Adjust the position the thread B so that the distance between A and B is 60cm.
- The ball of known diameter is dropped gently in the liquid. It falls down in the liquid with accelerated velocity for about one-third of the height. Then it falls with uniform terminal velocity.
- When the ball crosses the point A, start the stop watch and the time taken by the ball to reach the point B is noted.
- If the distance moved by the ball is d and the time taken to travel is t.
- Calculate the terminal velocity of the ball.
- Now, repeat the experiment by changing the diameter of the ball.

Observations

To find the diameter of the sphere using screw gauge:

Least count of the screw gauge (L.C.) =........... mm

Zero correction of the screw gauge (z) = ……..... mm

Glass spshere No.	P.S.R. (mm)	Observed H.S.R. (a) (div.)	Corrected H.S.R. (a+z) (div)	Corrected H.S.R.×L.C. (mm)	Total reading = P.S.R.+(Corrected H.S.R.×L.C.) (d) (mm)	Radius of the glass ball, r=d/2 ($\times 10^{-3}$ m)

To find the terminal velocity of the sphere :

Density of the liquid, ρ = ………..kg/m^3

Density of the sphere, σ = ……….kg/m^3

Distance travelled by the sphere, s = ………. 10^{-2} m

Glass sphere No.	Radius of glass sphere, r ($\times 10^{-3}$ m)	Time taken to travel the distance s, t (s)	Velocity, v' = s/t (m/s)	Terminal velocity, v = v' [1+(2.4r/R)] (m/s)	r^2/ v (m s)
1					
2					
3					
4					
5					

Calculations

Radius of the sphere, r = d/2 =.......... mm = ...$\times 10^{-3}$ m

Coefficient of viscosity,

$$\eta = \frac{2}{9}\frac{r^2(\rho-\sigma)g}{v}$$ = ... Nsm^{-2}

Result

The coefficient of viscosity of the given liquid, η

By calculation, = ...Nsm^{-2}

RIGIDITY MODULUS-TORSION PENDULUM

Expt No:

Date:

Aim:

To determine the rigidity modulus of the suspension wire using torsion pendulum.

Apparatus Required

The given torsion pendulum, screw gauge, stop watch, metre scale.

Formula used

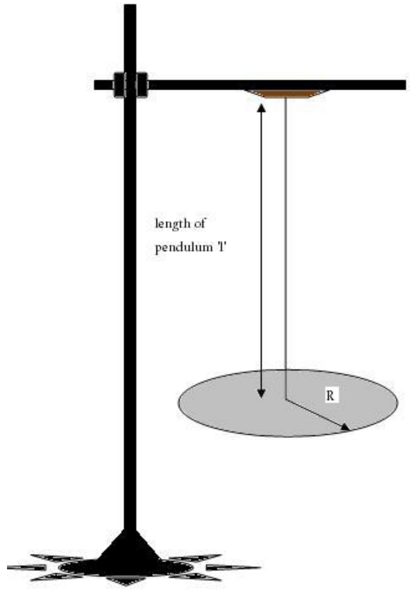
$$n = \frac{8\pi I l}{r^4 T_0^2} = \ldots\ldots\ldots Nm^{-2}$$

I=moment of inertia of the suspended body

l =length of the suspension wire, m

r=radius of the wire, m

n=rigidity modulus of the suspension wire N/m^2



Experimental Procedure

Determination of Rigidity modulus using Torsion pendulum

- The radius of the suspension wire is measured using a screw gauge.
- The length of the suspension wire is adjusted to suitable values like 0.3m,0.4m,0.5m,.....0.9m,1m etc.
- The disc is set in oscillation. Find the time for 20 oscillations twice and determine the mean period of oscillation ' T_0 '.
- Calculate moment of inertia of the disc using the expression, $I = (1/2)MR^2$.
- Determine the rigidity modulus from the given mathematical expression.

Observations:

Length of the suspension wire=................m

Radius of the suspension wire=..............m

Length of the suspension wire 'l' (m)	Time for 20 oscillation in seconds			Period of oscillation T_0 (s)	$I=MR^2/2$ (kgm^2)	n= $(8\pi Il)/(r^4T^2)$ (Nm^{-2})
	1	2	Mean			

Calculation

$$n = \frac{8\pi Il}{r^4 {T_0}^2} = \ldots\ldots\ldots Nm^{-2}$$

Result:

Rigidity modulus of the given wire is -------- N/m^2

Viva questions

1. What is called rigidity modulus?
2. Define moment of Inertia.
3. What is called time period?