Manonmaniam Sundaranar University,

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Tirunelveli - 627 012 Tamilnadu, India

OPEN AND DISTANCE LEARNING (ODL) PROGRAMMES

(FOR THOSE WHO JOINED THE PROGRAMMES FROM THE ACADEMIC YEAR 2023–2024)

B.Sc. Mathematics
Course Material
ALLIED PRACTICAL–I
JEPHP1

Prepared

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Tirunelveli - 12

ALLIED PRACTICAL–I

Minimum of Eight Experiments from the list:

1. Young's modulus by non-uniform bending using pin and microscope

2. Young's modulus by non-uniform bending using optic lever, scale and telescope

3. Determination of g by Compound Pendulum

4. Rigidity modulus by static torsion method.

5. Rigidity modulus by torsional oscillations without mass

6. Surface tension and interfacial Surface tension – drop weight method

7. Comparison of viscosities of two liquids – burette method

8. Specific heat capacity of a liquid–half time correction

9. Verification of laws of transverse vibrations using sonometer

10. Calibration of low range voltmeter using potentiometer

11. Determination of thermo emf using potentiometer

12. Verification of truth tables of basic logic gates using ICs

13. Verification of De Morgan's theorems using logic gate ICs.

14. Use of NAND as universal building block.

Note: Use of digital balance permitted

1. Young's modulus by non-uniform bending using pin and microscope

Aim

To determine Young's modulus of the material of the given beam by measuring the elevation of its Centre when equally loaded at its ends.

Apparatus required

A uniform rectangular beam, two knife edges, two weight hangers with slotted weights, Pin, Microscope, Vernier caliper and Screw gauge etc.,

Formula

Young modulus,

$$Y = \frac{3mgal^2}{2b\,d^3y}\,Nm^{-2}$$

where;

m = The load producing the elevation of the beam (kg)

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

a = Distance between the point of suspension of the load and nearer knife edge (m)

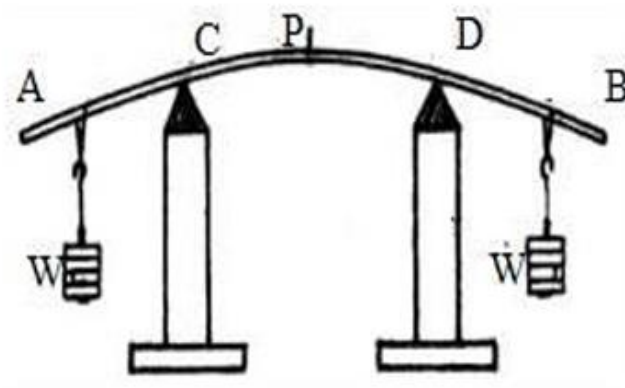l = length of the beam between knife edges (m)

b = Breadth of the beam (m)

d = Thickness of the beam (m)

y = Elevation at the midpoint of the beam due to a load (m)

Experimental setup

Observation

Table 1

To determine the thickness (d) of the beam using screw gauge

Zero Error (ZE) :   Div ;   Zero Correction (ZC) :   mm

$$LC = \frac{Pitch}{Number\ of\ head\ scale}$$

$$Pitch = \frac{Distance\ moved}{Number\ of\ rotations\ given}$$

Least count (LC) = 0.01 mm

S. No.	Pitch Scale Reading (PSR) 10^{-3} m	Head Scale Coincidence (HSC) Div	Observed Reading OR = PSR + (HSC x LC) (10^{-3} m)	Correct Reading CR = OR ±ZC (10^{-3} m)

Table 2

To determine the breadth (b) of the beam using vernier calliper.

$$LC = \frac{\text{Value of 1 Main Scale Division (MSD)}}{\text{Number of divisions in the vernier}}$$

$$LC = \frac{0.1}{10} = 0.01 \text{ cm}$$

Zero Error (ZE):   Zero Correction (ZC):

S. No.	Main Scale Reading (MSR) (10^{-2} m)	Vernier Scale Coincidence (VSC) (div)	Observed Reading OR = MSR + (VSC × LC) (10^{-2} m)	Correct Reading CR = OR ± ZC (10^{-2} m)

Table 3

S.No	Load in Kg ×10^{-3}	Telescope Reading(m) × 10^{-2}		Mean × 10^{-2} m	Mean elevation for a load of 100 gm × 10^{-2} m
		Load Increasing	Load Decreasing		
1.	50				
2.	100				
3.	150				
4.	200				
5.	250				

Procedure

1. Place the bar symmetrically on two knife edges.
2. Suspend two weight hangers at equal distance from the knife edges. Measure the distance 'between knife edges and distance 'a' of weight hangers from knife edges.
3. Fix a pin vertically at the midpoint of the bar with its pointed end upwards.
4. Arrange the microscope in front of the pin and focus the tip of the pin.
5. Add the slotted weights one by one on both the weight hangers and remove one by one a number of times, so that the bar is brought into an elastic mood.
6. With the some "dead load" W0 on each weight hanger, adjust the microscope so that the image of the tip of the pin coincides with the point of intersection of cross wires.
7. Note down the reading of the main scale and vernier of microscope. Add weights one by one and note down the corresponding readings.
8. From these readings, determine the mean elevation (y) of the mid-point of the bar for a given mass is determined. Measure the breadth of the bar (b) by using vernier calipers and thickness of the bar (d) is by using screw gauge.
9. Calculate the Young's modulus by substituting the values in the formula.

Calculation

$$Y = \frac{3mgal^2}{2b\,d^3y}\,Nm^{-2}$$

Result

Young's modulus of the material of the beam $Y = \qquad Nm^{-2}$

2. Young's modulus by non-uniform bending using optic lever, scale and telescope

Aim

To determine Young's modulus of the material of the given beam by measuring the depression of its center when loaded at its center.

Apparatus required

A uniform rectangular beam, two knife edges, two weight hangers with slotted weights, Scale and telescope, Optic lever, Vernier caliper and Screw gauge etc.,

Formula

Young's modulus of the material of the beam

$$Y = \frac{mgl^3 2D}{4bd^3 Ps} \; Nm^{-2}$$

  m   - The load producing the depression of the beam (kg)

  g   - Acceleration due to gravity (m / s^2)

  P   - Perpendicular distance between the single leg and the line joining the other two (m)

  D   - Distance between mirror and scale (m)

  l   - length of the beam between knife edges (m)

  b   - Breadth of the beam (m)

  d   - Thickness of the beam (m)

  s   - Shift in scale reading for a load (m)

Experimental setup
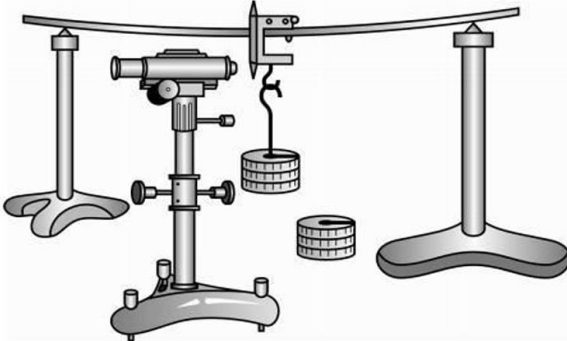
Procedure

1. Support the given bar symmetrically on two knife edges. Measure the length l of the bar between the knife edges.

2. Suspend a weight hanger exactly at the midpoint of the bar. Place an optic lever vertically at the midpoint of the bar.

3. Arrange the telescope in front of the set up.

4. Focus the scale in the telescope at the mirror of optic lever.

5. Add the slotted weights one by one on both the weight hangers and removed one by one a number of times, so that the bar is brought into an elastic mood.

6. With the some "dead load" W_0 on each weight hanger, adjust the telescope so that the image of the scale is focused in the mirror of optic lever.

7. Note down the reading of the telescope. Add weights one by one and note down the corresponding readings. From these readings, determine the mean depression (e) of the mid-point of the bar for a given mass.

Observation

Table 1

To determine the thickness (d) of the beam using screw gauge

Zero Error (ZE) :   Div ;   Zero Correction (ZC) :   mm

$$LC = \frac{Pitch}{Number\ of\ head\ scale}$$

$$Pitch = \frac{Distance\ moved}{Number\ of\ rotations\ given}$$

Least count (LC) = 0.01 mm

S. No.	Pitch Scale Reading (PSR) 10^{-3} m	Head Scale Coincidence (HSC) Div	Observed Reading OR = PSR + (HSC x LC) (10^{-3} m)	Correct Reading CR = OR ±ZC (10^{-3} m)

Table 2

To determine the breadth (b) of the beam using vernier calliper.

$$LC = \frac{Value\ of\ 1\ Main\ Scale\ Division\ (MSD)}{Number\ of\ divisions\ in\ the\ vernier}$$

$$LC = \frac{0.1}{10} = \ 0.01\ cm$$

8

Zero Error (ZE):   Zero Correction (ZC):

S. No.	Main Scale Reading (MSR) (10-2 m)	Vernier Scale Coincidence (VSC) (div)	Observed Reading OR = MSR + (VSC × LC) (10-2 m)	Correct Reading CR = OR ± ZC (10-2 m)

Table 3

S.No	Load in Kg ×10-3	Telescope Reading(m) × 10-2		Mean × 10-2 m	Shift in scale for a load of 100 gm × 10-2 m
		Load Increasing	Load Decreasing		
6.	W				
7.	W+50				
8.	W+100				
9.	W+150				
10.	W+200				

Calculation

Young's modulus of the material of the beam

$$Y = \frac{mgl^3 2D}{4bd^3 Ps} \, Nm^{-2}$$

Result

Young's modulus of the material of the beam $Y = \qquad Nm^{-2}$

3. Determination of g using compound pendulum.

Aim

To determine the acceleration due to gravity g using compound pendulum.

Apparatus required

Bar pendulum, stop watch and meter scale etc,
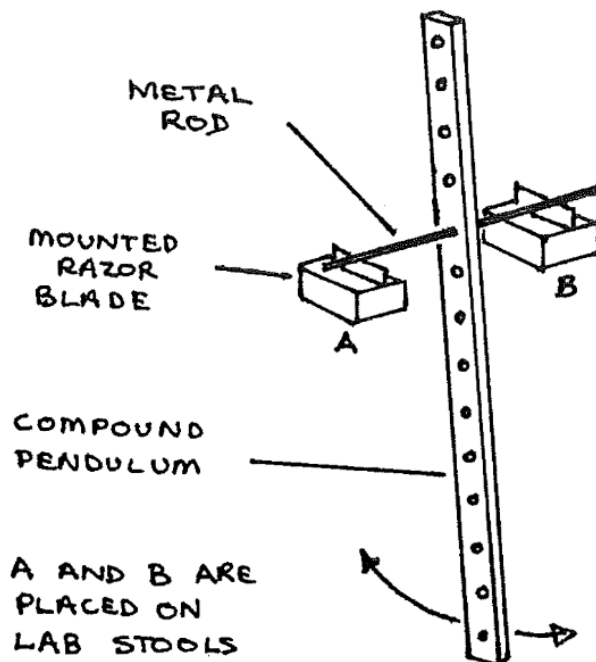
Formula

Acceleration due to gravity,

$$g = \frac{4\pi^2 L}{T^2} \quad m/s$$

Where;

L = length of the pendulum bar.

T = time period for 10 oscillations.

Experimental setup

Procedure

1. Gather a stick with evenly spaced holes along its length.

2. Set up a wire to suspend the stick horizontally.

3. Use a scale to measure and record the mass of the stick.

4. Start with the wire in the hole nearest one end of the stick.

5. Release the stick and record the time required for 20 oscillations of small amplitude.

6. Calculate T using the formula: T = (time for 20 oscillations) / 20.

7. Record the distance from each hole to the end of the stick where the wire was initially placed.

8. Repeat this process for each hole along the length of the stick.

9. Plot T^2 on the y-axis and d on the x-axis to create a graph.

10. This graph will display a pair of roughly parabolic curves symmetric about a line parallel to the y-axis.

11. Choose six values of T from the data obtained.

12. Draw lines parallel to the x-axis through these selected values of T on the graph.

13. The lines drawn should intersect each curve twice.

14. Identify the points of intersection between the lines and the curves.

15. Measure the distance along the x-axis from left to right between the first point of intersection with the left-hand curve and the first point of intersection with the curve on the right.

16. Record this value as L.

17. Create a table with columns for d, T, T^2, and L.

18. Tabulate the corresponding values of T, T^2, and L for each distance (d) along the stick.

Table 1

Distance from hole to end (d)	Time for 20 oscillations	Period T (s)	T^2 (s^2)	L (m)	$\dfrac{L}{T^2}$ (ms^{-2})

<div align="center">

Average $\dfrac{L}{T^2} =$ (ms^{-2})

</div>

Calculation

Acceleration due to gravity,

$$g = \frac{4\pi^2 L}{T^2} \quad m/s$$

Result

Using compound pendulum acceleration due to gravity determined as

$$g = \quad 9.8 \quad m/s$$

4. Determination of rigidity modulus by static torsion.

Aim

To determine the rigidity modulus by static torsion method.

Apparatus required

Meter scale, Screw gauge, Thread, Load, Mirror etc.,

Formula

Rigidity modulus,

$$n = \frac{4mgR}{\pi r^4} \times \frac{lD}{s} \, Nm^{-2}.$$

Where;

      M   = mass suspended.

      G   = acceleration due to gravity.

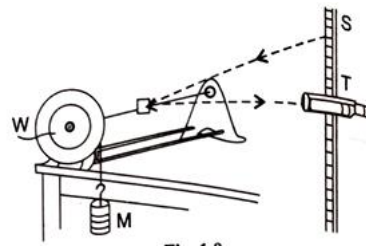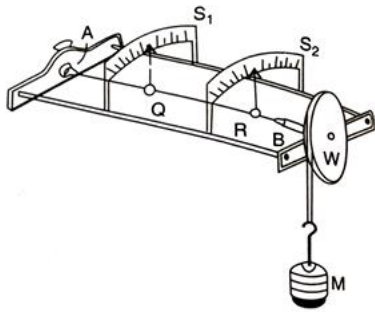   r   = radius of the rod.

      L   = length of the rod.

      D   = distance of the scale from the mirror.

      S   = shift for m in Kg.

      R   = radius of the wheel.

Experimental setup

Procedure

1. Setup the Searles apparatus as shown in the figure.

2. Measure the length of the rod using a meter scale.

3. Measure the diameter d and radius using the screw gauge.

4. Tabulate the values in the table 2.

5. Place the loads in the increasing order to find the loading and unloading value using the telescope.

6. Record the readings in the table and follow the calculations to determine the rigidity modulus.

Observation

Radius of the wheel, R $= C/2\pi$ m

Radius of the rod, r   =   m

Value of load, m   =   kg

Distance between scale and mirror, D   =   m

Table1

To find $\dfrac{lD}{s}$

   Distance between scale and mirror, D=   **m**

Length l (m)	Load	Telescope reading								Mean	Shift (S) for 4m	$\frac{lD}{s}$
		Clockwise				Anticlockwise						
		Loading	unloadi	Mean	Shift for4m	Loading	Unloadi	Mean	Shift for4m			
0.4	W			X_0				Y_0				
	W+m			X_1				Y_1				
	W+2m			X_2				Y_2				
	W+3m			X_3				Y_3				
	W+4m			X_4	$X_4 - X_0$			Y_4	$Y_4 - Y_0$			
	W+5m			X_5	$X_5 - X_1$			Y_5	$Y_5 - Y_1$			
	W+6m			X_6	$X_6 - X_2$			Y_6	$Y_6 - Y_2$			
	W+7m			X_7	$X_7 - X_3$			Y_7	$Y_7 - Y_3$			

Mean $\frac{lD}{s}$ =   m

Table 2

To determine the diameter (d) of the beam using screw gauge.

$$LC = \frac{Pitch}{Number\ of\ head\ scale}$$

$$Pitch = \frac{Distance\ moved}{Number\ of\ rotations\ given}$$

Least count (LC) = 0.01 mm

(Z.E) Zero error   :   mm

(Z.C) Zero correction   :   mm

PSR (mm)	HSC (Div)	HSR =HSC×LC	TR =MSR+VSR	MEAN (mm)

Calculation

Rigidity modulus,

$$n = \frac{4mgR}{\pi r^4} \times \frac{lD}{s}$$

Result

Rigidity modulus of the material, $\boldsymbol{n} =$ $\boldsymbol{\times 10^{10} Nm^{-2}}$.

5. Determination of rigidity modulus without mass using Torsional pendulum.

Aim

To Determination of rigidity modulus without mass using Torsional pendulum.

Apparatus required

Torsional pendulum, Stop clock, Meter scale, screw gauge.

Formula

Moment of inertia of the disc,

$$I = \frac{MR^2}{2} (kgm^2)$$

Rigidity modulus of the material of the wire,

$$n = \frac{8\pi I}{r^4} \frac{L}{T^2} \quad (N/m 2)$$

Where;

    I   - Moment of inertia of the pendulum Kg m^2.

    R   - Radius of the wire in meter.

    L   - Length of the pendulum from the fixed end in meter.

    M   - Mass of the disc in Kg.

    T   - Time period for ten oscillations in sec

Model graph

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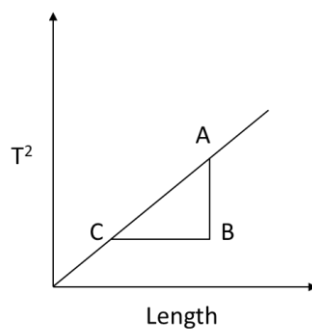
Experimental setup
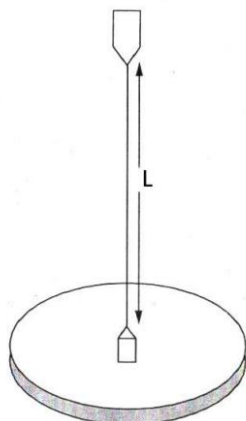
Torsional Pendulum
(without masses)

Procedure

1. The wire's substance is secured at one end with a vertical chuck. At the opposite end of the cable is a metallic disc.
2. The radius of the wire(r) is found using a screw gauge.
3. Measure the length L of the pendulum from the fixed end in meter. Vary the length and note different readings.
4. The suspension wire's length is set at a specific length. To produce torsional oscillations, the disc is slightly twisted.
5. A stop clock is used to record the amount of time needed for ten oscillations. For every length, two trials are collected. We find the mean time period T.
6. Repeat the above step for various length as in step 2 and tabulated the values and plot the graph.

Observation

i.To find R

$$2\pi R \quad = \quad \times 10^{-2} m$$

$$R \quad = \quad m$$

ii.Mass of the disc,

$$M \quad = \qquad\qquad m$$

Table 1 - To measure the radius of the wire R

L.C   =   mm;   Z.R   =   mm

S.No.	(PSR) in mm	(HSC) in div	HSR= (HSC×LC)	Observed reading OR=PSR+HSR	Correct Reading =OR$\pm$ZC
1					
2					
3					
4					
5					

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

Radius R   = $\times 10^{-3}$

Table 2 - To find L/T^2,

S.No.	Length (cm)	Time for 10 Oscillation (sec)			Period T (sec)	T^2 (sec^2)	L/T^2 (m/sec^2)
		Trial 1	Trial2	Mean			
1.							
2.							
3.							

4.						
5.						

Mean -   **(m/sec²)**

Calculation

I. From Calculation:

Moment of inertia of the disc,

$$I = \frac{MR^2}{2} \, (kgm^2)$$

Rigidity modulus of the material of the wire,

$$n = \frac{8\pi I}{r^4} \frac{L}{T^2} \quad (N/m\,2)$$

II. From graph:

$$slope = \frac{AB}{BC}$$

$$n = \frac{8\pi I}{r^4} \frac{1}{slope} \quad (N/m\,2)$$

Result

The rigidity modulus of the wire of the torsional pendulum is determined without mass

     i.   From Calculation   **n**   = $(N/m\,2)$**.**

     ii.   From graph   **n**   = $(N/m\,2)$**.**

6. Determination of surface tension and interfacial surface tension by drop weight method.

Aim

To determine the surface tension and interfacial surface tension by drop weight method.

Apparatus required

A glass fitted with a rubber tube, glass tube, beaker, stand, stop clock, screw gauge, pinch cock.

Formula

I. Surface tension,

$$T1 = \frac{mg}{3.8R} (Nm^{-1})$$

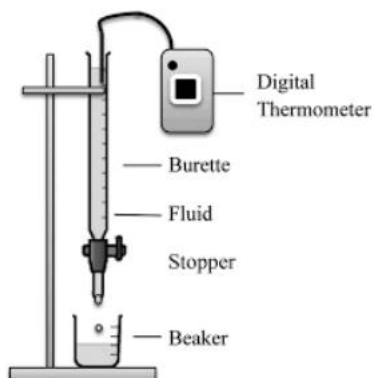II. Interfacial surface tension,

$$T_2 = \frac{mg}{3.8R}\left[1 - \frac{P_2}{P_1}\right](Nm^{-1})$$

Where;

m   - average mass of one drop of water.

R   - external radius of glass tube

g   - acceleration due to gravity

P_1, P_2 - densities of water and kerosene

Experimental setup

Procedure

1. The figure displays the experimental configuration. Under the glass tube, there is a beaker. Water that has fallen from the funnel is collected in the weighed beaker. The stop clock is set to produce eight to ten liquid drips per minute at a slow pace. In the beaker, a predetermined number of drops—say let's 25—are gathered.

2. Once more, the mass of the beaker filled with water is determined. The difference between the two values yields the mass of 25 drops of water, from which the mass of each drop is computed.

3. After repeating the process, the average mass of a single water drop in metres is determined. A screw gauge is also used to accurately measure the glass tube's exterior radius.

4. The above formula (|) is used to determine the surface tension of water at laboratory temperature.

5. The mass of the beaker with kerosene oil is found the beaker is placed

6. below the glass tube such that water drops are formed inside the

7. kerosene oil as shown in the fig

8. The mass of each of the 25 water droplets that are gathered in the kerosene is calculated. The previous experiment is conducted again.

9. Using formula (||), one can determine the interfacial tension between water and kerosene.

Table1

To determine the radius of glass tube (R) using screw gauge.

$$LC = \frac{Pitch}{Number\ of\ head\ scale}$$

$$Pitch = \frac{Distance\ moved}{Number\ of\ rotations\ given}$$

Least count (LC) = 0.01 mm

(Z.E) Zero error   :   mm

(Z.C) Zero correction   :   mm

PSR (mm)	HSC (Div)	HSR =HSC×LC	TR =MSR+VSR	MEAN (mm)

Radius R =   m

Table2

Determination of the surface tension of water by the drop-weight method

Liquid drops	m_0 (g)	$m_0 + m_{liq} =$ m_{total}(g)	m_{liquid} (g)	Average mass One drop m (Kg)
0				
25				
75				

Table3

Determination of the surface tension of kerosene by the drop-weight method

Liquid drops	m_0 (g)	$m_0 + m_{liq} =$ m_{total}(g)	m_{liquid} (g)	Average mass One drop m (Kg)
0				
25				
75				

Calculation

    I.   Surface tension,

$$T1 = \frac{mg}{3.8R}(Nm^{-1})$$

    II.   Interfacial surface tension,

$$T_2 = \frac{mg}{3.8R}\left[1 - \frac{P_2}{P_1}\right](Nm^{-1})$$

Result

I.   Surface tension of water $T1 =$ (Nm^{-1})

II.   Interfacial surface tension between kerosene in water $T_2 =$ (Nm^{-1})

7. Comparison of viscosities of two liquids – burette method

Aim

To compare the viscosity of two liquids by Poiseuille's flow method using a burette.

Apparatus required

A graduated burette, a capillary tube of about 25cm, given two liquids, stopwatch, hare's apparatus

Formula

$$\frac{\eta_1}{\eta_2} = \frac{\rho_1 t_1}{\rho_2 t_2}$$

Where;

η_1, η_2 = Coefficient of viscosities of liquid 1&2

ρ_1, ρ_2 = Density of liquid 1&2

t_1, t_2 = Time of flow liquids 1&2

Experimental setup

Hare's apparatus
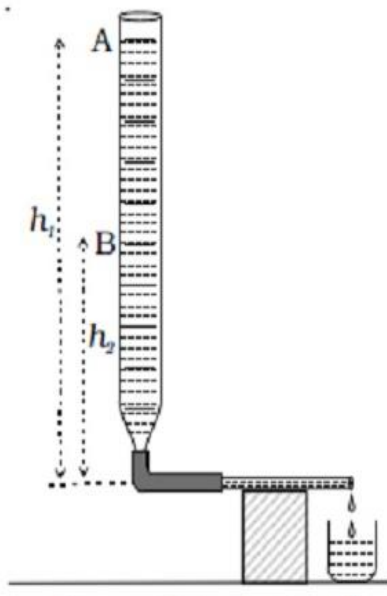
Liquid A
(ρ_1)
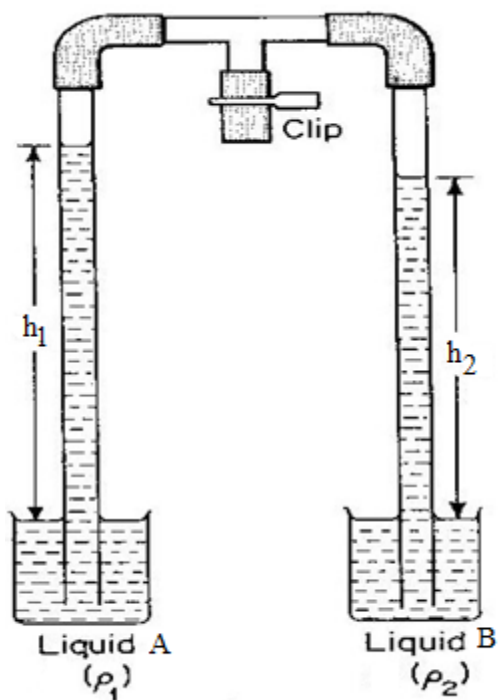
Liquid B
(ρ_2)

Table 1

Burette reading	Time of flow of liquids (Sec)		$\dfrac{t_1}{t_2}$
	water	kerosene	
0-5			
5-10			
10-15			
15-20			
20-25			
25-30			
30-35			

Table 2 - To find $\frac{\rho_1}{\rho_2}$ Hare's apparatus

S. No	Water ($\times 10^{-2}$ m)		h_1 ($\times 10^{-2}$ m)	Kerosene ($\times 10^{-2}$ m)		h_1 ($\times 10^{-2}$ m)	$\frac{\rho_1}{\rho_2} = \frac{h_1}{h_2}$
	Limb level	Beaker level		Limb level	Beaker level		

Calculation

Theoretical

Coefficient of viscosity of water, $\eta_1 = \mathbf{0.0008}\ Nsm^{-2}$

Coefficient of viscosity of kerosene, $\eta_2 = \mathbf{0.002}\ Nsm^{-2}$

$$\frac{\eta_1}{\eta_2} = 0.4$$

Experimental

$$\frac{\eta_1}{\eta_2} = \frac{P_1 t_1}{P_2 t_2}$$

Result

The coefficient of viscosities of the two given liquids has been compared and their ratio is found to be

i. Theoretically, $\frac{\eta_1}{\eta_2} = \mathbf{0.4}$

ii. Experimentally, $\frac{\eta_1}{\eta_2} =$

8. Determination of specific heat by cooling- graphical method

Aim

To determine the specific heat capacity of an unknown liquid by cooling method

Apparatus required

A calorimeter with Stirrer, Thermometer, Stopwatch, Heating setup, etc.

Formula

Average rate of heat loss $(M_1 S_1 + ms)\dfrac{(\theta_1 - \theta_2)}{t_1}$

Average rate of heat loss $(M_2 S_2 + ms)\dfrac{(\theta_1 - \theta_2)}{t_2}$

$$(M_1 S_1 + ms)\frac{(\theta_1 - \theta_2)}{t_1} = (M_2 S_2 + ms)\frac{(\theta_1 - \theta_2)}{t_2}$$

$$Specific\ heat\ capacity, S_1 = \frac{M_2 S_2 t_1 + ms(t_1 - t_2)}{M_1 t_2}\ calg^{-1}/°C$$

Where;

$(M_1 S_1 + ms)$	$\rightarrow$	Thermal capacity of the system
M_1, S_1	$\rightarrow$	Mass and Specific heat of liquid one
M_2, S_2	$\rightarrow$	Mass and Specific heat of liquid two
m	$\rightarrow$	Mass of calorimeter and stirrer
s	$\rightarrow$	Specific heat of calorimeter
θ_1	$\rightarrow$	Initial temperature before cooling
θ_2	$\rightarrow$	Final temperature after cooling
t_1	$\rightarrow$	Time taken by liquid 1 to reach the temperature from θ_1 to θ_2
t_2	$\rightarrow$	Time taken by liquid 2 to reach the temperature from θ_1 to θ_2

Experimental setup
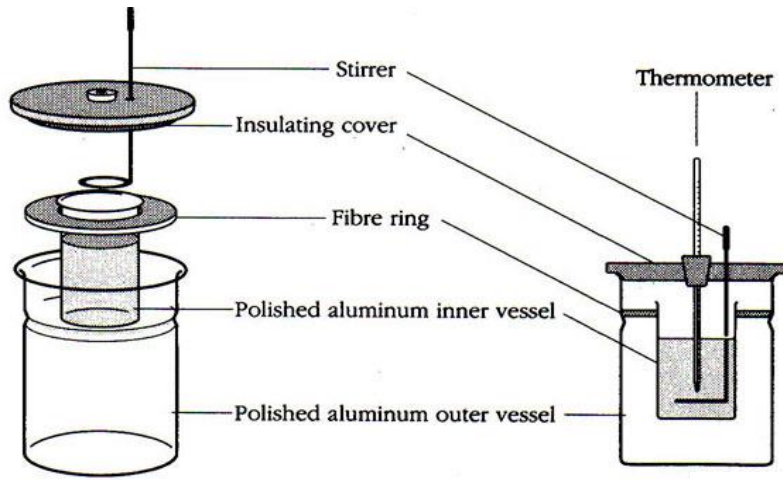
Model graph
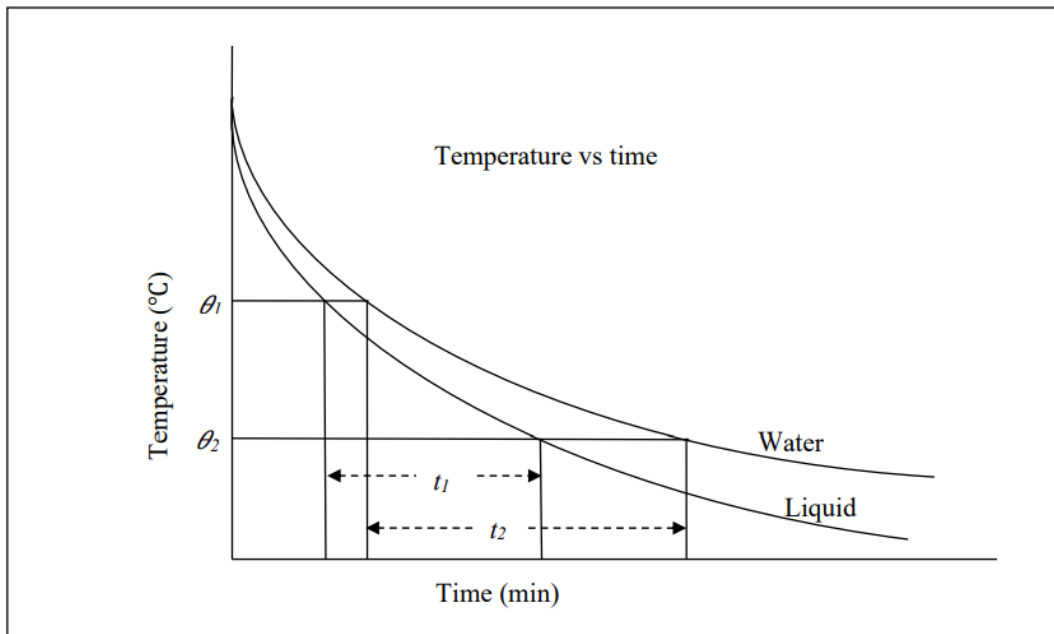
Procedure

1. Clean and dry the calorimeter and measure the mass (m) of the calorimeter and stirrer using a balance.

2. Pour water up to two- third volume of the calorimeter. Measure the total mass M^{11} (mass of water, calorimeter, stirrer) to calculate the mass M_2 of water.

3. Raise the temperature to approximately 62 °C by placing the calorimeter on the heater and holding the thermometer bulb in the centre of the water. Using tongs, hold the calorimeter inside the double-walled enclosure. When the thermometer's bulb is in the centre of the water, close the lid and secure it with its holder.

4. When the temperature is almost 60 °C, start the stopwatch. Note this temperature in the table.

5. Continue taking minutes-long records of the water's temperature for up to 25 or more. All throughout the operation, gently stir the water.

6. Empty the calorimeter of its water and give it a thorough cleaning. Consider the experimental liquid to be the same volume of water in the calorimeter. For experimental liquid, repeat steps 2, 3, and 4.

7. Plot curves (for both water and liquid) on a graph paper with temperature as the Y-axis and time as the X-axis. Determine t1 and t2 based on the graph.

8. Using the given formula, determine the specific heat of the given liquid.

Table 1

No. of. Obs	Time (min)	Temperature of water (°C)	Temperature of liquid (°C)
1	0		
2	1		
3	2		
4	3		
5	4		
6	5		
7	6		
8	7		
9	8		
10	9		
11	10		
12	11		
13	12		
14	13		
15	14		
16	15		
17	16		
18	17		
19	18		
20	19		
21	20		

22	21		
23	22		
24	23		
25	24		
26	25		

Observation

Mass of the calorimeter + stirrer, **m** =

g

Mass of the calorimeter + stirrer + liquid, $\mathbf{M^1}$ =

g

Mass of the liquid, $\mathbf{M1 = M^1 - M^{11}}$ =

g

Mass of the calorimeter + stirrer + water, $\mathbf{M^{11}}$ =

g

Mass of the water, $\mathbf{M2 = M^{11} - m}$ =

g

Specific heat capacity of water, $\mathbf{S_2} = 1.00$ **Cal g^{-1} °C^{-1}**

Specific heat capacity of calorimeter Aluminum, **S** $= 0.2096$ **Cal g^{-1} °C^{-1}**

Specific heat capacity of calorimeter Copper, **S** $= 0.0909$ **Cal g^{-1} °C^{-1}**

Water's cooling time from $\theta 1 =$___°C to $\theta 2 =$____°C, as determined by graph,

t2 =_____ min

Liquid's cooling time from $\theta 1 =$___°C to $\theta 2 =$____°C, as determined by graph,

t1 =_____min

Calculation

$$Specific\ heat\ capacity, S_1 = \frac{M_2 S_2 t_1 + ms(t_1 - t_2)}{M_1 t_2}$$

Result

Specific heat capacity of an unknown liquid S =_____Cal g^{-1} °C^{-1}

9. **To verify the Laws of Transverse Vibration Using Sonometer**

Aim

To verify the laws of transverse vibration using sonometer

Apparatus required

Sonometer with metallic wire, tuning fork, meter scale, slotted half Kg weights, two knife edges etc.,

Formula

Law of Length:

$$\nu \propto 1/L$$

Law of Tension:

$$\nu \propto \sqrt{T}$$

Law of Mass:

$$\nu \propto \sqrt{M}$$

Where,

L   → Length of the vibrating string.

T   → Tension of the string.

M   → Mass of the string with load.

Model graph
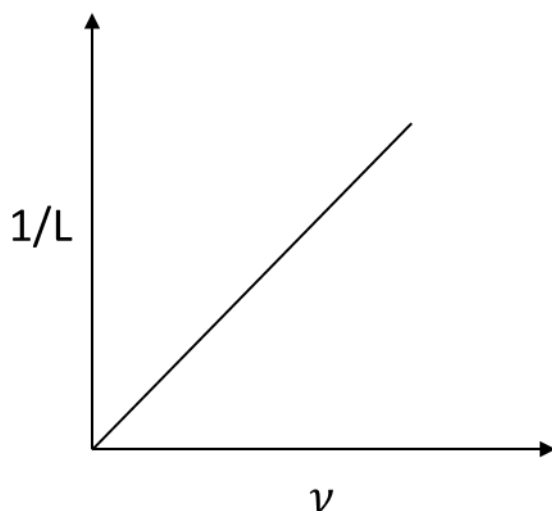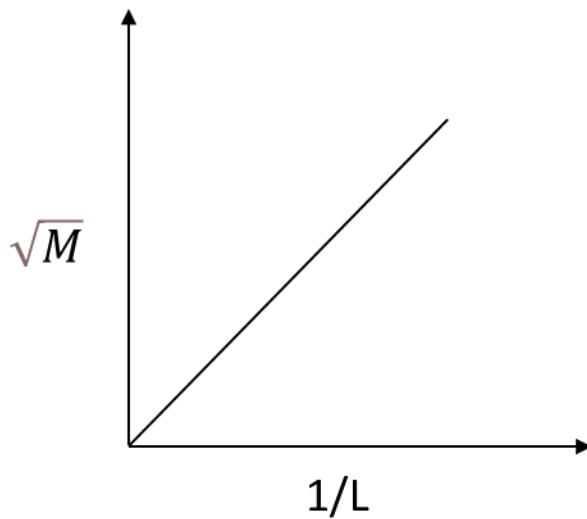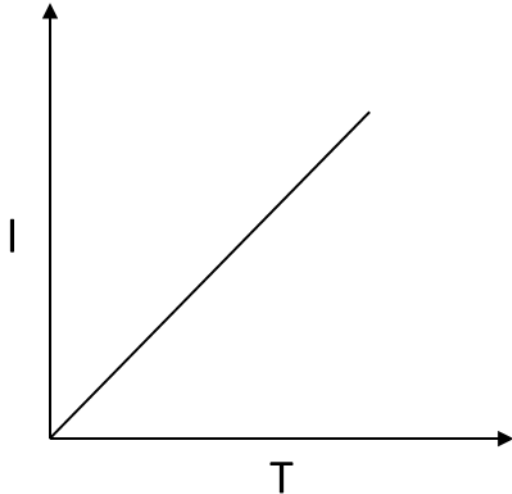
Procedure

1.Assemble the setup as shown in the figure. Firstly, the wire, as its one end fired and other end passing over pulley, carrying a hanger of weights

2.Mount the 1 clamp. of soil with the screws of sonometer base at a distance 2-3 mm above the wire. Now connect mains cord between mains and sonometer

3.Take two patch cords from the accessory box and connect the 6V Ac supply from sonometer to the coil with the polarity.

4.Now hang the weight of 1000 gms to the hanger connected with one end of steel wire switch on the Ac supply.

5.Now adjust two knife edges by slowly increasing the distance between them so that you get some vibrations in wire

6.Now slowly adjust both knife edges for maximum vibration in the wire. Note the length (l1) of wire between two knife edges by given meter scale. Also note load (w) in kg (including weight of hanger)

7.Now increase load by 500 gms and again get the position of maximum vibration by adjusting both knife edges. Note length of wire.

8.Repeat the same procedure by increasing weight by 500 gms and take reading for maximum vibration.

9.Note all values in observation table. Repeat the steps adjusting two knife edges by slowly decreasing the distance between them so that slowly decreasing maximum vibrations.

10.Note the values of length of vibrating for respective loads.

11. Plot the graph and do the calculation to verify the laws.

Table 1: Law of Length

Sl. No	Frequency of Tuning Fork ν (Hz)	Length of the Vibrating segment L (cm)	1/L (cm^{-1})	$\nu \times l$ $= constant$
1.				
2.				
3.				

Table 2: Law of Tension

Sl. No.	Weight	Tension T	√T	Length of the Vibrating segment L (cm)	$\sqrt{\dfrac{T}{l}} = constant$
1.					
2.					
3.					

Table 3: Law of Mass

Sl. No.	Mass/unit length	√M	Length of the Vibrating segment L (cm)	$L\sqrt{M} = constant$
1.				
2.				
3.				
4.				

Calculation

Frequency of tuning fork,

$$v = \frac{1}{2l}\sqrt{T/M}$$

Law of Length,

$$v \times l = constant$$

Law of Tension,

$$\sqrt{\frac{T}{l}} = constant$$

Law of Mass,

$$L\sqrt{M} = constant$$

Result

I. $v \times l = C1, \sqrt{\frac{T}{l}} =$ C2, L√M=C3 the constants verified the laws of transverse vibrations.

II. A graph between v and 1/L, T and l and 1/ L and √***M*** is a straight line verified the law of length, tension and mass respectively.

10.Calibration of low range voltmeter using potentiometer

Aim

To calibrate the given low range voltmeter using potentiometer and to draw the calibration curve.

Apparatus required

Potentiometer, Low range voltmeter (0-3V), Accumulator, Plug key, rheostat, Daniel cell, High resistance, Galvanometer, Jockey and Connecting wires etc.,

Formula

The voltage V' will be calculated by,

$$V' = E_0 \frac{l}{l_0} volt$$

Where;

$V' - V$ = Correction for the voltmeter reading

E_0 = emf of standard cell (volt) = 1.08 volt

l_0 = Balancing length of standard cell (m)

l = Balancing length of the standardized potentiometer wire will correspond to the voltage V (m)

V = Voltmeter reading (volt)

Circuit diagram

Primary circuit
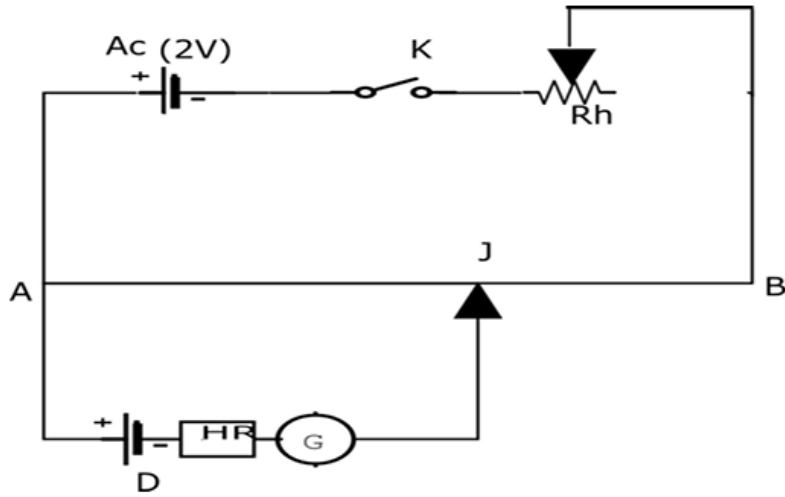
Secondary circuit
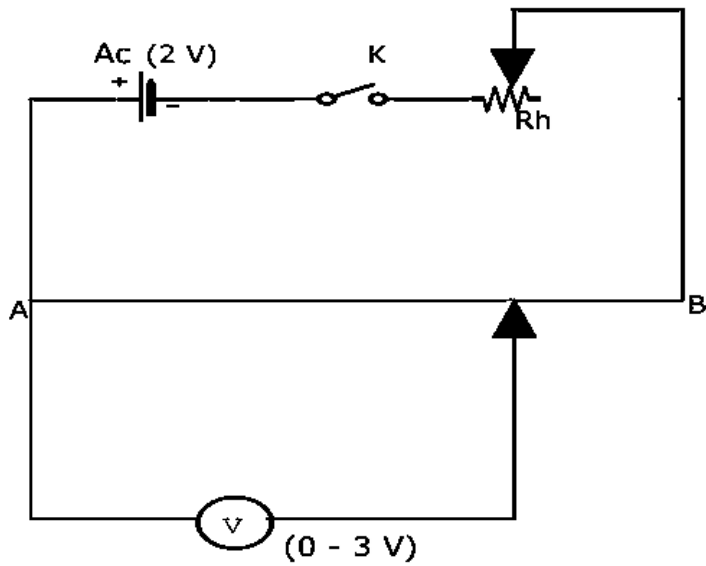
Model graph
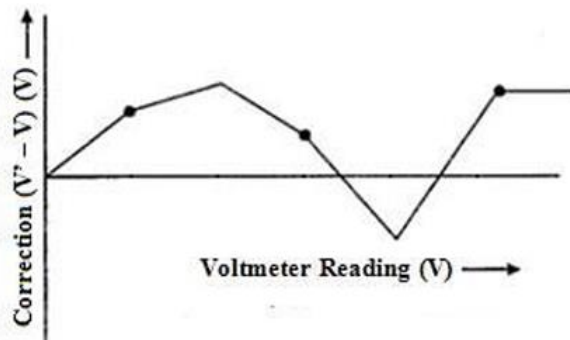
Observation

EMF of the Daniel cell $E_0 =$ volts

Balancing length of the Daniel cell $l_0=$ $\times 10^{-2}$m

S.No	Voltmeter reading (Volt)	Balancing length (l) $\times 10^{-2}$m	Calculated voltage(V') (volt)	Correction (V' – V)
1.	0			
2.	0.1			
3.	0.2			
4.	0.3			
5.	0.4			
6.	0.5			
7.	0.6			
8.	0.7			
9.	0.8			
10.	0.9			
11.	1.0			

Procedure

1. Make connections as in primary circuit. Connect positive terminal of accumulator with potentiometer end A. Connect the negative terminal of accumulator in series with key, rheostat and potentiometer end B. End A of potentiometer is connected in series with daniel cell, high resistance, galvanometer and jockey.

2. Switch on the accumulator (2 V) and daniel cell.

3. Slide the jockey on the potentiometer till the galvanometer shows null deflection. Measure this balancing length of daniell cell (l0).

4. Make connections as shown in secondary circuit. Connect positive terminal

of accumulator with potentiometer end A. Negative terminal of accumulator is connected in series with key, rheostat and potentiometer end B. Connect the voltmeter and jockey in series with potentiometer end A. Switch on the accumulator (2 V).

5. Set 0.1 V in the voltmeter by sliding the jockey on the potentiometer and note the balancing length (l). Repeat the experiment for different values of voltages and note down the corresponding balancing lengths.

6. Calculate V' by using the formula given and record the correction value.

7. Plot a graph by taking voltmeter reading (V) along X axis and correction along Y axis.

Result

The given voltmeter was calibrated using potentiometer and the calibration curve was drawn.

11.Determination of thermo emf using potentiometer

Aim

To determine the thermo emf using potentiometer.

Apparatus required

A potentiometer, a battery of constant emf, a rheostat, thermocouple, a millivoltmeter or digital multimeter, a sensitive galvanometer, a one-way plug key, a mercury thermometer, two beakers, two tripod stands, two wire gauges, Bunsen burner, mustard oil or glycerol, connecting wires, sand paper and a clamp stand.

Formula

$$\text{Thermo emf} = \frac{V \times l}{L} \ (\textbf{mV})$$

Where;

V	= Potential drop across the ends of potentiometer wire
l	= Balancing length in meter
L	= Total length of the potentiometer wire

Experimental circuit

(a)   (b)
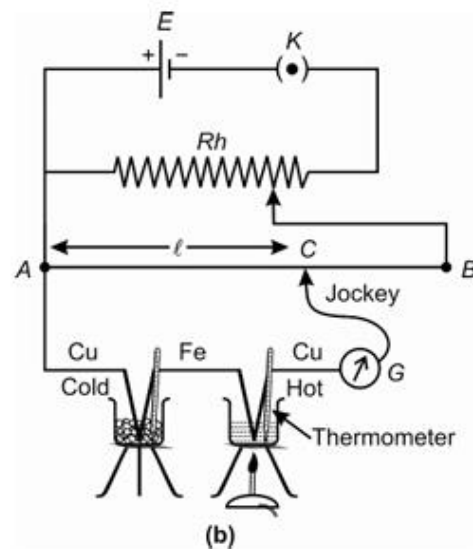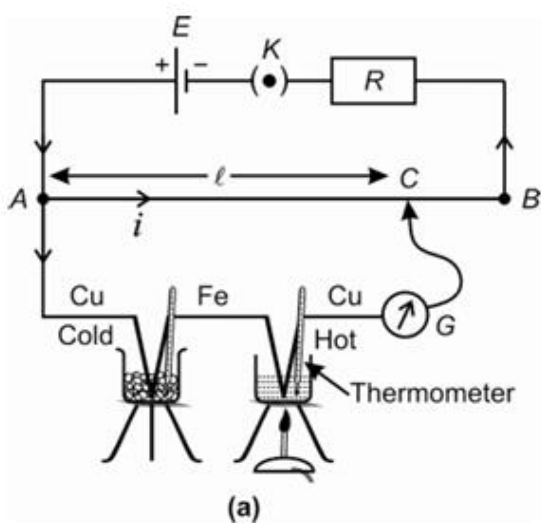
Procedure

1. Insert the plug-in key K so that the current starts flowing through the potentiometer wire.

2. Adjust the slider of the rheostat such that the fall of potential along the potentiometer wire is only a few hundred mV. Measure this with the help of millivoltmeter or a multimeter and record it in Observation Table 7.2.

3. Measure the length of the potentiometer wire and record it.

4. Divide the fall of potential with the total length of the wire. This gives potential gradient along the potentiometer wire. Divide the fall of potential with the total length of the wire. This gives potential gradient along the potentiometer wire.

5. Record the temperature of the cold junction, i.e. water. You must shield the cold water beaker from the hot junction beaker.

6. Light the burner and heat the oil/glycerol.

7. While the heating is in progress, check the connections by tapping the jockey at the two extreme ends of potentiometer wire. Note the directions of deflections in the galvanometer on pressing the jockey. If the two deflections are on opposite sides of the zero, the circuit is in order.

8. Heat the oil, say, up to 350°C, and then let it cool.

9. After every 10 minutes, measure the balancing length by identifying the null point, i.e., observing zero deflection position in the galvanometer. This is done by pressing the jockey at different points on the potentiometer wire. For convenience you should begin location of null point a few seconds before the 10-minute limit each time. Record the temperature of the hot junction in Observation Table 7.2 at the time you locate the null position (zero deflection position). You should not press the jockey on the potentiometer wire with large force.

10. The product of the balancing length and the potential gradient gives the magnitude of thermo-emf for a given temperature difference between the

hot and the cold junctions.

11. Plot the temperature difference along x-axis and the thermo-emf along y-axis and draw a smooth curve. What is the nature of your graph? Theoretically, we expect it to be a part of a parabola. Discuss your result with your counsellor.

12. Note the value of neutral temperature from the graph and record it.

Observation

Total length of the potentiometer wire (L)   =   cm

Potential drop across the ends of potentiometer wire (V)   =   mV

Potential gradient along the potentiometer wire $= \dfrac{V}{L}$ =   mV cm^{-1}

Temperature of the cold junction   = ^{0}C

S. No	Temperature Of hot junction (^{0}C)	Temperature difference between hot and cold junction (^{0}C)	Balancing length l (cm)	Thermo emf $\dfrac{V \times l}{L}$ (mV)

Result

The average thermo emf =   **mV**

12. Verification of truth tables of basic logic gates using ICs

Aim

To verify the truth tables of basic logic gates using ICs

Apparatus required

Bread board, LED, connecting wires, IC-7404, IC-7408, IC-7432.
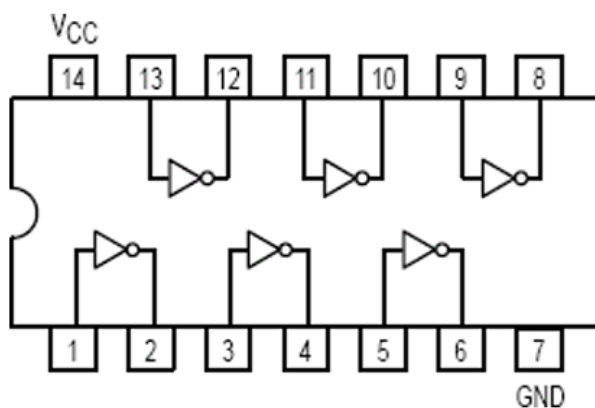
Formula

NOT Gate,

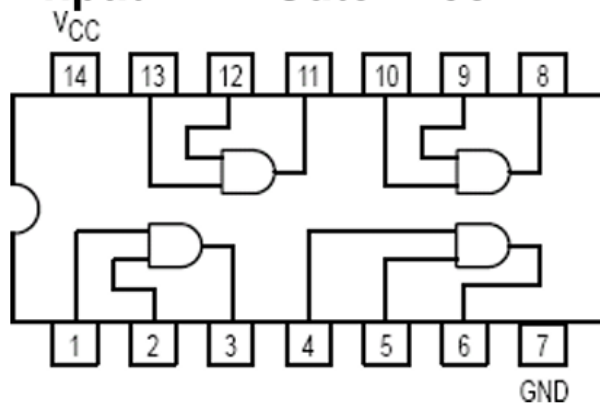$$O/P = \bar{A}$$

AND Gate,

$$O/P = A.B$$

OR Gate,

$$O/P = A+B$$

Experimental circuit
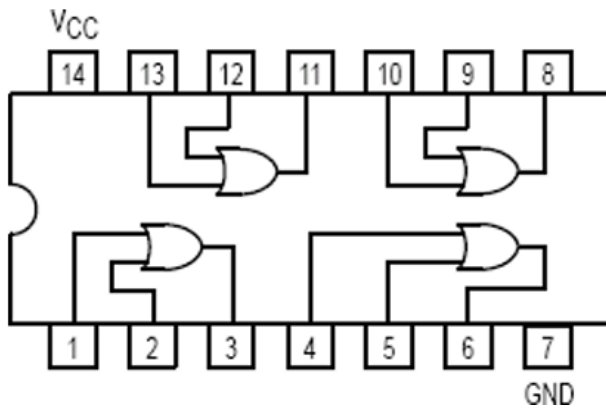
Inverter Gate (NOT Gate) 7404

2-Input AND Gate 7408

2-Input OR Gate 7432

Procedure

1. Place the IC on the Breadboard.

2. Connect VCC and ground to respective pins of IC Trainer Kit.

3. Connect the inputs to the input switches provided in the IC Trainer Kit.

4. Connect the outputs to the switches of O/P LEDs,

5. Apply various combinations of inputs according to the truth table and observe condition of LEDs.

6. Disconnect output from the LEDs and note down the corresponding multimeter voltage readings for various combinations of inputs.

Observation

Table 1: NOT – Gate   **Table 2: AND - Gate**

A	O/P
0	1
1	0

A	B	O/P
0	0	0
0	1	0
1	0	0
1	1	1

Table 3: OR - Gate

A	B	O/P
0	0	0
0	1	1
1	0	1
1	1	1

Result

Truth tables of the basic logic gates were verified.

13. Verification of De Morgan's theorems using logic gate ICs.

Aim

　　To verify De Morgan's theorems using logic gate ICs.

Apparatus required

NAND - IC 7400, OR - IC 7432, AND - IC 7408 Gates, Breadboard, Resistor – 220-ohm, Battery, LED, Connecting wire
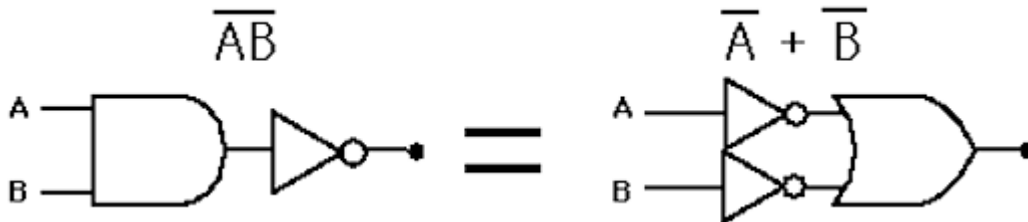
Formula

　　Theorem 1

$$\overline{A.B} = \bar{A} + \bar{B}$$

　　Theorem 2
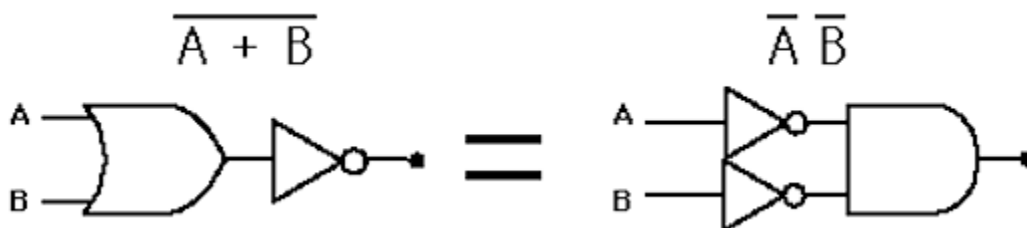
$$\overline{A + B} = \bar{A}.\bar{B}$$

Circuit diagram

Theorem 1

Theorem 2

Procedure

1. Realize the De morgan's theorem using logic gates.
2. Connect VCC and ground as shown in the pin diagram.
3. Make connections as per the logic gate diagram.
4. Apply the different combinations of input according to the truth tables and

verify that the results are correct.

Observation

Theorem 1

A	B	$\overline{A.B}$	$\bar{A} + \bar{B}$

Theorem 2

A	B	$\overline{A + B}$	$\bar{A}.\bar{B}$

Result

De Morgan's theorems using logic gate ICs were verified.

14. Use of NAND as universal building block.

Aim

To study and verify the use of NAND gate as a universal gate

Apparatus required

NAND - IC 7400 Gate, Breadboard, Resistor – 220-ohm, Battery, LED, Connecting wire

Formula

NAND Gate as inverter,

$$Y = \overline{A}$$

NAND Gate as AND Gate,

$$Y = A.B$$

NAND Gate as OR Gate,

$$Y = A + B$$

NAND Gate as NOR Gate,

$$Y = \overline{A + B}$$
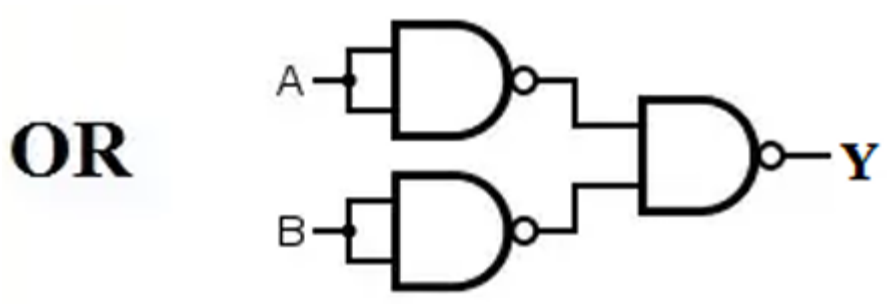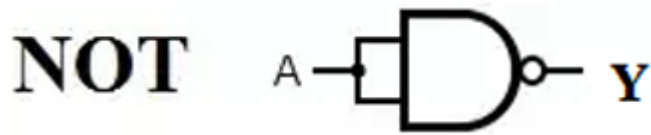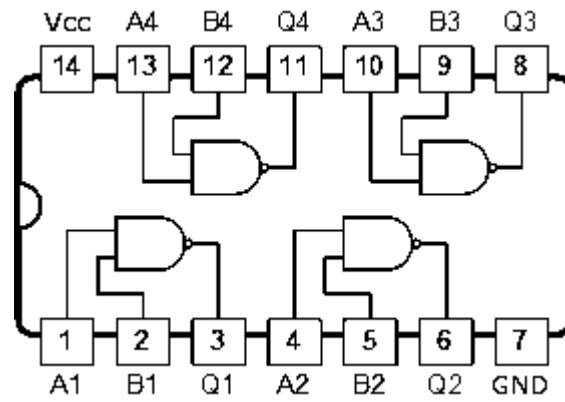
NAND Gate as EX-OR Gate,

$$Y = A\overline{B} + \overline{A}B$$

Where;

A, B = Inputs
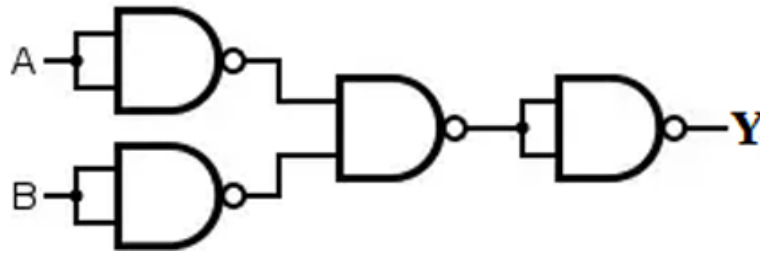
Y = Output

Circuit diagram
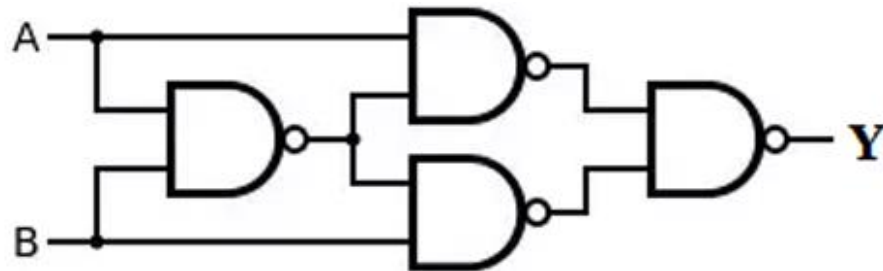
Pin diagram

NOT

AND

OR

NOR

XOR

Procedure

1. Make the connections as per the logic diagram.
2. Connect +5v to pin 14 & ground to pin 7.
3. Apply diff combinations of inputs to the i/p terminals.
4. Note o/p for NAND as universal gate.
5. Verify the truth table.

Observation

Table 1

INPUT	OUTPUT
A	Y
0	1
1	0

Table 2

INPUT A	INPUT B	OUTPUT Y
0	0	0
0	1	0
1	0	0
1	1	1

Table 3

INPUT A	INPUT B	OUTPUT Y
0	0	1
0	1	1
1	0	1
1	1	0

Table 4

INPUT A	INPUT B	OUTPUT Y
0	0	1
0	1	0
1	0	0
1	1	0

Table 5

INPUT A	INPUT B	OUTPUT Y
0	0	0
0	1	1
1	0	1
1	1	0

Result

NAND gate as a universal gate were verified using truth tables.