EXPERIMENT NO: 01

VERIFICATION OF POLYGON LAW

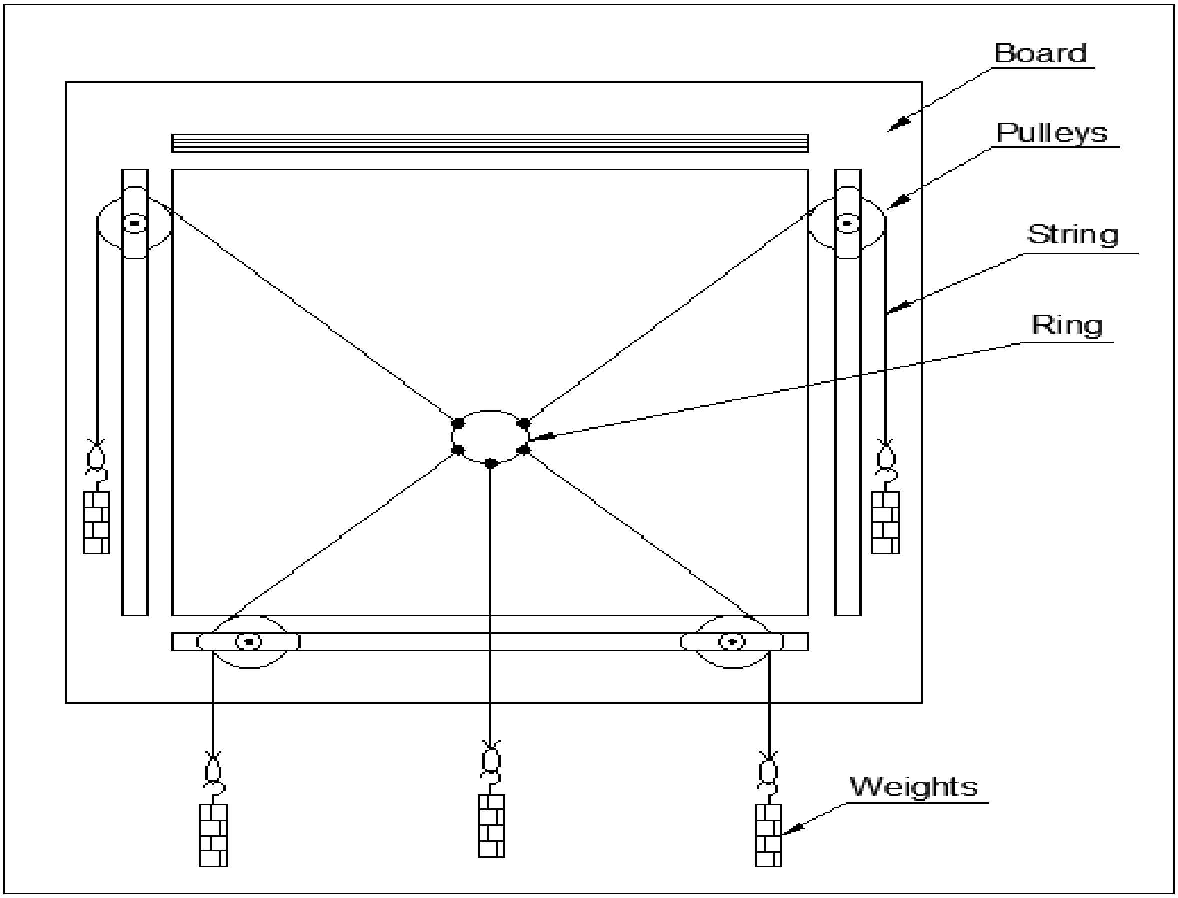
NAME:

CLASS:

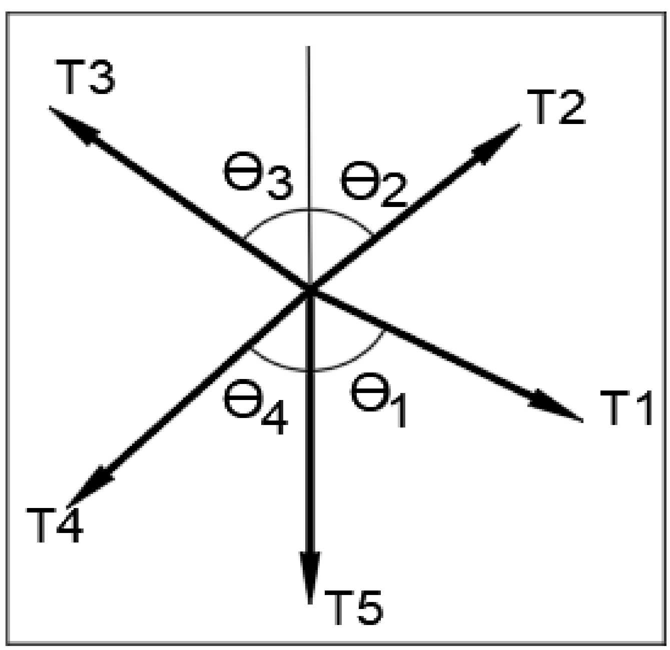
ROLL NO:

DOS:

MARKS:



Experimental setup



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Experiment No. 01

VERIFICATION OF POLYGON LAW

DOP: **DOS:**

AIM:

To verify the law of polygon of forces for a number of coplanar forces in equilibrium.

APPARATUS:

Concurrent Coplanar Force system apparatus, hangers, weights, Angle measuring instrument.

PRINCIPLE:

The Law of Polygon of Forces states that – if any number of coplanar concurrent forces can be represented in magnitude and direction by the sides of a polygon taken in order; then their resultant will be represented by the closing side of the polygon taken in opposite order".

Also, if the forces form a closed polygon, then the system is in equilibrium.

OBSERVATION TABLE:

Obs No.	T_1 (N)	T_2 (N)	T_3 (N)	T_4 (N)	T_5 (N)	Θ_1 (Deg)	Θ_2 (Deg)	Θ_3 (Deg)	Θ_4 (Deg)
1									
2									
3									
4									
5									

SAMPLE CALCULATION [READING NO.   ]

For each observation, first do the Analytical Calculation, and then find the result using Graphical Method. For graphical methods, draw one Space Diagram and one Vector Diagram. Do mention the Scale for the Vector Diagram. Do attach the Sheet of Paper, on which the experiment is performed, with this journal.

$\Sigma F_x = T_1 \sin\Theta_1 + T_2 \sin\Theta_2 - T_3 \sin\Theta_3 - T_4 \sin\Theta_4$

$= \_\_\_$ N (approx. zero)

$\Sigma F_y = - T_1 \cos\Theta_1 + T_2 \cos\Theta_2 + T_3 \cos\Theta_3 - T_4 \cos\Theta_4 - T_5$

$= \_\_\_$ N (approx. zero)

CONCLUSION:

Drawn Polygon is closed approximately hence polygon law is verified.

EXPERIMENT NO: 02

NON CONCURRENT COPLANAR FORCE SYSTEM

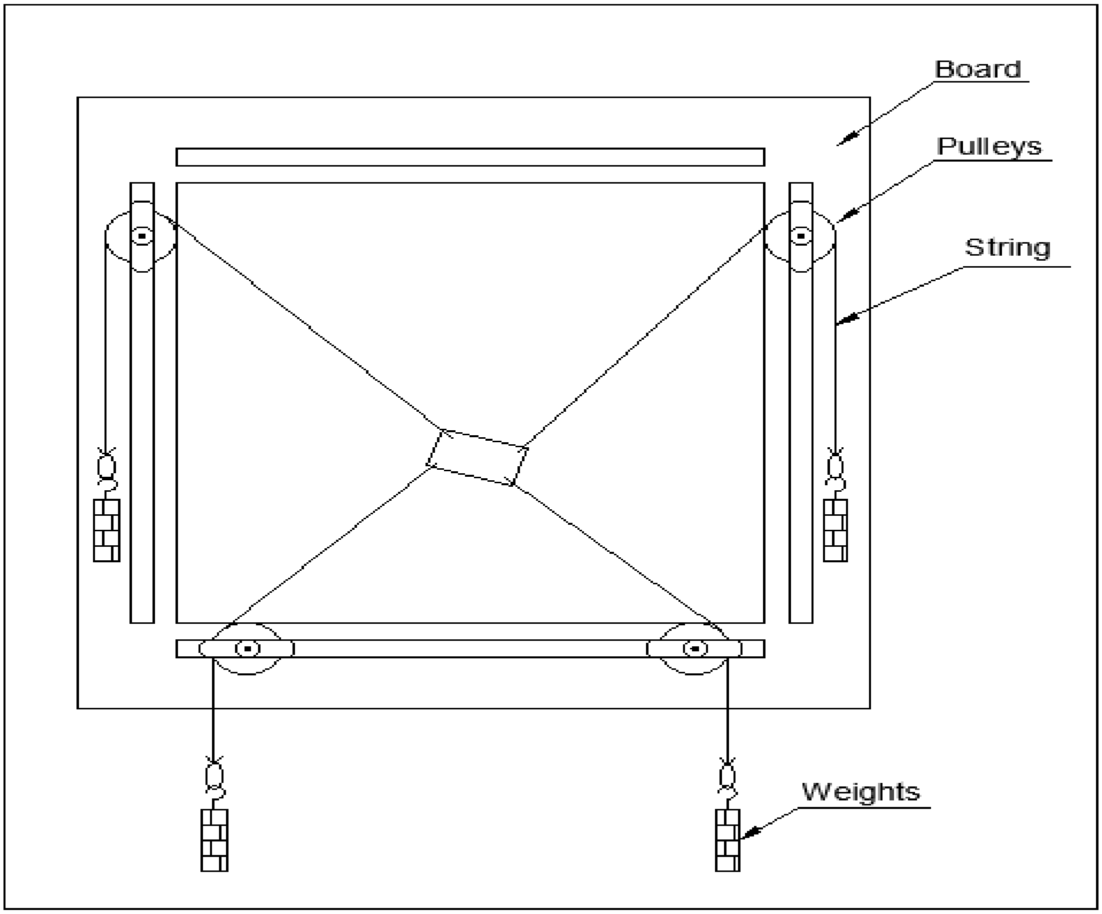
NAME:

CLASS:

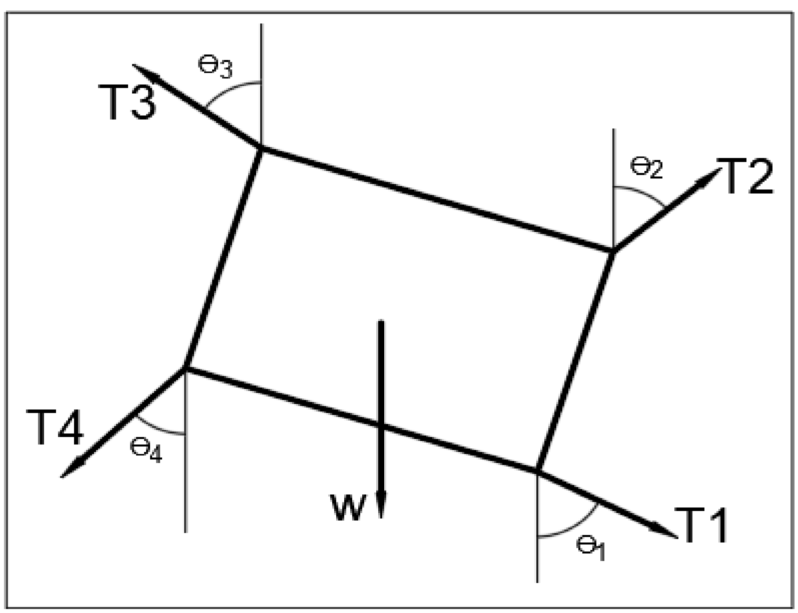
ROLL NO:

DOS:

MARKS:



Experimental setup



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Experiment No. 02

NON CONCURRENT COPLANAR FORCE SYSTEM

DOP: **DOS:**

AIM:

For non concurrent non parallel force systems by using conditions of equilibrium find the unknown weight of plate.

APPARATUS:

Non concurrent coplanar Force system apparatus, hangers, weights, Angle measuring instrument.

PRINCIPLE:

The conditions of equilibrium are:

i. Sum of all horizontal components of forces i.e. ΣF_x is equal to zero
ii. Sum of all vertical components of forces i.e. ΣF_y is equal to zero
iii. Sum of moments of all the forces about a point is equal to zero.

OBSERVATION TABLE:

Obs No.	T_1 (N)	T_2 (N)	T_3 (N)	T_4 (N)	W (N)	θ_1 (Deg)	θ_2 (Deg)	θ_3 (Deg)	θ_4 (Deg)	$\sum F_X$
1										
2										
3										
4										
5										

SAMPLE CALCULATION [READING NO.   ]:

To verify conditions of equilibrium:

$\Sigma F_x = T_1 \sin\Theta_1 + T_2 \sin\Theta_2 - T_3 \sin\Theta_3 - T_4 \sin\Theta_4$

$=$ ____ N (approx. Zero)

$\Sigma F_y = 0$

- $T_1 \cos\Theta_1 + T_2 \cos\Theta_2 + T_3 \cos\Theta_3 - T_4 \cos\Theta_4 + W = 0$

W = _____ N

CONCLUSION:

Unknown weight of plate (W) = ____ N

EXPERIMENT NO. 03

SIMPLE BEAM

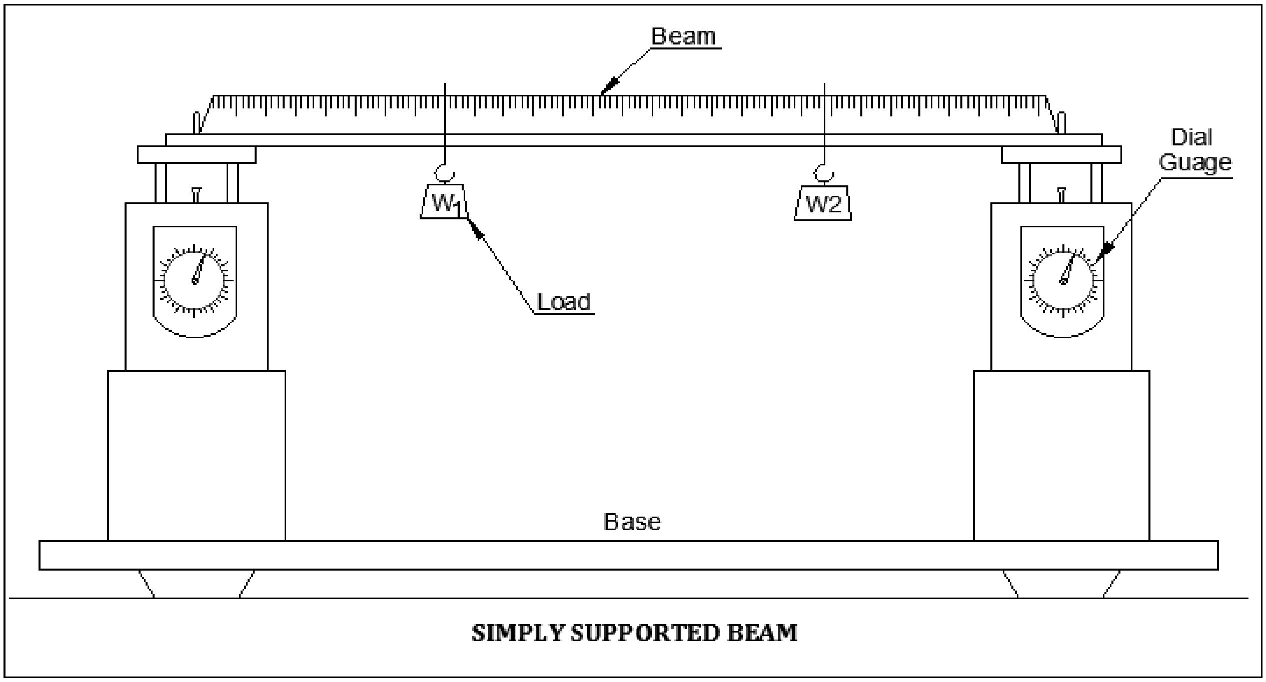
NAME:

CLASS:

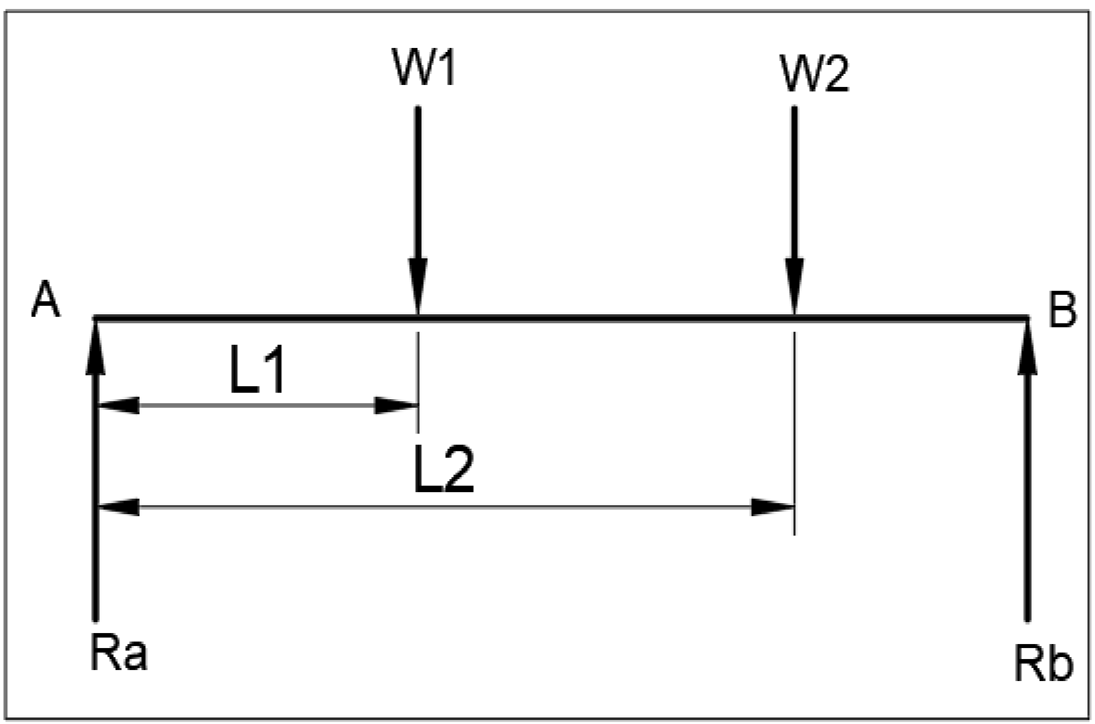
ROLL NO:

DOS:

MARKS:



Experimental setup



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Experiment No. 03

SIMPLE BEAM

DOP: **DOS:**

AIM:

To find reactions at the end supports of a simple beam carrying concentrated loads.

APPARATUS:

Simple Beam, spring balance, Hangers, Weights.

PRINCIPLE:

To find reactions at the end supports, we use conditions of equilibrium.

i. Sum of all horizontal components of forces i.e. ΣF_x is equal to zero
ii. Sum of all vertical components of forces i.e. ΣF_y is equal to zero
iii. Sum of moments of all the forces about a point is equal to zero.

PROCEDURE:

(1) Set up the apparatus and note the initial readings.
(2) Put the hangers at different positions with weights (W_1 and W_2) and note down the readings.
(3) The difference gives the reading of the spring balance R_A and R_B.
(4) Change the positions of the hangers and repeat the same experiment.
(5) Record the observed data in the Observation Table.
(6) Repeat the above procedure 4 times and tabulate the result.

OBSERVATION TABLE:

Obs No.	L_1 (m)	L_2 (m)	W_1 (N)	W_2 (N)	Observed		Calculated	
					R_A (N)	R_B (N)	R_A (N)	R_B (N)
1								
2								
3								
4								
5								

SAMPLE CALCULATION [READING NO.]:

Left and right gauges are set to zero. So, the weight of the beam need not be considered.

Since the given system is in equilibrium,

$\Sigma M_A = 0$

i.e. $R_B(1) - W_1(L_1) - W_2(L_2) = 0$ (L_1 & L_2 are measured from left end A)

$R_B = W_1(L_1) + W_2(L_2)$

$= \_\_\_\_\_\_\_\_$ N

To find R_A:

$\Sigma F_y = 0$

i.e. $R_A + R_B - W_1 - W_2 = 0$

$R_A = W_1 + W_2 - R_B$

$= \_\_\_\_\_\_\_\_$ N

CONCLUSION:

Support Reactions			
Analytically		Experimentally	
R_A (N)	R_B (N)	R_A (N)	R_B (N)

The support reactions obtained experimentally and analytically are nearly equal.

EXPERIMENT NO: 04

BELL CRANK LEVER

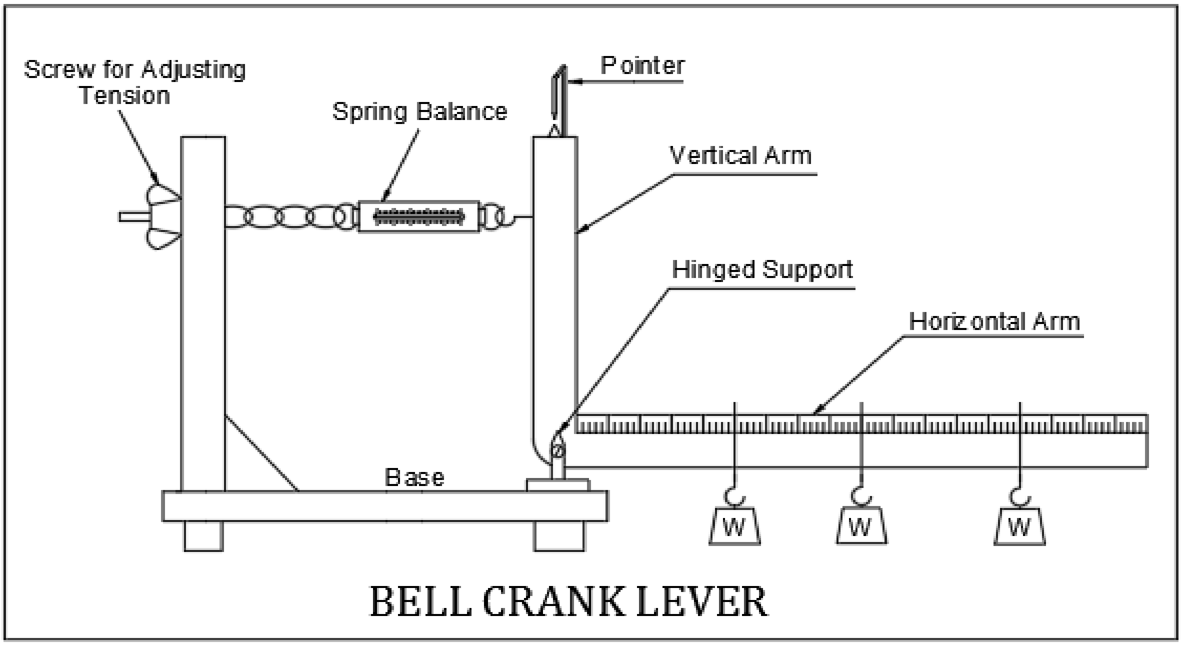
NAME:

CLASS:

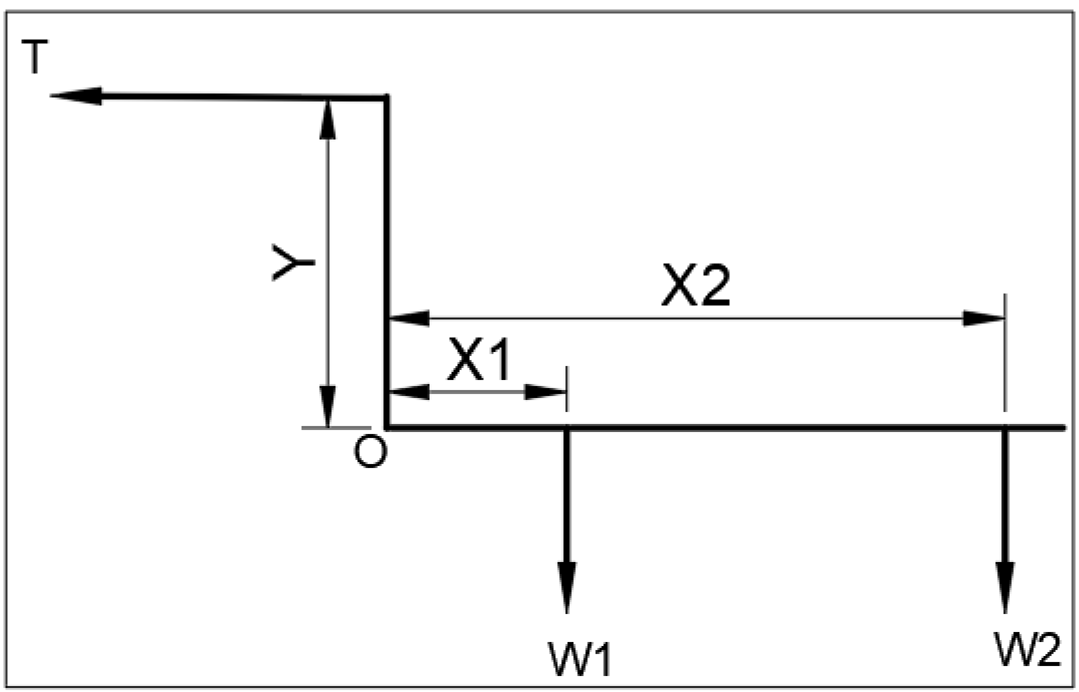
ROLL NO:

DOS:

MARKS:



Experimental setup



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Experiment No. 04

BELL CRANK LEVER

DOP: **DOS:**

AIM:

To verify principle of moments using Bell Crank Lever apparatus and to find the percentage error of the apparatus.

APPARATUS:

Bell Crank lever, hangers, Weights, Spring Balance.

PRINCIPLE:

Principle of Moments states, „the algebraic sum of the moments of a system of coplanar forces about any point in the plane is equal to the moment of the resultant force of the system about the same point. Or the sum of all moments about any point equals to zero when the system is in equilibrium. This principle would be verified for a bell crank lever arrangement.

A lever whose two arms form a right angle, or nearly a right angle and having its fulcrum at the apex of the angle is referred to as a bell crank lever. These levers were originally used to operate the bell from a long distance and hence the name. Now bell crank levers are used in machines to convert the direction of reciprocation movement.

PROCEDURE:

1. Arrange two hangers at arbitrary locations on the horizontal arm and note the locations $x1$, and $x2$, of these hangers from the hinge.

2. Adjust the tension in the spring connected to the vertical arm such that the arm which has loads comes in horizontal position.

3. Note the tensile force in the spring as the initial tension Ti .

4. Hang the weights $\mathbf{W_1}$ and $\mathbf{W_2}$ from the hangers. This will cause the arms to tilt and the pointers to move away from each other. Now again adjust the tension in the spring such that that the arm which has loads comes in a horizontal position.

5. Note the tensile force in the spring as the final tension Tf.

6. The tensile force T due to the application of loads on horizontal arm is equals to $Tf - Ti$.

7. Therefore, to verify the principle of moments we need to take moments M of all the external forces (which include the weights of the hangers hanging from the horizontal arm) and the tension in the spring connected to the vertical arm about the hinge.

8. If the total sum is zero, verify the law of moments since the moment of the resultant is also zero about the hinge.

9. Repeat the above steps by changing the weights and their location on the horizontal arm for more sets of observations.

OBSERVATION TABLE:

Obs No.	W_1 (N)	W_2 (N)	X_1 (m)	X_2 (m)	Initial T T_i (N)	Final T T_f (N)	$T = T_f - T_i$ (N)	ΣM (N-m)
1								
2								
3								
4								
5								

Distance y = 0.21m

SAMPLE CALCULATION [READING NO.   ]:

Summation of moments of all external forces about the hinge 'O'

$\Sigma M_O = T_{obs} * y - W_1 * X_1 - W_2 * X_2$

= _______ N-m (approx. zero)

To find percentage Error:

$T_{obs} = T_f - T_i$

T_{obs} = _______ N

$\Sigma M_O = 0$

$T_{cal} * y - W_1 * X_1 - W_2 * X_2 = 0$

T_{cal} = _______ N

% Error = $(T_{cal} - T_{obs}) / T_{cal} * 100$

= ________ % which is within the permitted limits of ±5%

CONCLUSION:

The sum of moments of all external forces about point 'O' on the bell crank lever (within limits of experimental error) being close to zero, is in accordance with the law of principle of moments. Hence, the law of Principle of Moments is verified.

EXPERIMENT NO: 05

Coefficient of Friction

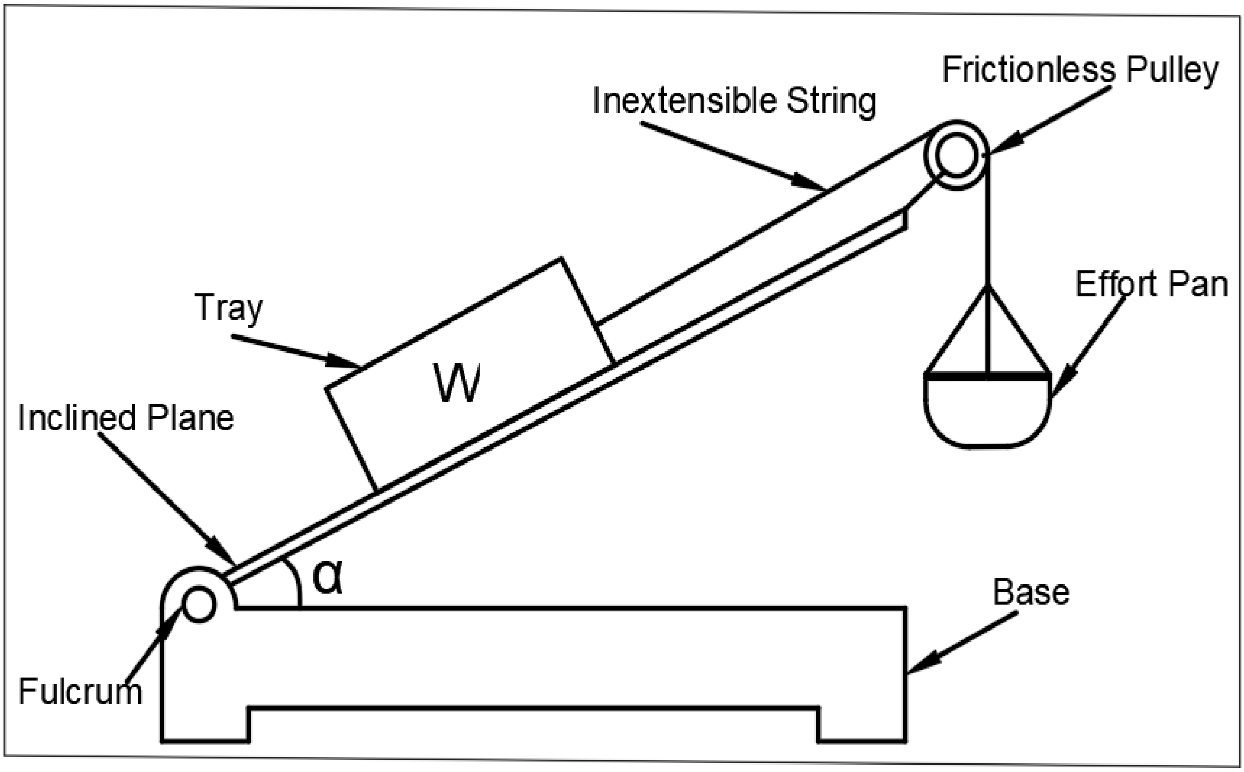
NAME:

CLASS:

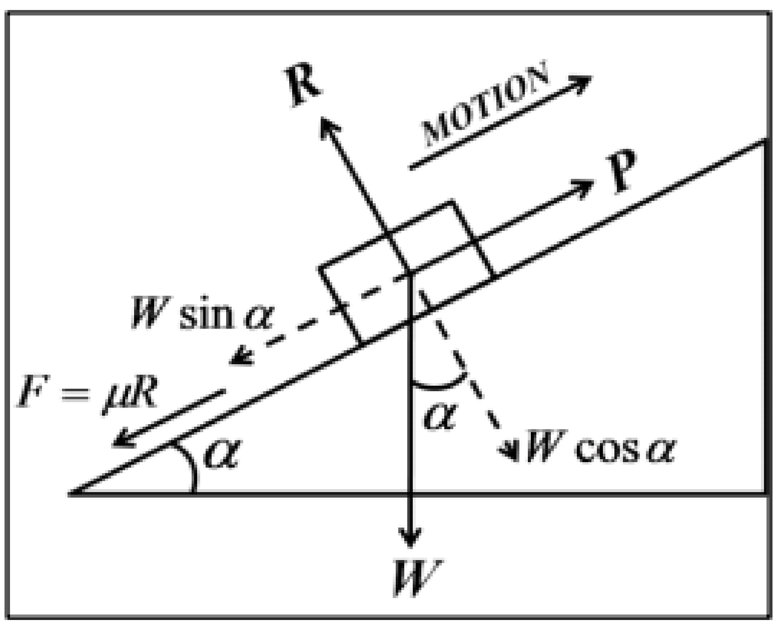
ROLL NO:

DOS:

MARKS:



Experimental setup



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Experiment No. 05

FRICTION

DOP: **DOS:**

AIM:

Experimental Computation of Coefficient of Friction between an Inclined Plane (Glass) and Trolley (wooden & aluminium).

APPARATUS:

Friction plane apparatus with glass top, weights, tray with wooden base, tray with aluminium base, string, effort pan, Fractional weights.

THEORY:

Frictional force is developed when there is a motion or tendency of motion of one body with respect to the other body involving rubbing of surfaces of contact.. When the body is on the verge of motion, the contact surface offers maximum frictional force called 'Limiting Frictional Force'. The limiting frictional force doesn't depend on the area of contact but depends on the materials involved and the normal reaction between them.

$\boldsymbol{\alpha}$ = Angle of inclination of the plane with the horizontal at which the trolley moves with a minimum uniform speed up the plane.

$\boldsymbol{W}$ = Load on the tray

$\boldsymbol{P}$ = Force which pulls the tray up with uniform movement

$\boldsymbol{R}$ = Normal Reaction

$\boldsymbol{F}$ = Frictional forces acting against the movement

Procedure:

1. Put a suitable load on the pan and adjust the angle of the plane so that the trolley moves with uniform speed up the plane.

2. Note the value of W, P and α.

3. Repeat the experiment for different values of W, P and α.

4. Calculate value of μ for each reading.

5. Find the average of μ.

OBSERVATION TABLES:

Surfaces of contact: Glass & Wood

S.No.	Weight of block W (N)	α (Degrees)	Force P (N)	μ_s
1				
2				
3				

Surfaces of contact: Glass & Aluminium

S.No.	Weight of block W (N)	α (Degrees)	Force P (N)	μ_s
1				
2				
3				

SAMPLE CALCULATION [READING NO.]:

Applying conditions of equilibrium,

$\Sigma F_y = 0$

$R = W \cos\alpha$

$\Sigma F_x = 0$

$P - W\sin\alpha - \mu_s R = 0$

$$\mu_s = \frac{P - W\sin\alpha}{W\cos\alpha}$$

CONCLUSION:

μ_s between Glass & Wood = __________

μ_s between Glass & Aluminium = __________

EXPERIMENT NO: 06

KINEMATICS OF PARTICLE

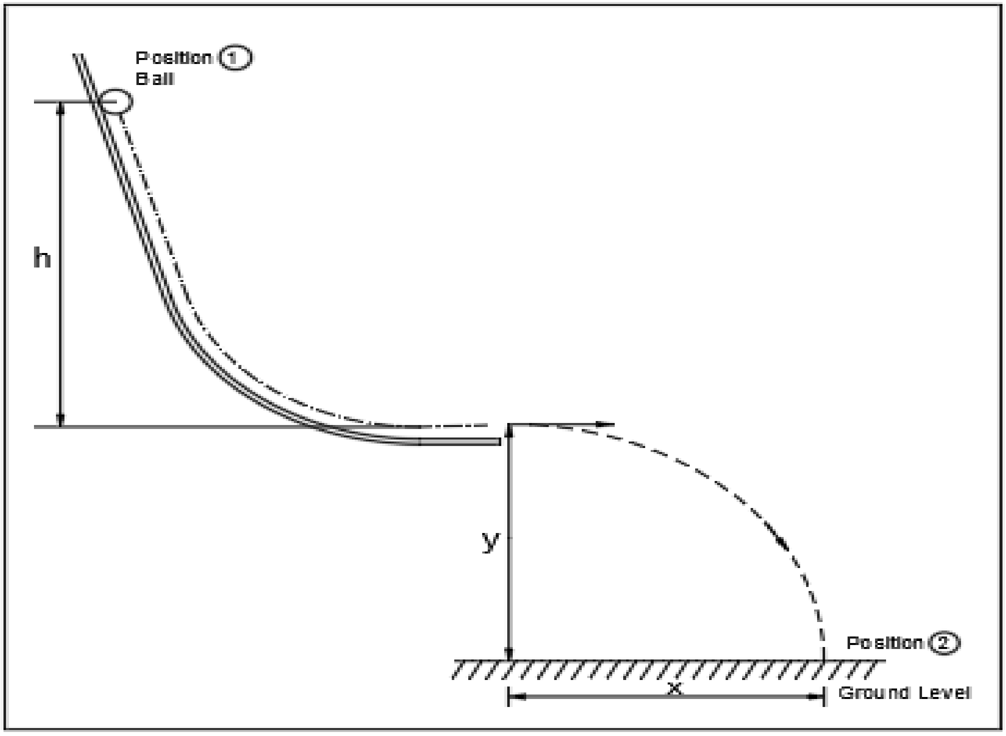
NAME:

CLASS:

ROLL NO:

DOS:

MARKS:



Experimental setup

Experiment No. 06

KINEMATICS OF PARTICLE

DOP: **DOS:**

AIM:

Verification of Trajectory equation

APPARATUS:

Impact apparatus, steel ball, meter scale, chalk piece.

Theory:

In horizontal direction, the body possesses uniform motion i.e. constant velocity and in vertical direction, it's under gravitational force i.e. motion with uniform acceleration.

Trajectory equation is, $y = x \tan\alpha + \frac{1}{2} (gx^2 / u^2\cos^2\alpha)$

OBSERVATION TABLE:

Obs No.	Height H (m)	Initial velocity (u) (m/s)	X (m)		y (m)
			$X_{obs.}$	X_{cal}	
1					
2					
3					
4					
5					

SAMPLE CALCULATION [READING NO.]:

u = $\sqrt{2gH}$

H = Height from where steel ball released (change H for each reading)

g = - 9.81 m/s^2

α (angle of projection) = 0

$X_{\mathbf{cal}}$ = horizontal range

y = vertical displacement (table height)

Trajectory equation is,

$y = \mathbf{x_{cal}} \tan\alpha + 1/2\ (gx^2/u^2\cos^2\alpha)$

CONCLUSION:

Observed range and calculated range from Trajectory equation are approximately the same. So, Trajectory equation is verified.