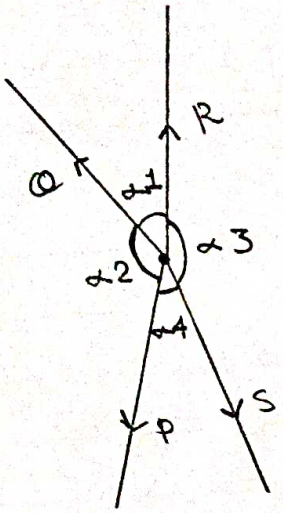
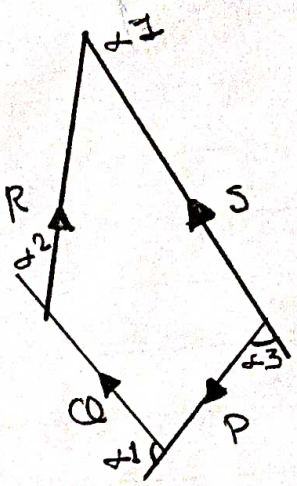
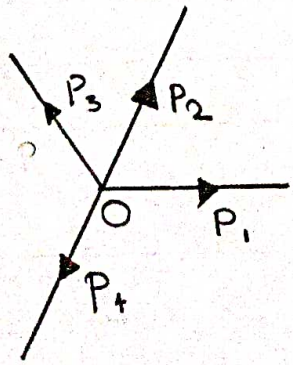
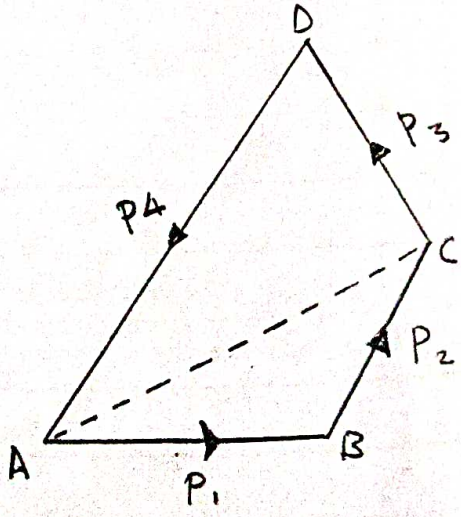

R
Q
α1
α2
α3
α4
P
S


α1
R
S
α2
α3
Q
P
α1


P3
P2
O
P1
P4


D
P3
P4
C
P2
A
B
P1

1. Object: Verification of Law of Polygon of Forces.

2. Theory: If number of forces acting on a particle be represented in magnitude and direction by the sides of a polygon, taken inorder, the forces shall be in equilbrium.

Let the forces F_1, F_2, F_3, F_4 acting at 'O' be represented in direction and magnitude by the sides AB, BC, CD and DA of the polygon ABCD
Join AC,

Then

$$AB + BC = AC$$
$$AC + CD = AD$$
$$AD + DA = 0$$

Hence the system is in equilibrium

It is clear that the resultants of the forces represented by AD.

3. Apparatus: Universal force table, Hanger weights.

4. Procedure:

1. Arrange that the four strings tied to central ring and each pulled by a definite measured force and pass these strings over the smooth pulleys.

2. Set out the angles between the strings till the ring comes in centre then forces are in equilibrium.

3. Note down these weights and angles between them.

4. Now on a paper take a point and draw the lines representing the direction and magnitude of the direction forces on space digram.

5. Give Bow's Notation to the forces set out space digram.

6. Choose a suitable scale and draw vector digram. If last point falls on a initial point, we obtain a closed polygon. Then a system of coplanar concurrent forces is in equilibrium. The law of polygon of forces is verified.

7. Measure a closing line to the scale employed for the forces AB, BC, CD and note its direction.

8. Take at least two sets of reading and for each set draw space and vector diagram.

5. Observation Table: Scale: 1cm = ... Gm.Wt

S.No	P Gm	Q Gm	R Gm	S (Last Forces) Practical	Graph	ANGLES α1	α2	α3	Pract.	Graph.

Precautions:

1. The ring should remain in the centre. While taking reading.
2. Pulleys should be friction less.
3. Note down the angles between two forces very carefully.
4. Weight of hanger must be included while counting the weights placed on hangers.
5. Force table must be set on the levelled table.

Object: Determination of Mechanical Advantage, Velocity Ratio, and efficiency for single Purchase.

Apparatus: Single purchase winch crab, Scale, loads.

Theory: For single purchase Winch crab

1. Velocity Ratio (V.R.) = $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

$$V.R. = \frac{2\pi R_1}{\frac{T_1}{T_2} \times 2\pi R_2}$$

Here,

$2\pi R_1$ = Circumference of effort wheel
$2\pi R_2$ = Circumference of load drum.
T_1 = No of Teeth on Pinion
T_2 = No of teeth on Spur.

2. Mechanical Advantage (M.A.) = $\frac{\text{Total lifted load (W)}}{\text{Total effort (P)}}$

3. Efficiency : $\eta = \frac{M.A.}{V.R.} \times 100\%$

Procedure :

Measure the circumference of effor wheel and load drum. Count the No. of teeth (T_1) on pinion and No of Teeth (T_2) on spur. Find out velocity ratio.

Then hang some load W at load drum place suitable weight (effort) on the Pan, having with effort wheel, just sufficient to move the wheel.

Repeat the experiment with different loads and efforts. In a single purchase winch crab, a rope is fixed to the drum and is wound a few turns around it. The free end of rope carries W. A toothed wheel rigidly mounted on the load drum. Another toothed wheel called

pinion , is geared with the spur (which is rigidly mounted).

Observation:

Circumference of load Drum = $2\pi R_2$
Circumference of effort wheel = $2\pi R_1$

No of teeth in pinion (T_1) =
No of teeth in spur (T_2) =

S no.	Load 'W' kg	Effort 'P' kg	V.R.	M.A.	Efficiency η %
1	2000 gm	145 gm	25.94	13.79	53.16%
2	5000 gm	345 gm	25.94	14.49	55.83%
3	7000 gm	450 gm	25.94	15.55	59.96%
4	10000 gm	600 gm	25.94	16.66	64.25%

Experiment No. 4

Object: To determine the coefficient of Friction between Wood and metal surface on Horizontal plane.

Apparatus: Apparatus of co-efficient of friction slider box of metal base (3 Nos.) Weight, 50 grams of 10 weights and weight Box, Thread and pan, spirit level.

Description: The apparatus consists of a wooden long board having fixed pully at one end for hanging the pan attached with the slider box.

Theory: Coefficent of friction

$$\mu = \frac{P}{W} = \frac{\text{Effort}}{\text{load}}$$

Procedure: keep some load in the slider box and than apply effort by keeping weights in the pan, so that the slider just to move with uniform speed. By taking different loads, take the set of 3 readings for each surface and

Result:

1. The coefficient of friction between wood and glass is 0.382.
2. The coefficient of friction between copper and glass is 0.201.
3. The coefficient of friction between iron and glass is 0.275.

Precautions:

1. Check the motion of the pully.
2. Add the weight of slider box and pan in observed reading.
3. Tape gentally near the pully.

Observation:

S.no	Surfaces of Contact	Weight of Box W_1	Weight of Pan P_1	Weight in Box W_2	Weight in Pan P_2	Total weight $W = W_1 + W_2$	Total effort $P = P_1 + P_2$	Coefficient of friction $\mu = \frac{P}{W}$	Average of μ
1.	Wood and Glass	136 gm	45 gm	50 gm	40 gm	186 gm	85 gm	0.360	
		136 gm	45 gm	100 gm	40 gm	236 gm	85 gm	0.456	0.382
		136 gm	45 gm	150 gm	50 gm	286 gm	95 gm	0.332	
2.	Copper and Glass	215 gm	45 gm	50 gm	25 gm	265 gm	70 gm	0.233	
		215 gm	45 gm	100 gm	20 gm	315 gm	65 gm	0.185	0.201
		215 gm	45 gm	150 gm	30 gm	365 gm	75 gm	0.187	
3.	Iron and Glass	145 gm	45 gm	50 gm	15 gm	195 gm	60 gm	0.307	
		145 gm	45 gm	100 gm	20 gm	245 gm	65 gm	0.265	0.275
		145 gm	45 gm	150 gm	30 gm	295 gm	75 gm	0.254	

Experiment no. 5

Object: Find the coefficient of friction for surfaces of different metal sliding on inclined plane.

1. Wood on wood. 2. Copper on wood
3. Iron on wood. 4. Brass on wood.

Theory: When a body moves over another body under the action of a force P, its motion is opposed by a resistance along the surface of contact of the two bodies. This resting force is called friction. The value of the frictional force increases to its maximum limits as external force P, on the body increases depending upon the nature of surfaces of contact. The ratio of limiting friction to the normal reaction between the two bodies is called coefficient of friction.

Now considering a load W placed on an inclined plane, is being pulled by applying an effort P,

,and the load is just on the point of moving upward the frictional force μR. will come into play opposing the motion of the load W.

Resolving the forces along and perpendicular to the plane,

we get;

$$P = W \sin\alpha + \mu R \quad \text{- I}$$

$$R = W \cos\alpha \quad \text{- II}$$

Eliminating R in I and II

we get, $\dfrac{P - W \sin\alpha}{W \cos\alpha}$

In this the valve of P, W and α is being know from experimental observation and coefficient of friction can be calculated.

Apparatus: An inclined plane, pan, weights Boxes with Brass, Copper, Iron and Wooden bottom surfaces and Rolling box.

Procedure: Adjust any perpendicular angles of the inclined plane say 5°, keep the wooden box on the inclined plane. Attach a string to a box which passes over a smooth pulley and carries a scale pan. The weight 'W' can be varried by putting various loads in the box and the effort required to just start the box to move up the plane, is determined in such cases M is calculated by using the above formula. Take at least 4 readings for each surface and inclination.

In case of rolling friction the boxes with roller (wheels) are used and the experiment is carried out as above.

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Observations:

S.no	Inclination of Plane	Wt. of Box W_1	Wt. Put in Box W_2	Total Wt. W_1+W_2 W	Wt. of Pan P_1	Wt. Put in Pan P_2	Total Wt. P_1+P_2 P	$\mu = \frac{P-W\sin\theta}{W\cos\theta}$
1	Wood and Wood							
1	5°	136 gm	100 gm	236 gm	45 gm	70 gm	115 gm	0.40
2	9°	136 gm	120 gm	256 gm	45 gm	120 gm	165 gm	0.49
3.	11°	130 gm	200 gm	336 gm	45 gm	140 gm	195 gm	0.39
								Avg: 0.42
	Wood and Copper							
1.	5°	215 gm	50 gm	265 gm	45 gm	50 gm	95 gm	0.27
2.	8°	215 gm	100 gm	315 gm	45 gm	100 gm	145 gm	0.32
3.	9°	215 gm	200 gm	365 gm	45 gm	90 gm	135 gm	0.21
								Avg: 0.26

Result : Mean values of coefficient of static friction between surfaces.

a. Wood and Wood

b. Wood and metal

Plot graph between load and effort.