Department of Mechanical Engineering
Engineering Mechanics Lab

Laboratory Incharge

Prof. Jayant Khede
Prof. Manoj Raut

Laboratory Technician

Mr. Paritesh Nim

List of Equipments with Price

S. No.	List of Equipments	Date	Price (in Rs.)
1.	Bell crank lever apparatus	13/12/2011	1600
2.	Bell crank lever apparatus on wooden base without weight	02/01/2016	2020
3.	Bending moment Apparatus	13/12/2011	2480
4.	Horizontal plane for coefficient of friction	28/03/2001	5100
5.	Joint roof Truss	13/12/2011	2400
6.	Laws of moments by rotating disc apparatus	13/12/2011	2160
7.	moment of inertia of a given fly-wheel (20 cm diameter)	13/12/2011	1840
8.	moment of inertia of a given fly-wheel (15 cm diameter)	02/01/2016	1950
9.	Parallel force apparatus	02/01/2016	6480
10.	parallelogram Law of forces apparatus	13/12/2011	1150
11.	Polygon Law of Forces apparatus	13/12/2011	2240
12.	Polygon Law of Forces apparatus with iron conical weights.	02/01/2016	2740
13	Simply supported beam	13/12/2011	1840
14	Simple wheel & Axle	28/03/2000	7400
15	Worm & worm wheel	28/03/2000	2160

List of Major Equipments with Price

S. No.	List of Equipments	Date of Purchase	Price (in Rs.)
1.	Bell crank lever apparatus on wooden base without weight	02/01/2016	1600
2.	Parallel force apparatus	02/01/2016	6480
3.	Horizontal plane for coefficient of friction	28/03/2001	5100
4.	Polygon Law of Forces apparatus with iron conical weights.	02/01/2016	2740

List of Equipments purchased in Last Three Years with Price

S. No.	List of Equipments	Date of Purchase	Price (in Rs.)
1.	Bell crank lever apparatus on wooden base without weights	02/01/2016	2020
2.	moment of inertia of a given fly-wheel (15 cm diameter)	02/01/2016	1950
3.	Parallel force apparatus	02/01/2016	6480
4.	Polygon Law of Forces apparatus with iron conical weights.	02/01/2016	2740

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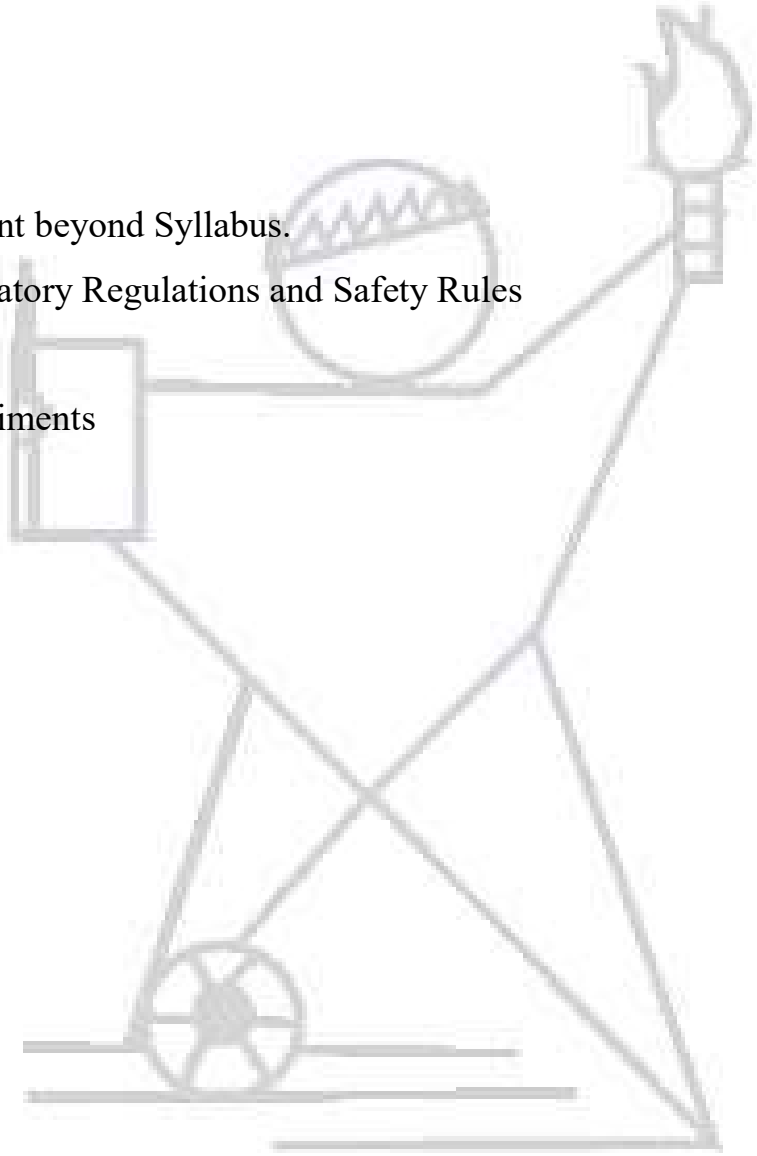

Vision of the Institute

To be the fountainhead of novel ideas & innovations in science & technology & persist to be a foundation of pride for all Indians.

Mission of the Institute

M1: To provide value based broad Engineering, Technology and Science where education in students are urged to develop their professional skills.

M2: To inculcate dedication, hard work, sincerity, integrity and ethics in building up overall professional personality of our student and faculty.

M3: To inculcate a spirit of entrepreneurship and innovation in passing out students.

M4: To instigate sponsored research and provide consultancy services in technical, educational and industrial areas.

Vision of the Department

To be a nationally recognized, excellent in education, training, research and innovation that attracts, rewards, and retains outstanding faculty, students, and staff to build a Just and Peaceful Society.

Mission of the Department

M1: Imparting quality education to the students and maintaining vital, state-of-art research facilities for faculty, staff and students.

M2: Create, interpret, apply and disseminate knowledge for learning to be an entrepreneur and to compete successfully in today's competitive market.

M3: To inculcate Ethical, Social values and Environment awareness.

Program Education Objectives (PEOs)

PEO1: To enrich graduates with fundamental knowledge of Physics, Chemistry and advanced mathematics for their solid foundation in Basic Engineering science.

PEO2: To provide graduates to design the solution of engineering problems relevant to mechanical engineering design through the process of formulating, executing & evaluating a design solution as per need with socio-economic impact consideration and related constraints.

PEO3: To provide graduates with experience in learning and applying tools to solve theoretical and open ended mechanical engineering problems.

PEO4: To provide a contemporary grounding in professional responsibility including ethics, global economy, emerging technologies and job related skills such as written and oral communication skills and to work in multidisciplinary team.

PEO5: Prepare graduates to be interested, motivated, and capable of pursuing continued life-long learning through beyond curriculum education, short term courses and other training program in interdisciplinary areas.

Program Outcomes (POs)

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of Mechanical engineering problems.

PO2: Problem analysis: Identify, formulate, and analyze mechanical engineering problems to arrive at substantiated conclusions using the principles of mathematics, and engineering sciences.

PO3: Design/development of solutions: Design solutions for mechanical engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: An ability to design and conduct experiments, as well as to analyze and interpret data.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to mechanical engineering problems with an understanding of the limitations.

PO6: The engineer and society: Apply critical reasoning by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.

PO7: Environment and sustainability: Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: An understanding of professional and ethical responsibility.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10: Communication: Ability to communicate effectively. Be able to comprehend and write effective reports documentation.

PO11: Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply this to Mechanical engineering problem.

PO12: Life-long learning: ability to engage in life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Engage professionally in industries or as an entrepreneur by applying manufacturing and management practices.

PSO2: Ability to implement the learned principles of mechanical engineering to analyze, evaluate and create advanced mechanical system or processes.

Course Outcomes (COs)

CO3 - Apply concepts of forces, their resolution and applications in engineering practice.

CO4 - Analyze various types of beams under different loading condition also the concept of shear force and bending moment diagram.

CO5 - Compute centroid, Centre of gravity and moment of inertia of various symmetrical sections.

Content beyond Syllabus

1. To determine the mechanical advantage, Velocity ratio and Mechanical efficiency of the Simple Wheel and Axle
2. To determine the coefficient of friction of different parts of the surface on horizontal plane using different materials.

Laboratory Regulations and Safety Rules

1. Read the instructions mentioned in the manual carefully and then proceed for the experiment.
2. Mishandling of lab equipment will not be tolerated at all. If any student is found guilty; he/she should be punished/ discarded from the lab.
3. Care must be taken while dealing with electrical connections.
4. Issued the needed/ supporting equipments by the concerned teacher/lab. technician & return the same duly before leaving the lab.
5. If any defect or discrepancy noticed in the particular instrument/ equipment while the students are using, they will be fined/ punished for the same.
6. Put your bags outside the lab before entering in lab.
7. Switch off the lights, fans and all the equipments used, before leaving lab.
8. Students will replace their chairs to its specific position before leaving the lab.

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Experiment No. 01

Objective: To verify law of parallelogram of forces

Theory: If two forces P and Q acting on a particle be represented in magnitude and direction by the two sides of a parallelogram, then their resultant (R) is represented both in magnitude and direction by the diagonal of the parallelogram.

R = $\sqrt{P^2 + Q^2 + 2\,PQ\cos\theta}$

Tan α = $\frac{Q\sin\theta}{P+Q\cos\theta}$, where α is the angle that Resultant R makes with force P.

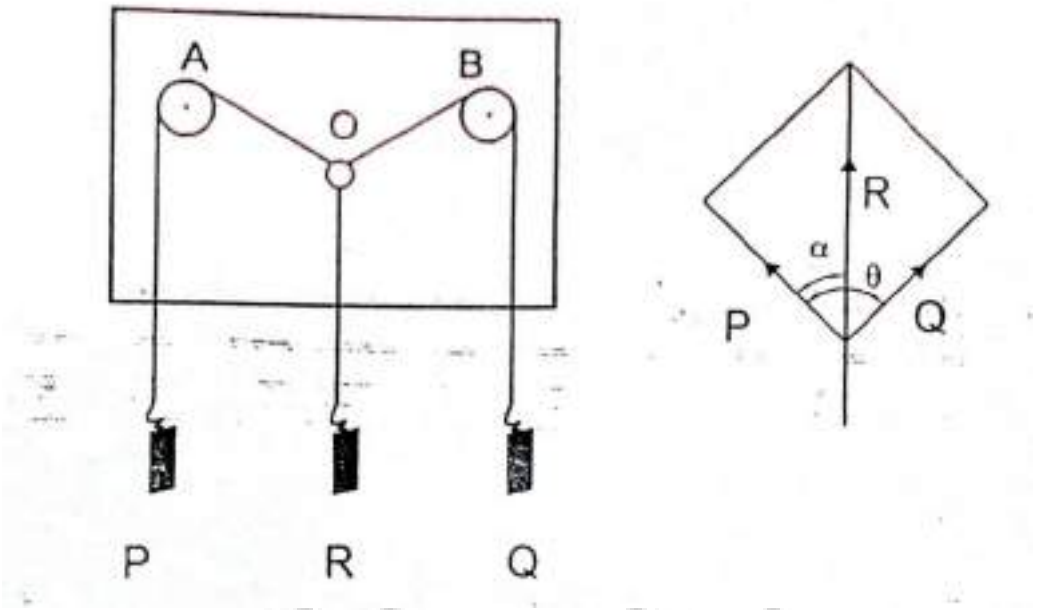


Fig.1 parallelogram law of forces

Apparatus:

1. A board fixed with pulleys.
2. Strings.
3. Weights.
4. Mirror strip etc.

Procedure:

a) Connect the hangers at the end of each string.
b) Suspend the string on the pulleys.
c) Fix drawing sheets on the board.
d) Add suitable weights in the hangers such that equilibrium achieved.
e) After equilibrium is reached, mark the directions of strings on them.
f) Repeat the experiment with five sets of weights.
g) Taking proper scale, draw the adjacent sides of the parallelogram to OA & OB , representing forces P and Q.
h) Diagonal will represent graphical value of resultant R.

Observation:

S.No.	Force P (N)	Force Q (N)	Force R (N) Experimental(R_1)	Resultant R(N) Graphical (R_2)	% Error $= \frac{R_1 - R_2}{R_1} \times 100$

Results: Law of parallelogram is verified with error = %

Precaution:

a) Weight of hangers should be taken into consideration.
b) Weight should be placed gently.
c) Parallax should be removed.
d) Pulleys should be smooth and , if required properly lubricated
e) Proper scale should be chosen.

f)Drawing sheet should be fixed properly.

g) Weights should be in stationary position while marking the point.

Questions

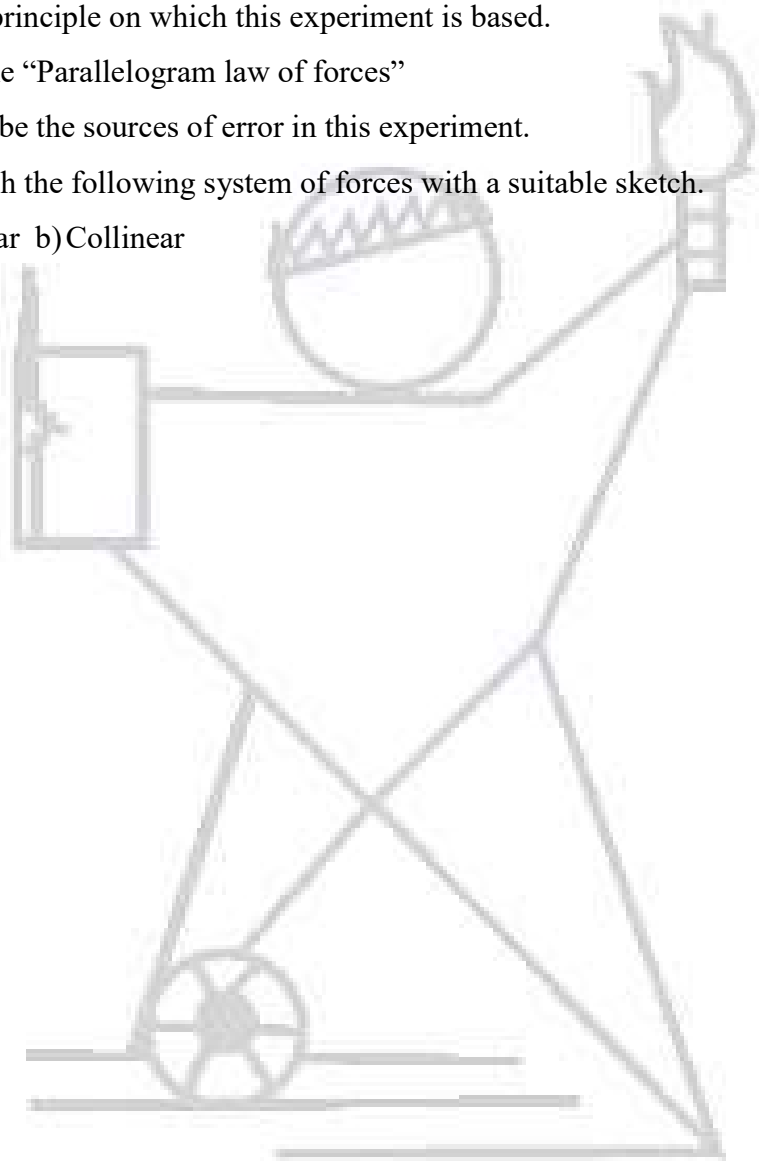
Q.1 State the principle on which this experiment is based.

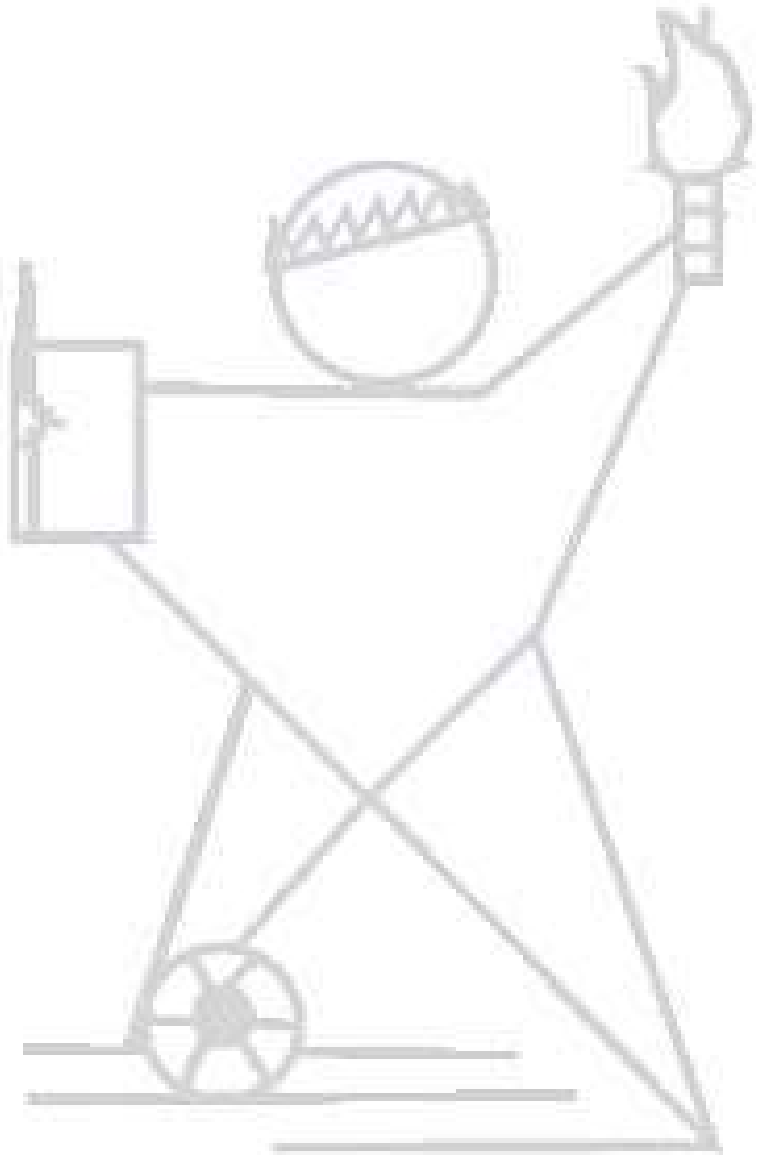
Q.2 What is the "Parallelogram law of forces"

Q.3 What can be the sources of error in this experiment.

Q.4 Distinguish the following system of forces with a suitable sketch.

a) Coplanar b) Collinear





Experiment No.02

Objective: To verify the law of triangle of forces

Theory: Law of triangle of forces states that "if three coplanar forces acting at a point are in equilibrium they can be represented in magnitude and direction by the triangle drawn in such a manner that the side of triangle are parallel to the force taken in order". It can be interpreted that if two forces acting simultaneously on a particle be represented in magnitude and direction by the two side of triangle taken in order their resultant may be represented in magnitude and direction by the third side of triangle taken in opposite order.

Apparatus:

1. Board fixed with pulleys.
2. Strings.
3. Weight.
4. Plane mirror strips.
5. Pencil etc.

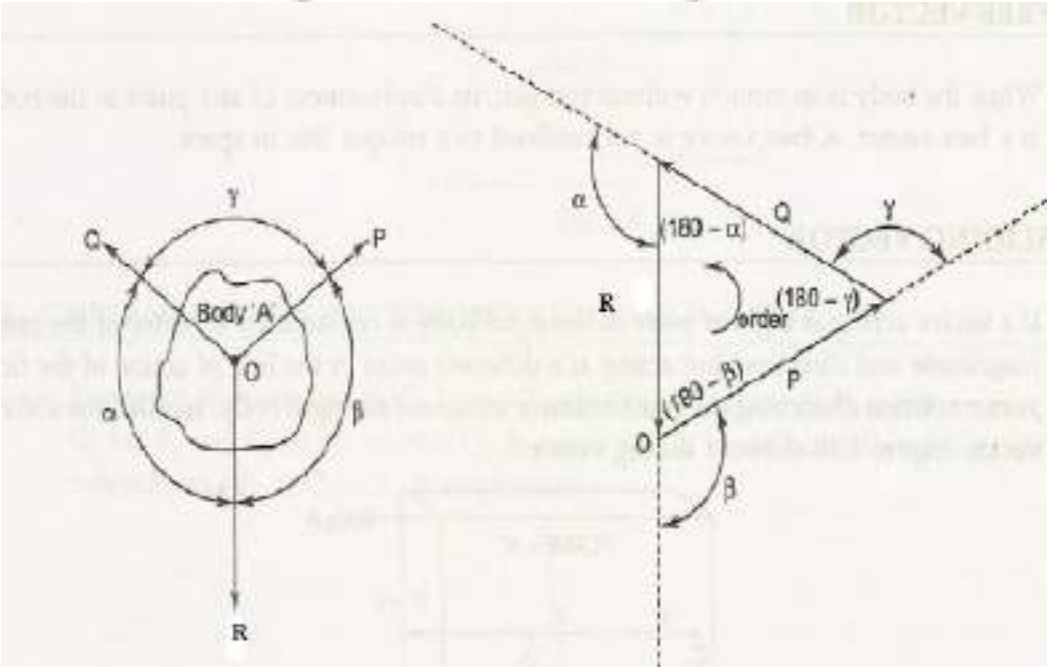


Fig.2 Triangle law of forces

Procedure:

(a) Connect the hanger at the end of such strings.

(b) Suspected the strings on the pulleys.

(c) Fix drawing sheet on the board.

(d) Add suitable weight in the hanger such that equilibrium condition achieved.

(e) After equilibrium is reached mark the direction of strings on the paper using mirror strips.

(f) Repeat the experiment for five sets of reading.

Observation:

S.No.	Force P(N)	Force Q(N)	Force R(N) Experimental	Resultant R'(N) Graphical	% Error $= \frac{R - R'}{R} \times 100$
1					
2					
3					
4					
5					

Precaution:

a) Weight of hangers should be taken into consideration.
b) Weight should be placed gently.
c) Parallax should be removed.
d) Pulleys should be smooth and , if required properly lubricated
e) Proper scale should be chosen.
f) Drawing sheet should be fixed properly.
g) Weights should be in stationary position while marking the point.

Questions:

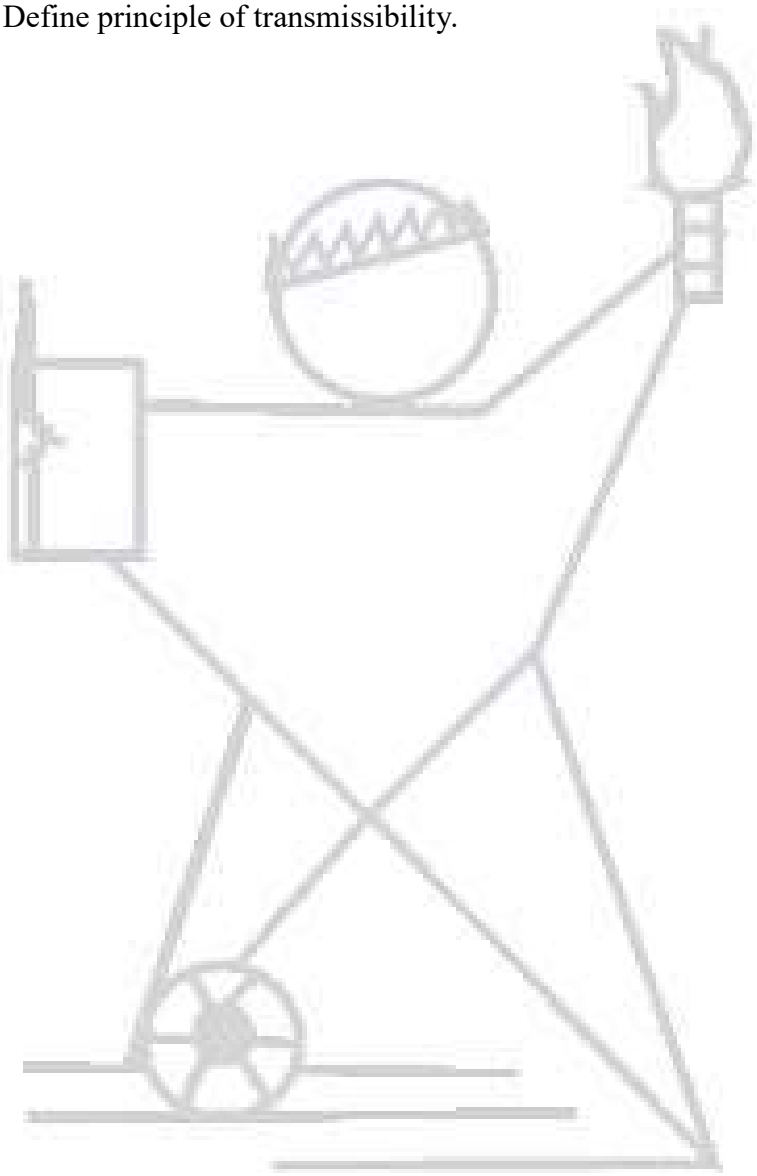
Q.1 State the principle on which this experiment is based.

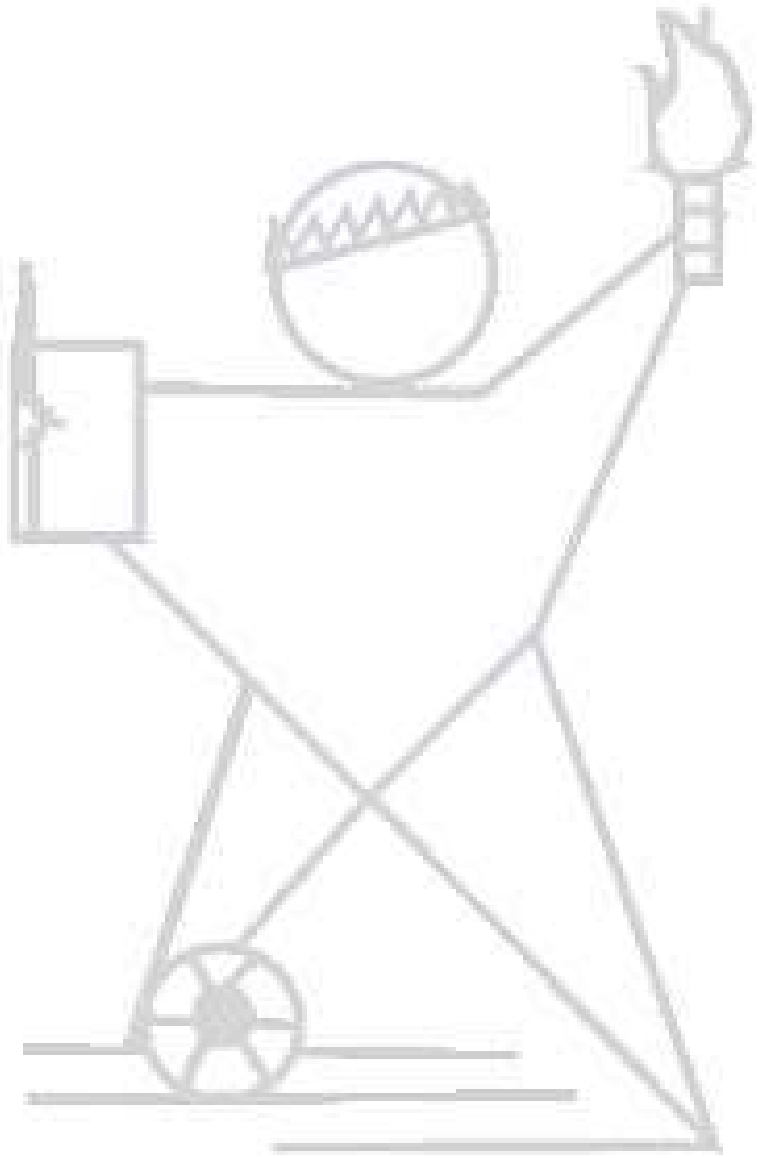
Q.2 What is the Triangle law of forces?

Q.3 What can be the sources of error in this experiment.

Q.4 Differentiate between ‘Resultant’ and ‘Equilibrant’.

Q.5 Define principle of transmissibility.





Experiment No.03

Object: To Verify the Polygon Law of Forces

Theory: Polygon Law of Forces states that if a number of forces acting on a particle are represented in magnitude and direction by the sides of a polygon taken in same order, then their resultant is represented in magnitude and direction by the closing side of the polygon taken in the opposite direction.

Apparatus: Gravesend's apparatus, paper sheet, Weight box, thread, Drawing pins, mirror strip, pans, set squares, pencil etc.

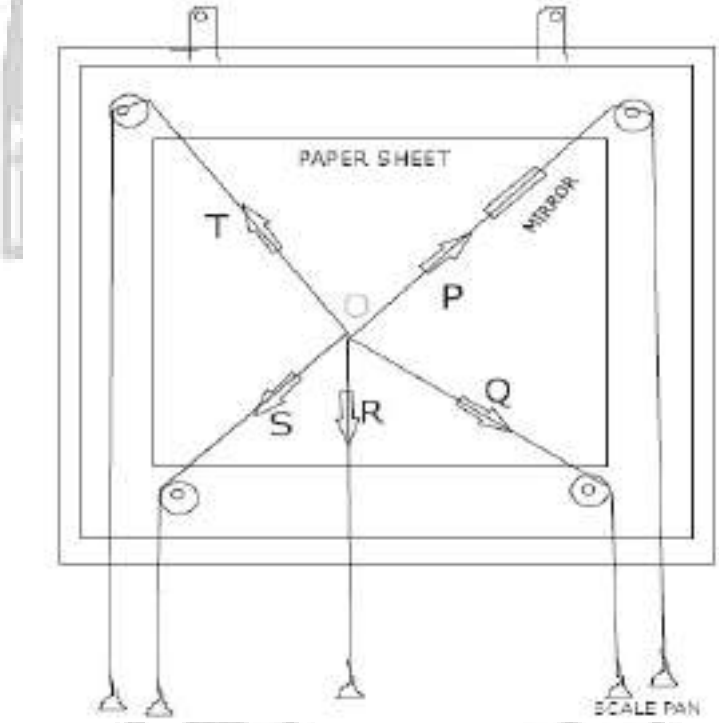


Fig.3 Polygon Law of Forces

Procedure:

1. Set the board on a vertical plane and fix a paper sheer with drawing pins.
2. Pass a thread over two pulleys.
3. Take a second thread and tie the middle of this thread to the middle of the first thread. Pass the ends of the second thread over other set of two pulleys.
4. Take a third thread and tie its one end to the point of first two threads.

5. Attach pans to the free ends of the threads as shown in figure.
6. Place the weights in the pans in such a manner that the knot comes approximately in the centre of the paper.
7. Take the mirror strip and place it under the threads turn by turn and mark the points by keeping the eye, the thread and its image in the same line without disturbing the system. Mark the lines of forces and write down the magnitude of forces.
8. Remove the paper from the board and produce the lines to meet at O.
9. Select a suitable scale and draw the vector diagram by moving in one direction i.e. clockwise or counter clockwise.
10. Draw ab parallel to AB and cut it equal to force P; draw bc parallel to BC and cut it equal to force R; draw de parallel to DE and cut it equal to force S. Vector ae will be the resultant force T1, taken in the opposite direction and should be equal to force T which proves the law of polygon of forces.
11. If ae is not equal to T then percentage error is as given below.

$$\% \text{ Error} = \frac{T - T_1}{T} \times 100$$

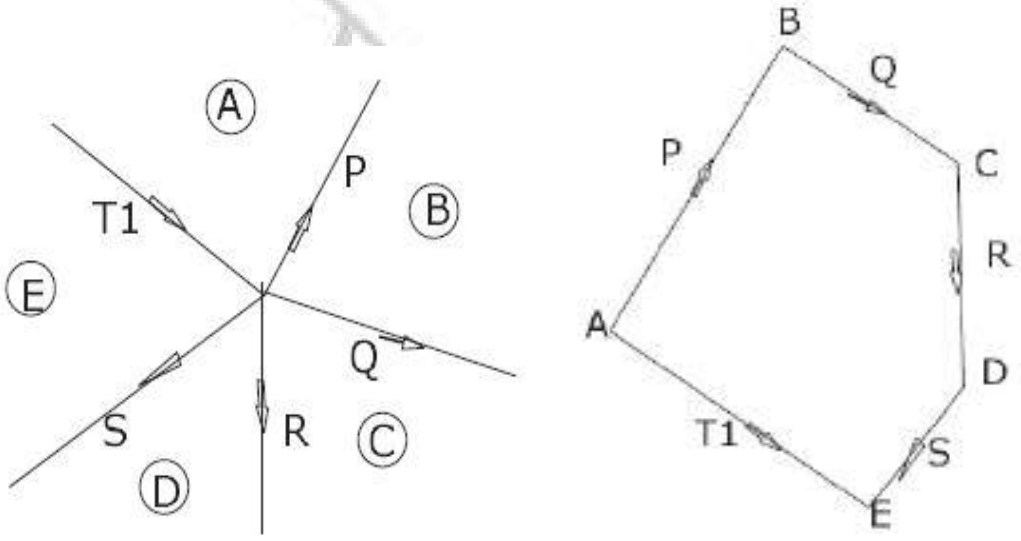


Fig. 3.1 Space and Vector diagram

Observations: Scale.....

S.No.	Forces (Total weights of pans)					Calculated Resultant	Percentage Error
	P	Q	R	S	T	T1	$\frac{T - T1}{T} \times 100$
1							
2							
3							
4							
5							

Precautions:

1. Pans/weights should not touch the board.
2. There should be only one central knot on the thread which should be small.
3. While calculating the total force in each case the weight of the pan should be added to the weight put in the pan.
4. Make sure that all the pans are at rest when the lines of action of forces are marked.
5. All the pulleys should be free from friction.

Questions:

Q. 1 State the principle on which this experiment is based.

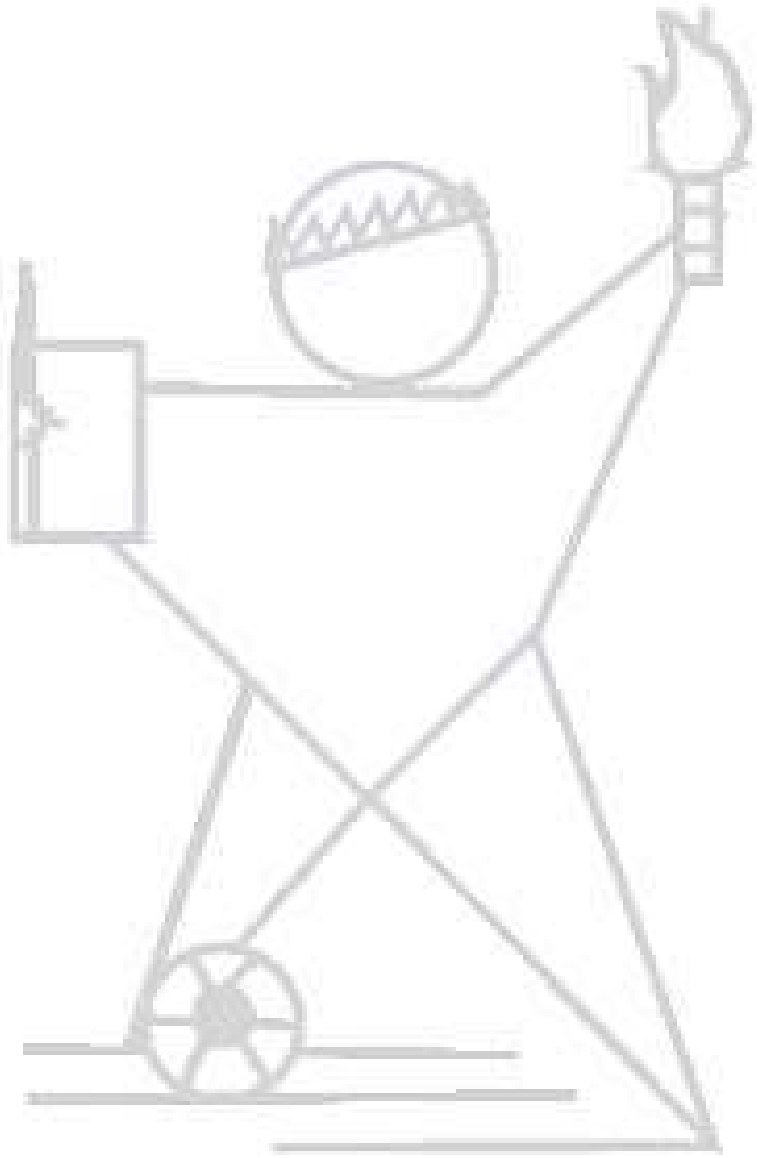
Q.2 What is the Polygon Law of forces

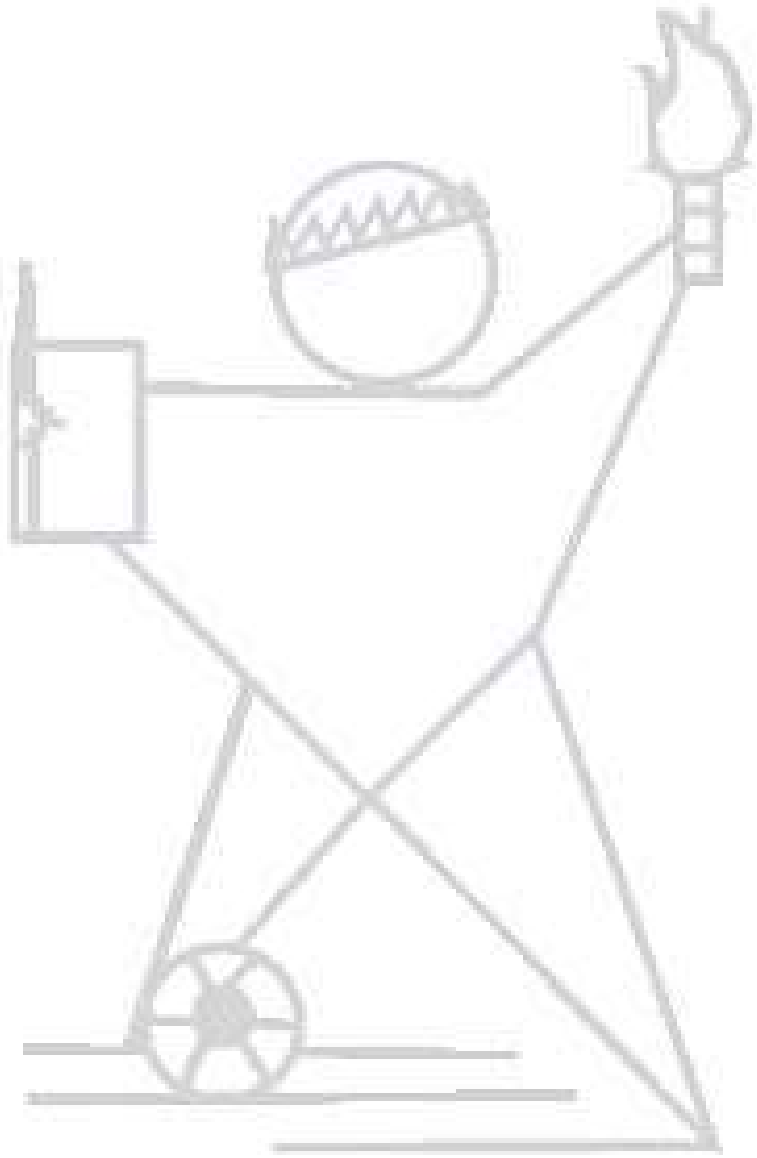
Q.3 What can be the sources of error in this experiment.

Q.4 Distinguish the following system of forces with a suitable sketch.

a) Coplanar b) concurrent c) Parallel d) Collinear

Q.5 State parallelogram law and triangle law of forces





Experiment No.04

Object: To verify the Lami's Theorem

Theory: Lami's theorem states that " if three forces acting on a body are in the state of equilibrium then the magnitude of forces is proportional to the sine of angle between the other two forces". Thus theorem is applied when the forces are in equilibrium.

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$

Apparatus:

1. Board fixed with pulleys.
2. Strings.
3. Weight.
4. Plane mirror strips.
5. Pencil etc.

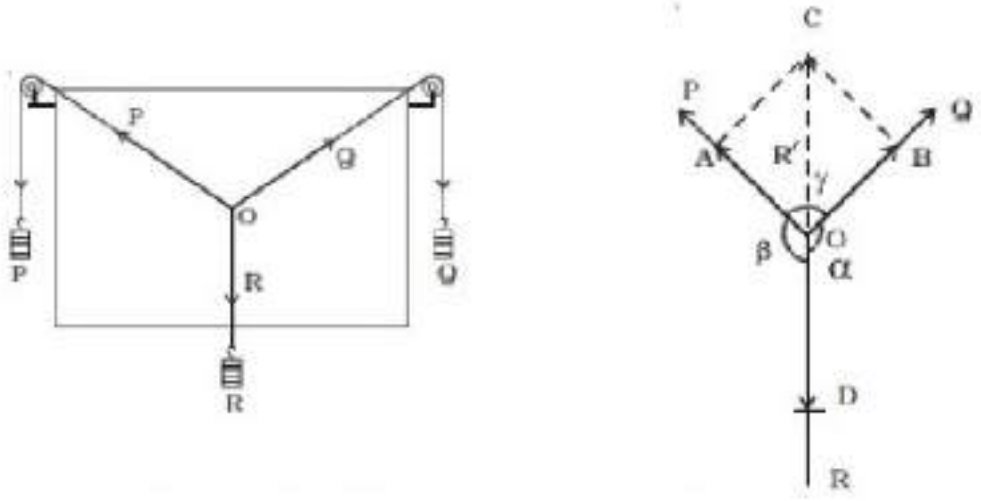


Fig.4 Lami's Theorem

Procedure:

(a) Connect the hanger at the end of such strings.

(b) Suspended the strings on the pulleys.

(c) Fix drawing sheet on the board.

(d) Add suitable weight in the hanger such that equilibrium condition achieved.

(e) After equilibrium is reached mark the direction of strings on the paper using mirror strips.

(f) Repeat the experiment for five sets of reading.

Observation:

S. No.	Force P(N)	Force Q(N)	Force R(N) Experimental	Angle α	Angle β	Angle γ	Theoretical R'			% Error $=\frac{R_1 - R_2}{R_1} \times 100$
							R_1	R_2	R'= $(R_1+R_2)/2$	
1										
2										
3										
4										
5										

Precautions:

a) Weight of hangers should be taken into consideration.

b) Weight should be placed gently.

c) Parallax should be removed.

d) Pulleys should be smooth and , if required properly lubricated

e) Proper scale should be chosen.

f)Drawing sheet should be fixed properly.

g) Weights should be in stationary position while marking the point.

Questions:

Q.1 State the principle on which this experiment is based.

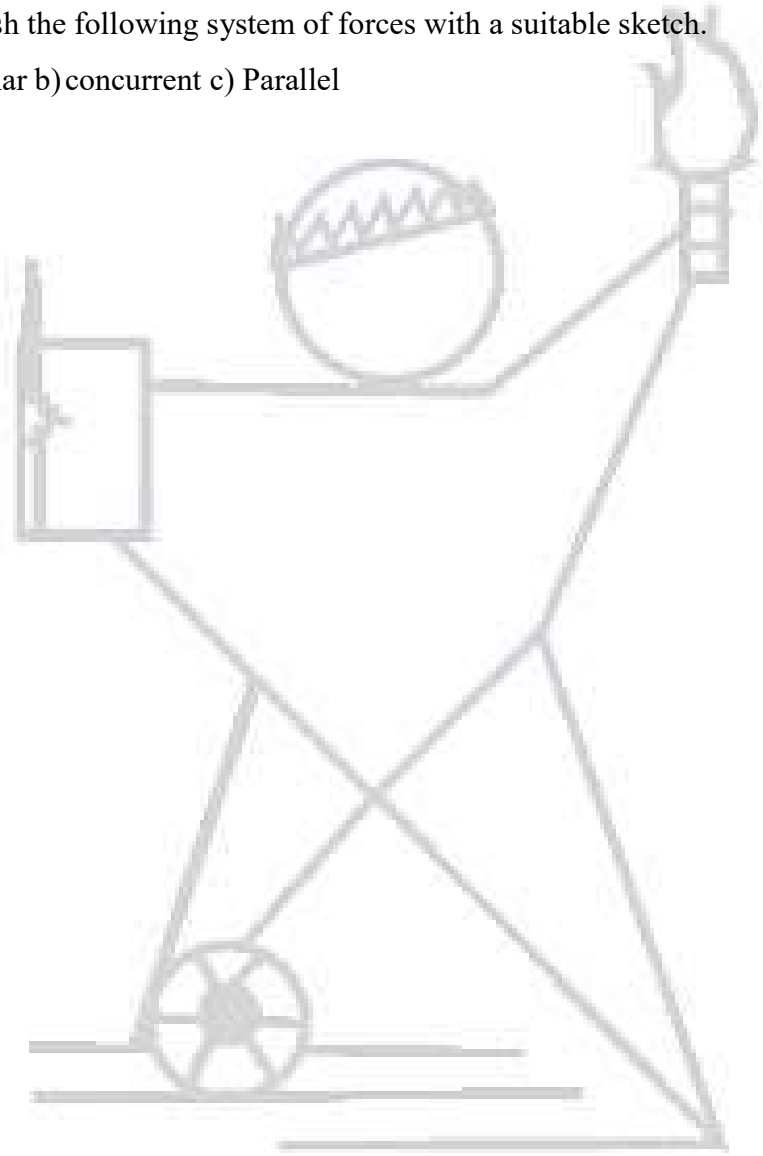
Q.2 What do you mean by Lami's theorem?

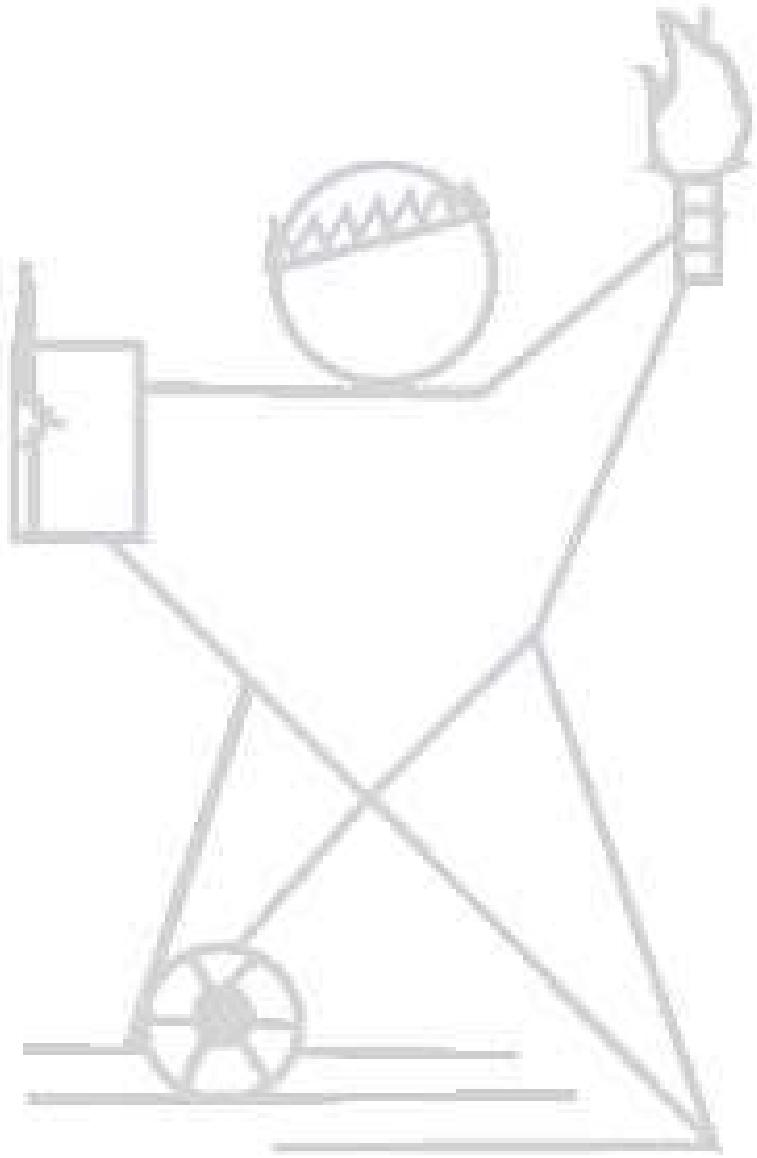
Q.3 What can be the sources of error in this experiment.

Q.4 Differentiate between 'Resultant' and 'Equilibrant'

Q.5 Distinguish the following system of forces with a suitable sketch.

a) Coplanar b) concurrent c) Parallel





Experiment No.05

Objective: To verify the law of moments using Bell crank lever.

Theory: The experiment is based on the varignon's theorem of moment. If states that if number of coplanar forces acting simultaneously on a body then algebraic sum of moment of all forces about any point in the same plane in which force lie will be equal to the moment of the resultant about the same point. This theorem can be further modified for the condition of equilibrium such that if number of coplanar forces is acting on a body simultaneously then algebraic sum of clockwise moments will be equal to algebraic sum of anticlockwise moments

Apparatus:

1. Bell crank lever with spring balance and inextensible string,
2. Weights
3. Graduated scale

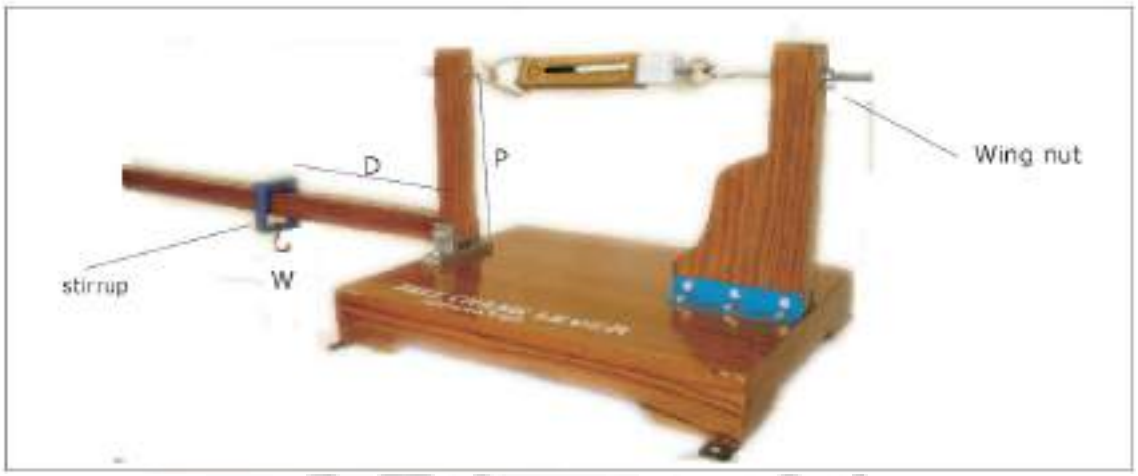


Fig. 5 Bell crank lever Apparatus

.**Procedure:**

1. Bring the bell crank lever in equilibrium by the tightening the screw considerably. Apply load on the lever scale and bring the tip in equilibrium condition and take the reading of spring balance.
2. Now remove the load and set the instrument for further reading.

3. Repeat the same process for different positions of load.

Observation:

S.No.	Suspended Weight(W)(kg)	Length of side(D)(M)	Spring Balance Reading $T=S_2-S_1$		Moments		% Error $= \frac{M_1 - M_2}{M_1} \times 100$
			S_1	S_2	$M_1=W\times D$	$M_2=T\times L$	
1							
2							
3							
4							
5							

Calculation:

Precaution:

1. Weight should be applied without any jerk.
2. Apparatus should be leveled properly.

Result:

Plot graph between M2 against M1.

Questions:

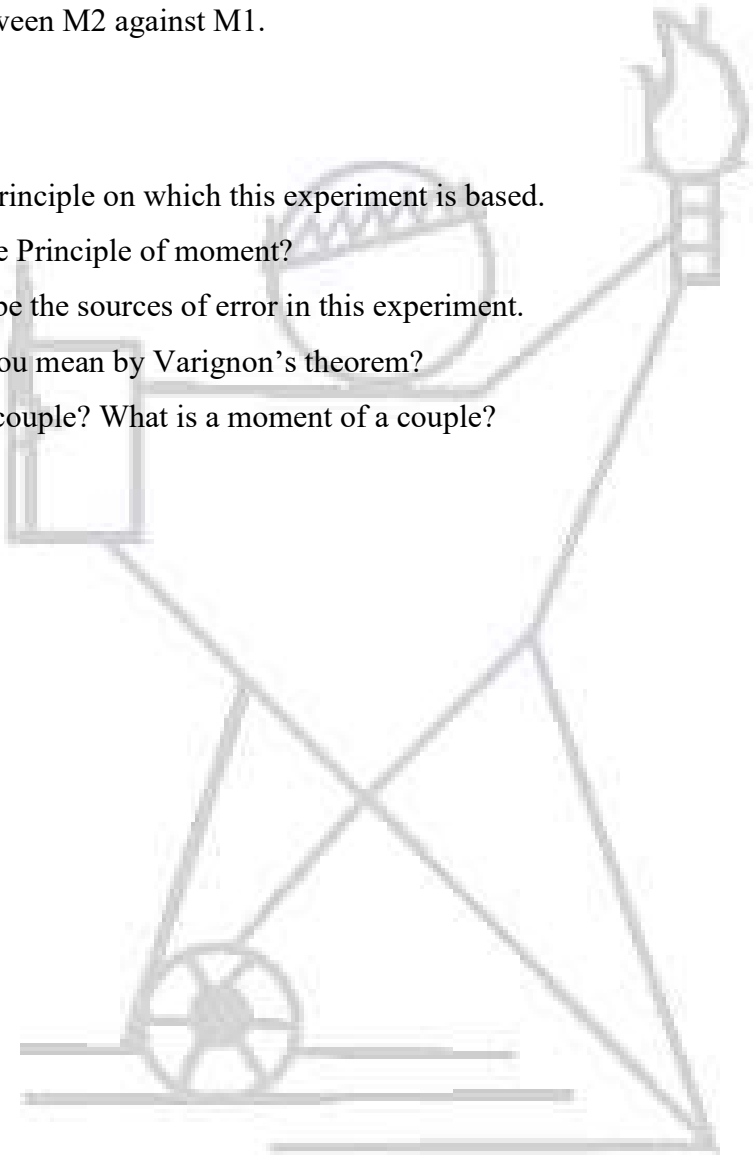
Q.1 State the principle on which this experiment is based.

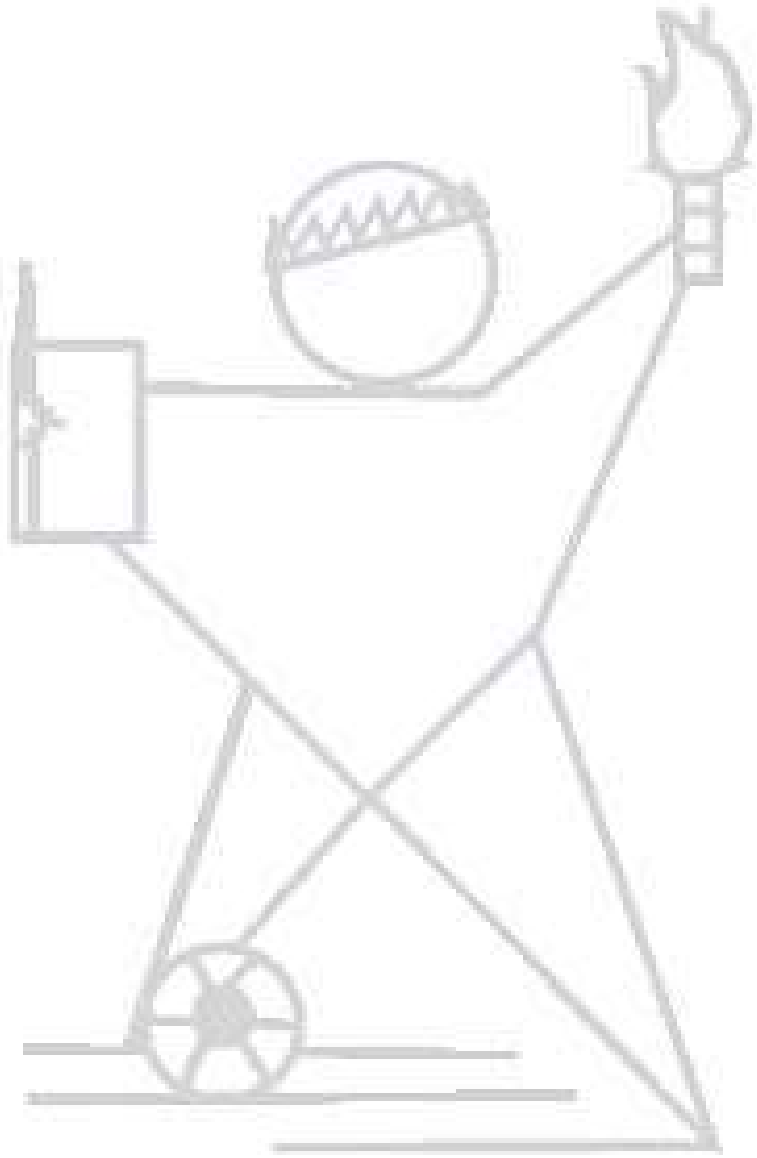
Q.2 What is the Principle of moment?

Q.3 What can be the sources of error in this experiment.

Q.4 What do you mean by Varignon's theorem?

Q.5 What is a couple? What is a moment of a couple?





Experiment No. 06

Objective: To find the support reactions of a simply supported beam.

Apparatus :

Parallel force apparatus to find support reaction of a simply supported beam meter scale, weights etc. The apparatus consists of a graduated wooden beam supported at its ends on spring balance OR Dial type balance. The balance facilitates to read the reaction due to applied loads directly. The detachable hangers hold the desired load resting in the grooves.

Diagram:-

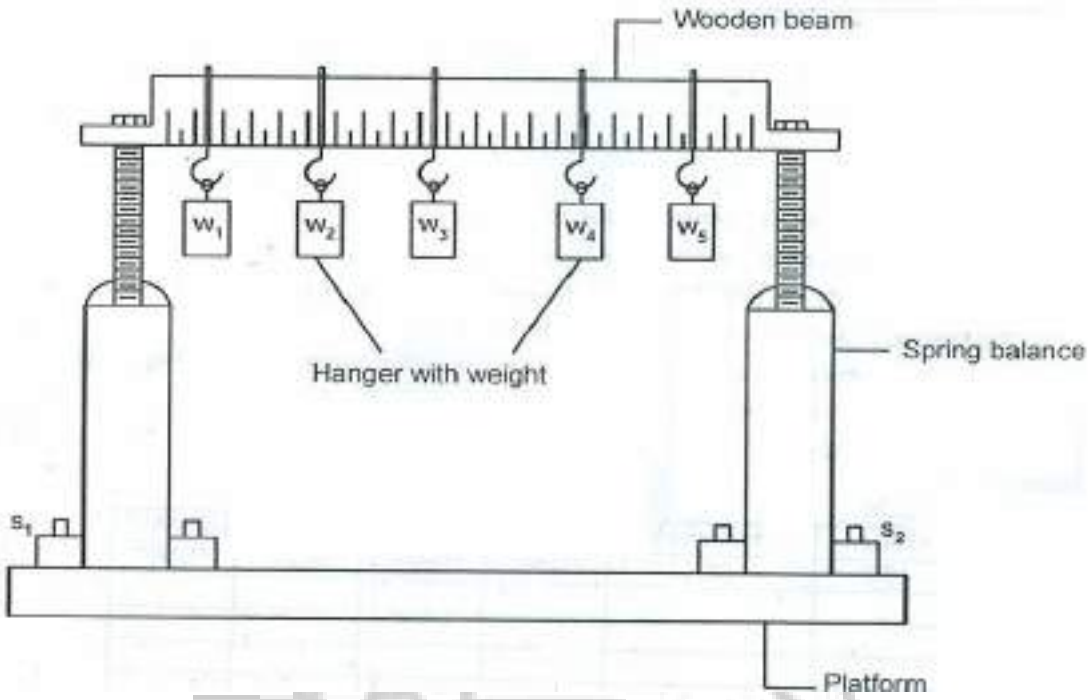


Fig.8 Apparatus for Reaction of Forces in Beam

Principle & Theory:

1. The experiment is based on the principle of static equilibrium.
2. The beam subjected to number of coplanar parallel forces remains in equilibrium, if the resultant of all active forces is equal in magnitude and opposite in direction to resultant of reactive forces.
3. Applied loads and reactive forces constitute two systems of forces which oppose each other to keep the beam in equilibrium.

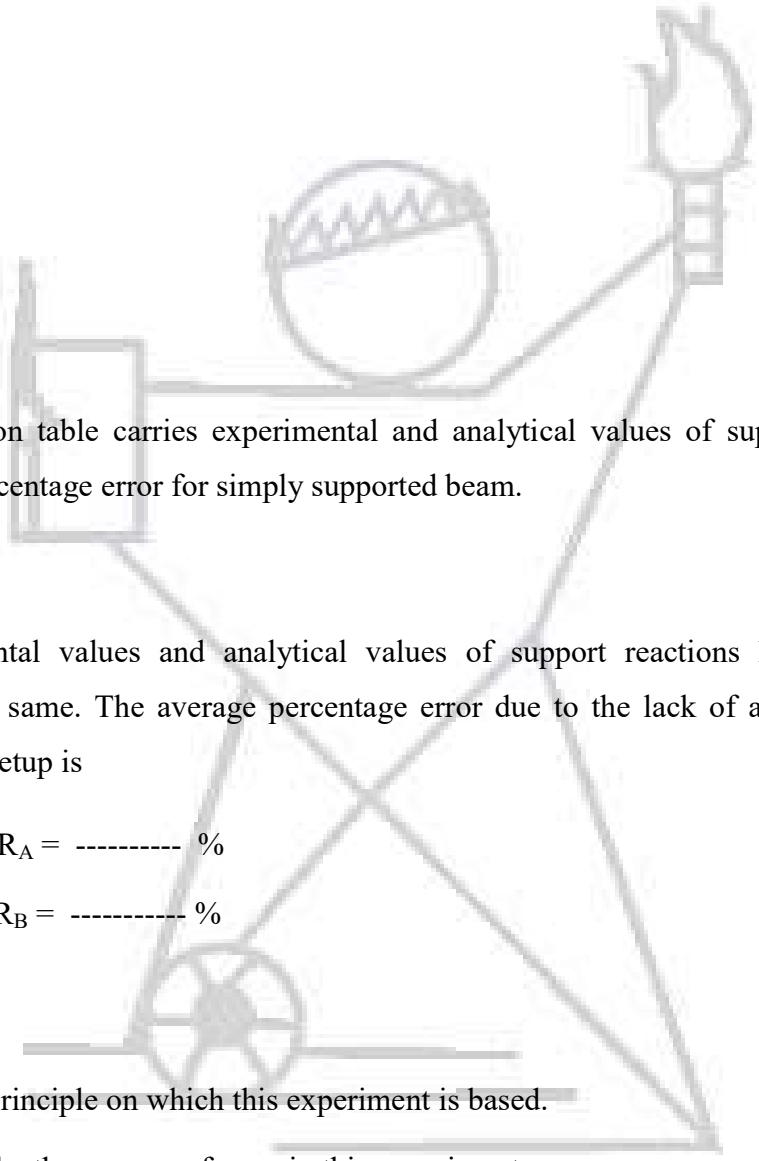
Procedure:-

1. The beam is supported on compression balances.
2. Initial readings of both the balances are noted.
3. Different weights are suspended on different locations on beam say L_1, L_2.
4. The final readings of both balances are noted.
5. The difference between final and initial readings gives actual expected value of support reactions.
6. Above procedure is repeated for different sets of loads and locations.
7. Reactions are calculated analytically and results are compared.

Observation Table:

Set	**Weight**	**Distance from A**	**Experimental Reaction**		**Analytical reactions**		% Error $= \frac{R_A - R_A'}{R_A} \times 100$	% Error $= \frac{R_B - R_B'}{R_B} \times 100$
	(kg)	(m)	R'_A	R'_B	R_A	R_B		
I								
II								
III								

Calculation:



Result:

The observation table carries experimental and analytical values of support reactions along with percentage error for simply supported beam.

Conclusion:-

The experimental values and analytical values of support reactions happen to the approximately same. The average percentage error due to the lack of accuracy in the experimental setup is

R_A = ---------- %

R_B = ---------- %

Questions:

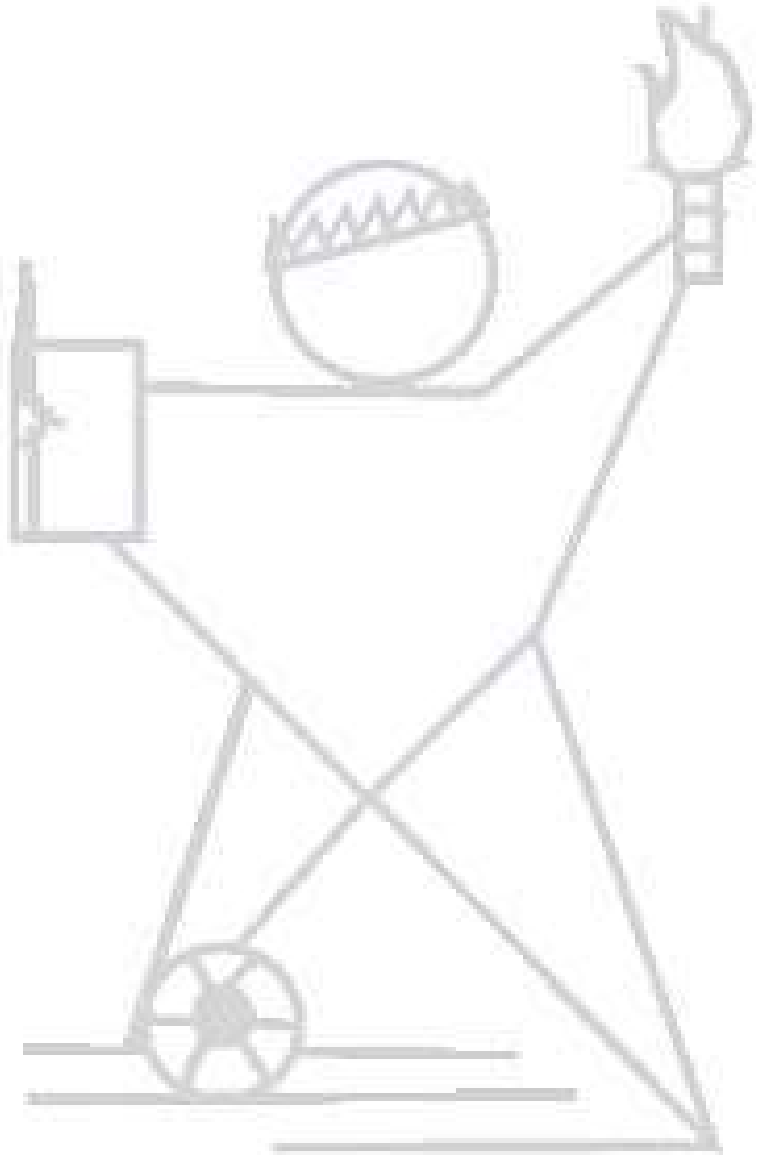
Q.1 State the principle on which this experiment is based.

Q.2 What can be the sources of error in this experiment.

Q.3 What do you mean by a simply supported beam.

Q.4 What do you mean by the Parallel force system.

Q.5 Sketch the different types of supports.



Experiment No.07

Objects: To determine moment of inertia of a given fly-wheel about its polar axis

Theory: Fly wheel is a body in form of large heavy wheel mounted on long axel, This can store large amount of kinetic energy while in rotation due to this heavy weights. This energy can be used in engines and other machines for minimizing the fluctuation in speed, for making the motion uniform.

Put the wheel in rotation by suspending a mass m from its axle and allow it to fall through a certain height h. Let n1 be the number of revolutions made by fly wheel while the mass is falling and n2 be the number of revolutions made by fly wheel before coming to rest after the mass is detached in time t1 then.

$$\text{K.E. of rotation of the fly wheel} = \frac{1}{2} I\omega^2$$

Where, I is the moment of inertia and ω is the angular velocity when the mass is detached.

K.E. of the moving mass =1/2Mv^2,where v is velocity.

Initial potential energy,

$$mgh = 1/2Mv^2+1/2\ I\ \omega^2 = nlf$$

Where f is the work done per revolution against friction. As the wheel comes to rest after n2 revolution, i.e. K.E. stored in the wheel is used in overcoming friction in n2 revolutions, therefore

$$F=1/2\ I\ \omega^2$$

Or

$$f=1/2\ I\ \omega^2/n^2$$

Thus, mgh=1/2Mv^2+1/2 I ω^2+n1.1/2 I ω^2/n2.

Since v=rω

Or, mgh=1/2 ω^2 [mr^2+ I (1+n1/n2)]

But mean angular velocity w= 2πn2 / t , hence angular velocity just after detachment os mass will be 4πn2 / t

$mgh = 1/2*16\pi^2 n_2^2[mr^2+I(n_1+n_2)/n_2]/t^2$

Or

$I = (n_2/ n_1+n_2)[(mght^2/8\ \pi^2 n_2^2) - mr^2]$

Apparatus:

1. Fly wheel apparatus
2. Weights
3. Cord
4. Stop watch
5. Vernier Caliper
6. Scale

Diagram:

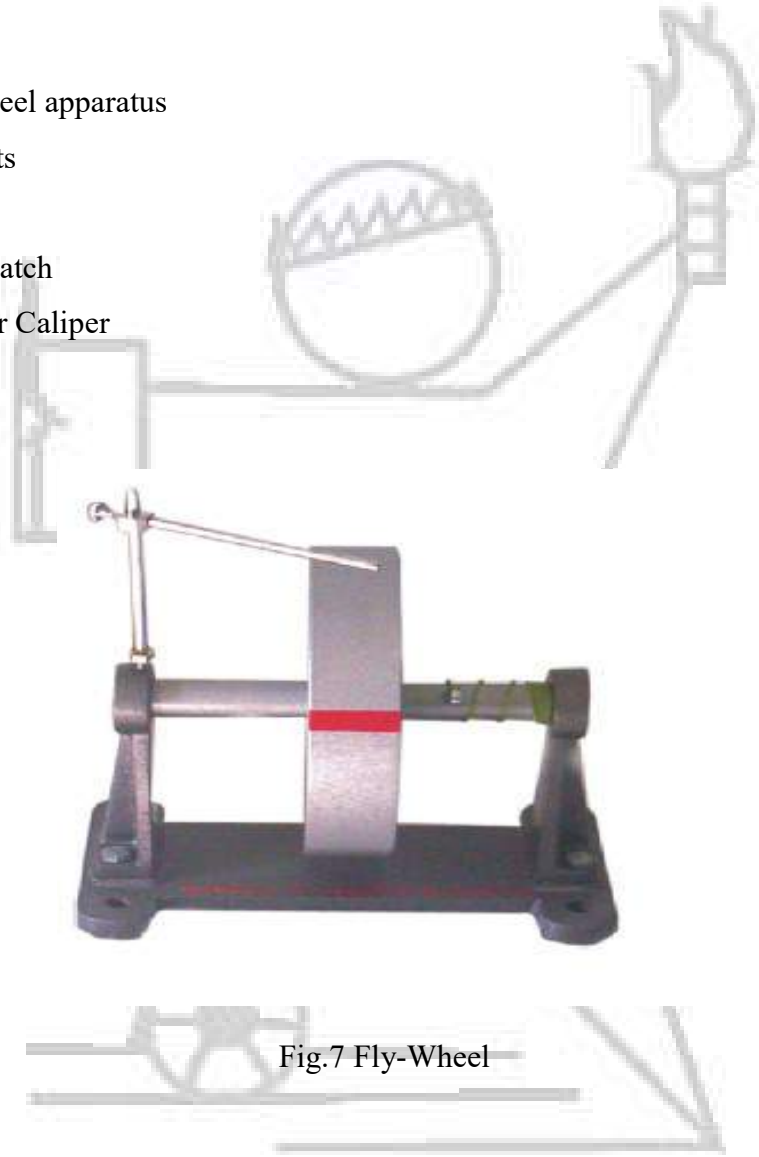


Fig.7 Fly-Wheel

Procedure:

1. Take a cord having a loop at one end and of length equal to the distance between the horizontal peg and floor.
2. Attach the string to the peg and bind it on the axle, so as to have completed numbers of turns.
3. Count these numbers of turns say n.

4. Attach some weight to the order end of the strings.
5. Measure the distance between the bottom of hangers and the floors.
6. Release the wheels makes n_1 revolutions.
7. Start the watch as soon as the weight is detached and observe the time taken by wheel come to the rest. Simultaneously count the number of revolution n_2 made by the wheel before coming the rest.
8. Measure the diameter of the axle with the help of vernier calipers.

Observations:

S. No.	Weight in gm	Time in second	No. of revolution		M.I. in kgm^2	Average M.I.
			n_1	n_2		
1						
2						
3						
4						
5						
6						

Results: Average value of Moment of Inertia of wheel =

Questions:

Q.1 State the principle on which this experiment is based.

Q.2 What can be the sources of error in this experiment.

Q.3 What do you mean by moment of inertia?

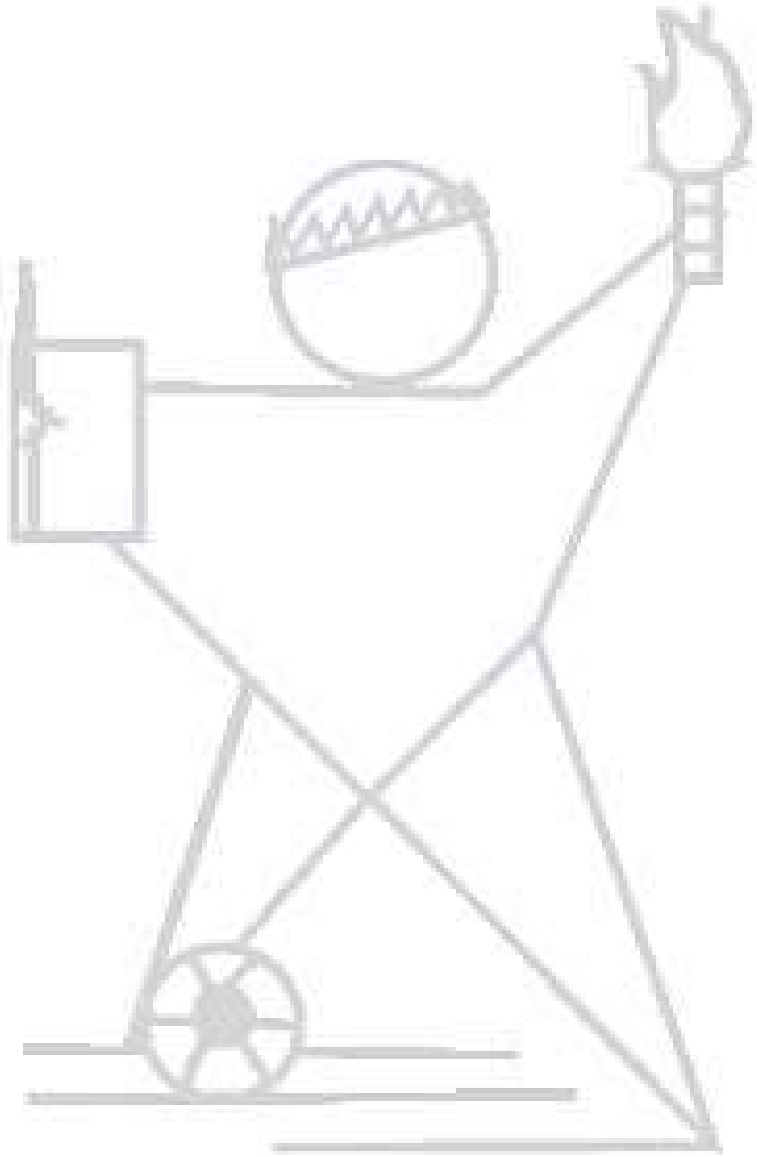
Q.4 State parallel axis theorem

Q.5 State perpendicular axis theorem

Q.6 Define principal axes and principal moment of inertia

Q.7 Define polar moment of inertia.

Q.8 Distinguish between centroid and center of gravity.



Experiment No.08

Objective: To determine the coefficient of friction of different surfaces on horizontal plane by using different materials

Theory: When a body is dragged along the roughness of plane surface opposes its motion as surface can't be perfectly smooth. if F be the force of friction and R be the normal reaction of the load W on the surface, when W is just in the point of moving a force equal be R will come into plane in the direction opposite to that of its motion in the equilibrium position.

$$F=\mu R$$

Where w is applied force.

Coefficient of friction μ = force of friction/ normal reaction

Apparatus:

1. Wooden plane with pulley.
2. Trolleys with base of different materials.
3. Weight.
4. Scale.
5. Threads.

Diagram:

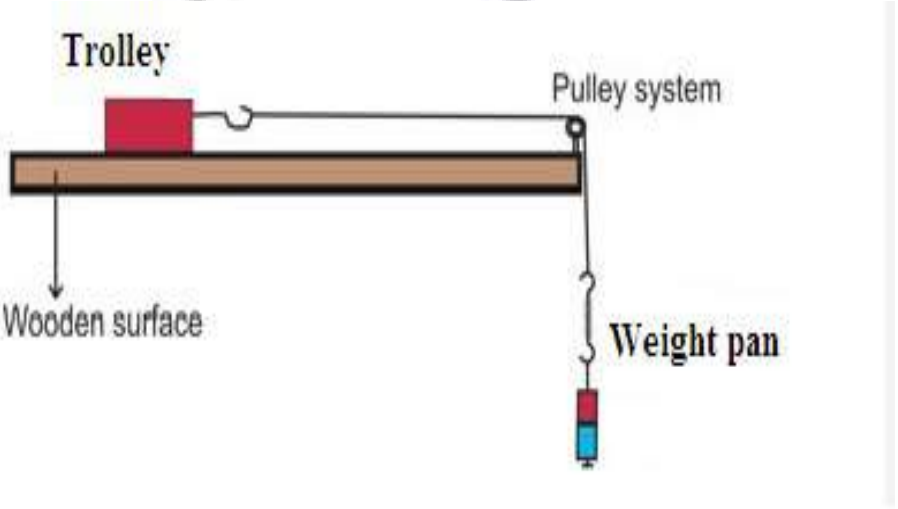


Fig.6 Coefficient of friction

Procedure:

The two wooden planes adjusted to be in a horizontal position hardly in kept on the plane. Threads tied to hook passes over the pulley and a pan is suspended at its free end.

weight are added to the pan so that the trolley just moves, weights are added to the trolley to change the normal reaction and effort required to make the trolley just move is noted. Experimental is relocated for trolley with different weight.

Observations:

Surface	S. No.	Trolley Weight (Normal reaction)			Load (Force of Friction)			Coefficient of Friction(P/W) μ	Mean(μ)
		Wt. of Trolley W1	Wt. in Trolley W2	Total W=W1+W2	Wt of pan P1	Wt in pan P2	Total P=P1+P2		
Wood on Wood	1								
	2								
	3								
Wood on Aluminium	1								
	2								
	3								

Calculation:

Total reaction= weight of trolley + weight in trolley (w1+w2).

Force of friction= weight of pan+ weight in pan (p1+p2).

Coefficient of friction μ = force of friction/ normal reaction.

Precaution:

1. No jerk should be applied to the trolley.
2. See that plane is perfectly in horizontal position which can be checked by spirit level.

Result:

Average μ =

Questions:

Q.1 State the principle on which this experiment is based.

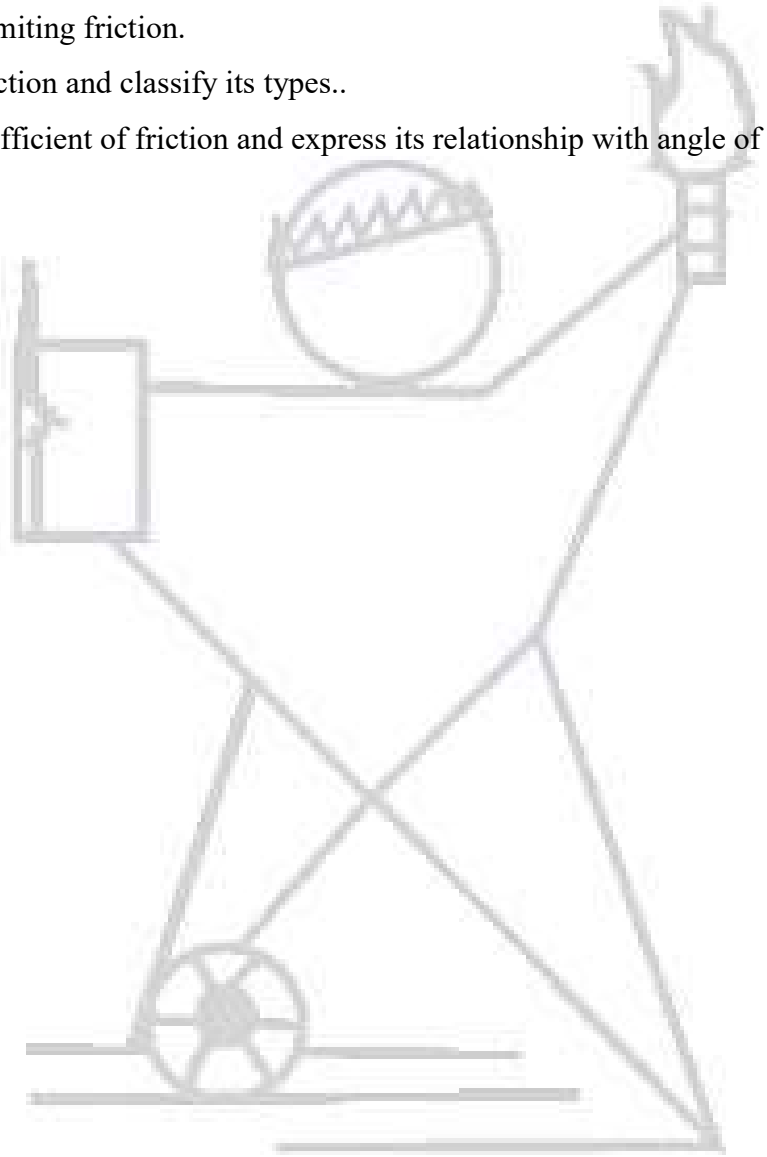
Q.2 Define an inclined plane and Coefficient of friction.

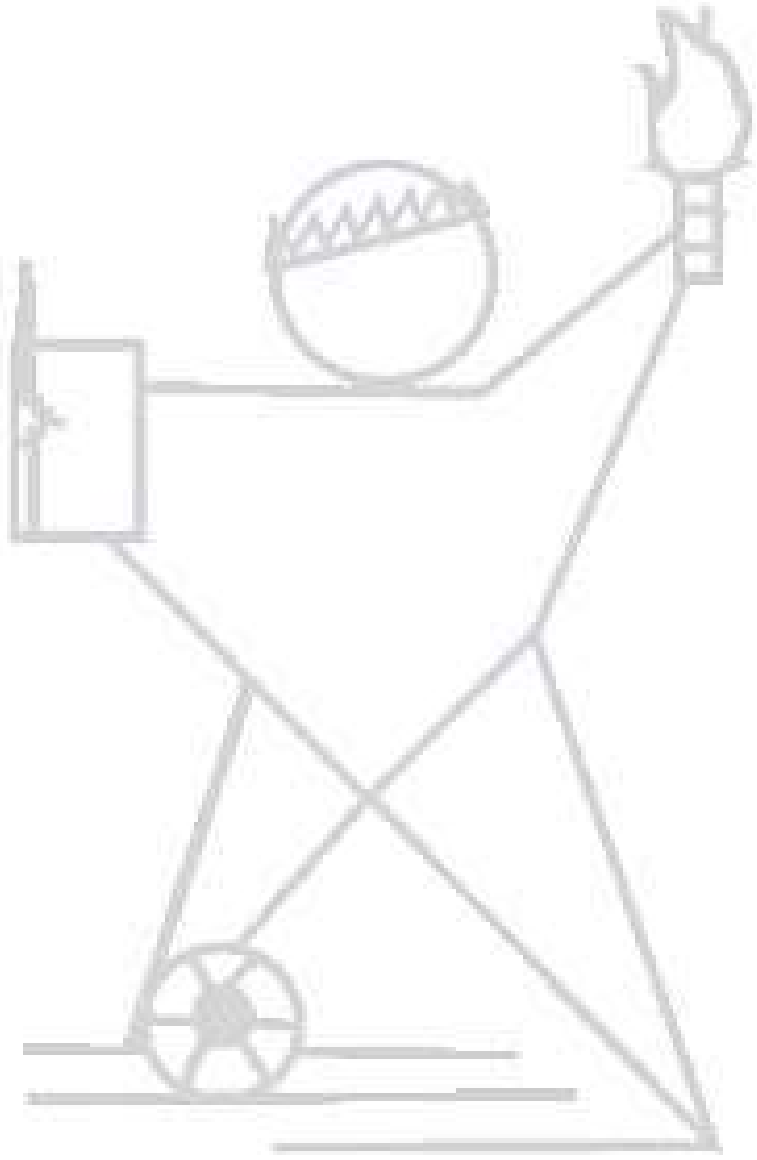
Q.3 What can be the sources of error in this experiment.

Q.4 Define Limiting friction.

Q.5 Define friction and classify its types..

Q.6Define coefficient of friction and express its relationship with angle of friction.





Experiment No.09

Objects: To determine the mechanical advantage, Velocity ratio and Mechanical efficiency of the Simple Wheel and Axle

Theory: The most simple machine which is in use, since ages is the simple wheel and axle used for drawing up water from a well. It is device to raise heavy loads. It consists of two cylinder A and B of different diameters. The bigger cylinder A is called the Wheel and the smaller cylinder B the Axle and they rotate about a common axis.

A string is wound round the axle. The one end of this string is fixed to the Axle and the other is attached to the Load W.

Another string is wound round the Wheel. one end of which is fixed to the wheel and to the other. The Effort is applied.

The two strings are wound in opposite directions. So , when the effort P pulls the string down it unwind and turn the wheel. This causes the string on the axle to wind and to lift the load up.

Let D = Diameter of the Wheel

d = Diameter of the Axle

W = Load lifted

P = Effort applied

When the wheel and Axle turn through one revolution.

Distance through which Load moves = πd

Distance through which Effort moves = πD

$$\text{V.R.} = \frac{\text{Distance moved by the Effort}}{\text{Distance moved by the Load}} = \frac{\pi D}{\pi d}$$

$$\text{V.R.} = \frac{D}{d}$$

$$\text{Mechanical Advantage M.A.} = \frac{W}{P}$$

$$\text{Efficiency } \eta = \frac{\text{M.A.}}{\text{V.R.}} = \frac{\text{W/P}}{\text{D/d}}$$

$$\eta\ \% = \frac{\text{W/P}}{\text{D/d}} \text{ X } 100$$

Apparatus:

1. wheel & Axle
2. Weights\
3. Steel rule
4. String

Diagram:

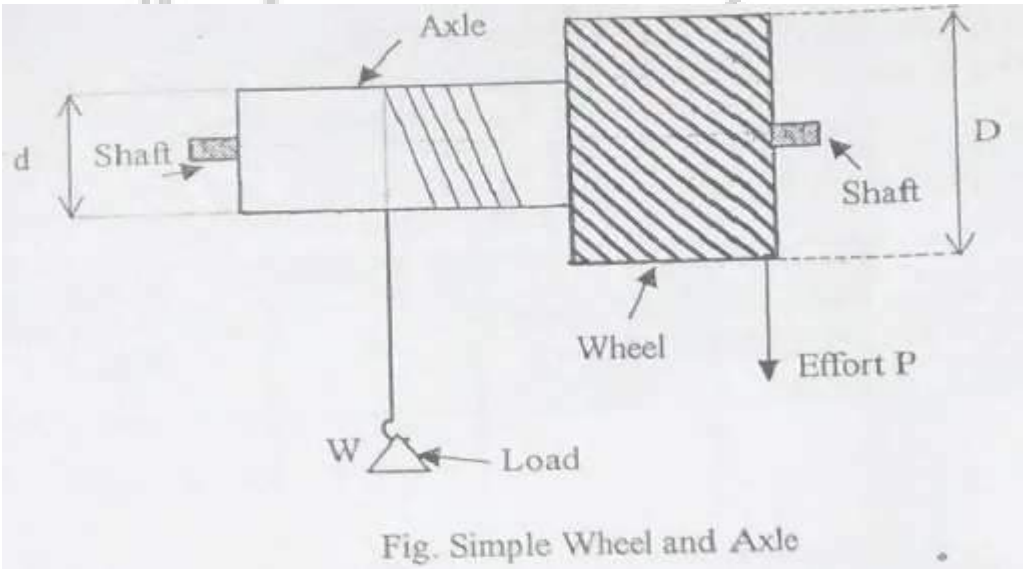


Fig. Simple Wheel and Axle

Procedure:

1. Wrap a cotton string round the axle or drum to carry the load W. The string should wrapped in such a manner that when the effort p is applied ,the load W is lifted upwards.
2. Wrap another string round the Axle A to carry the effort P.
3. Apply a load W so the free end of the string, which is coming over worm wheel.

4. Apply another effort P to the free end of the string, which is coming over down. Thus effort P should be increased gradually suitable to give a just motion to the load W upward.
5. Note down the value of W and P in observation table.
6. Repeat step 2 to5 for different values of load W and calculate corresponding values P.
7. Measure the circumference of the Drum over which P is coming and the axle over which W is coming.

Observations:

S.NO.	W Load	P Effort	M.A.	V.R.	η%
1					
2					
3					
4					
5					

Results :

Average value of M.A. =

Average value of V.R. =

Average value of η% =

Precaution:

1. Lubricate the apparatus to minimize the frictional losses.
2. Weight should be applied gently on free end.
3. Take into account the instrument error also
4. Over lapping of string over pulleys should be avoided.
5. W and P should not touch the wall.

Questions:

Q.1 What is law of a machine

Q.2 What is an ideal machine.

Q.3 What can be the sources of error in this experiment.

Q.4 Define Mechanical Advantage

Q.5 Define Velocity Ratio

Q.6 Distinguish clearly between a simple wheel & axle and a differential wheel and axle