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Date

Expt. No. 01

Name of Experiment :- To measure length, radius of a given cylinder, a test tube & a beaker using a vernier calipers & find the volume of each object.

Appratus Required :- A vernier calipers
A calorimeter
A graduated cylinder
A glass slab.

Rule of experiment, finding least count by vernier constant.

You should have studied about vernier capliers. It consists of a pair of capliers having a vernier and main scale.

* Arrangement :- The instrument has two jaws A & B. The vernier scale can easily slide along the edge of the main scale. The graduations of the vernier scale, say 10 are coincident to a number of divisions of main scale & one divtsion of the vernier scale is known as vernier constant and is also that the least constant of vernier device.

* Observe the number of vernier divisions (n), which match against. One less numbers of divisions of main scale (n-1)

$\because$ 1 division of vernier scale $= \frac{n-1}{n}$ division of main scale

$\therefore$ least count = 1 main scale - 1 vernier scale division.

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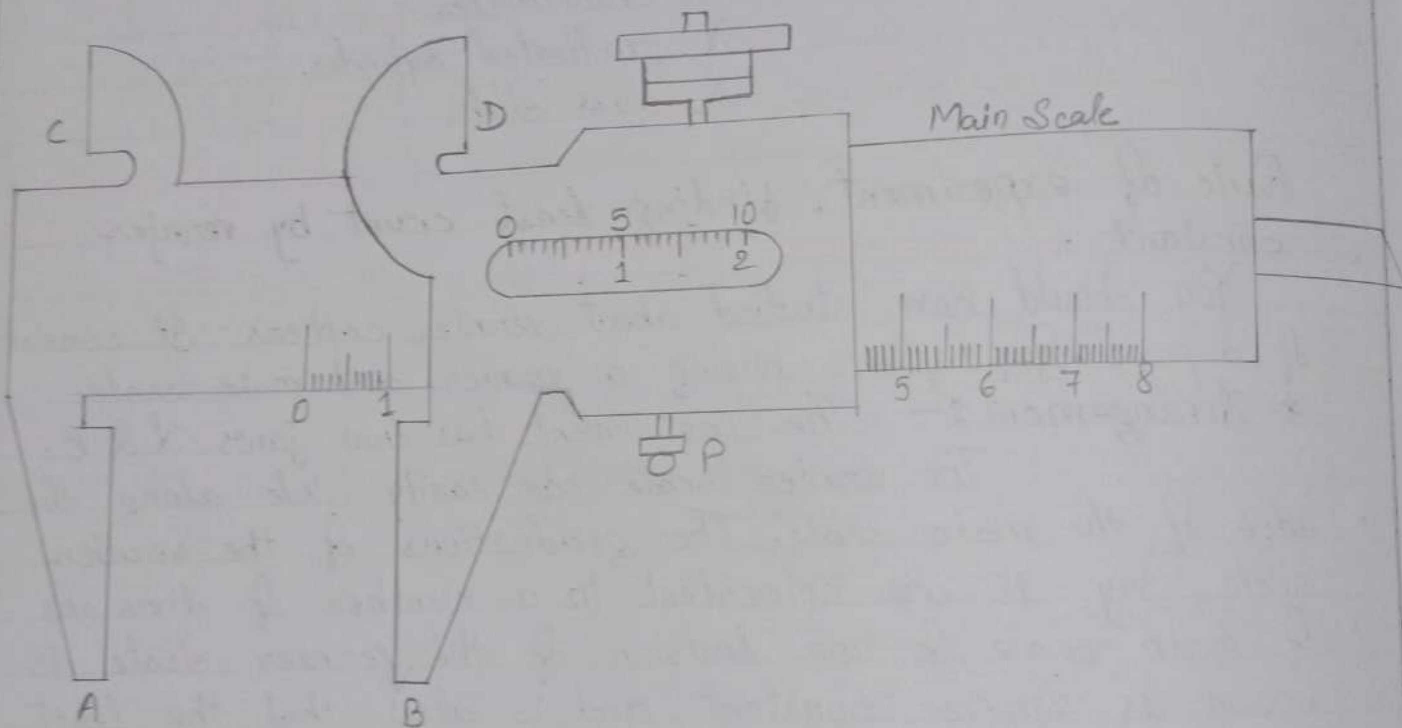

C
D
Main Scale
0 5 10
1 2
0 1
5 6 7 8
P
A
B

$= 1$ main scale division $= \frac{n-1}{n}$ main scale division.

$= \frac{1}{n}$ main scale division.

Measuring internal Diameter :—

To measure the internal diameter of the calorimeter place the vernier caliper with the jaws inside the calorimeter as shown in the diagram. The upper jaws of the vernier calipers should firmly touch the ends of a diameter of the calorimeter but without deforming the calorimeter.

NOTE :- The main scale reading immediately before the zero mark of the vernier & also note the division of the vernier which consides with any of the main scale division.

Since the Calorimeter not be of precisely circular shape, take one more observations along a diameter perpendicular to previous one.

Report the pair of observations at least three times & record them, $V = \pi r^2 h = \pi (d/2)^2 h$.

Measuring Depth :— Let the end of the vernier calipers stand on its end on its on glass slab, push down its depth gauge (the central moving strip), So that it also firmly touches the glass slab, then note the zero error of its depth gauge.

Next, set the vernier callipers with its end resting on the upper edge of the calorimeter & its depth of the calorimeter. Calculated corrected depth by applying zero correction.

Verification :— In order to verify the capacity of calorimeter measured by vernier calliper till it completely with water, pour this water into an empty graduated cylinder & observe the volume of the water. Both values should be in agreement within experiment error.

Name of Experiment :- To determine diameter of a wire, a solid ball and thickness of cardboard using a screw gauge.

The Theory

The screw gauge is an instrument used for measuring accurately the diameter of a thin wire or the thickness of a sheet of metal. It consists of a U-shaped frame fitted with a screwed spindle which is attached to a thimble.

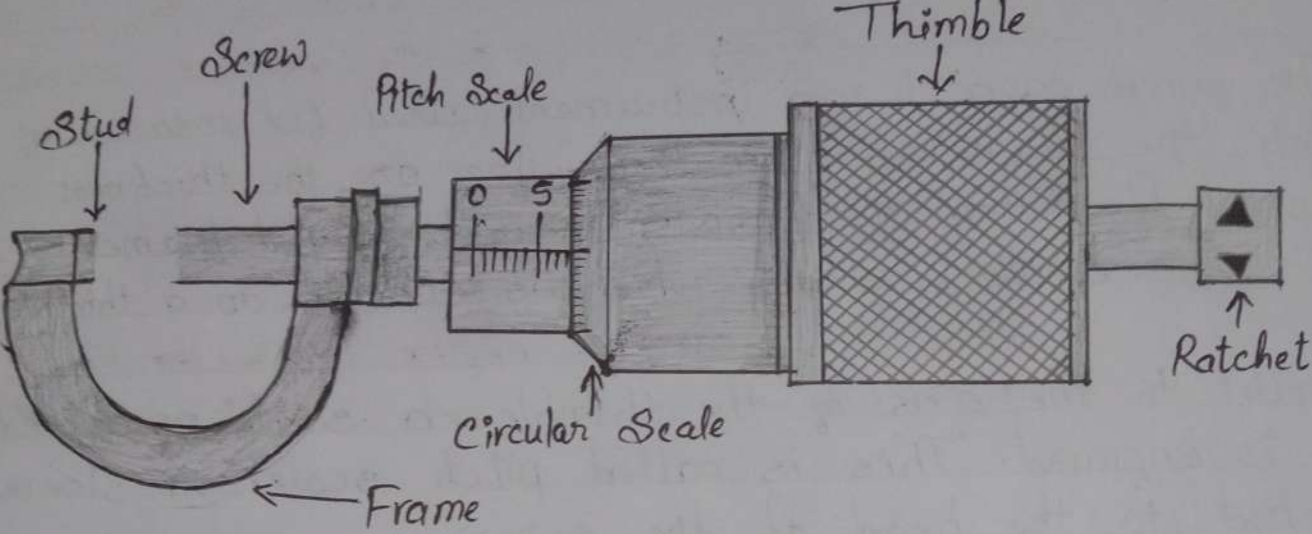
Parallel to the axis of the thimble, a scale graduated in mm is engraved. This is called pitch scale. A sleeve is attached to the head of the screw.

The head of the screw has a ratchet which avoids undue tightening of the screw. On the thimble there is a circular scale known as head scale which is divided into 50 or 100 equal parts. When the screw is worked, the sleeve moves over the pitch scale.

A stud with a plane end surface called the anvil is fixed on the 'U' frame exactly opposite to the tip of the screw. When the tip of the screw is in contact with the anvil, usually, the zero of the head scale coincides with the zero of the pitch scale.

Pitch of the Screw Gauge

The pitch of the screw is the distance moved by the tip


Thimble
Screw
Pitch Scale
Stud
0
5
Ratchet
Circular Scale
Frame

spindle per revolution. To find this, the distance advanced by the head scale over the pitch scale for a definite number of complete rotation of the screw is determined.

The pitch can be represented as;

$$\text{Pitch of the screw} = \frac{\text{Distanced moved by screw}}{\text{No. of full rotations given}} \quad \text{------ (i)}$$

Least Count of the Screw Gauge

The least count (LC) is the distance moved by the tip of the screw, when the screw is turned through 1 division of the head scale.

The least count can be calculated using the formula:

$$\text{Least Count} = \frac{\text{Pitch}}{\text{Total number of divisions on the circular scale}} \quad \text{------ (2)}$$

Zero error and Zero correction

To get the correct measurement, the zero error must be taken into account. For this purpose, the screw is rotated forward till the screw just touches the anvil and the edge of cap is on the zero mark of the pitch scale. The screw gauge is held keeping the pitch scale verticle with its zero downwards. When this is done, anyone of the following three situtions can arise:

The zero mark of the circular scale comes on the refrence line. In this case, the zero error and the zero correction, both are nill.

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2. The zero mark on the circular scale remains above the refrence line and does not cross it. In this case, the zero error is positive and the zero correction is negative depending on how many divisions it is above the refrence line.

3. The zero mark of the head scale is below the refrence line. In this case, the zero error is negative and zero correction is positive depending on how many divisions it is below the refrence line.

To find the diameter of the lead shot

With the lead shot between the screw and anvil, if the edge of the cap lies ahead of the N^{th} division of the linear scale. Then, linear scale reading (P.S.R.) = N.

If n^{th} division of circular scale lies over refrence line. Then, circular scale reading (H.S.R.) = $n \times (L.C.)$

(L.C. is the least count of screw gauge)

Total reading (T.R.) = P.S.R. + corrected H.S.R. = $N + (n \times L.C.)$.

If D be the mean diameter of lead shot, Then, volume of the lead shot,

$$V = \frac{4}{3}\pi\left(\frac{D}{2}\right)^3$$

To find the diameter and hence to calculated the volume of the wire

Place the wire between the anvil and the screw and note down the PSR and HSR as before.

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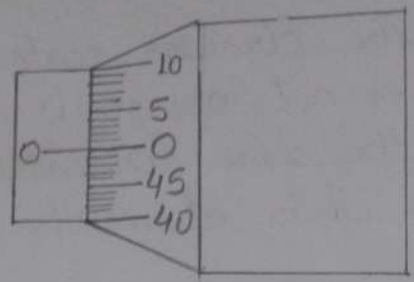
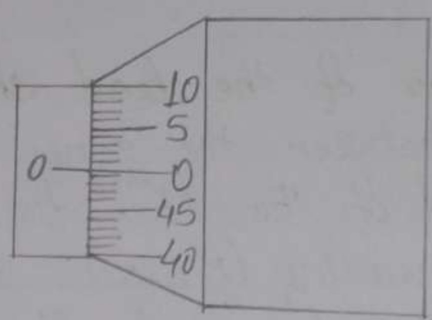
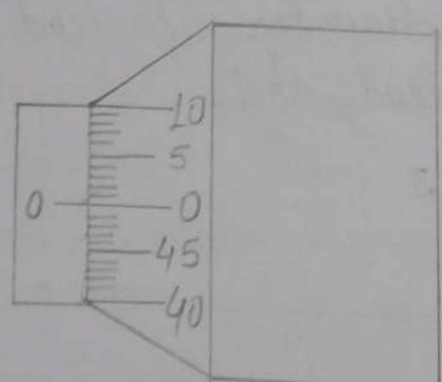


Zero error nil
Case-1



Zero error positive
Case - 2



Zero error negative
Case - 3

The diameter of the wire is given by:

$$T.R. = PSR + (\text{corrected } HSR \times L.C) = N + (n \times L.C.) \quad \text{------} (3)$$

If r is radius of the wire, and l be the mean length of the wire. Then, volume of the wire,

$$V = \pi r^2 l \quad \text{------} (4)$$

To find the thickness of the glass plate.

The glass place is gripped between the tip of the screw and the anvil. The PSR and HSR are noted as before.

The thickness of the glass plate is;

$$t = PSR + \text{corrected } HSR = N + (n \times L.C.) \quad \text{------} (5)$$

To find the volume of glass plate (irregular lamina)

Find the thickness, t of irregular lamina as before. Then place the lamina over a graph paper and trace its outline on the graph paper. The area A of the lamina is taken from the graph paper.

The volume of the glass place is calculated from the equation;

$$V = A \times t \quad \text{------} (6)$$

Name of Experiment :- To determine radius of curvature of a given spherical surface by a Spherometer.

Aim: To determine radius of curvature of a given spherical surface by a spherometer.

Apparatus: Spherometer, convex surface (it may be unpolished convex mirror), a big size plane glass slab or plane mirror.

Theory: It works on the principle of micrometre screw (Section 2.09). It is used to measure either very small thickness or the radius of curvature of a spherical surface that is why it is called a spherometer.

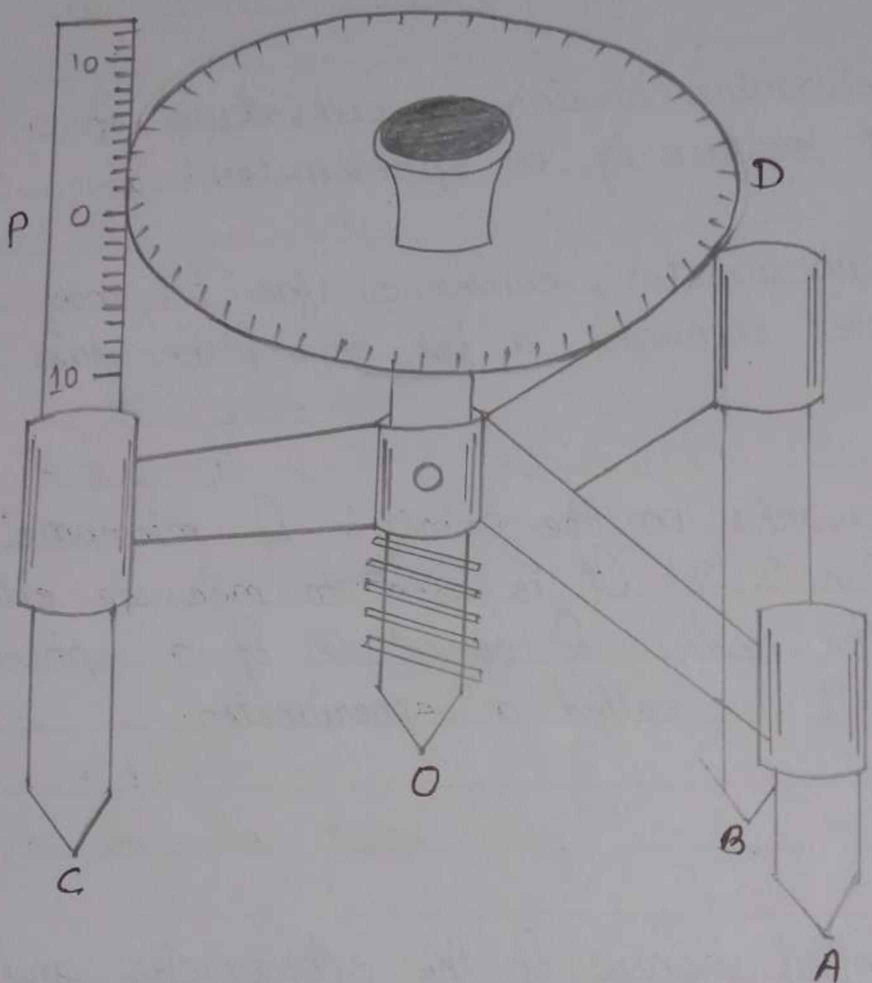
Procedure:

1. Raise the central screw of the spherometer and press the spherometer gently on the practical note-book so as to get pricks of the three legs. Mark these pricks as A, B and C.

2. Measure the distance between the pricks (points) by joining the points as to form a triangle ABC.

3. Note these distances (AB, BC, AC) on notebook and take their mean.

4. Find the value of one verticle (pitch) scale division.



Spherometer

5. Determine the pitch and the least count of the spherometer [Art 2.13 (c)] and record it step wise.

6. Raise the screw sufficiently upwards.

7. Place the spherometer on the convex surface so that its three legs rest on it.

8. Gently, turn, the screw downwards till the screw tip just touches the convex surface. (The tip of the screw will just touch its image in the convex glass surface).

9. Note the reading of the circular (disc) scale which is in line with the vertical (pitch) scale. Let it be a (It will act as refrence).

10. Remove the spherometer from over the convex surface and place over a large size plane glass slab.

11. Turn the screw downwards and count the number of complete rotations (n) made by the disc (one rotation becomes complete when the refrence reading crosses past the pitch scale).

12. Continue till the tip of the screw just touches the plane surface of the glass slab.

13. Note the reading of the circular scale which is finally in line with the vertical (pitch) scale. Let ~~is~~ it be b.

14. Find the number of circular (disc) scale division in last incomplete rotation.

15. Repeat step 6 to 14, three times. Record the observation in tabular form.

Observations :

1. Distance between two legs of the spherometer
In ΔABC marked by legs of the spherometer

$AB = \text{-----} \ cm$

$BC = \text{-----} \ cm$

$AC = \text{-----} \ cm$

Mean value of $l = \frac{AB + BC + AC}{3} = \text{-----} \ cm$

2.) Least count of spherometer
1 pitch scale division $= 1mm$
Number of full rotations given the screw $= 5$
Distance moved by the screw $= 5mm$
Hence, pitch, $p = \frac{5mm}{5} = 1mm$

Number of divisions on circular (disc) scale $= 100$
Hence, least count $= \frac{1mm}{100} = 0.01mm = 0.001 \ cm$

S.I no. of observation	Circular (disc) scale reading: On convex surface initial (a)	Circular (disc) scale reading: On plane glass sheet final (b)	No. of complete rotations on plane (n_1) glass sheet	No. of disc scale divisions in incomplete rotation $x = (a-b)$ or $(100+a)-b$	Total reading $h = n_1 \times p + x \times (L.C.)$ (mm)
1.					$h_1 =$
2.					$h_2 =$
3.					$h_3 =$

Distance between the two legs of the spherometer.

Calculations:

1. Find value of h in each observation and record it in column 5.
2. Find mean of value of h recorded in column 5.

   Mean value of $h = \frac{h_1 + h_2 + h_3}{3}$ mm = ... mm = ... cm

3. Calculate $R = \frac{l^2}{6h} + \frac{h}{2}$ cm = ... cm

Result:

The radius of curvature of the given convex surface is cm.

Precautions:

1. The screw should move freely without friction.
2. The screw should be moved in same direction to avoid back-lash error of the screw.
3. Excess rotation should be avoided.

Sources of error:

1. The screw may have friction.
2. The spherometer may have back-lash error.
3. Circular (disc) scale divisions may not be of equal size.

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Experiment Name :- Parallelogram Law of Vectors.

Objective: Our objective is to find the weight of a given body using the Parallelogram Law of Vectors.

Theory:

What does the Parallelogram Law of Vectors state?

If two vectors acting simultaneously on a particle are represented in magnitude and direction by the two adjacent sides of a parallelogram drawn from a point, then their resultant is completely represented in magnitude and direction by the diagonal of that parallelogram drawn from the point.

Parallelogram Law of Vectors explained.

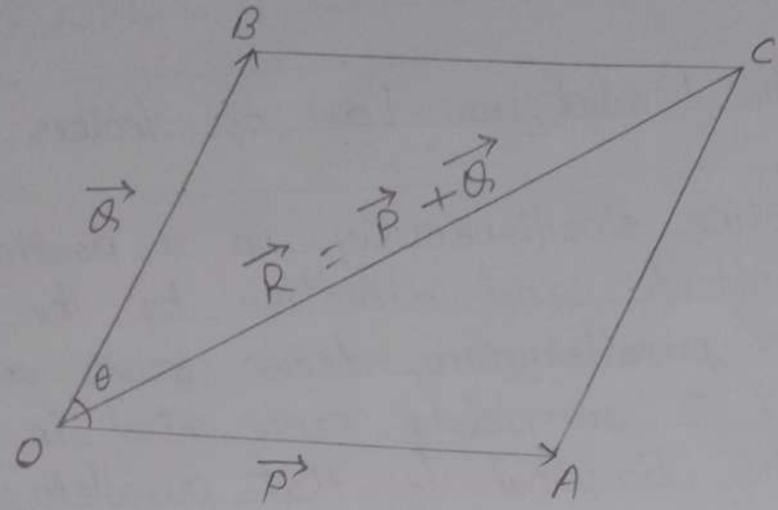
Let two vectors P and Q act simultaneously ~~on~~ a particle O at angle θ. They are represented in magnitude and direction by the adjacent sides OA and OB of a parallelogram OACB drawn from a point O. Then the diagonal OC passing through O, will represent the resultant R in magnitude and direction.

On a Gravisand's apparatus, if the body of unknown weight (say S) is suspended from the middle hanger and balancing weights P and Q are suspended from other two hangers then,

$$\vec{R} = \vec{P} + \vec{Q}$$

or

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta} \quad \text{------} (1)$$



Parallelogram Law of Vectors

The unknown weight can be calculated from the equation (1).

On a Gravesand's apparatus, if the body of unknown weight (say S) is suspended from the middle hanger and balancing weights.

P and Q are suspended from the other two hangers then,

$$\vec{P} + \vec{Q} + \vec{S} = 0$$

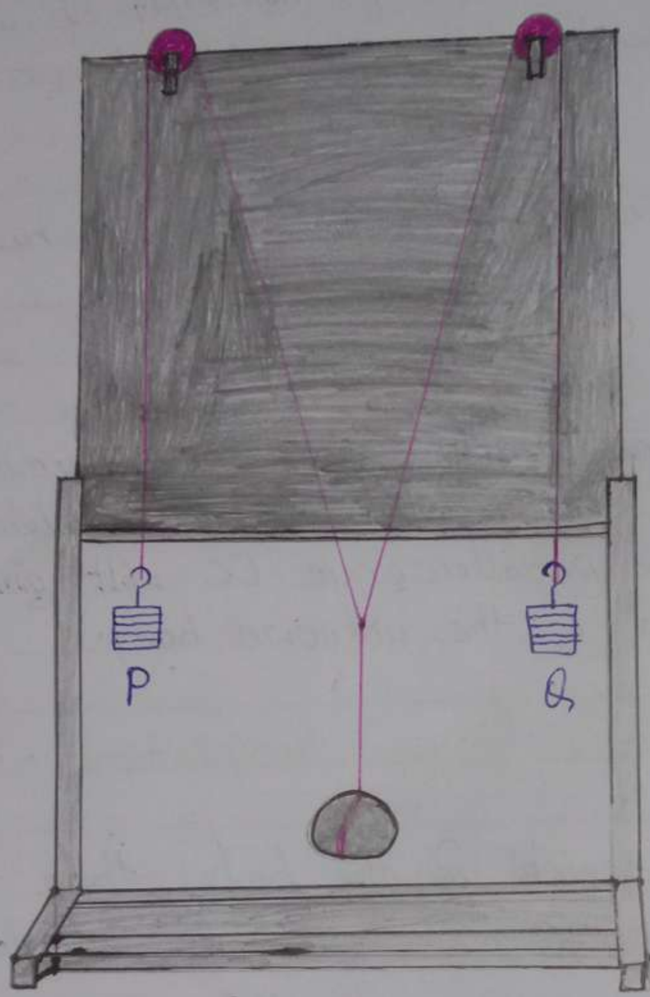
Now, construct a parallelogram OACB by assuming a scale (say 1 cm = 50 gwt) corresponding to the weights P and Q. The diagonal of the parallelogram OC will give the resultant vector. The weight of the unknown body.

$$S = OC \times scale \quad \text{-------} \quad (2)$$

If W is the actual weight of the body, then the percentage error in the experiment can be calculated using the equation,

$$\text{Percentage error} = \frac{(\text{Actual error} - \text{Calculated } \cancel{\text{error}} \text{ weight})}{\text{Actual weight}} \times 100 \quad \text{----} \quad (3)$$

$$\text{Percentage error} = \frac{(W - S)}{W} \times 100$$


P
Q

Aim :- To find moment of Inertia of a flywheel.

Apparatus :- A flywheel, suitable weight thread, vernier calliper, a meter scale and a stop-watch.

Theory :- As the mass descends through a certain height 'h' under the action of gravity. It imparts an angular acceleration to the wheel, from the principle of conservation of energy.

Potential energy of falling mass is = kinetic energy gained by mass + Kinetic energy gained by wheel + work done against friction.

i.e. $mgh = \frac{1}{2} mv^2 + \frac{1}{2} I\omega^2 + nf$

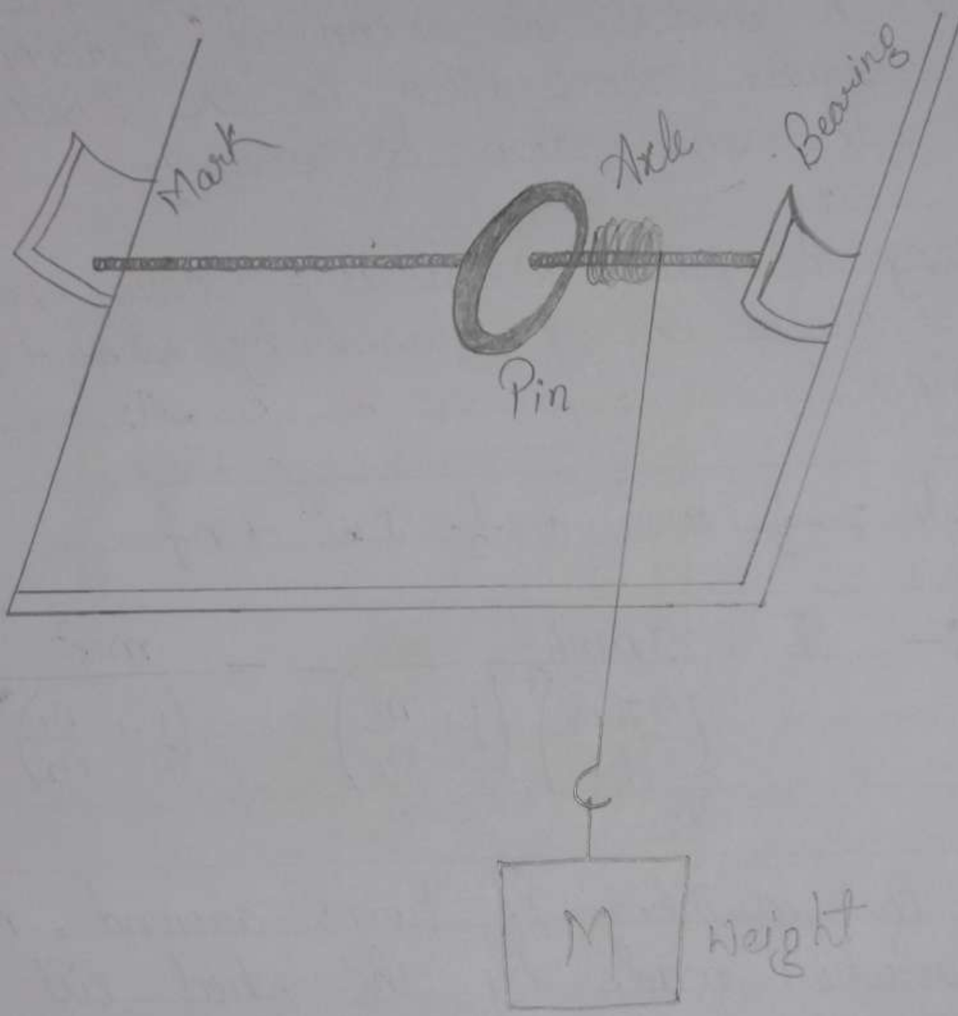
Formula used :- $I = \frac{2mgh}{\left(\frac{4\pi n_2}{t}\right)^2 \left(1+\frac{n_1}{n_2}\right)} - \frac{mr^2}{\left(1+\frac{n_1}{n_2}\right)}$

where,

n_1 = is the number of turns around, n_2 is the number of revolution made by the wheel till the mass detaches, r is the radius of the axis, h is the hight of the thread and m is the mass.

Procedure :-

1. One end of the string is supplied over a small peg on axis and the other end tied to a mass 'm'.


Mark
Axle
Bearing
Pin
M
Weight

The thread is wrapped round on the axis and n_1 is the number of turns round is counted.

2. The mass is now allowed to descend form rest and the stop watch be started at the instant when the thread detaches the no. of rotation N_2 made by flywheel is counted and the time taken by it to come to the rest is noted.

3. The diameter of the axle is measured as a no. of point along the manually ⊥ direction by vernier calliper.

4. Repeat the process for the same hight and mass making the wheel rotate in opposite direction.

5. Repeat the experiment with different masses.

Observation:-

Vernier constant of calliper = 0.01 cm
Diameter of the axle = (i) 2.35 cm
(ii) 2.32 cm

Mean radius, r = 1.1 cm

least count of stop watch is 0.01 sec.

S.No.	Rotation (I_1)	Mass (gm)	Height	h_1	n_2	t	mean n_2	mean (I_1)
1. (i)	Clockwise	350	164	18	32	25.21	33	25.39
(ii)	Anticlockwise	350	164	18	34	25.26		
2. (i)	Clockwise	400	164	18	46	32.69	46.5	31.41
(ii)	Anticlockwise	400	164	18	45	30.12		

Calculations :-

$$I = \frac{2mgh}{\left(\frac{4\pi n_2}{t}\right)^2\left(1+\frac{n_1}{n_2}\right)} - \frac{mr^2}{\left(1+\frac{n_1}{n_2}\right)}$$

$$= \frac{2\times350\times9.8\times100\times164}{\left(\frac{4\times3.14\times33}{25.39}\right)^2\left(1+\frac{18}{33}\right)} - \frac{350\,(1.12)^2}{\left(1+\frac{18}{33}\right)}$$

$$= 277298.315 \ g\,cm^2$$

$$= 0.02772 \ kg\,m^2$$

Now,

$$I_2 = \frac{2\times400\times9.8\times100\times164}{\left(\frac{4\times3.14\times45.5}{31.41}\right)^2\left(1+\frac{18}{45.5}\right)} - \frac{400\times(1.17)^2}{\left(1+\frac{18}{45.5}\right)}$$

$$= 277112.734 \ g\,cm^2 = 0.02771 \ kg\,m^2$$

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Mean value $I = \frac{I_1 + I_2}{2}$

$= \frac{0.02772 + 0.02771}{2} = 0.027715 \; kgm^2$

Result :— Moment of Inertia of the flywheel about its axle is $0.027715 \; kgm^2$.

Precautions :—

(i) measure carefully.

(ii) diameter of the string should be very small.

(iii) mass tied to the end of the string should be such as capable to overcome friction at the beginings.

(iv) There should be non-overlapping of or a gab left between the various turns of the string.

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