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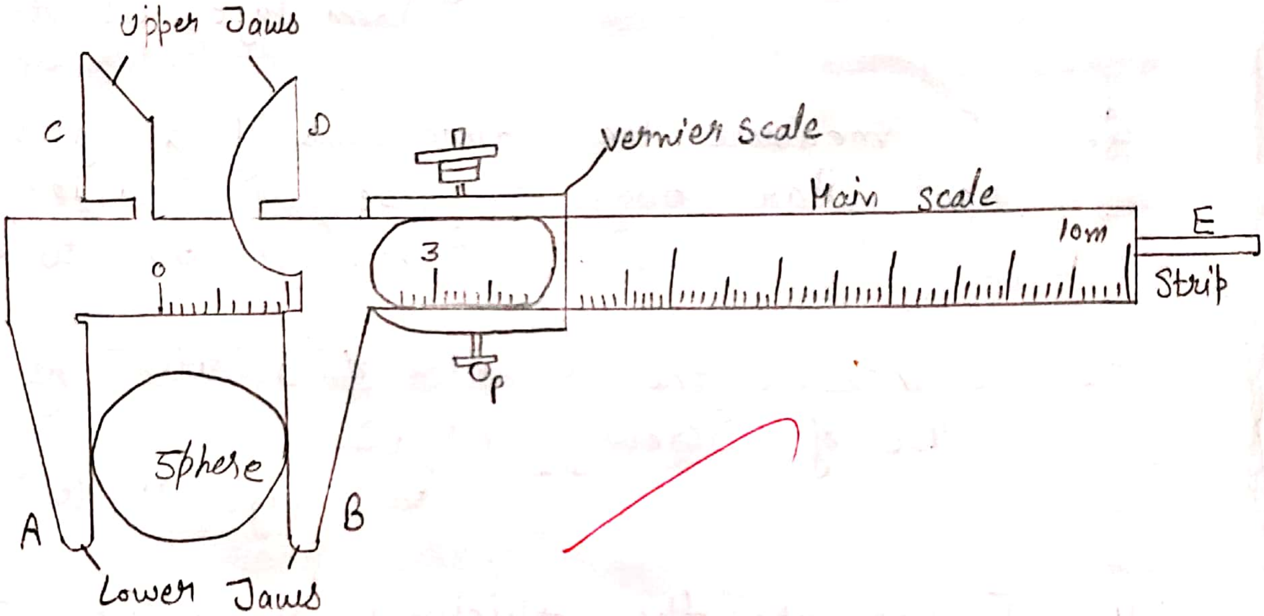
Experiment → 1

Aim ⇒ To measure the diameter of a small spherical body with a vernier callipers.

Apparatus ⇒ Vernier Callipers, a spherical body (pendulum bob) or a cylinder.



Formula used ⇒ 1. Vernier Constant = 1 M.S.D − 1 V.D

or Vernier constant = $\frac{\text{Value of M.S.D}}{\text{Total no. of divisions on the vernier scale}}$

2. Zero error, $e = \pm n \times$ Vernier Constant

3. Zero correction, $C = -$ Zero error (e)

4. The reading of the vernier callipers (for the observed diameter)

$$D' = x + n \times \text{Vernier constant}$$

Experiment → 1

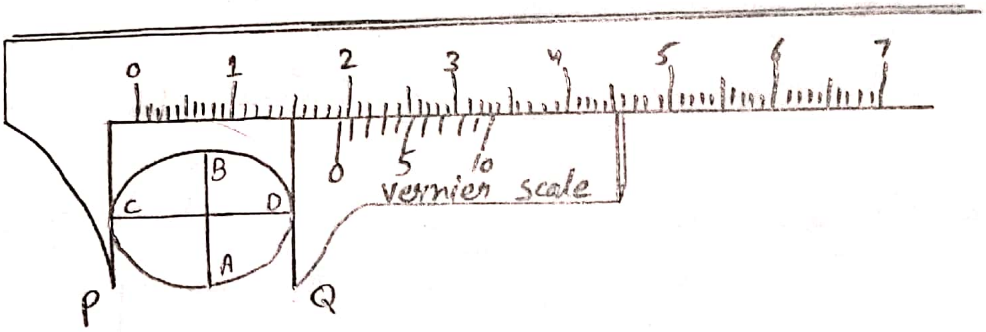
Aim ⇒ To measure the diameter of a small spherical / cylindrical body with a vernier callipers.

Apparatus → Vernier callipers, a spherical body (pendulum bob) or a cylinder.

Theory : Principle of Vernier Calliper

We know that a metre scale can be used to measure lengths accurately upto 1mm. In case the lenght of an object is to be measured to a greater accuracy (sy upto 0.1 millimetre), then each mm on the scale has to be further divided into equal parts (say 10). It was difficult with normal scale because the division marks may be too close to be seen separately. So, pierre vernier, a Belgian Mathematician invented a device called **Vernier Calliper.**

A Vernier Calliper of a main scale, against which another calliper scale called **Vernier Scale** can slide. A division of the Vernier scale is smaller than the size of a division of main scale. Usually 10 divisions of the scale coincide with 9 divisions of the main scale as shown in figure 1.



Observations :-

(a) To find vernier constant :

The number of divisions on the vernier scale = 10

Now 10, vernier divisions coincide 9 main scale divisions

$$1 \text{ V.D} = \frac{9}{10} \text{ M.S.D}$$

$$\text{Vernier constant} = 1 \text{ M.S.D} - 1 \text{ V.D} = 1 \text{ M.S.D} - \frac{9}{10} \text{ M.S.D}$$

$$= \frac{1}{10} \text{ M.S.D}$$

$$1 \text{ M.S.D} = \frac{1}{10} \text{ cm}$$

$$\text{Vernier Constant} = \frac{1}{10} \times \frac{1}{10} \text{ cm} = \frac{1}{100} \text{ cm} = 0.01 \text{ cm}$$

Vernier constant ⇒ The Vernier constant of a vernier is difference between the value 1 main scale division (M.S.D) and 1 vernier division (1 V.D.)

Vernier constant is the smallest lenght that can be measured by the vernier. It is also called the **least count** of the instrument.

Let us find the vernier constant of a vernier in which n division of the Vernier scale coincide with (n-1) divisions of the main scale, it implies that

$$n \text{ V.D.} = (n-1) \text{ M.S.D.}$$

$$1 \text{ V.D.} = \frac{(n-1)}{n} \text{ M.S.D}$$

$$\text{Vernier Constant} = 1 \text{ M.S.D} - 1 \text{ V.D.}$$

$$= 1 \text{ M.S.D} - \frac{(n-1)}{n} \text{ M.S.D} = \frac{n-(n-1)}{n} \text{M.S.D}$$

$$\text{Vernier Constant} = \frac{1 \text{ M.S.D}}{n}$$

$$\text{Vernier Constant} = \frac{\text{Value of 1 M.S.D}}{\text{Total no. of divisions of the Vernier scale}}$$

As we know:

$$10 \text{ V.D} = 9 \text{ M.S.D}$$

$$1 \text{ V.D} = \frac{9}{10} \text{ M.S.D}$$

$$\text{Vernier constant} = 1 \text{ M.S.D} - 1 \text{ V.D}$$

$$= 1 \text{ M.S.D} - \frac{9}{10} \text{ M.S.D}$$

(b) To measure diameter of Bob :-

Serial no.	Main scale reading (x)	Vernier scale reading (n)	Fraction to be added ($y = n \times V.C$)	Observed dimension	Result
1.	1.8 cm	1	1×0.01 cm $= 0.01$ cm	$1.8 + 0.01$ cm $= 1.81$ cm	1.81 cm
2.	1.7 cm	8	8×0.01 cm $= 0.08$ cm	$1.7 + 0.08$ cm $= 1.78$ cm	1.78 cm
3.	1.8 cm	1	1×0.01 cm $= 0.01$ cm	$1.8 + 0.01$ cm $= 1.81$ cm	1.81 cm

(c) Caclulations :-

$$D = \frac{D_1 + D_2 + D_3}{3} = \frac{1.81 + 1.78 + 1.81}{3} = \frac{5.40}{3}$$

$= 1.80$ cm

Diameter of Bob, $D = 1.80$ cm

Result ⇒ The mean diameter of the given bob, $D = 1.80$ cm

$$= \frac{1}{10} \text{ M.S.D} = \frac{1}{10} \times 1 \text{ mm}$$

$$\text{Vernier Constant} = \frac{1 \text{ mm}}{10} = 0.1 \text{ mm} = 0.01 \text{ cm}$$

Vernier Callipers is used to measure a small lengths or thickness ; internal and external diameters of a cylinder and the dept of a vessel.

Procedure:

1. Determine the Vernier constant of the Vernier Callipers as explained above.
2. Grip the cylinder between the two Jaws, tightly, without applying undue pressure on them. Tighten the screw S, gently in this position.
3. Note the main scale reading (x) before the zero of the Vernier Scale and also the numbers (n) of the division of the Vernier scale that coincide with some divisions of the main scale. Record the values of x and n in tabular form as observation.

The observed value of the diameter AB is given by

$$D_1 = x + n \times V.C$$

Result:

The Mean diametre of the given cylinder,
D = ...1.80...cm

Precautions:

1. Motion of Vernier scale should be frictionless.
2. Undue pressure on body by vernier callipers should be avoided.
3. Read the Vernier callipers by keeping the eye vertically above it to avoid parallax.

Sources of Error:

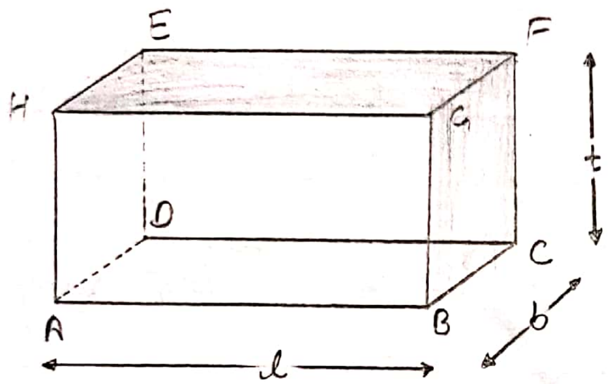
1. The two jaws P and Q of the callipers may not be at right angles to the main scale of the callipers.
2. The graduation of the two scales may not be evenly marked.
3. Parallax may creep in while taking observations.

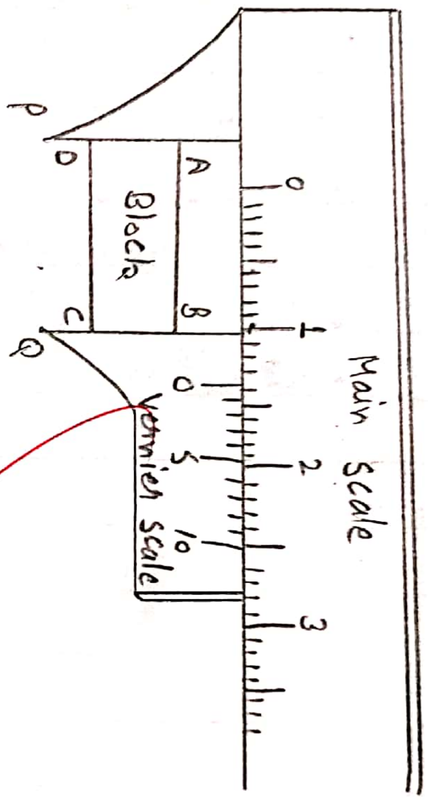
Good

Experiment => 2

Aim => To measure dimensions of a given rectangular body of known mass and hence find its density.

Apparatus => A rectangular block of known mass and a vernier callipers.





Formula used:- (1) The volume of the rectangular block,

$V = t \times b \times l$.

(2) If M is mass of the block, then density of its material, $\rho = \frac{M}{V}$

Experiment => 2

Aim => To measure dimensions of a given rectangular body of known mass and hence find its density.

Apparatus => A rectangular block of known mass and a vernier callipers.

Theory => We know that a metre scale can be used to measure lenghts accurately upto 1mm. In case the lenght of an object is to be measured to a greater accuracy (upto 0.1 millimetre), then each mm on the scale has to be further divided into equal parts (say 10). It was difficult with normal scale because the division marks may be too close to be seen separately. So, Pierre vernier, a Belgian Mathematician intented a device called Vernier Calliper.

Procedure => (i) Determine the vernier Constant of the Vernier Callipers.

(ii) Mark the lenght, breadth and thickness of the rectangular ~~bat~~ block ABCDEFGH as AB = l, BC = b and CF = t respectively as shown in figure.

(iii) Place the rectangular block between the two jaws (P and Q) of the vernier callipers in such a way that the edge AB of the block is held.

Observations ⇒ To measure lenght, breadth and thichness of the rectangular block:

Dimensions	Serial No.	Main Scale reading (x)	Vernier Scale (n)	Fraction to be added y = (n × v.c)	Observed Dimensions x+y	Result
Lenght (AB)	1)	3.3 cm	1	1 × 0.01 ⇒ 0.01 cm	3.3 + 0.01 ⇒ 3.31 cm	3.31 cm
	2)	3.3 cm	1	1 × 0.01 ⇒ 0.01 cm	3.3 + 0.01 ⇒ 3.31 cm	3.31 cm
	3)	3.3 cm	1	1 × 0.01 ⇒ 0.01 cm	3.3 + 0.01 ⇒ 3.31 cm	3.31 cm
Breadth (BC)	1)	1.7 cm	2	2 × 0.01 ⇒ 0.02 cm	1.7 + 0.01 ⇒ 1.71 cm	1.71 cm
	2)	1.7 cm	1	1 × 0.01 ⇒ 0.01 cm	1.7 + 0.01 ⇒ 1.71 cm	1.71 cm
	3)	1.7 cm	2	2 × 0.01 ⇒ 0.02 cm	1.7 + 0.02 ⇒ 1.71 cm	1.72 cm
Thickness (CF)	1)	1.0 cm	2	2 × 0.01 ⇒ 0.02 cm	1.0 + 0.02 ⇒ 1.02 cm	1.02 cm
	2)	1.0 cm	3	3 × 0.01 ⇒ 0.03 cm	1.0 + 0.03 ⇒ 1.03 cm	1.03 cm
	3)	1.0 cm	2	2 × 0.01 ⇒ 0.02 cm	1.0 + 0.02 ⇒ 1.02 cm	1.02 cm

Parallel to the main scale of the callipers. Tighten the screw S in the position.

(iv) Note the main scale reading (x) before the zero of the vernier scale and also the number (n) of the division of the vernier scale that coincide with some division of the main scale, record the values of x and n in the observed value of the lenght AB of the block.

$l' = x + n \times$ Vernier Constant

(v) Measure the lenght of the block at 3 different places.

(vi) By proceeding as in steps 4 and 3, note the value of x and n for measuring the observed breadth BC (= b') and observed thickness CF (= t') of the block at three different places and record the observations in tabular form.

(vii) Find the mean observed lenght, breadth & thickness of the block.

Result => The Volume of the material of given rectangular block, V = 5.77 cm^{+3}

Precautions => (i) Motion of vernier scale should be frictionless.

(ii) Undue pressure on body by vernier callipers should be avoided.

Calculations ⇒

Mean lenght (AB) ⇒ $\frac{3.31 + 3.31 + 3.31}{3}$ ⇒ 3.31 cm

Mean Breadth (BC) ⇒ $\frac{1.72 + 1.71 + 1.72}{3}$ ⇒ 1.71 cm

Mean Thickness (CF) ⇒ $\frac{1.01 + 1.03 + 1.02}{3}$ ⇒ 1.02 cm

Volume ⇒ $l \times b \times t$

⇒ $3.31 \times 1.71 \times 1.02$

⇒ $5.77 cm^3$

Result ⇒ The volume of the material of given rectangular block, $V = 5.77 cm^3$.

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(3) At any place along the lenght of the cylinder measure its diameter is two mutually perpendicular position.

(4) Read the Vernier callipers by keeping the eye vertically above it to avoid parallax.

Sources of Error ⇒ (i) The two jaws P and Q of the callipers may not be at right angles to the main scale of the callipers.

(ii) The graduation of the two scales may not be evenly marked.

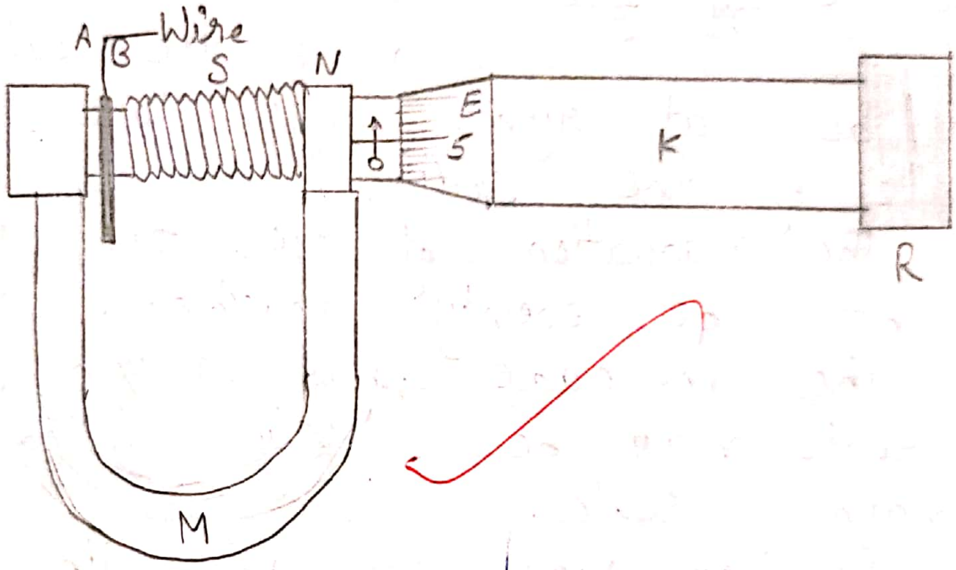
(iii) The moveable jaws carrying the vernier scale may be losely fitted over the main scale.

(iv) Parallax may creep in while taking observations.

Experiment ⇒ 3

Aim ⇒ To measure the diameter of a wire by using a screw gauge.

Apparatus ⇒ A screw gauge, given wire.



Observations ⇒

1. Determine the least count of the screw gauge

L.S.D = 1 mm

Numbers of full rotation given to screw = 5.

Distance moved by the screw = 5mm

$$\text{pitch}, P = \frac{5mm}{5} = 1mm$$

Experiment ⇒ 3

Aim ⇒ To measure the diameter of a wire by using a Screw gauge.

Apparatus ⇒ A screw gauge, given wire.

Theory ⇒ Screw gauge works on the principle of a screw moves backwards of forward linearly when its head is rotated backward or forward. The screw gauge can measure lenght accurately upto one hundredth of a milimetere (say thickness of wire, needle, etc). The screw gauge commonly available consists of a U-shaped steel frame at one end of which a study is fixed and at other there is nut through which screw moves. The flat end of screw and stud serves as two jaws of screw gauge. A hollow cylinder is attached to nut on which there is straight line called reference line on base line. One reference line the scale is engraved in millimetre and is called main scale or pitch scale. Circular scale is engraved on another hollow cylinder which is engraved on another hollow cylinder which is attached to the head of the screw. A ratched is also attached to screw which on being turned, makes the screw advanced. The ratched helps to avoid undue pressure on object placed between studs of screw gauge.

Hence

Numbers of divisions on circular scale = 100

least count $= \frac{1\,mm}{100} = 0.01\,mm = 0.001\,cm$

2. Table for the diameter (D)

Serial No.	Main scale reading (N) (mm)	Circular scale reading (n)	value n×(L.C) (mm)	observed N+n(L.c) (mm)	Result (mm)
1.	1	48	48×0.01 ⇒ 0.048mm	1+0.048 ⇒ 1.048 mm	1.048 mm
2.	1	48	48×0.01 ⇒ 0.048 mm	1+0.048 ⇒ 1.048 mm	1.048 mm
3.	1	47	47×0.01 ⇒ 0.047 mm	1+0.047 ⇒ 1.047 mm	1.047 mm

Calculations :-

$$\text{Mean diameter} \Rightarrow \frac{1.048 + 1.048 + 1.047}{3} \Rightarrow \frac{3.143}{3}$$

$$= 1.04\,mm$$

Result ⇒ Diameter of a given wire is, D = 1.04 mm

Pitch of the screw is the distance moved forward by the screw when its head is given a complete rotation. It is equal to the distance between the consecutive threads of the screw.

To use a screw gauge, we must first find its pitch and least count.

To find pitch => Rotate the screw so that the zero of the circular scale is in line with the reference line. Note the reading on the main scale. Give five complete rotations to the head of the screw and note the final reading on the main scale. Let d be the distance moved on the main scale i.e. difference of the final and initial redings.

$$\text{The pitch} = \frac{\text{Distance moved by the screw}}{\text{No. of complete rotations}} = \frac{d}{5}$$

The pitch of the screw gauge is generally 1mm or 0.5mm

Least count of screw gauge => It is the distance moved by the screw when it is related by one circular scale division. It is given by. least count = $\frac{\text{Pitch}}{\text{No. of divisions of the circular scale}}$

Procedure ⇒ (i) find the value of one linear scale division (L.S.D).

(ii) Determine the pitch and the least count of the screw gauge and record it stepwise.

(iii) Place the wire between the jaws and fix it in between them by moving or rotating the ratchet stop when R turns (slips) without moving the screw.

(iv) Note the number of divisions of the linear scale visible and uncovered by edge of the cap. The reading (N) is called linear scale reading (L.S.R)

(v) Note the number (n) of the division of the circular scale lying over reference line.

(vi) After rotating the wire by 90° . Repeat 4 & 5 for measuring diameter in a perpendicular direction.

(vii) Measure the lenght of the wire by using a half meter scale. Do it three times & record them.

Result ⇒ Diameter of given wire, D = 1.04 mm.

Precautions ⇒ (i) Check the free movement of the screw gauge as well as the functioning of the ratchet.

(ii) Always use ratchet R to rotate the screw. Do not put undue pressure on it.

(iii) Avoid error due to parallax.

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Sources of Error:- (i) The backlash error may be there in the screw gauge.
(ii) The wire may not have uniform cross section.
(iii) The divisions on the linear scale and or circular scale may not be evenly spaced.

Experiment ⇒ 4

Aim ⇒ To measure the thickness of a given sheet by using screw gauge.

Apparatus ⇒ Screw gauge, given sheet (sunmica sheet, any metal sheet or any glass sheet).

Formula used ⇒ (i) Pitch ⇒ $\dfrac{\text{distance moved by the screw}}{\text{number of rotations given to the scale}}$

(ii) Least count $= \dfrac{\text{Pitch}}{\text{total no. of division on the circular scale}}$

(iii) The reading of screw gauge (for observed diameter)

$D' = x + n \times \text{least count}$

The thickness of a single sheet is very small and hence cannot be measured accurately. A large number of such small sheets (say 30) are taken so that they have some measurable thickness. If d is thickness of pieces of the sheet of paper, then thickness of the given sheet of paper.

$$t = \frac{d}{30}$$

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Experiment ⇒ 4

Aim ⇒ To measure the thickness of a given sheet by using screw gauge.

Apparatus → Screw gauge, given sheet (sunmica sheet, any metal sheet or any glass sheet).

Procedure ⇒ (i) find the value of one linear Scale division (L.S.D).

(ii) Determine the pitch and the least count of the screw gauge and record it stepwise.

To measure the thickness of the sheet of paper.

(iii) The sheet of a paper is quite thin. Therefor, the thickness of a single sheet can't be accurately found. Cut the sheet into small pieces and take 30 such pieces.

(iv). Hold the 30 pieces of the sheet of paper between the two studs of the screw gauge and move the screw with the help of ratchet arrangement, till the ratchet arrangement becomes free with the sound of click. Make sure the gentle placing of the pile of pieces of the sheet of paper between the two studs of the screw gauge.

(v) Note the main scale reading (x) and the number (n) of the division of the circular

Observations =>

Serial No.	Main Scale reading (x) (mm)	Circular Scale (n) (mm)	n × L.C (mm)	Observed x + n × L.C	Result
1.	2	71	71 × 0.01 ⇒ 0.071	2 + 0.071 ⇒ 2.071	2.071 mm
2.	2	67	67 × 0.01 ⇒ 0.067	2 + 0.067 ⇒ 2.067	2.067 mm
3.	2	66	66 × 0.01 ⇒ 0.066	2 + 0.066 ⇒ 2.066	2.066 mm

Calculations =>

Mean $\Rightarrow \dfrac{2.071 + 2.067 + 2.066}{3} = \dfrac{6.204}{3}$

$\Rightarrow$ 2.68 mm of 30 pages

$$t = \frac{2.68}{30} = 0.081 \text{ mm}$$

Result => Thickness of a sheet of paper = 0.081 mm

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scale that coincide with the reference line. Record the values of x and n in the tabular form, observed thickness of 25 pieces of the sheet of paper.

$$d' = x + n \times \text{least count}$$

(vi) Repeat 4,5 steps at least three times more at three different places.

(vii) Find mean observed thickness (d') of the 30 pieces of sheet of paper.

The thickness of sheet of paper

$$t = \frac{d}{30}$$

Result ⇒ The thickness of the given sheet of paper = 0.081 mm.

Precautions ⇒ (i) Check the free movement of the screw as well as the functioning of the ratchet.

(ii) Always use ratchet R to rotate the screw. Do not put undue pressure on it.

(iii) The screw should be moved in the same direction (or the ratched should be rotated in the same direction) to avoid backlash error.

(iv) Measure the diameter in two perpendicular directions at a given place of the wire.

(v) The reading of diameter should be taken at least five places along the whole lenght of the wire.

(vi) Avoid error due to parallax.

Sources of error => (i) The backlash error may be there in the screw gauge.

(ii) The wire may not have uniform cross section.

(iii) The divisions on the linear scale and on circular scale may be evenly spaced.

Experiment ⇒ 7

Aim ⇒ To determine radius of curvature of a given spherical surface using spherometer.

Apparatus ⇒ Spherometer, concav surface, plane glass slab.

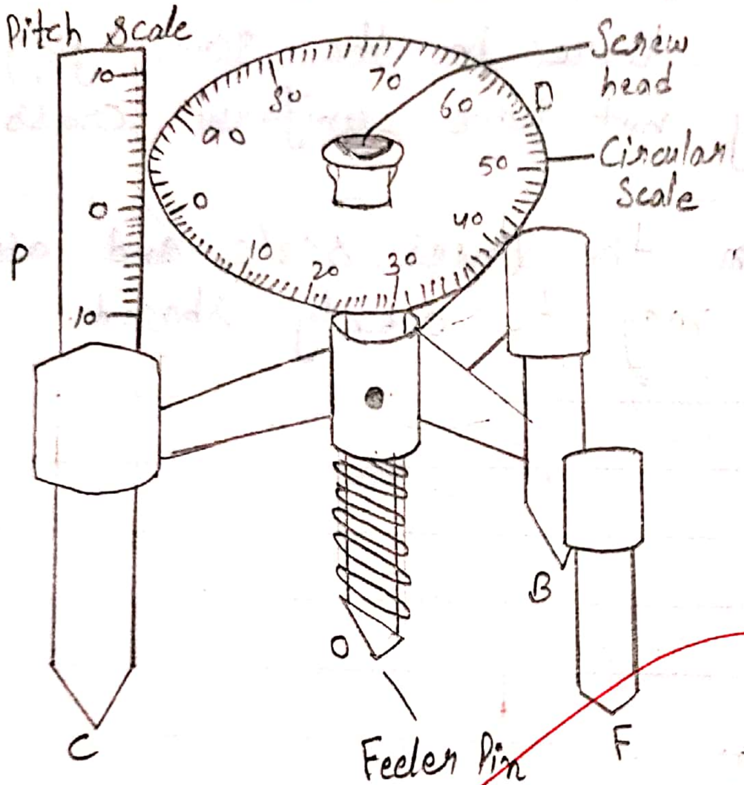


figure 1

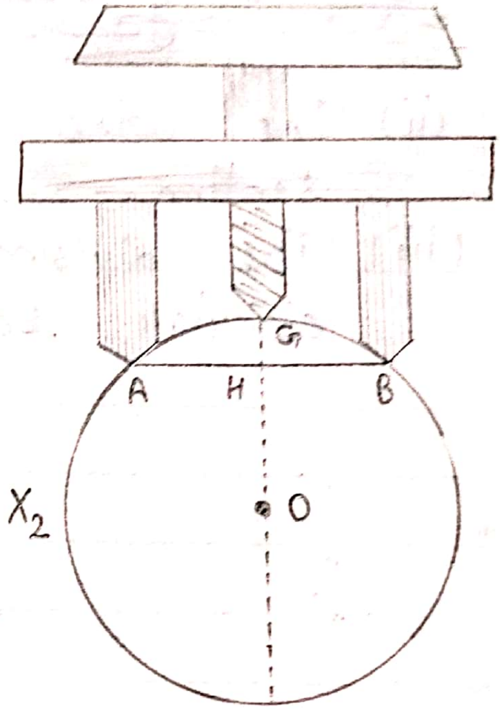


figure 2

Experiment → 5

Aim ⇒ To determine radius of curvature of a given spherical surface using spherometer.

Apparatus ⇒ Spherometer, Convex surface, plane glass slab.

Theory ⇒ A spherometer also works on the principle of a screw. It is used to measure the radius of curvature of a spherical surfaces. It can also be used to find thickness of small surfaces.

A spherometer consists of a screw which can turn in a nut fixed to metallic frame. A circular scale is attached to the screw. The circular scale generally have 50 or 100 divisions on it. A vertical scale called the pitch scale is also fixed to the metallic frame as shown in the figure 1.

Pitch of the spherometer ⇒ Pitch of the spherometer is the distance moved forward by the screw when one complete rotation is given to circular scale.

$$\text{The Pitch} = \frac{\text{Distance moved by the screw}}{\text{No. of complete rotations}}$$

Observation table:-

Serial no.	Circular scale: Spherical surface (a)	Circular scale: Plane surface (b)	no. of rotations (n)	x = a-b , 100 + a-b
h_1	50	14	4	50-14 = 36
h_2	84	2	5	84-2 = 82
h_3	88	18	5	88-18 = 70

Calculations:-

$h_1 \Rightarrow n \times \text{Pitch} + x \times LC$

$= 4 \times 1 + 36 \times 0.01$

$= 4 + 0.036$

$= 4.036$ mm

$h_2 \Rightarrow 5 \times 1 + 82 \times 0.01$

$= 5 + 0.082$

$= 5.082$ mm

$h_3 \Rightarrow 5 \times 1 + 70 \times 0.01$

$= 5 + 0.070$

$= 5.070$ mm

Mean $\Rightarrow \dfrac{h_1 + h_2 + h_3}{3} = \dfrac{4.036 + 5.082 + 5.070}{3}$

$= \dfrac{14.186}{3} = 4.72$ mm

Least count of Spherometer => It is the distance moved by the screw when the circular scale is moved through one division.

Least count = $\frac{\text{Pitch}}{\text{No. of divisions of the circular scale}}$

To calculate the pitch and least count =>

Distance moved by the screw in four complete rotations,

$d = 4mm$

Pitch of the screw $= \frac{d}{4} = \frac{4mm}{4} = 1mm$

No. of divisions on circular scale = 100

Least count of the spherometer $= \frac{\text{Pitch}}{n} = \frac{1mm}{100}$

$= 0.01\ mm$

Procedure :- (i) Find Pitch and least count of the spherometer.

(ii) Place spherometer on curved surface with the central raised upwards.

(iii) Turn central screw forward till it just touches the curved surface.

(iv) Note reading of circular scale just before main scale.

(v) Now remove the spherometer from the convex surface and place it on plane glass slab and turn screw forward so just it touches glass surface, count no. of rotations and final reading on circular scale.

(vi) Repeat about procedure atleast two times.

Result => The radius of curvature of the given convex surface is 4.72 mm.

Precautions => (i) Circular disc should always be rotated in same direction to avoid backlash error.

(ii) Reading should be noted when spherometer just begins to rotate central screw.

(iii) Excess rotation should be avoided.

(iv) Screw should move freely without friction.

Sources of error => (i) Spherometer may have backlash error.

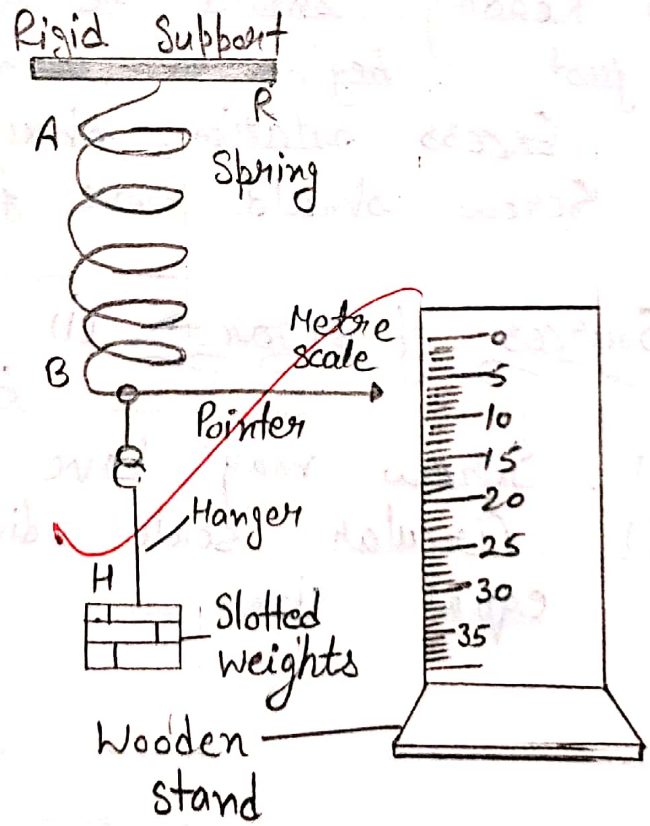
(ii) Screw may have friction.

(iii) Circular scale divisions may not be of equal size.

Experiment ⇒ 6

Aim ⇒ To find the spring/force constant of a helical spring by measuring the time period of vertical oscillations of a known load and check it by measuring its extension by known force.

Aparatus ⇒ The given spring, a pointer, a scale, rigid support, a hanger, 8 slotted weights each of 50 g, a stopwatch, wooden stand to mount the metre rod or a clamp stand.



Experiment → 6

Aim → To find the spring/force constant of a helical spring by measuring the time period of vertical oscillations of a known load & check it by measuring its extension by known force.

Aparatus → The given spring, a pointer, a scale, rigid support, a hanger, 8 slotted weights each of 50 g, a stopwatch, wooden stand to mount the metre rod or a clamp stand.

Theory → When a mass m_1 is attached to the free end of a spring suspended from a rigid support is pussed and then released. It executes simple harmonic oscillations Time period of S.H.M., $T_1 = 2\pi\sqrt{\frac{m_0 + m_1}{k}}$ ——(i)

There, m_0 is the mass of the spring and k is ~~spring~~ factor of the spring.

Similarly, If mass m_2 is suspended then the time peroid of S.H.M.

$$T_2 = 2\pi\sqrt{\frac{m_0 + m_2}{k}} \quad \text{—— (ii)}$$

By solving the above equations (i) & (ii)

Observations :-

Value of mass, m_1 = 50 g = 0.05 kg

Value of mass, m_2 = 100 g = 0.1 kg

Least count of the stopwatch .... (0.1 s)

Observation table :-

S. no.	Mass Used	Number of Oscillations (n) (Say n = 20)	Time for n oscillations t (in seconds)			Mean value of t $t = \frac{t_1+t_2+t_3}{3}$	Time period $T = \frac{t}{n}$
			t_1	t_2	t_3		
1.	m_1	20	11	11	11	$\frac{11+11+11}{3} = 11$	$T_1 = 0.55$
1.	m_2	20	15	15	15	$\frac{15+15+15}{3} = 15$	$T_2 = 0.75$

Calculations :-

$$K = 4\pi^2 \left(\frac{m_2 - m_1}{T_2^2 - T_1^2} \right)$$

$$K = 4 \times (3.14)^2 \left[\frac{0.1 - 0.05}{(0.75)^2 - (0.55)^2} \right]$$

$$= 4 \times 9.8596 \left[\frac{0.05}{0.5625 - 0.3025} \right]$$

$$= 4(9.8596) \left[\frac{0.05}{0.2600} \right]$$

$$= 4(9.8596) \cdot \left[\frac{5}{26} \right]$$

$$= \frac{197.192}{26} \Rightarrow \boxed{7.58 \ N/m^2}$$

From the equation (i) & (ii)

$$m_0 = \frac{T_1^2 k}{4\pi^2} - m_1 \quad \text{------} \quad (iii)$$

$$m_0 = \frac{T_2^2 k}{4\pi^2} - m_2 \quad \text{------} \quad (iv)$$

From the equation (iii) & (iv)

$$\frac{T_1^2 k}{4\pi^2} - m_1 = \frac{T_2^2 k}{4\pi^2} - m_2$$

$$\frac{T_1^2 k}{4\pi^2} - \frac{T_2^2 k}{4\pi^2} = -m_2 + m_1$$

$$\frac{k}{4\pi^2}\left[T_1^2 - T_2^2\right] = \cancel{+}(m_1 - m_2)$$

$$\cancel{+}(T_2^2 - T_1^2)\frac{k}{4\pi^2} = \cancel{+}(m_2 - m_1)$$

$$k = \left(\frac{m_2 - m_1}{T_2^2 - T_1^2}\right) 4\pi^2$$

So spring constant $k = 4\pi^2 \left(\frac{m_2 - m_1}{T_2^2 - T_1^2}\right)$

Procedure ⇒ (i) Suspend the spring AB from rigid support R. Attach a hanger to slotted of a spring. The spring along with the hanger has mass m_0.

(ii) Place the given mass m_1 on hanger. Pull it a little downwards and place it on so that it is set into vertical oscillations.

(iii) Using stopwatch measure the time for 20 Oscillations. Repeat step 1 & 2 three times.

Result ⇒ The value of the spring constant (K) of the given spring is found to be 7.58 N/m⁺².

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4) Now replace the load m_1 by load m_2. Again measure the time for oscillations three times.
5) Find the mean of times for 20 oscillations in each case and then time period T_1 & T_2.
6) Record your observations as below.

Result ⇒ The value of spring constant (k) of the given spring is found to be 7.58 Nm^{-1}

Precautions ⇒ (i) Do not load the spring beyond elastic limit.
(ii) The spring should be suspended freely from a rigid support.
(iii) Loading and unloading should be done gradually.
(iv) The pan or the pointer should not touch the scale.

Sources of Error ⇒ (i) Amplitude of oscillations may not be small.
(ii) Support may not be rigid.
(iii) The slotted weights may not be of standard mass.

good