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Particulars of the Experiment Performed

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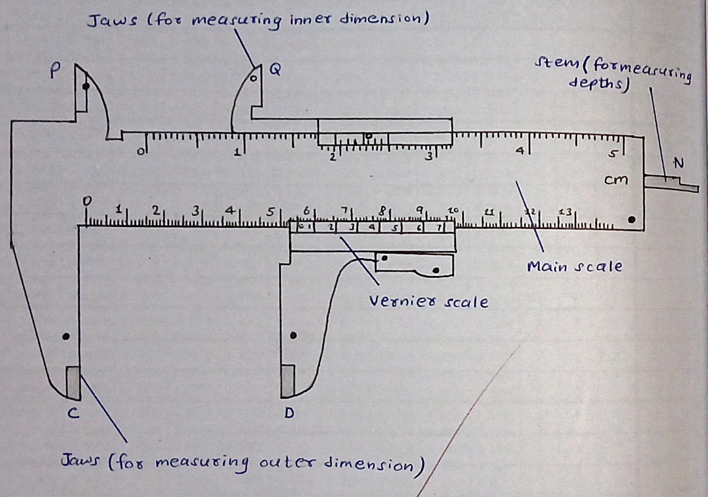

Vernier Calliper

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* Experiment-1 *

* Object :-

To measure diameter of a small /cylindrical body using a vernier callipers.

* Material Required :-

1) Vernier Callipers
2) A spherical body

* Theory :-

1) **Vernier Callipers**: This instrument is used to measure accurately upto 0.1 mm. It is difference between one main scale division and one vernier scale division.

$$n(VSD) = (n-1)\,MSD$$

2) **Formula used:**

a) Least count of vernier's calliper $= \dfrac{\text{Magnitude of the smallest division on the main scale}}{\text{Magnitude of the smallest division on the vernier scale}}$

b) Corrected diameter = Mean observed diameter - Zero error

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3) Determining of zero error: If the zero of main scale coincides with zero of vernier scale when jaws C and D are brought in contact with each other, then the instrument is free from error or it is said to have no zero error. But in actual practise, it is never so. Due to wear & tear of jaws and sometime due to manufacturing ~~defects~~ defects, the zero mark of the vernier scale does not coincide with zero of main scale. It gives rise to an error called zero error. Zero error can be positive or negative.

(I) Positive zero error: The zero error is positive when the zero mark of the vernier scale lies towards the right side of the zero of the main scale when jaws C and D are made to touch each other.

(ii) Negative zero error: The zero error is negative when the zero mark of the vernier scale lies towards the left side of the zero of the main scale when jaws are in contact.

4) Determination of least count or vernier constant:

Least count is the smallest value of a physical quantity which can be measured accurately with an instrument. From Fig. 1, 10 div. of vernier scale coincide with 9 div. of main scale and length of 1 div. of main scale is 1 mm

S.No.	Main Scale reading (x cm)	Vernier Scale div. coinciding with (MSD) 'n'	Fraction to be added 'y' $y = (n \times 0.01)$ cm	Observed diameter $(x+y)$ cm	Mean observed diameter
1) AB	1.9cm	9	$y = 9 \times 0.01$ $= 0.09$	$1.9 + 0.09$ $= 1.99$	1.99cm
EF					
2) AB	1.9cm	3	$y = 3 \times 0.01$ $= 0.03$ cm	$1.9 + 0.03$ $= 1.93$	1.93cm
EF					
3) AB	1.9cm	2	$y = 2 \times 0.01$ $= 0.02$ cm	$1.9 + 0.02$ $= 1.92$	1.92.cm
EF					

$$10\ VSD = 9\ MSD$$

$$1\ VSD = \frac{9}{10}\ MSD$$

The quantity (1 MSD − 1 VSD) is called vernier constant (VC).

$$VC = \left(1 - \frac{9}{10}\right) MSD$$

$$= \frac{1}{10}\ MSD$$

$$= \frac{1}{10} \times 1\ mm$$

$$VC = 0.1\ mm = 0.01\ cm$$

* Observation :-

VC (Vernier Constant) = 0.01 cm

* Zero Error :-

1. 0 cm
2. 0 cm
3. 0 cm

Mean zero Error = 0 cm
Mean zero correction = 0 cm
Mean diameter (d) = 1.946 cm
Mean corrected diameter = d + zero correction = 1.94 cm

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* **Result :-**

The diameter of the given sphere / cylinder is 1.94 cm

* **Precautions :-**

1) Motion of vernier scale on main scale should be made smooth.
2) Vernier constant and zero error should be carefully found and properly recorded.
3) The ~~bob~~ body should be gripped between the jaws firmly but gently (without under pressure on it from the jaws).
4) Observation should be taken at the right angles at one place and taken atleast as three different places.

* **Sources of Error :-**

1) The vernier scale may be loose on main scale.
2) The jaws may not be at right angles to the main scale.
3) The graduations on scale may not be evenly marked.
4) Parallax may creep in while taking observations.

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* Experiment - 2 *

* Object:-

To measure internal diameter, depth and volume of a beaker using vernier callipers and hence find its volume.

* Material Required:-

1) Vernier Callipers
2) A beaker
3) Magnifying Glass

* Theory:-

1) For measuring internal diameter and depth.

2) For volume: Volume of beaker = Internal area of cross section x Depth.

or $V = \pi\left(\frac{D}{2}\right)^2 \cdot d$

Where, D = internal diameter of beaker
d = depth of beaker

* Observations:-

Vernier constant = 0.01 cm
zero error = 0 cm
zero correction = 0 cm

S.No.	Main Scale reading (x cm)	VSD coinciding with MSD (n)	Fraction to be added $y = n \times vc$ (cm)	Observed diameter $(x+y)$ cm
1. (a)	4.7	2	$2 \times 0.01 = 0.02$	4.72 cm
(b)				
2. (a)	4.7	3	$3 \times 0.01 = 0.03$	4.73 cm
(b)				
3. (a)	4.7	1	$1 \times 0.01 = 0.01$	4.71 cm
(b)				

Table: Internal Diameter

S.No.	MSR (x cm)	VSD coinciding with MSD (n)	Fraction to be added $y = n \times vc$ (cm)	Observed depth $(x+y)$ cm
1.	7.1	7	$7 \times 0.01 = 0.07$	7.17 cm
2.	7.1	6	$6 \times 0.01 = 0.06$	7.16 cm
3.	7.1	5	$5 \times 0.01 = 0.05$	7.15 cm
4.				
5.				

Table: Depth of beaker

Mean observed diameter = 4.72 cm
Mean corrected diameter = 4.72 cm
Mean observed depth d = 7.16 cm
Mean corrected depth d = 7.16 cm

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Remark ....

* Calculation :-

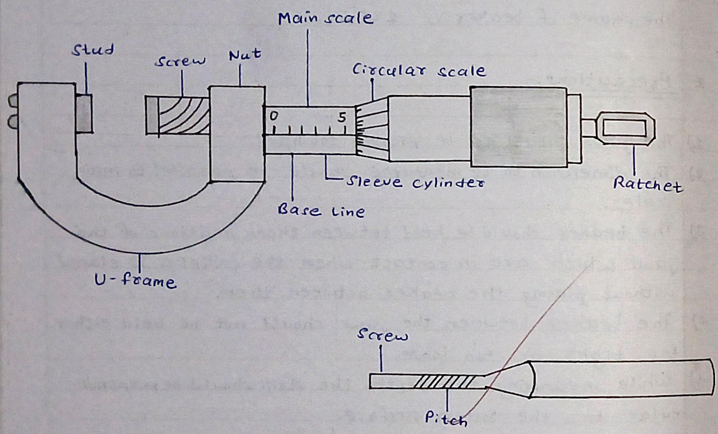
Volume of beaker (v) = $\pi\left(\frac{d}{2}\right)^2 \cdot d$ = $125.5\,cm^3$

* Result :-

The volume of beaker is $125.5\,cm^3$

* Precautions :-

1) The jaws should not be pressed too hard.
2) The dimension to be measured should be parallel to main scale.
3) The beaker should be held between those positions of the jaws which are in contact when the callipers is closed without placing the beaker between them.
4) The beaker between the jaws should not be held either too tight or too loose.
5) While measuring the depth, the strip should be perpendicular to the bottom surface.



Screw Guage

* Experiment-3 *

* Object:-

To determine the diameter of a given wire using a screw guage.

* Material Required:-

Screw guage
Wire
Half meter scale
Magnifying glass

* Theory:-

1) A screw guage is a measuring instrument used for measuring very small distances of the order 1/100 th part of a mm.

2) Least count:
Least count of the screw guage
= Pitch of the screw / Total no. of divisions on the circular scale.

3) Linear Scale reading is taken by noticing the mark on the linear scale which is close to the edge of the

circular scale.

4) Circular scale reading is taken by noticing the division on the circular scale that coincides with the main scale reading.

5) Zero error: When the two studs of a screw guage are bought in contact with each other, the zero of the circular scale should coincide with the reference line on the main scale. In the case, there is no zero error However, when the zero of the circular scale does not coincide with the reference line, the screw guage is said to have zero error. Zero error may be positive or negative.

(i) Positive zero error: The zero error is said to be positive, if on bringing studs in contact, the zero of the circular scale is ~~above~~ below the reference line on the main scale.

(ii) Negative zero error: The zero error is said to be negative, if on bringing studs in contact, the zero of the circular scale is above the reference line on the main scale.

* Observation :-

Zero error (i) 0mm ; (ii) 0mm ; (iii) 0mm

S.No.		Linear Scale Reading N mm	CSR coinciding with reference line (n)	Fraction to be added (mm) n X LC	Total Reading	
					Observed diameter $D_o = N + n(LC)$ (mm)	Corrected diameter $D = D_o \pm$ zero correction (mm)
1)	(a) A ⊖ B	2	88	88 X 0.01 = 0.88	2 + 0.88 = 2.88	$D_1(a)$ = 2.88 mm
	(b) A ⦶ B	2	87	87 X 0.01 = 0.87	2 + 0.87 = 2.87	$D_1(b)$ = 2.87 mm
2)	(a) A ⊖ B	2	90	90 X 0.01 = 0.90	2 + 0.90 = 2.90	$D_2(a)$ = 2.90 mm
	(b) A ⦶ B	2	89	89 X 0.01 = 0.89	2 + 0.89 = 2.89	$D_2(b)$ = 2.89 mm
3)	(a) A ⊖ B	2	89	89 X 0.01 = 0.89	2 + 0.89 = 2.89	$D_3(a)$ = 2.89 mm
	(b) A ⦶ B	2	88	88 X 0.01 = 0.88	2 + 0.88 = 2.88	$D_3(b)$ = 2.88 mm
4)	(a) A ⊖ B					
	(b) A ⦶ B					
5)	(a) A ⊖ B					
	(b) A ⦶ B					

Mean zero error (e) = 0 mm

Mean zero correction = 0 mm

Mean Diameter (D)

$$= \frac{D_1(a) + D_2(a) + D_3(a) + D_4(a) + D_5(a) + D_1(b) + D_2(b) + D_3(b) + D_4(b) + D_5(b)}{10}$$

= 2.89 mm

* **Result:-**

The diameter of the given wire D = 2.89 cm

* **Precautions:-**

1) To avoid undue pressure, the screw should always be rotated by ratchet R and not by cap k.
2) The screw should move freely without friction.
3) The zero correction, with proper sign should be noted very carefully and added algebraically.
4) For same set of obrervations, the screw should be moved in the same direction to avoid back-lash error of the screw.
5) At each place, the diameter of the wire should be measured in two perpendicular directions and then the mean of two be taken.
6) Reading should be taken atleast for five different places

equally spaced along the whole length of the wire.
7) Error due to parallax should be avoided.

* Sources of Error:-

1) The screw may have friction.
2) The screw guage may have back-lash error.
3) Circular scale divisions may not be of equal size.
4) The wire may not be uniform.

* **Observations :-**

S. No.	Linear scale reading (N)mm	CSR coinciding with the reference line (n)mm	Fraction to be added (mm) n x (LC)	Observed thickness $d_0 = N + n(LC)$ mm	Corrected thickness $d = d_0 +$ zero correction (mm)
1.	3	80	$80 \times 0.01 = 0.80$	$3 + 0.8 = 3.8$	$3.8 - 0.07 = 3.73$ mm
2.	3	82	$82 \times 0.01 = 0.82$	$3 + 0.82 = 3.82$	$3.82 - 0.07 = 3.75$mm
3.	3	78	$78 \times 0.01 = 0.78$	3.78	$3.78 - 0.07 = 3.71$mm
4.	3	75	$75 \times 0.01 = 0.75$	3.75	$3.75 - 0.07 = 3.68$mm
5.	3	70	$70 \times 0.01 = 0.70$	3.70	$3.70 - 0.07 = 3.63$mm