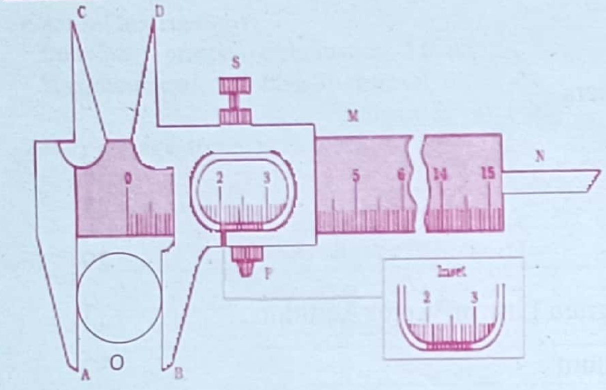
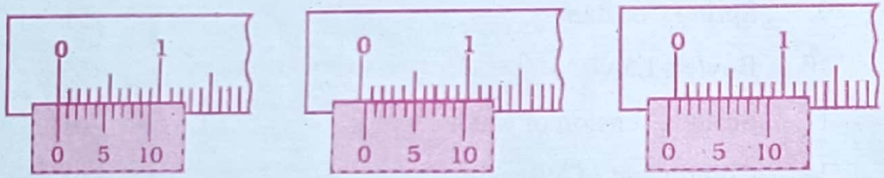
Diagram:



A & B - Lower Jaws
C & D - Upper Jaws
S - Screw
M - Main Scale
V - Vernier Scale
N - Strip
O - Object

Zero Error (ZE):



ZE = 0   **ZE = + (5 X LC)**   **ZE = - (5 X LC)**

Observation:

Value of 1 MSD = ………… cm

Total number of VSD = ……….

$$LC = \frac{\text{Value of 1 MSD}}{\text{Total number of VSD}} = \text{———} = \text{…………} \text{ cm}$$

ZE = ………… = …………cm

Experiment No. 1 Date: …………

VERNIER CALLIPERS

Aim: i) To measure diameter of a small spherical / cylindrical body,

ii) To measure the internal diameter and depth of a given cylindrical object like beaker / glass / calorimeter and hence to calculate its volume using vernier callipers.

Apparatus: Vernier Callipers, Spherical body, rectangular block of known mass and cylindrical object like a beaker / glass / calorimeter.

Principle : The magnitude of 'n' vernier scale divisions is equal to the magnitude of (n – 1) number of main scale divisions.

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

i) To measure diameter of a small spherical / cylindrical body:

Formula:

1) Least Count, $LC = \frac{\text{Value of 1 MSD}}{\text{Total number of VSD}}$

2) Total Reading, **TR = MSR + (CVD x LC)**

Where **MSR** - Main scale reading
CVD - Coinciding vernier division

Procedure:

1) The least count of the callipers is found.
2) When the lower jaws A and B are in contact firmly, the position of the vernier zero with respect to main scale zero is noted. If the vernier zero coincides with the main scale zero, then there is no zero error. If not so, there is zero error. The zero error will be positive or negative based on whether the vernier scale zero lies either to right or to the left of main scale zero. The number (n) of the vernier scale division coinciding with some division of the main scale is noted. Then zero error, ZE = ± n x LC.
3) The spherical / cylindrical body whose diameter D to be measured is held between the lower jaws of the vernier callipers firmly.
4) The position of the vernier scale zero against the main scale is noted. Note down main scale reading (**MSR**) just to the left of vernier scale zero.

Tabular Column:

Object	Dimension	Trial No.	MSR in cm	CVD	TR in cm	Mean TR in cm
Spherical Ball	Diameter	1				
		2				
		3				

Mean Diameter = ... cm

Corrected Diameter = Mean Diameter – ZE = ... cm

Calculation:

5) The number of particular vernier scale division which coincides with some division of the main scale is noted. This gives coinciding vernier scale division (**CVD**).

6) The total reading is calculated using the formula **TR** = **MSR + (CVD x LC).** This gives diameter.

7) The experiment is repeated for different positions of the object and readings are tabulated.

8) The mean diameter of the object is found.

9) Zero error is subtracted from the mean diameter to get the corrected diameter **D**.

Result : Diameter **D** of the spherical / cylindrical body = ... cm

= .... m

Precautions:

1. Avoid excessive pressure on the jaws of the callipers.
2. Motion of vernier scale on main scale should be made smooth.
3. The eye should be kept vertically above the vernier callipers, while recording the reading from it.

Observation:

Value of 1 MSD = ... cm

Total number of VSD = ...

$$LC = \frac{\text{Value of 1 MSD}}{\text{Total number of VSD}} = \frac{\quad}{\quad} = \text{..........}\ cm$$

ZE = ... = ...cm

Tabular Column:

Object	Dimension	Trial No.	MSR in cm	CVD	TR in cm	Mean TR in cm
cylindrical object like beaker/glass/calorimeter	Internal diameter	1				
		2				
		3				
	Internal depth	1				
		2				
		3				

Mean Internal diameter = ... cm

Corrected Internal diameter (D) = Mean Internal diameter – ZE

= .... cm = ...m

Mean Internal depth = ... cm

Corrected Internal depth (h) = Mean Internal depth – ZE

= .... cm = ...m

ii. **To measure the internal diameter and depth of a given cylindrical object like beaker/glass/calorimeter and hence to calculate its internal volume.**

Formula:

1) Least Count, $LC = \frac{\text{Value of 1 MSD}}{\text{Total number of VSD}}$

2) Total Reading, **TR = MSR + (CVD x LC)**

Where **MSR** - Main scale reading

CVD - Coinciding vernier division

3) Volume of the cylindrical object,

$$V = \frac{\pi D^2 h}{4}$$

Where D – internal diameter

h – internal depth

Procedure:

To find the internal diameter (D):

1) After finding least count and zero error, the upper jaws of callipers are inserted into the beaker and the jaws are pulled apart till they touches the inner wall of the beaker.

2) The total reading is calculated using the formula, **TR = MSR + (CVD x LC).** This gives internal diameter of the beaker.

3) The experiment is repeated for different positions in the beaker and readings are tabulated. The mean internal diameter is found. Zero error is subtracted from the mean internal diameter to obtain corrected value of internal diameter D of the beaker.

Calculation:

Volume of the cylindrical object,

$$V = \frac{\pi D^2 h}{4}$$

To find the internal depth (h):

1) The edge of the main scale of the callipers is kept on the upper edge of the beaker.

2) The moving jaw of the callipers is slided until the tip of the strip touches the bottom of the beaker.

3) The total reading is calculated using the formula, **TR = MSR + (CVD x LC).** This gives internal depth of the beaker.

4) The experiment is repeated for different positions on the bottom of the beaker and readings are tabulated. The mean internal depth is found. Zero error is subtracted from the mean internal depth to obtain corrected value of internal depth h of the beaker.

5) The internal volume of the beaker is calculated using the corrected values of the internal diameter and depth, using the formula,

$$V = \frac{\pi D^2 h}{4}$$

Result :

1. Internal diameter of the beaker, D = ... m
2. Internal depth of the beaker, h = ... m
3. Internal volume of the beaker, V = ... m^3

Note: The principle is one and the same for all parts of the experiment