EXPERIMENT 1

AIM

To measure the diameter of a small spherical/ cylindrical body and to measure internal diameter and depth of a given beaker/calorimeter using Vernier callipers and hence find its volume.

YOU NEED

1. Vernier callipers 2. Spherical body (pendulum bob) or a cylinder. 3. A beaker or a calorimeter.

THEORY

When the body is placed between the two jaws A and B, the main scale reading is x and if n is the number of vernier scale division coinciding, then the observed reading is given as

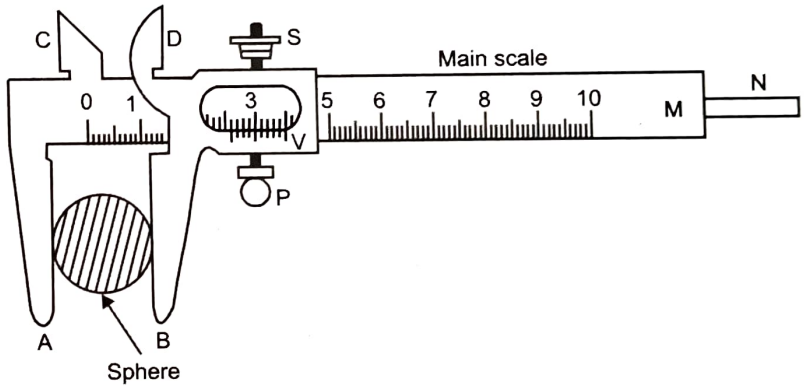

Fig. 9. Vernier callipers, measuring diameter of a sphere

Observed reading = $x + n$ (V.C.)

Volume of beaker or calorimeter = V = Internal area of cross-section × Depth

$$V = \pi\left(\frac{d}{2}\right)^2 \times h \qquad \text{or} \qquad V = \frac{\pi d^2 h}{4}$$

where d is the internal diameter of beaker or calorimeter, and
h is the depth of beaker or calorimeter.

HOW TO DO

(a) Measurement of Diameter of a Cylinder or Sphere

1. Determine the Vernier constant (V.C.) of the Vernier Callipers as discussed earlier.
2. Bring the movable jaw BD in close contact with the fixed jaw AC and determine the zero error. Take atlea three readings. Record the zero error. If there is no zero error, then record zero error nil.
3. Place the sphere or cylinder between the two jaws AC and BD, and adjust the jaw BD so that it gently gri the body between the two jaws. Now tight the screw S attached to the vernier scale V.
4. Take the main scale reading, *i.e.*, note the position of zero mark of the vernier scale V on main scale. F this record the main scale reading just before the zero mark of the vernier scale. This reading x is calle main scale reading (M.S.R.).
5. Note the number of vernier scale division (n) which coincides with some division of the main scale. Th coinciding number is to be counted from the zero end of vernier scale.
6. Find the product of n and V.C., y which is called vernier scale reading (V.S.R.). Add V.S.R. and M.S.R. obtain diameter of the sphere or cylindrical object.
7. Repeat the observations for the diameter at least three times, for three different positions of the sphere cylinder. Record the observation in the table.
8. To obtain the corrected diameter, subtract the zero error algebraically from the observed diameter.

(b) Measurement of Internal Diameter

9. Insert the jaws P and Q (Fig. 10) in the interior of calorimeter and adjust the position of movable jaw so that P and Q touch the walls of the calorimeter gently. Tight the screw S attached to the vernier scale.
10. Note the position of the zero of the vernier scale on the main scale. This reading is called main scale reading (x).
11. Note the number of vernier scale division (n) which is coinciding with some division of the main scale.
12. Repeat the observations for internal diameter three times by changing the position of the calorimeter and record the observations.

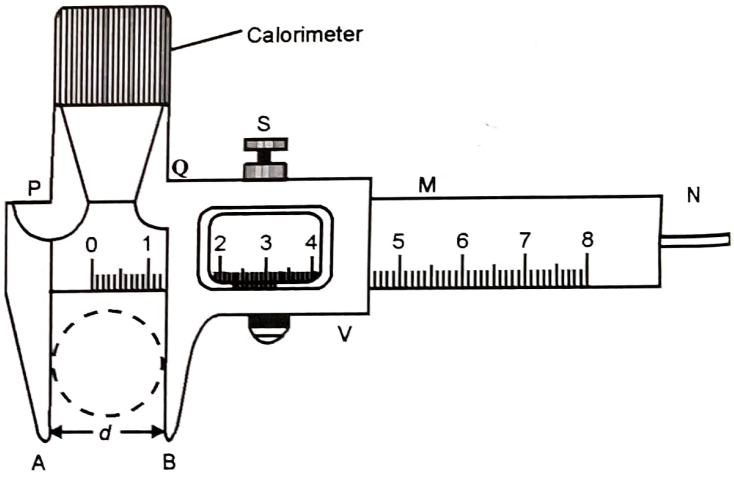

Fig. 10. Measurement of internal diameter of a calorimeter

13. Find the corrected mean value of internal diameter by applying the zero error.

(c) Measurement of Depth

14. To measure the depth of the calorimeter, use strip N of the Vernier Callipers.
15. Keep the edge of main scale of Vernier Callipers on the upper edge of the calorimeter so that strip N is able to g inside the calorimeter along its length as shown in Fig. 10.
16. Now move the sliding jaw till the end of the strip N touches the bottom of the calorimeter gently.
17. To get correct depth repeat the steps 10 to 13 at the four different positions along the circumference of the upper edge of the calorimeter.

OBSERVATIONS

1. **Vernier constant.** Value of one main scale divisions (1 M.S.D.) = 1 mm
10 vernier scale divisions (V.S.D.) = 9 main scale divisions (M.S.D.)

i.e. 10 V.S.D. = 9 M.S.D. or 1 V.S.D. = $\frac{9}{10}$ M.S.D.

Vernier constant (V.C.) = 1 M.S.D. – 1 V.S.D. = 1 M.S.D. – $\frac{9}{10}$ M.S.D.

$$\text{V.C.} = \left(1-\frac{9}{10}\right) 1 \text{ M.S.D.} = \frac{1}{10} \times 1 \text{ M.S.D.} = \frac{1}{10} \times 1 \text{ mm} = 0.1 \text{ mm}$$

V.C. = 0.01 cm

2. Zero error = (*i*) ..... cm (*ii*) ..... cm (*iii*) ..... cm
Mean zero error = (*e*) .... cm
Mean zero correction = – *e* = ... cm

Table for calculation of diameter

Observation for	Main scale reading x (cm)	No. of Vernier division coinciding (n)	Vernier scale reading $y = n \times$ (V.C.) (cm)	Observed diameter $= x + y$ (cm)	Mean observed diameter D_o (cm)	Mean corrected diameter $D = D_o + (-e)$ (cm)
Diameter I	1.					
	2.					D_1 =
Diameter II	1.					
	2.					D_2 =
Diameter III	1.					
	2.					D_3 =

Table for Calculation of internal diameter (d) of Calorimeter

S.No.	Main scale reading x (cm)	No. of Vernier division coinciding (n)	Vernier scale reading $y = n \times$ (V.C.) (cm)	Observed internal diameter $d_o = x + y$ (cm)	Corrected internal diameter $d_i = d_o + (-e)$ (cm)
1.					
2.					
3.					
4.					

Table for calculation of depth (h) of calorimeter

S.No.	Main scale reading x (cm)	No. of Vernier division coinciding (n)	Vernier scale reading $y = n \times$ (V.C.) (cm)	Observed depth $h_o = x + y$ (cm)	Corrected depth $h = h_o + (-e)$ (cm)
1.					
2.					
3.					
4.					

CALCULATIONS

1. Mean corrected diameter of cylinder = $D = \dfrac{D_1 + D_2 + D_3}{3}$ = ... cm.

2. Mean corrected internal diameter,

$$d = \frac{d_1 + d_2 + d_3 + d_4}{4} = \text{.....} \text{ cm}$$

3. Mean corrected depth,

$$h = \frac{h_1 + h_2 + h_3 + h_4}{4} = \text{.....} \text{ cm}$$

Internal volume $(V) = \pi \dfrac{d^2}{4} h$ = ... cm^3

RESULT

1. The diameter of the given cylinder is ..... cm.
2. The internal diameter of calorimeter is ..... cm.
3. The depth of calorimeter is ..... cm.
4. The volume of the given calorimeter is ..... cm^3.

BE CAREFUL

1. While measuring the depth, the strip should be perpendicular to the bottom surface.
2. While measuring the depth, the edge of the main scale should not get out of contact from the edge of t circumference of the calorimeter when the end of strip N touches the bottom.
3. The motion of vernier scale on main scale should be smooth. If not it should be oiled.
4. The jaws of the Vernier Callipers should not be pressed hard.
5. The Vernier constant and zero error should be carefully calculated and recorded.

SOURCES OF ERROR

1. Jaws of the callipers may not be at right angle to the main scale.
2. Vernier scale may be loosely fitted with the movable jaw.
3. The graduations on scale may not be correct and clear.
4. Parallax may be there in taking observations.

EXERCISE BASED ON VERNIER CALLIPERS