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Puspa Shrestha

EXPERIMENT NO 2

NAME OF EXPERIMENT: TO DETERMINE VOLUME OF THE GIVEN HOLLOW CYLINDRICAL TUBE BY USING VERNIER CALLIPERS

APPARATUS REQUIRED

1. Vernier Callipers
2. Given tube

THEORY

The vernier constant (V.C.) of the vernier callipers is the value of the difference between a vernier division and a main scale division expressed in terms of 1 main scale division(s). Hence, if n vernier divisions coincide with $(n-1)$ main scale divs.

1 vernier division coincides with $\frac{(n-1)}{n}$ main scale division

$\therefore$ Difference between a main scale and 1 vernier div. $= 1 - \frac{n-1}{n} = \frac{1}{n}$

$\therefore$ Vernier Constant (V.C.) $= \frac{1}{n} \times \text{Value of 1 main scale division} = \frac{S}{n} = \frac{1}{10} = 0.1 \text{ mm} = 0.01 \text{ cm}$

$\therefore$ Length of the tube $= \text{Main scale reading} + \text{vernier reading} \pm \text{Instrumental error}$

Let, l = length of the tube

d_1 = external diameter of the tube

d_2 = internal diameter of the tube

We have,

$$\text{External volume} = \frac{\pi}{4} d_1^2 l$$

$$\text{Internal volume} = \frac{\pi}{4} d_2^2 l$$

$$\therefore \text{Volume of the tube} = \text{External volume} - \text{Internal Volume}$$

$$= \frac{\pi}{4} d_1^2 l - \frac{\pi}{4} d_2^2 l$$

$$\therefore V = \frac{\pi}{4} l (d_1^2 - d_2^2)$$

PROCEDURE

1. The vernier constant of the instrument was determined in the usual way and the zero error if any was noted.
2. The experimental tube was next introduced lengthwise between the jaws of the callipers and held tight between them. The main scale reading immediately before the zero of the vernier was noted. Then the no. of divisions of the vernier coinciding with a certain main scale division was counted and noted. This reading multiplied by the vernier constant gives the value of the vernier reading which when added to the main scale reading gives the total value of

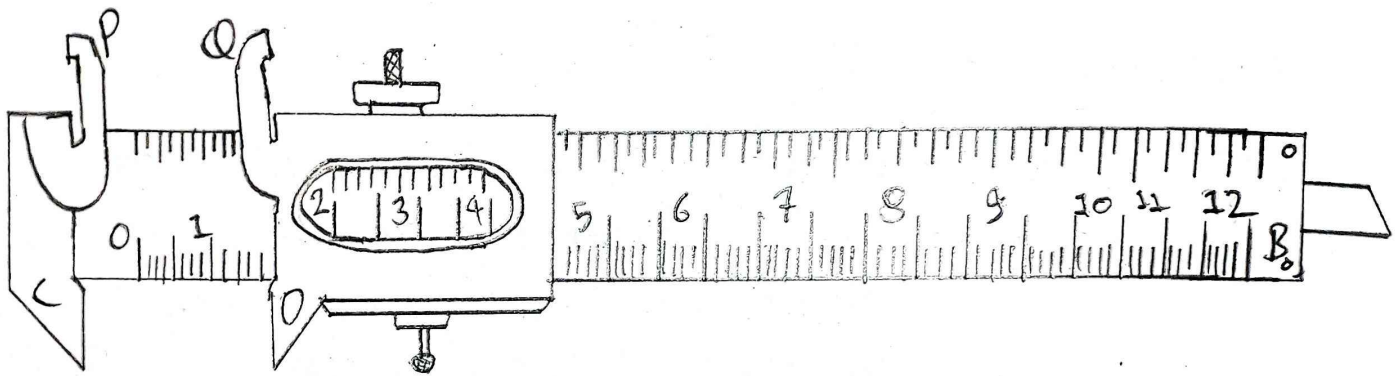


Fig. Vernier Callipers

the length of the tube. Another reading for its length was taken. This was repeated five times and the mean was calculated. The zero correction if any was applied.

3. Similarly, the reading for the external diameter of the tube were taken at five different places along its length taking two observations at each place along two mutually perpendicular diameters, this time placing it vertically instead of lengthwise in between the jaws. The mean diameter was taken and the zero correction applied as before.
4. To measure internal diameter of the tube, the outward projected points of the jaws P and Q of the callipers were introduced inside the given tube. The jaws were opened till projected points touch the diametrically opposite walls of the tube. The reading was taken. This was repeated five times by rotating the tube about its axis.

5.

OBSERVATIONS

Value of 10 divisions of the main scale = 10 mm

Value of 1 div. of main scale = 1 mm

Vernier divs. coincide with 9 main scale divs (n)

$$\therefore 1 \text{ division of vernier scale} = \frac{9}{10}$$

$$\therefore \text{Vernier constant (V.C.)} = S - V = \frac{S}{n}$$

ZERO ERROR

The zero of the vernier coincides with or is to the left or is to the right of the zero of the main scale by x div.

$$\therefore \text{Instrumental error} = 0$$

$$\text{or, } -x \times \text{V.C.}$$

$$\text{or, } +x \times \text{V.C.}$$

$$\therefore \text{Zero correction} = 0$$

$$\text{or, } +x \times \text{V.C.}$$

$$\text{or, } -x \times \text{V.C.}$$

OBSERVATION TABLE

No. of Obs.	Obs. for	Reading of the			Total at b cm	Apparent mean cm	Corrected mean cm
		Main Scale cm (a)	Vernier Scale V	Value of $V = (b) \text{ cm}$			
1.	length	6.5	0	0	6.5	6.722	1
2.		6.8	5	0.05	6.85		
3.		6.8	2	0.02	6.82		
4.		6.9	4	0.04	6.94		
5.		6.5	0	0	6.5		
1.	Ext. diameter	2.5	0	0	2.5	2.504	d ₁
2.		2.5	1	0.01	2.51		
3.		2.5	0	0	2.5		
4.		2.5	1	0.01	2.51		

No. of Obs.	Obs. for	Reading of the			Total at b cm	Apparent mean cm	Corrected mean cm
		Main Scale cm (a)	Vernier Scale V	Value of $V = (b) \text{ cm}$			
5.		2.5	0	0	2.5		
1.		1.7	4	0.04	1.74		
2.	Int.	1.7	3	0.03	1.73		
3.	diameter	1.7	4	0.04	1.74	1.736	d_2
4.		1.7	4	0.04	1.74		
5.		1.7	3	0.03	1.73		

CALCULATION

$$V = \frac{\pi}{4} (d_1^2 - d_2^2)$$

$$= \frac{22}{7} \times \frac{1}{4} \times 6.722 ((2.504)^2 - (1.736)^2)$$

$$= 5.17.19 \text{ cc}$$

RESULT

Hence, the volume of the given tube was determined by using vernier callipers.

PRECAUTIONS

1. The zero error must be carefully determined before any measurement.
2. Extra pressure should not be applied to the jaws while holding the object to be measured.
3. The vernier should be tightly screwed in position before removing the object from the gap.