Vernier Calipers

OBJECT: To determine the radius of a cylinder using Vernier calipers
Apparatus used: Cylinder, Vernier calipers.
Formula: Radius =diameter/2 or r=D/2
Theory - **Vernier calipers-** It is a device to measure the length or width of any small object with greater precision than with a normal cm scale. While the least count of a cm scale is one mm. The least count of Vernier calipers is normally 0.1 mm or even lesser. Different Vernier calipers have different least counts.
Vernier calipers consist of a rectangular steel bar graduated in inches on one side and centimeters on the other side. This is known as the main scale. Over this scale, another small scale slides called Vernier scale (fig.1). The instrument has two jaws A and B. The jaw A is fixed at the end of the main scale, while the jaw B is movable. It is a part of the sliding Vernier scale. Each jaw is at right angles to the main scale. Usually when the two jaws are touching each other, the zero of the Vernier scale coincides with the zero of the main scale. If it is not so then the instrument has a zero error.
It has also the jaws protrude upwards as P and Q. These projecting jaws are used to measure the internal diameter of the tubes. The movable jaw also carries a thin rectangular rod R that is used to measure the depth of a vessel.

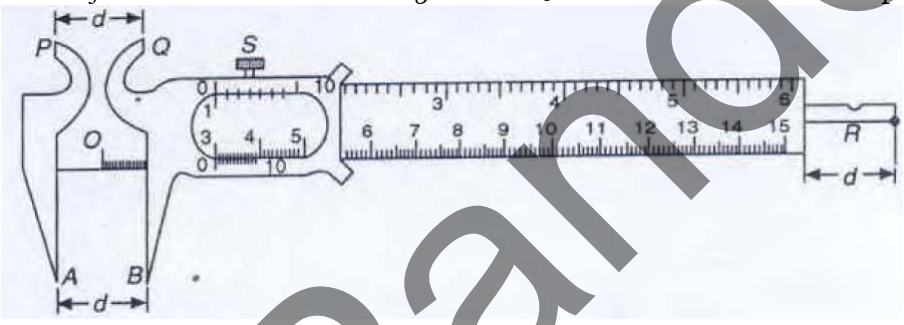


Fig.1

Procedure:
A. Least count of Vernier calipers or Vernier constant: First of all find out the least count of Vernier calipers. The least count of Vernier can be determined by two methods.
First method:
1. Find out the value of one division of main scale.
2. See how many division of main scale is equivalent to Vernier scale divisions.
3. The difference between one main scale division and one Vernier division is called Vernier constant or least count of the Vernier calipers.

Vernier constant=least count of Vernier calipers= 1 M.S.D- 1V.D

Example: Let the value of one division on main scale is equal to 1mm and the 9 main scale divisions is equivalent to 10 Vernier scale divisions.
1 V.D = 9/10 M.S.D
Least count of Vernier calipers= 1 M.S.D- 1V.D = 1/10 M.S.D = 0.1 M.S.D = 0.1 mm=0.01cm

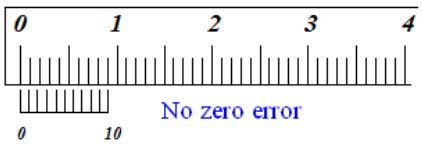
Second method:
1. Find out the value of one division of main scale.
2. Find out the total number of divisions on Vernier scale.
3. The ratio of value of one division of main scale and total number of divisions on Vernier scale is called as Vernier constant or least count of the Vernier calipers.

$$\text{Vernier constants=least count of Vernier calipers=} \frac{\text{value of one division of main scale}}{\text{number of divisions on Vernier scale}}$$

Example 1: Let the 1cm of main scale is divided in to 10 divisions and total number of Vernier scale divisions are 10.
Value of one division of main scale =1/10=0.1cm
Total number of divisions on Vernier scale=10
Least count of Vernier calipers=0.1/10 =0.01cm

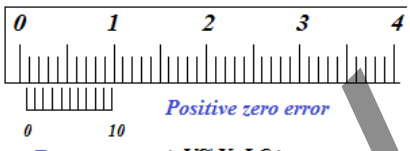
Example 2: Let the 1cm of main scale is divided in to 20 divisions and total number of Vernier scale divisions are 50
Value of one division of main scale =1/20=0.05cm
Total number of divisions on Vernier scale=50
least count of Vernier calipers= 0.05/50=0.001cm

B. Checking of Zero error: *Coincide the two jaws of Vernier calipers. If the zero of the Vernier scale coincides with the zero of the main scale then zero error in the Vernier calipers is zero. If it is not so then the instrument has a zero error. If zero of Vernier scale stays on right hand side of main scale zero then there is positive zero error. And if zero of Vernier scale goes to left hand side of main scale zero then there is negative zero error. Positive error is subtracted with measured length/diameter to find the correct length/diameter while negative error is added to measured length/diameter to find the correct length/diameter (see fig.2a, 2b and 2c).*



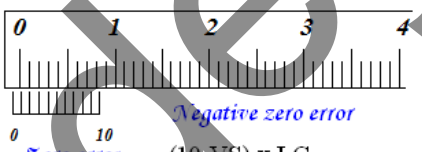
Zero error =0

Fig.2a



Zero error = + *VS X LC*
= + *8 X 0.01*
= + *0.08 cm*

Fig.2b



Zero error = - (10-VS) x LC
= - (10-2) x 0.01
= - 8 x 0.01
= -0.08 cm

Fig.2c

C. Measurement: *In order to find the diameter of a cylinder,*

1. Hold it diameter wise between the jaws of the Vernier calipers tightly.

2. Now see the position of the zero of the Vernier against the main scale.

3. Note the reading on main scale and

4. Note which division of Vernier scale coincides with main scale division.

5. Use the following expression to find diameter.

Diameter= M.S. + V.S. X L.C.

6. Repeat the procedure 1 to 5 at least four/five times by changing the position of the jaws.

7. Find the mean value.

8. Apply zero error to find the corrected diameter.

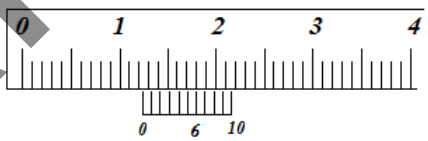


Fig.3

Example: *Let least count of Vernier calipers is 0.01cm. Assume that the zero of Vernier lies between 1.2 cm and 1.3 cm on the main scale (Fig.3). This means that the diameter of the cylinder is more than 1.2 cm and less than 1.3 cm. Now main scale reading will be 1.2cm. If 6th division of Vernier coincides with any main scale division then Vernier scale reading will be 6.*

Now total diameter will be, D= M.S. + V.S. x L.C. = 1.2 + 6 x 0.01=1.26 cm

Observations-

1. Value of one division of main scale =…..cm

2. Total number of divisions on Vernier scale=……..

3. Least count of Vernier calipers = ……..cm

4. Zero error =……..cm

5. ***Table for diameter (D) of cylinder***

Sr. no.	M.S. (cm)	V.S. (div)	un-corrected diameter (d= MS + VS x LC) (cm)	Mean un-corrected diameter (d: cm)	corrected diameter (D=d± zero error) (cm)
1.					
2.					
3.					
4.					
5.					

Calculation: D = ……cm, *r*=D/2=…..cm

Result: *The radius of cylinder = ……cm*

Precautions-

1. Calculate the least count carefully.

2. Note the zero correction carefully.

3. Take the readings carefully.