Screw gauge

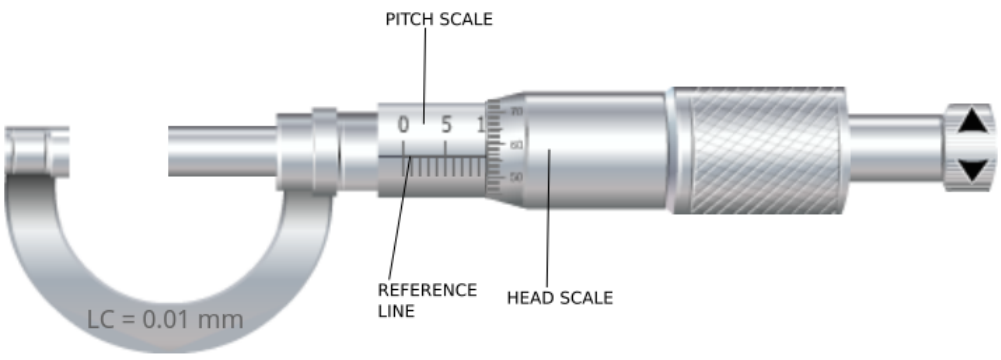


Figure 1: Screw gauge

Uses:

- To measure diameter of a given wire.
- To measure thickness of a given sheet.
- To determine volume of an irregular lamina.

It consists of two scales: pitch scale calibrated in millimeters, head scale (circular scale) consisting of 100 divisions. See figure (1).

Principle:
The linear distance moved by the screw is directly proportional to the rotation given to it. The linear distance moved by the screw when it is rotated by one division of the circular scale, is the least distance that can be measured accurately by the instrument. It is the least count of the screw gauge.

Pitch of the screw:
The distance head scale traverses on the pitch scale when one 360^o rotation is given to the head scale. The head scale traverses by 1 mm when rotated by 360^o. Hence pitch is 1 mm.

Least count:
The least non-zero value screw gauge can measure is its least count (LC) given by the formula

$$\boxed{\text{LC} = \frac{\text{Pitch}}{\text{No. of HSD}}}$$

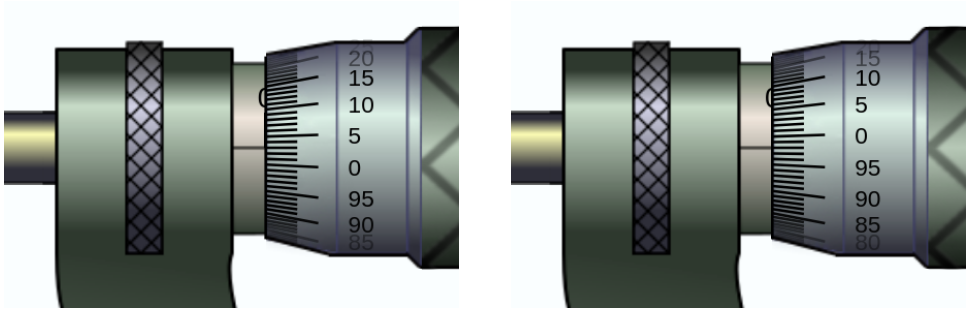
Pitch = 1 mm,
No. of Head scale divisions (HSD) = 100.

$$\text{LC} = \frac{1\,\text{mm}}{100} = 0.01\,\text{mm}.$$

For a given screw gauge LC is fixed.

Zero error (ZE):
When the screw is fully closed, the reading on the screw gauge must be zero. But because of instrumental defects, the zero of the head scale does not coincide with the reference line of the pitch. This error is called zero error of the screw gauge. Zero error can be measured and used to correct the reading. The convention for taking zero error is as follows:

- If the zero of the head scale is below the reference line on the pitch scale, then error is taken as positive. e.g. If zero of head scale is below the referene line on the pitch scale by 3 divisions, then ZE = +3.
- If the zero of the head scale is above the reference line on the pitch scale, then error is taken as negative. e.g. If zero of head scale is above the referene line on the pitch scale by 2 divisions, then ZE = -2.
- If the zero of the head scale perfectly coincides the reference line on the pitch scale, then error is taken as zero.
  See figure (2) and (3).



(a) Positive zero error, ZE = +3 (b) Negative zero error, ZE = -2

Figure 2: Positive and negative zero error in screw gauge.

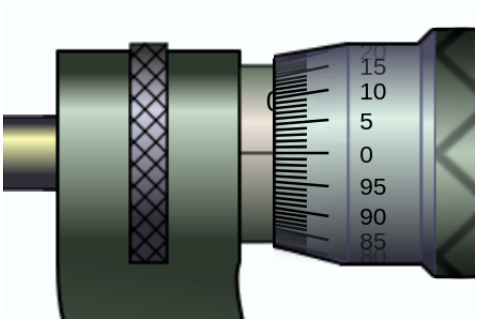


Figure 3: No zero error.

How to take readings in screw gauge?

- After placing the sample (sheet, wire, etc), tighten the screw until you hear a few clicks. Pitch scale reading (PSR) is the division that can be seen on the pitch scale.
- The division of head scale which coincides with the reference line is head scale division (HSD).
- Using the already measured zero error, calculate corrected head scale division (CHSD).
  CHSD = HSR − ZE.

- Using the formula calculate the total reading (TR).
  Formula:

$$\boxed{\text{TR} = \text{PSR} + (\text{CHSD} \times \text{LC})}.$$

  e.g. Suppose 2^{nd} division is seen on pitch scale, then PSR = 2 mm; 50^{th} division of head scale is coinciding with reference line, then HSD = 50; taking ZE = -2, TR = 2.52 mm. See figure (4).

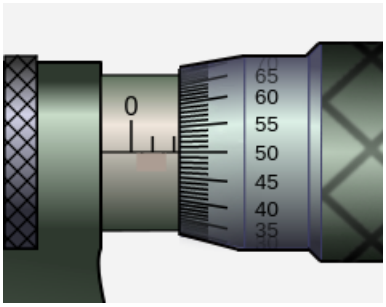


Figure 4: PSR = 2 mm, HSD = 50.

You can learn about screw gauge using free online simulator:
Screw gauge simulator

- https://maheshkurmi.github.io/experiments/micrometer.html.
- http://amrita.olabs.edu.in/?sub=1&brch=5&sim=156&cnt=4.

Exercise

1. What is the use of screw gauge?
2. What is pitch of the screw?
3. What is least count?
4. What is the formula to calculate least count?
5. What is zero error?
6. When is zero error positive or negative?
7. How to take readings in screw gauge?