

Vernier & Micrometer Screw Gauge

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Learning Outcome

I highly recommend you to finish this checklist to determine whether you've achieved the learning objectives.

- Learn to read *verniers* and *microscrew gauge*
- Know the *absolute uncertainty* of the device
- Use verniers and microscrew gauge to **measure** tiny length
- Know the common *measuring equipment* in the lab

Leadin

Pierre Vernier invented the vernier calipers in 1631, which enables human to explore the physical world in a more precise perspective.

I cannot find any self portrait of Pierre Vernier¹, what a pity!

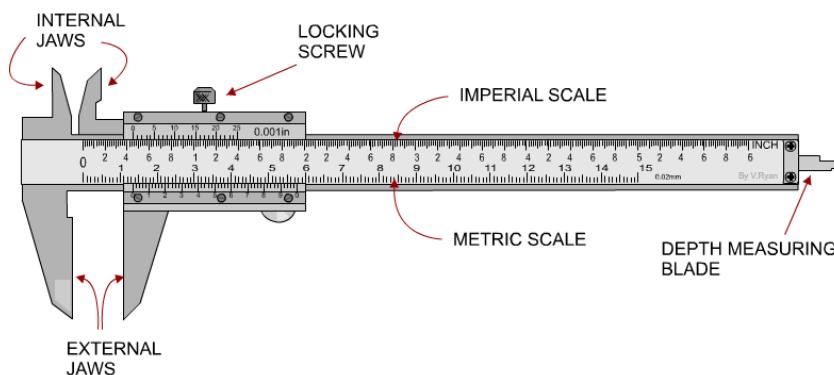


Figure 1: Pierre Vernier
1584-1638

Vernier

Structure of vernier

The following illustrates the parts of a vernier caliper. It can measure inter-



nal, external length or depth because of the jaws and blade.

Figure 2: Constituent part of a vernier

Rationale

Because of the vernier caliper has two graduated scales - main scale or vernier scale, The vernier has n divisions but the on the main scale, only $n-1$ division for the same length on vernier. Thus the vernier can measure to as small as one division on main scale/ n .

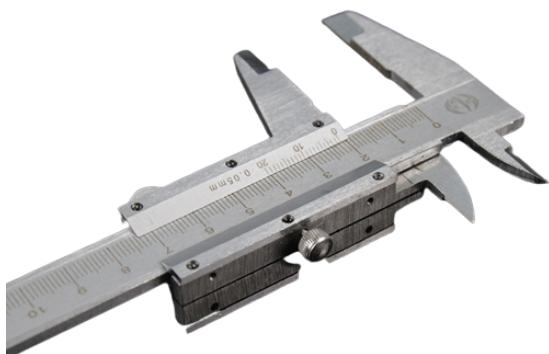
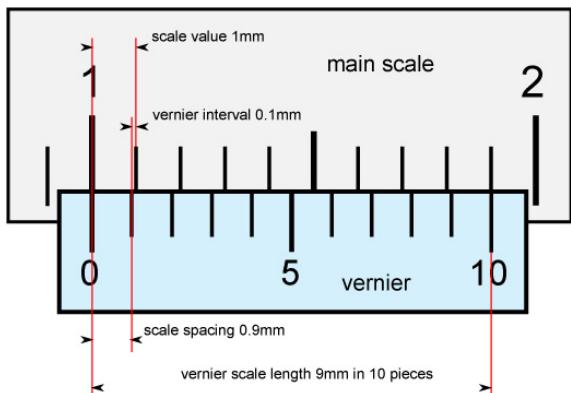
Read a Vernier

Just as we mentioned, the least length of a vernier is one division on main scale/ n , usually, there are three types of vernier. $n = 10$, $n = 20$ and $n = 50$ respectively. And the corresponding precision of the verniers are _____, and _____ respectively. Shown as the following figures.

The steps to read a vernier caliper, for example shown in figure4, is that:



Figure 3: Digital Vernier Caliper



1. Determine the *minimum division* of the vernier using $1/n$. In the figure, that would be $1\text{ mm}/10 = 0.1\text{ mm}$
2. The main scale contributes the main number(s) and one decimal place to the reading (e.g. 21 mm, whereby 21 comes from the main scale according to the 0 in the vernier)
3. The vernier scale contributes the second decimal place to the reading (e.g. 0.3 mm).

However, with the development, digital vernier calipers has already been invented, saving people out of the trouble of counting and reading, however, as ALevel candidates you shall grasp the way of reading mechanic vernier caliper.

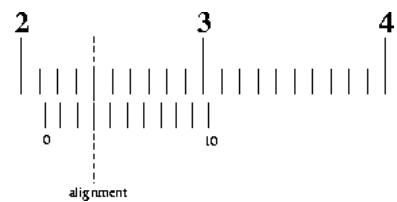


Figure 4: the main and vernier scale

Micro Screw Gauge

William Gascoigne³ follows Pierre Vernier's path and invented the micrometer screw gauge which has improved the precision to another level.

Micrometer Screw Gauge is also called Micrometer, just as the name suggested, it can measure with precision to $10\text{ }\mu\text{m}$ or 0.01 mm .

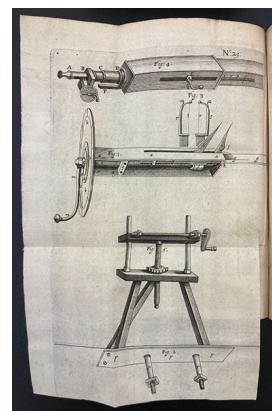


Figure 5: A telescope with a micrometer installed

³ born 1612,died at 1644, who also invented telescopic sight

Structure

You shall know the key parts name of a microscrew gauge, listed below, fill in the blank of the following picture Generally, the least count is

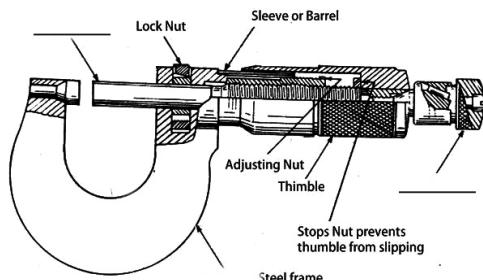


Figure 6: Structure of a Micro-screw Gauge

on the main scale while the circular scale is divided into _____ or equal parts.

A micrometer is composed of the following parts:

- Frame - It is the U-shaped or C-shaped body that holds the anvil and barrel in constant relation to each other. The frame is heavy and has high thermal mass. To prevent substantial heating up, it is covered by insulating plastic.
- Anvil -
- Barrel - Stationary round component with a linear scale on it
- Screw -
- Locknut - Component that one can tighten to hold the spindle stationary.

- Spindle -
- Ratchet - The device on the end of the handle that limits applied pressure by slipping at a calibrated torque.

Rationale

The micrometer screw gauge working principle is based on the *conversion of small distances into larger ones by measuring the rotation of the screw*. One revolution of screw represent 0.5 mm.

Read a Micrometer

You'll be required to read a micrometer

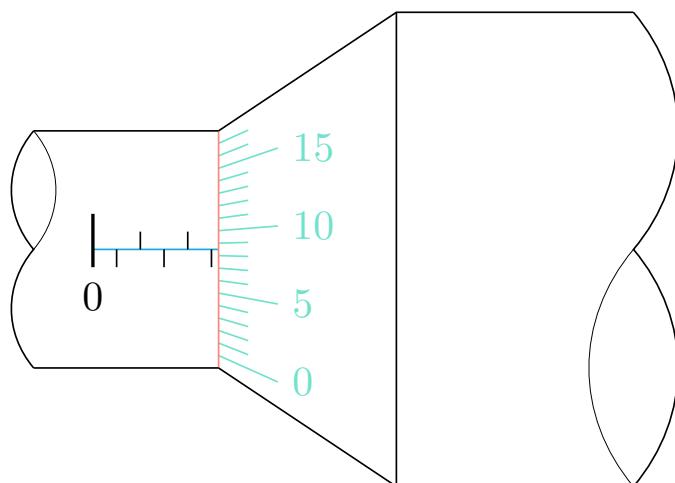


Figure 7: A virtual microscrew gauge

1. Read the Sleeve Scale, count how many divisions that displays in the sleeve.
2. Read the Thimble Scale, count how many sub-divisions that displays in the thimble.
3. Approximate on the thimble scale.
4. Main divisions $\times 0.5 \text{ mm}$ + Sub-division $\times 0.01 \text{ mm}$ + approximation $\times 0.001 \text{ mm}$