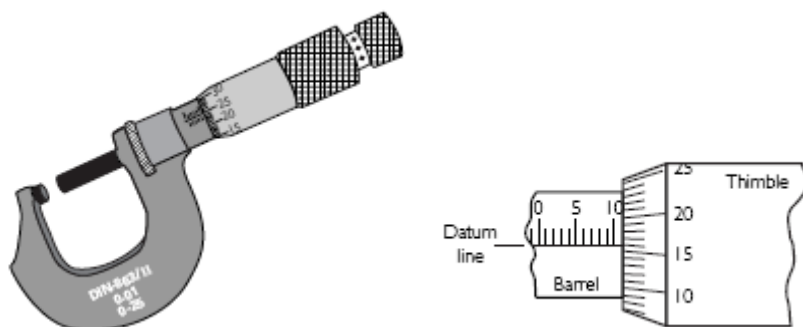


TAP 228- 6: Measure for measure

This sheet shows you how to use some precision measuring instruments.

The diagram below shows a micrometer screw gauge, which enables you to measure small thicknesses to a high degree of precision.



Above: - Micrometer screw gauge and (right) an example reading

The gauge consists of a very accurately threaded screw which, when the thimble is rotated, opens the micrometer's jaws by a precisely known distance. With the most common type, a rotation of the thimble through one revolution opens the jaws by 0.5 mm. The thimble is divided into 50 equal divisions, and so each division represents 0.5 mm/50 or 0.01 mm. The barrel has a datum line graduated in whole millimetres along the top (and some also have half millimetre intervals along the bottom).

Initially screw up the micrometer using its ratchet until its jaws are fully closed. Note the reading on the thimble at the datum line \pm usually this will be zero. If there is a reading apart from zero, then this is the zero error and needs to be recorded and allowed for. Zero errors are noted as + if they are above zero and - if they are below 0. They need to be subtracted from or added to the measured reading.

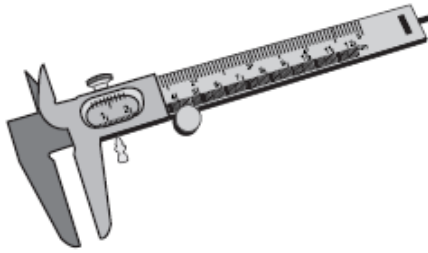
Taking a reading

See the diagram on the right above.

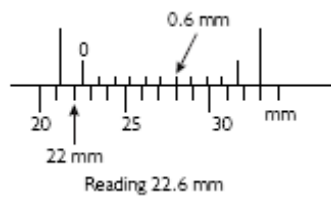
		Reading/mm
Highest number along the datum line	10	10.00
the next line along datum line is not yet uncovered so the final reading is less than 11 mm		
Reading on thimble	16 0	0.16
Uncorrected reading		10.16
Zero error (below zero)	-2	0.02
Corrected reading (add zero error)		10.18

Vernier callipers

The diagram shows callipers that can measure up to several centimetres to the nearest 0.1 mm by making use of a vernier scale. The upper jaws are used to measure distances internally, e.g. the internal bores of pipes. The lower jaws are used to measure distances externally, e.g. diameters of ball bearings.



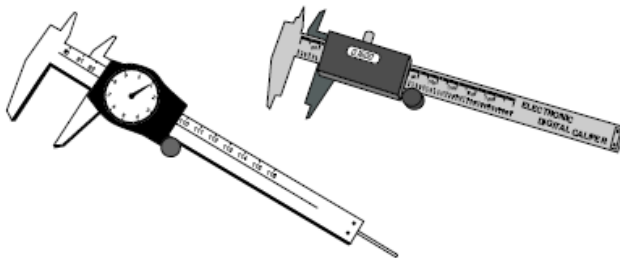
When the zero of the vernier scale is exactly opposite one of the mm marks on the main scale, only its zero mark lines up with a mark on the main scale, and all the others are 'out of kilter'. If the vernier is advanced by exactly 0.1 mm, then the first vernier mark is aligned with a mark on the main scale. If it is advanced by 0.2 mm, then the second vernier mark is aligned, and so on. The vernier scale thus effectively subdivides the main scale into 0.1 mm divisions.



On the part of the scale shown above the zero on the vernier is just beyond the 22 mm mark, so the reading must be 'twenty two point something'. The line of the vernier that exactly matches a graduation on the main scale is the 6, so the vernier must be 0.6 mm beyond the 22 mm mark. Hence the reading is 22.6 mm.

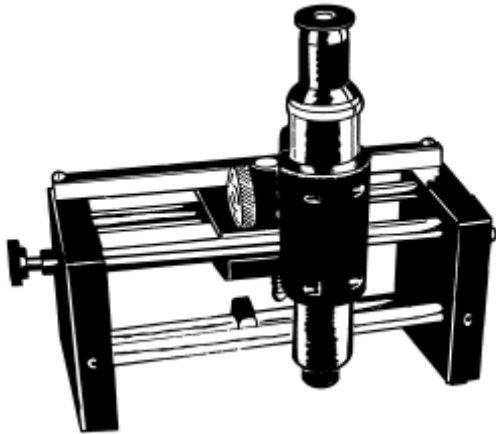
Initially you should close the jaws right up in order to note any zero error that needs to be accounted for. If it reads greater than 0 at this stage, then the reading needs to be subtracted from the final one and vice versa.

There are other types of callipers (below) having dial and digital LCD and LED displays which are, like the digital micrometer, very straightforward to use.



An applet simulation for vernier callipers is available at <http://www.phy.ntnu.edu.tw/java/ruler/vernier.html> (This was available in August 2005)

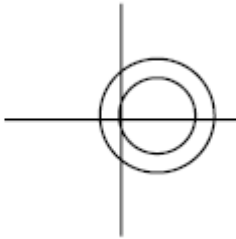
Vernier microscope



A vernier microscope, which can be used to measure distances to the nearest 0.01 mm.

The vernier scale is identical to that of the vernier callipers except that the divisions are 0.01mm instead of 0.1mm and you need to use a magnifying lens to read it.

One use for a vernier microscope is in measuring the internal bore of glass tubing. This is done by moving the microscope carriage on its rack-and-pinion drive by turning the adjusting screw and aligning the cross-wires first on one internal edge of the tube (below) and then on the opposite edge. The bore of the tube is found from the difference between the two readings.



Practical advice

It is useful for students to be able to use a micrometer and a vernier scale. You may choose to show this as part of an activity or have a lesson on use of these devices where the materials for the coming activity are measured.

External references

This activity is taken from Salters Horners Advanced Physics, Section GETE, Additional Sheet 8