Units and Measurements (Ruler, Vernier, Micrometer)

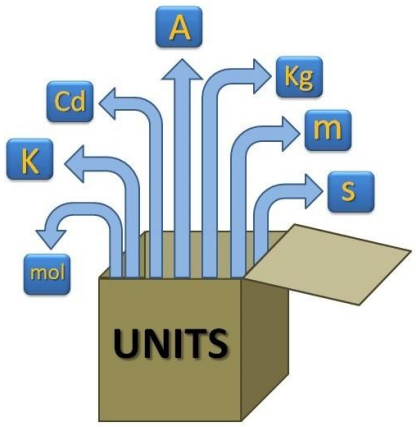
Theory

Physics explains the law of nature in a special way. This explanation includes a quantitative description, comparison, and measurement of certain physical quantities. To measure or compare a physical quantity we need to fix some standard unit of the quantity. The weight of lion is heavier than a goat. But how many times? Robin is taller than Prashant, but how tall? To answer such questions, we need to fix some unit. Suppose mass is the unit, then we can conclude that weight of the lion is 200 times to that of a goat. Similarly, if we use length as a unit, we can easily determine that Robin is 2 times unit taller to that of Prashant. Thus, the physical quantities are described in terms of a unit of that quantity.

Unit

To measure any quantity or compare two quantities we need an internationally acquired standard called **Unit**. The measurement of any physical quantity is expressed in terms of a number and a specific unit.

Measurement = Quantity × Unit



Vernier Caliper and Micrometer

Vernier calipers, Micrometers screw gauges and spherometers are all used to measure distances too small to be measured using a meter rule with a least count of 1 mm.

I. Vernier Caliper

A vernier caliper consists of a sliding scale which is divided such that the distance between two marks on this scale is smaller than the distance between two marks on the main scale. To measure an object, the object is kept between the jaws and the vernier scale is moved. By looking at which mark on the vernier scale lines up with a mark on the main scale, the distance between the jaws could be read off to a higher precision than the least count of the main scale.

Typically, vernier calipers can measure lengths to a precision of 0.1 or 0.05 mm. Most vernier calipers are equipped with a set of smaller jaws for measuring internal diameters and a depth probe to measure depths. Digital vernier calipers come with a small display that shows the value directly, and their accuracy could be as high as 0.01 mm.

Figure (1) shows a standard analogue vernier caliper; its parts are: (1) outside jaws; for measuring outer dimensions, (2) inside jaws; for measuring inner dimensions, (3) depth probe; for measuring depths, (4, 5) main scale, (6, 7) the vernier scale and (8) lock (a screw clamp on the opposite side in some types).

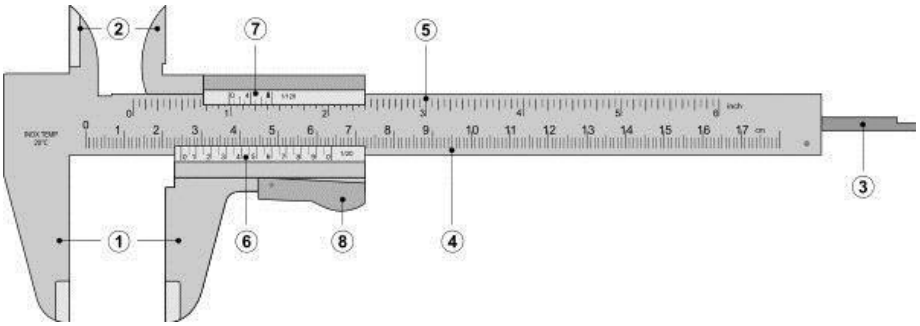


Fig.(1) Standard analogue vernier caliper.

Using the Vernier Calipers

. Both the main scale and the vernier scale readings are taken into account while making a measurement. The main scale reading is the first reading on the main scale immediately to the left of the zero of the vernier scale (3 mm), see Fig (2), while the vernier scale reading is the mark on the vernier scale which exactly coincides with a mark on the main scale (0.7 mm). The reading is therefore 3.7 mm.

This instrument may be used to measure outer dimensions of objects (using the outside jaws), inside dimensions (using the inside jaws at the top), and depths (using the depth probe). To measure outer dimensions of an object, the object is placed between the jaws

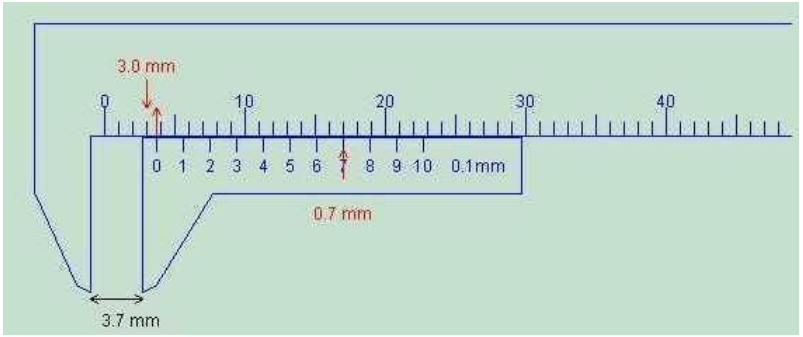


Fig.(2) The reading here is 3.7 mm.

II. The micrometer screw gauge

The micrometer screw gauge is used to measure even smaller dimensions than the vernier callipers. The micrometer screw gauge also uses an auxiliary scale (measuring hundredths of a millimetre) which is marked on a rotary thimble, see Fig. (3). The rotating thimble is subdivided into 50 equal divisions. The thimble passes through a frame that carries a millimeter scale graduated to 0.5mm. The jaws can be adjusted by rotating the thimble using the small ratchet knob. This includes a friction clutch which prevents too much tension being applied. The thimble must be rotated through two revolutions to open the jaws by 1 mm.

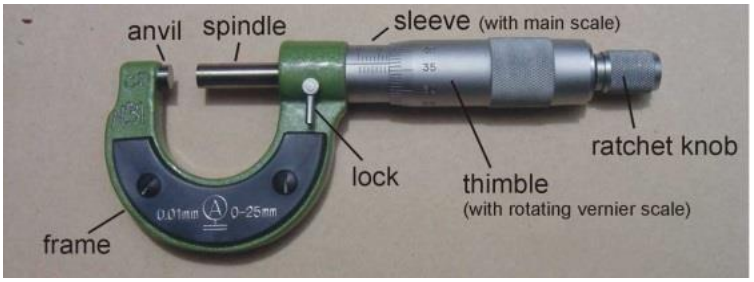


Fig.(3) The micrometer screw gauge.

Using the Micrometer Screw Gauge

In order to measure an object, the object is placed between the jaws and the thimble is rotated using the ratchet until the object is secured. Note that the ratchet knob must be used to secure the object firmly between the jaws, otherwise the instrument could be damaged or give an inconsistent reading.

The first significant figure is taken from the last graduation showing on the sleeve directly to the left of the revolving thimble. Note that an additional half scale division (0.5 mm) must be included if the mark below the main scale is visible between the thimble and the main scale division on the sleeve. The remaining two significant figures (hundredths of a millimeter) are taken directly from the thimble opposite the main scale.

Objective

Equipment:

1- Measuring tools (Ruler, Vernier, Micrometer)
2- Things to be measured

Procedure:

Before doing anything, check and record the zero error.

I. & II. Measuring length, thickness, outer and inner diameters of the given objects

Do the measurements use either vernier or micrometer, or both of them whenever possible?

Record the measurements in tabular form:

Table I

Object	Tool	Main scale reading	Vernier scale reading	Resulted reading	Precise tool*
Wire diameter	vernier				
	microm.				
Pencil diameter	vernier				
	microm.				
Paper thickness	vernier				
	microm.				
Glass slab thickness	vernier				
	microm.				
Small sphere	vernier				
	microm.				
Larger sphere	vernier				
	microm.				
Anything else	vernier				
	microm.				

* Indicate by (√) the instrument that is more precise, if so, and state why.

Questions and Discussion

1-State the tool (s) you would use to measure

A. temperature_____

B. volume _____

C. time _____

D. weight _____

2-What are some U.S. and SI units that are used to measure each of the following?

A. length

B. volume

C. weight

D. temperature

3-What is the unit of measurement in each of the following examples?

A. The patient's temperature is 102°F.

B. The sack holds 5 lbs of potatoes.

C. It is 8 miles from your house to school.

D. The bottle holds 2 L of orange soda.

4-Identify the measurement in metric units.

A. John's height is

1) 1.5 yards 2) 6 feet 3) 2 meters

B. The volume of saline in the IV bottle is

1) 1 liter 2) 1 quart 3) 2 pints

C. The mass of a lemon is

1) 12 ounces 2) 145 grams 3) 0.6 pounds

5- State the standard prefixed used to denote multiples of ten.