The Vernier and the Micrometer

The precision of length measurements may be increased by using a device that uses a sliding vernier scale. Two such instruments that are based on a vernier scale which you will use in the laboratory to measure lengths of objects are the vernier calipers and the micrometer screw gauge. These instruments have a main scale (in millimeters) and a sliding or rotating vernier scale.

The vernier:

A typical vernier calipers is shown in figure 1. To use this kind of device we need to follow the steps below:

1- To measure outer dimensions of an object, the object is placed between the jaws, which are then moved together until they secure the object.
2- The first significant figures are read immediately to the left of the "zero" of the vernier scale.
3- The remaining digits are taken from the vernier scale and placed after the decimal point of the main reading. This remaining reading corresponds to the division that lines up with any main scale division. Only one division on the vernier scale coincides with one on the main scale. See figures 2 and 3

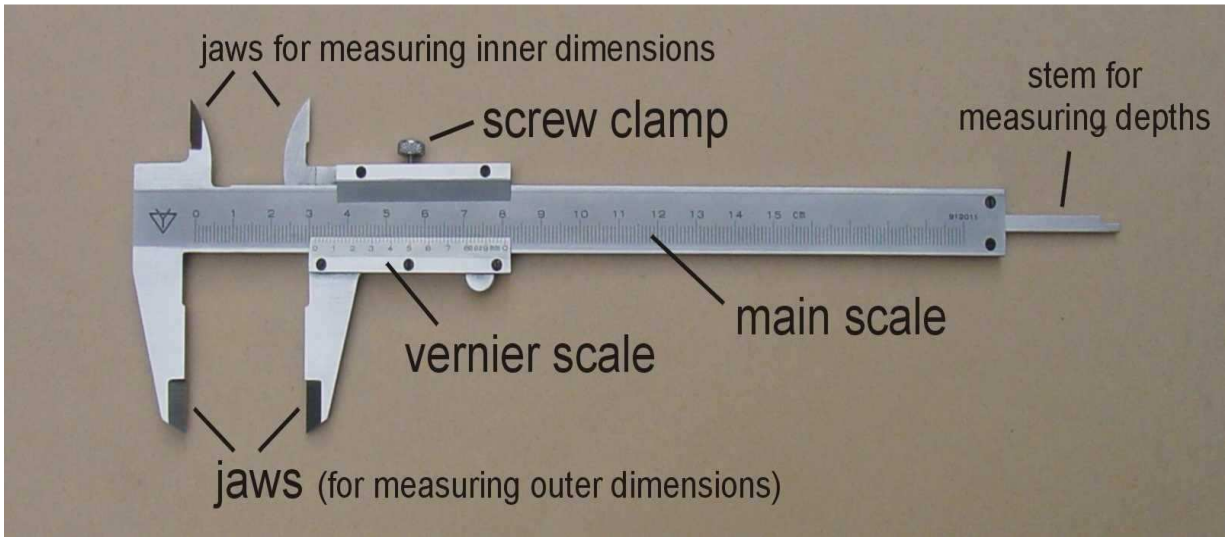

Figure 1: The shape of vernier calipers.

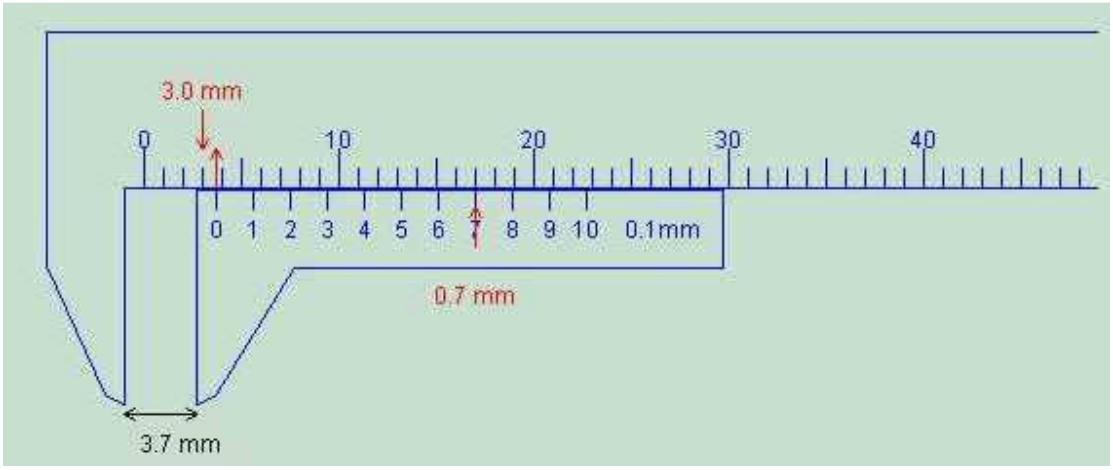

Figure 2: The reading here is 3.7 mm.

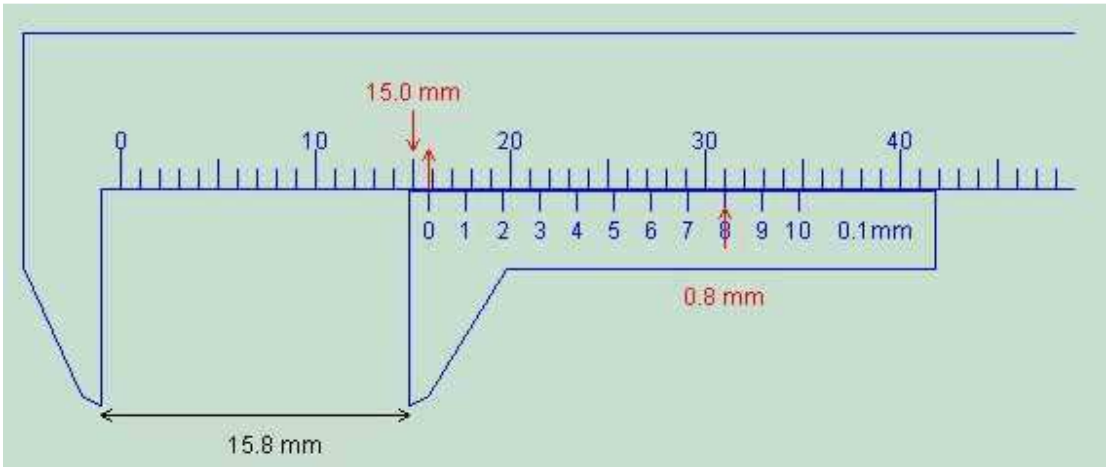

Figure 3: The reading here is 15.8 mm.

Some examples:
Note that the important region of the vernier scale is enlarged in the upper right hand corner of each figure.

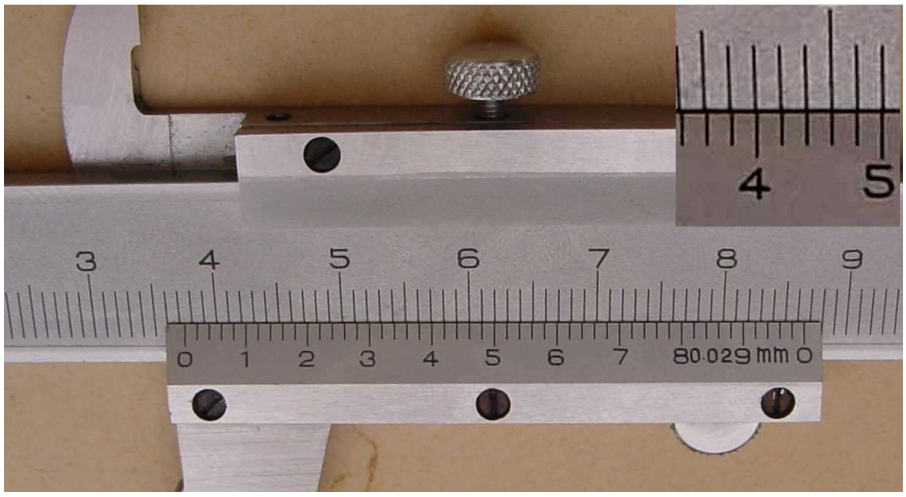

Figure 4: The reading is 37.46 mm.

In figure 4 above, the first significant figures are taken as the main scale reading to the left of the vernier zero, i.e. 37 mm. The remaining two digits are taken from the vernier scale reading that lines up with any main scale reading, i.e. 46 on the vernier scale. Thus the reading is 37.46 mm.

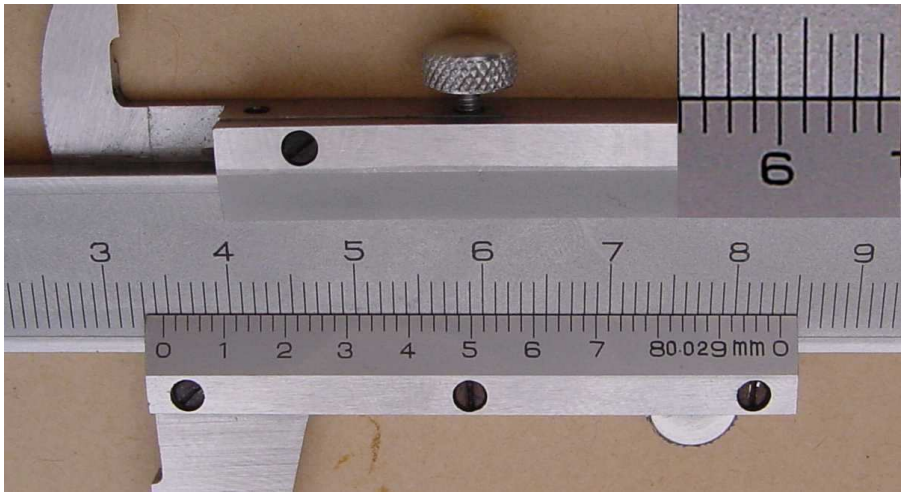

Figure 5: The reading is 34.60 mm.

In figure 5 above, the first significant figures are taken as the main scale reading to the left of the vernier zero, i.e. 34 mm. The remaining two digits are taken from the vernier scale reading that lines up with any main scale reading, i.e. 60 on the vernier scale. Note that the zero must be included because the scale can differentiate between fiftieths of a millimeter. Therefore the reading is 34.60 mm.

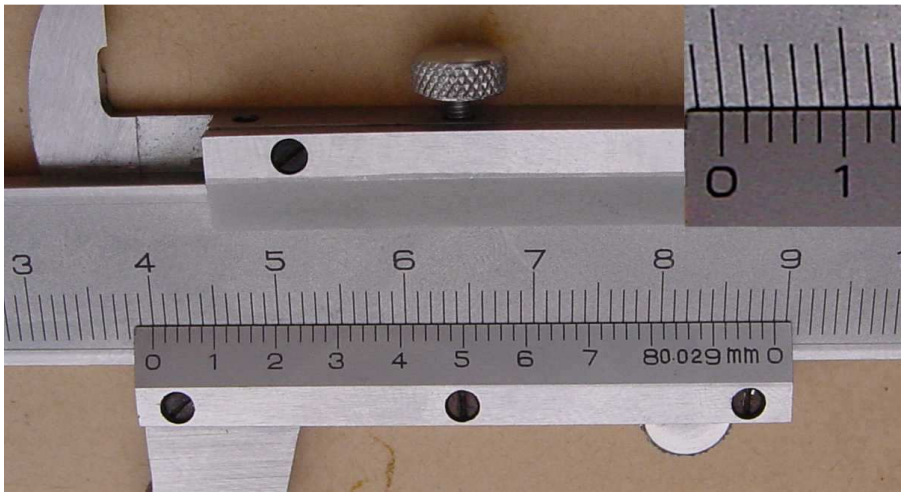

Figure 6: The reading is 40.00 mm.

In figure 6, the zero and the ten on the vernier scale both line up with main scale readings, therefore the reading is 40.00 cm.

Try the following for yourself:

(Write down the reading under each picture)

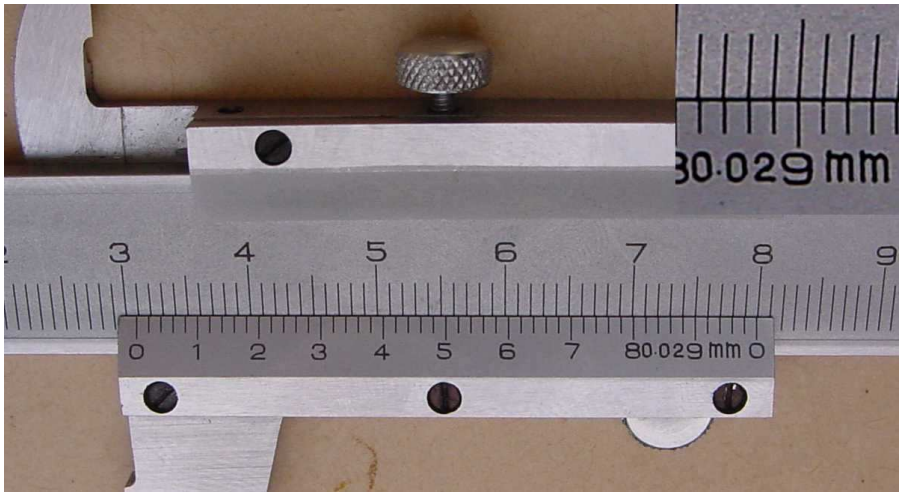

Figure 7:

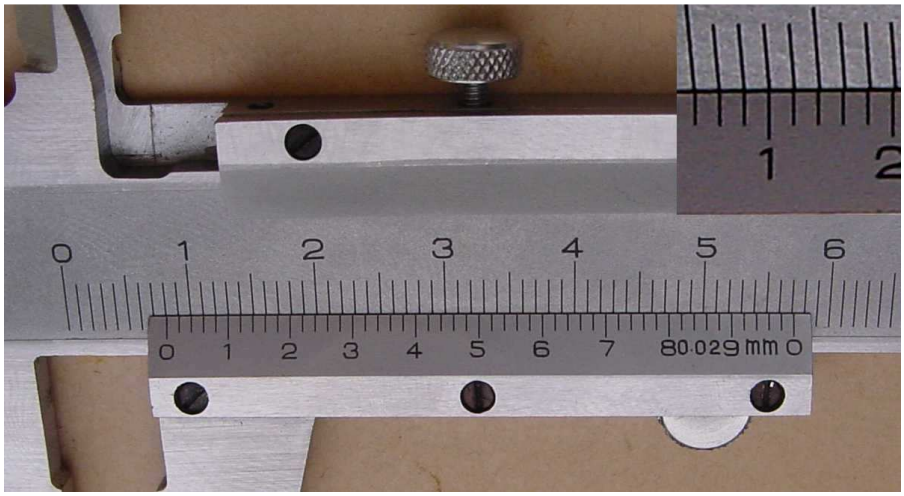

Figure 8:

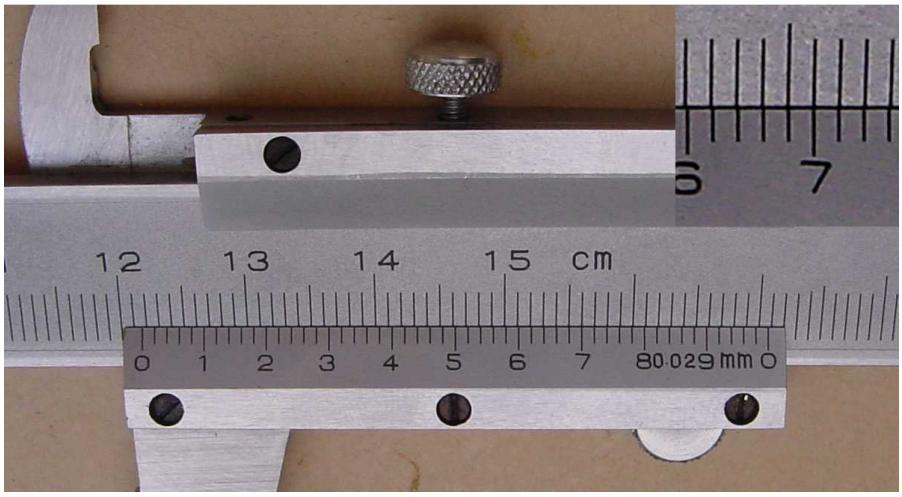

Figure 9:

The micrometer screw gauge

The micrometer screw gauge is used to measure even smaller dimensions than the vernier calipers. The micrometer screw gauge also uses an auxiliary scale (measuring hundredths of a millimeter) which is marked on a rotary thimble. Basically it is a screw with an accurately constant pitch (the amount by which the thimble moves forward or backward for one complete revolution). The rotating thimble is subdivided into 50 equal divisions. The thimble passes through a frame that carries a millimeter scale graduated to 0.5 mm. The jaws can be adjusted by rotating the thimble using the small ratchet knob. The thimble must be rotated through two revolutions to open the jaws by 1 mm.

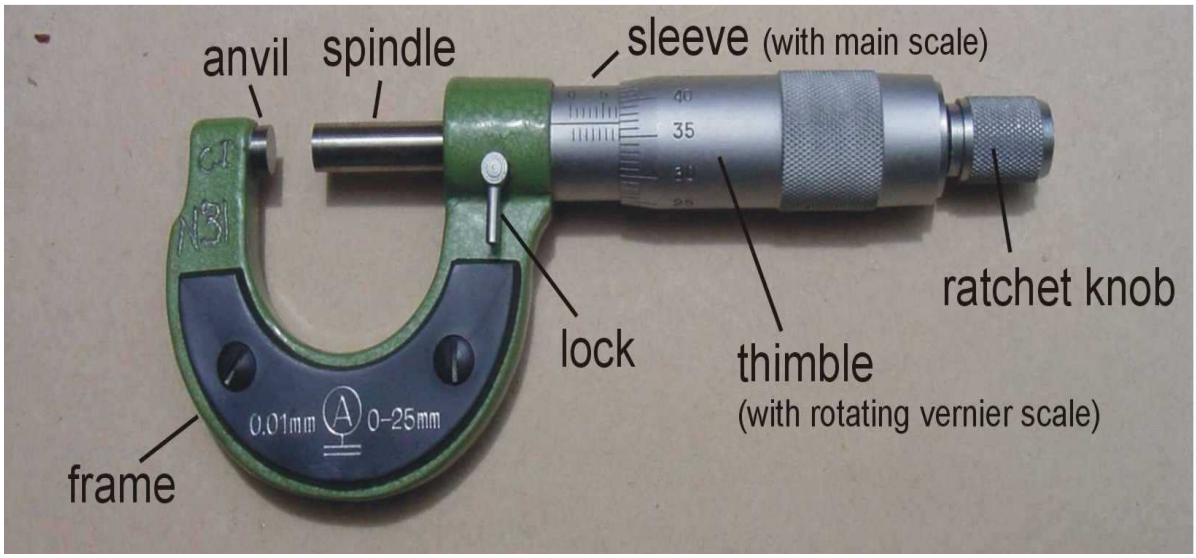

Figure 10: The micrometer screw gauge

To use this kind of device we need to follow the steps below:

1- Place the object to be measured between the jaws and the thimble is rotated using the ratchet until the object is secured.
2- 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.
3- The remaining two significant figures (hundredths of a millimeter) are taken directly from the thimble opposite the main scale. See the examples below.

Figure 11: The reading is 7.38 mm.

In figure 11 the last graduation visible to the left of the thimble is 7 mm and the thimble lines up with the main scale at 38 hundredths of a millimeter (0.38 mm); therefore the reading is 7.38 mm.

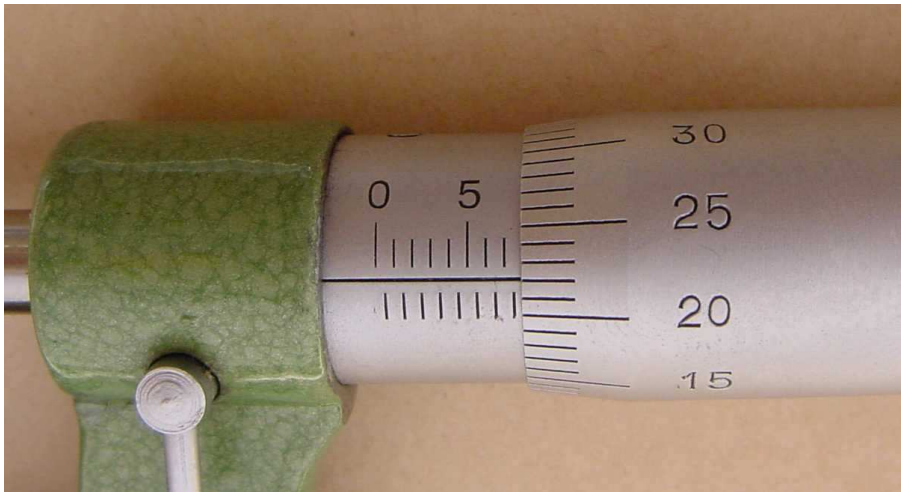

Figure 12: The reading is 7.72 mm.

In figure 12 the last graduation visible to the left of the thimble is 7.5 mm; therefore the reading is 7.5 mm plus the thimble reading of 0.22 mm, giving 7.72 mm.

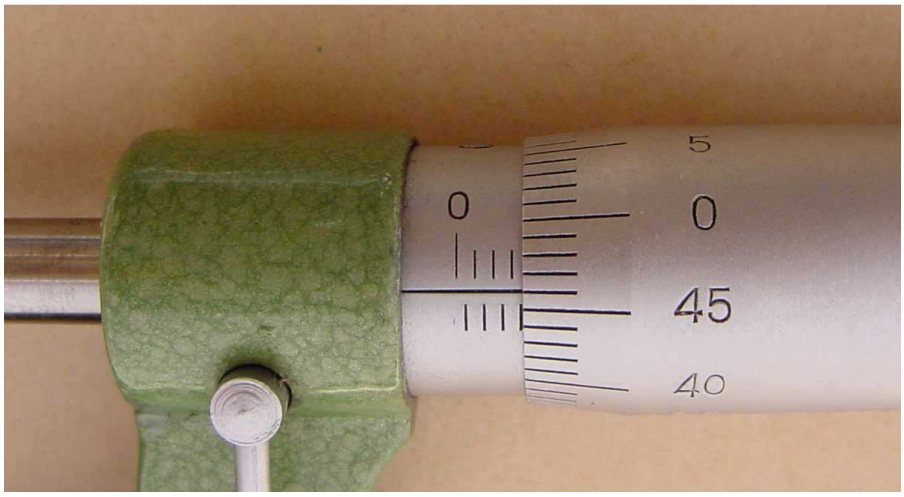

Figure 13: The reading is 3.46 mm.

In figure 13 the main scale reading is 3 mm while the reading on the drum is 0.46 mm; therefore, the reading is 3.46 mm.

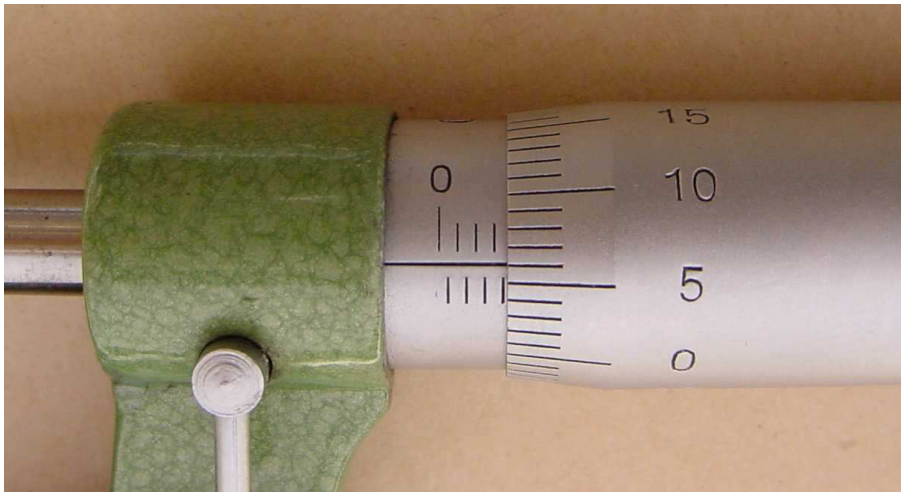

Figure 14: The reading is 3.56 mm.

In figure 14 the 0.5 mm division is visible below the main scale; therefore the reading is 3.5 mm + 0.06 mm = 3.56 mm.

<u>Try the following for yourself:</u>

(Write down the reading under each picture)

Figure 15:

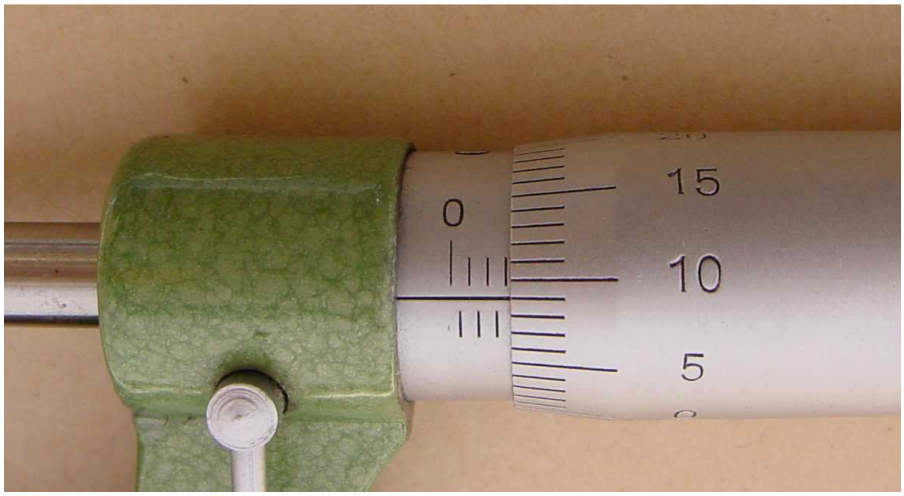

Figure 16:

Figure 17: