Name Surname:
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Department:

1. LENGTH MEASURING INSTRUMENTS

Purpose of the Experiment: To recognize some length measuring instruments and to obtain prior knowledge about measurement errors.

Theoretical Background: *Vernier caliper* is the name given to a length measuring instrument that has the ability to make precise readings by using a second division section on a ruler whose length is divided in mm. The vernier caliper to be used in this experiment is shown in Figure 1. Thanks to this tool, we can measure lengths in the order of centimeters with a sensitivity between 0.1 mm and 0.025 mm, depending on the structure of the tool.

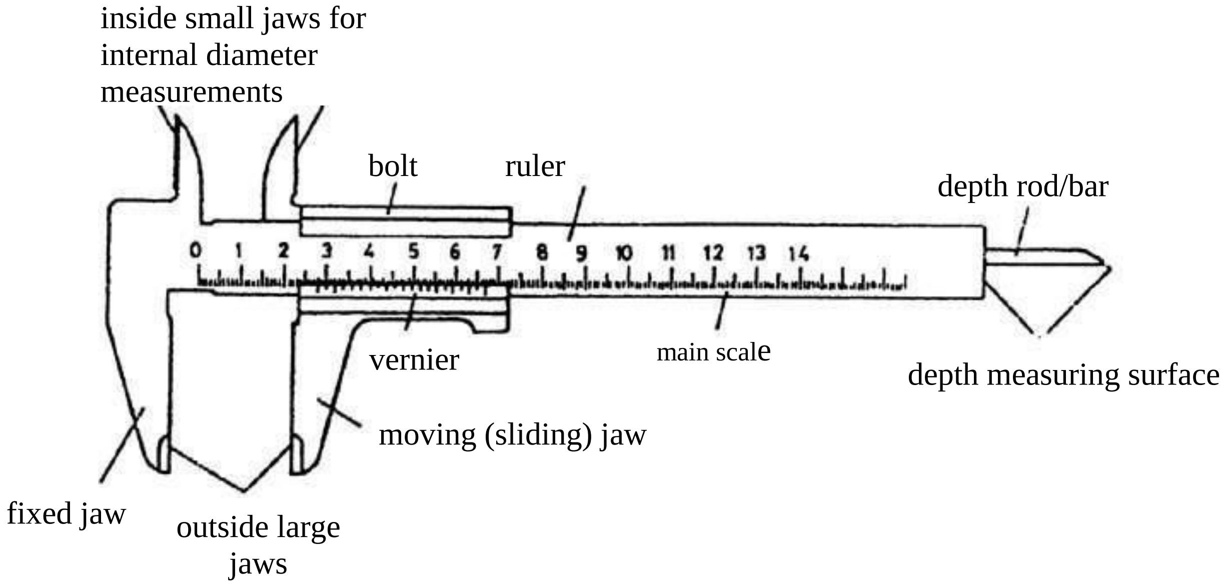


Figure 1. Vernier Caliper

The measurement made is calculated by the formula below, depending on the sensitivity of the caliper:

$$L = N + \frac{n}{B}$$

In the equation, L is the measured length, N is the value read on the ruler, n is the value read on the vernier, and B is taken according to the number of divisions of the vernier.

A vernier model is in Figure 2.

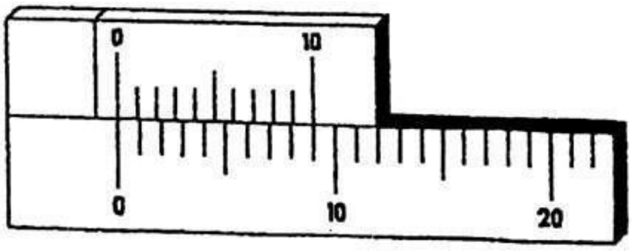


Figure 2. Vernier Model

In the vernier model in Figure 2, the main scale at the bottom is the ruler part where the number N is obtained. The upper segmented part is used to read the number n and the number B is determined by counting the number of divisions of this section (Since there are 10 divisions at the upper part of Figure 2, this number is taken as 10.).

The second measuring instrument we will use is the *micrometer* shown in Figure 3. With the help of a micrometer, we can measure lengths in the millimeter range with sensitivity between 0.01 mm and 0.005 mm.

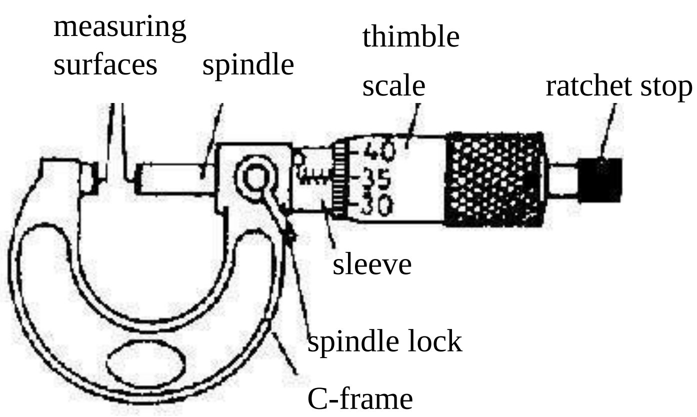


Figure 3. Micrometer

The measuring spindle of the tool is connected to the thimble with a screw with a pitch of 0.5 mm. Thus, with one complete rotation of the thimble, the measuring spindle moves 0.5 mm. Since the circumference of the thimble is divided into 50 equal parts, the distance of 0.5 mm is divided into 50 equal parts and the measuring device can make readings with a sensitivity of 0.01 mm.

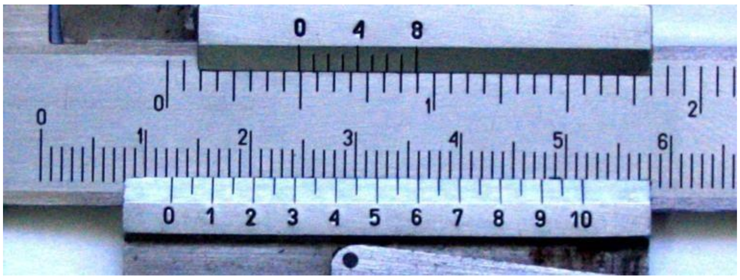
When a quantity is measured several times, different results (more or less) are usually obtained. Which one will be used to express this measured quantity? There are various approaches depending on the situation. However, the simplest approach we can give to start is the arithmetic mean. If n values such as $a_1, a_2, a_3, a_4, \ldots, a_n$ are read for the quantity a, the arithmetic mean is;

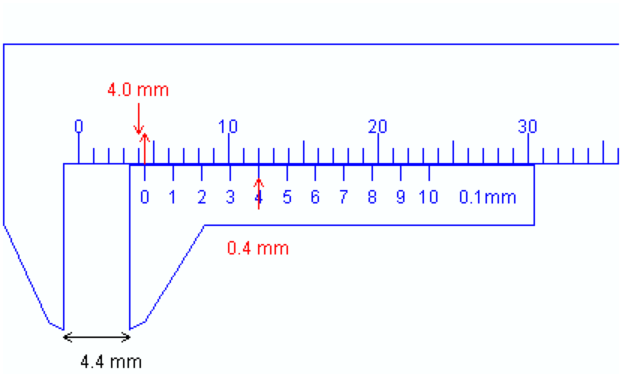
$$\bar{a} = \frac{1}{n}\sum_{i=1}^{n} a_i$$

The closer the a_i values are to each other, the better the average expression represents the quantity sought. If the a_i values are very different, the meaning of the mean loses its clearness. The expression standard deviation is used as its measure. This expression is given by the following relation;

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(a_i - \bar{a})^2}$$

Its derivation and discussion will not be discussed here. Suffice it to say that as it gets smaller, the average value better represents the measured value.





Experiment 1. Measurements with Caliper

1. Using calipers, measure the lengths of the cross-sections of the objects shown in the figures below and fill in the tables below for each.

Table1. Determining Dimensions for a Hollow Cylinder

	1	2	3	4	5	Average
D (mm)						
H (mm)						
d_1 (mm)						
d_2 (mm)						
h_1 (mm)						
h_2 (mm)						

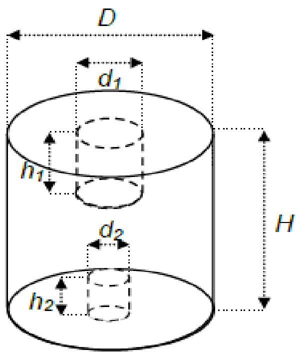


Table2. Determining Dimensions for the Cone

	1	2	Average
D (mm)			
H (mm)			

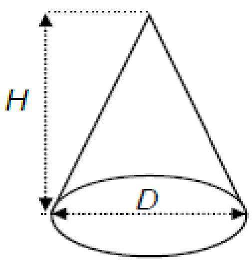
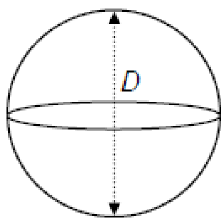


Table3. Determining Dimensions for a Sphere

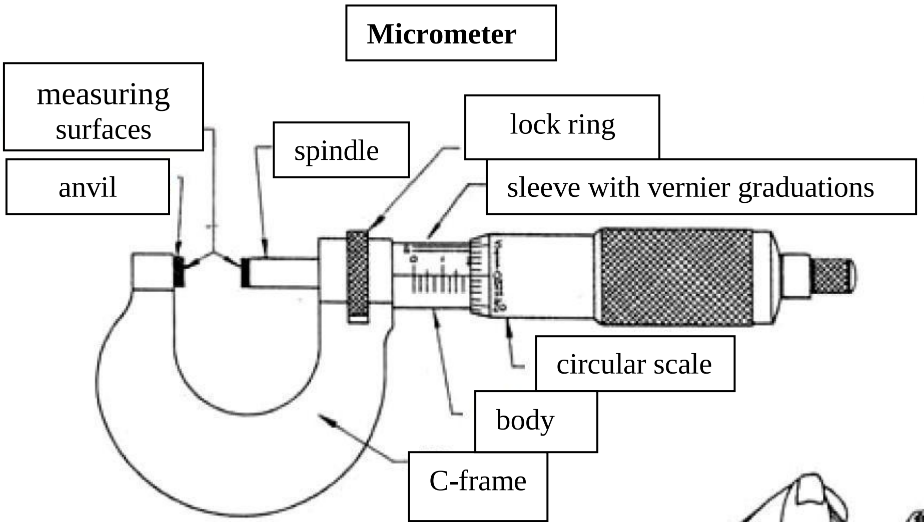
	1	2	Average
D (mm)			

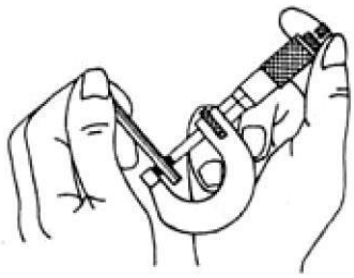


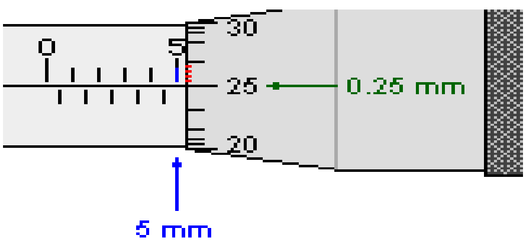
2. Calculate the volumes of each of the objects whose dimensions you have determined and fill in the table below.

Table4. Calculated Volumes

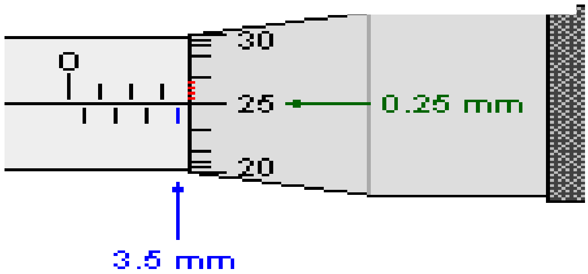
V (Cylinder)	V (Cone)	V (Sphere)







(5mm+0,25mm=5,25 mm)



(3,5mm+0,25mm=3,75 mm)

Experiment 2. Measurements with Micrometer

1- Read the diameters of the given wires using a micrometer and write them in Table 5.

2- Calculate the standard deviation for the <u>second</u> wire.

Table5. Diameter values measured using micrometer

Wire	1	2	3	4	5
Diameter (mm)					