Practical work N° 1: Measurement Methods and Error Calculations

1. The Objective of the Experiment

1. Identify some tools used to measure dimensions and choose the appropriate tool for the required accuracy.
2. Mastering the use of basic length measuring tools
3. Calculating the surfaces and volumes of objects of different shapes
4. Learn how to estimate measurement errors

2. Tools for Measuring Lengths

Ordinary ruler, metal meter, Vernier Calliper, screw or micrometric screw (micrometer) Rometer.

First, the ordinary ruler:

For an experimenter, who measures the dimensions of an object using an ordinary ruler, the measurement value in this case may not be appropriate as the calculation will be very estimated and ineffective. If the experimenter requires great accuracy this is due to two factors:

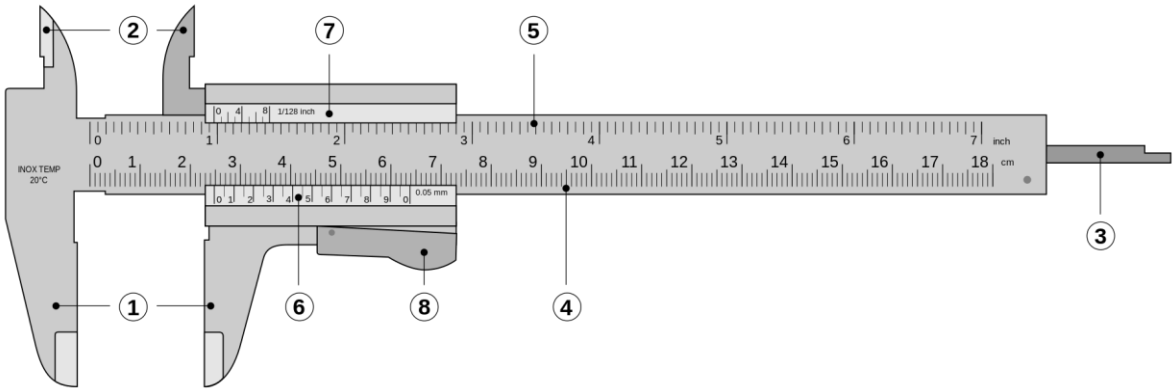
- ✓ The experimenter's ability to distinguish small dimensions and then the experimenter's uncertainty.
- ✓ The thickness of the line used for grading.

Secondly, Short Steel Tape Measure:

It measures relatively large lengths, usually of the order of meters. Uncertainty exceeds the normal procedure.

Third, the Vernier Calliper:

The Vernier Calliper is a useful measuring tool when we need to improve measurement accuracy.



3. Vernier Calliper

3.1 Components of the Vernier Calliper

The Vernier Calliper, as shown in the figure, consists of:

1. Outside large jaws: used to measure the external diameter of an object (like a hollow cylinder) or width of an object (like a rod), the diameter of an object (like a sphere).
2. Inside small jaws: used to measure the internal diameter of an object (like a hollow cylinder or pipe).
3. Depth probe/rod: used to measure the depths of an object (like a small beaker) or a hole.
4. Main scale (Metric): marked every millimeter and helps to measure length correctly up to 1 mm.
5. Main scale (Imperial): marked in inches and fractions.
6. Vernier scale (Metric) gives interpolated measurements to 0.1 mm or better.
7. Vernier scale (Imperial) gives interpolated measurements in fractions of an inch.
8. Retainer: used to block movable parts to allow the easy transferring of a measurement

3.2 Measurement using Vernier Calliper

- ✓ The object to be measured is fixed between the jaws
- ✓ Then read the measurement result from a regular ruler, which indicates the dimensions in millimeters.

- ✓ Then read the parts of a millimeter on the oven ruler by taking a reading of the oven scale that corresponds to the best Snaps to one of the regular ruler graduations.

Note:

Before starting the measurement, you must make sure that the zero of the regular ruler applies to the zero of the oven ruler. Make sure the jaws touch; otherwise an error will occur in the measurement, as well as knowing the number of corresponding gradations it varies from one canal foot to another.

Information:

"In the event that the zeros do not apply, this measurement error can be avoided by calibrating the device and when Unable to calibrate. We read the error value and add it to the measured reading, whether it is an increase or decrease"

3.3 How do we know the accuracy of measuring the Vernier Calliper?

Each one (1) millimeter of a regular ruler is divided into parts on the oven ruler: 10 parts, 20 parts, or 50 parts. So it will be

Vernier Calliper accuracy = 1mm/x

x: number of parts of the oven ruler

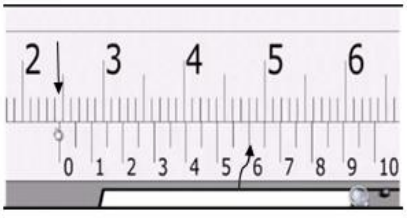
In other words, the accuracy of any device is the difference in reading between the two smallest successive readings of the device.

Example 1:

1. Reading on a regular ruler 2.4 cm = 24 mm

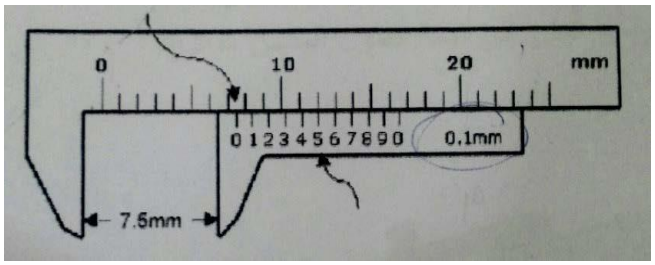
2. The reading on the second ruler is 0.60 mm

3. The total reading is 24 mm + 0.60 mm = 24.6 mm



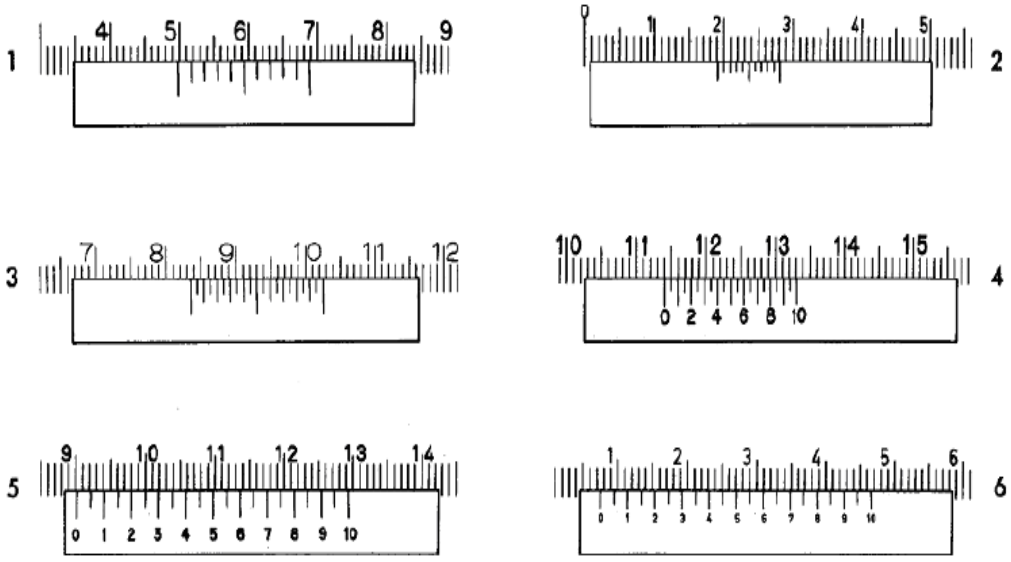
Example 2:

We also note that the graduations of the regular ruler refer to the graduation number 7, and the best application of the graduations is 5 Then the result of the measurement will be the oven at the number 7.5 mm



4. Experiments Required

1. Represent each value as a reading for the measuring instrument below



2. Things to measure

1. Table top

2. Parallelepiped

3. Cylinder

4. Sphere (steel ball)

3. Repeated length measurements using a ruler

Measure the length of each figure and repeat the measurement 4 times in the same way and with the same care to avoid error. The measured values were recorded in the table below.

Measurement	Measurement 1	Measurement 2	Measurement 3	Measurement 4	X_{avr}	ΔX
Table top						
Parallelepiped						
Cylinder						
Sphere (steel ball)						

- ✓ **Error:** is the difference between the measured value and the true value of this quantity
- ✓ **Absolute error:** The absolute error represents the upper limit of the error committed during the measurement. Thus, if we wish to measure a physical quantity x, we will write that: $\mathbf{X = X_{mes} \pm \Delta X}$
- ✓ **Relative error:** To determine the accuracy of the measurement, we resort to calculating the relative uncertainty, which is equal to the absolute uncertainty (Δx) over the measured value (x)

$$\mathbf{X_{evr} = \frac{X_1 + X_2 + \cdots + X_n}{n}}$$

$$\mathbf{\Delta X = Max(|X_i - X_{evr}| = Max(\Delta X_i)}$$

$$\mathbf{\varepsilon\ (\%) = \frac{\Delta X}{x_{evr}} \times 100}$$

5. Required Questions:

1. Complete the table by averaging the measured values
2. Write the measurement result with absolute error ($X_{mes} \pm \Delta X$)
3. Calculate the relative error (ε %)
4. Identify the various causes of errors