

EXPERIMENT 1

MEASUREMENT

1. Objectives

To study the vernier scale principle and to learn the use of vernier calipers (kompas) for the accurate measurement of length. To become familiar with the use of micrometer calipers for the accurate measurement of small lengths.

2. Equipment

Vernier caliper
Micrometer
Rectangular solids
Hard Rubber (Hard Gummi)
Wood (Holz)
Zinc
Iron
Brass
Copper
Lead

3. Theory

Careful quantitative measurements are very important for development of physics, the most exact of the experimental sciences. The measurement of length is basic to many of the experiments performed by physicists.

4. Procedure

The vernier caliper and micrometer will be used in order to make correct measurements of some materials.

• For vernier caliper

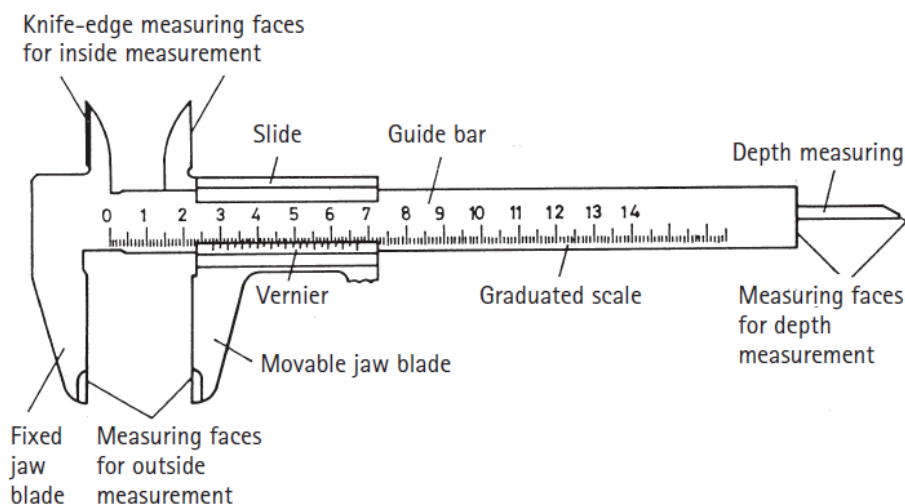


Figure 1 Vernier Caliper (Kumpas)

Fig. 1 shows a vernier caliper where you will set one length of a material into the 'measuring faces for outside measurement' part which will be between the parts of 'fixed jaw blade' and 'movable jaw blade'. After that, you will firstly look at both scales of the 'graduated scale' and vernier scale where the last scale line of 'graduated scale' nearest to the 'vernier' scale. You will write first this scale. Then, you will look at the vernier scale where you will detect a point which directly overlaps with the 'graduated scale'. After the

detection of this point, you will write this point in terms of vernier scale and it should be multiplied by the measurement standard size which is $0,05mm$.

Example: Assume that the part in graduated scale until the vernier scale: $8mm$
the overlap part in vernier scale: 4 which should be multiplied with $0.05mm$ standard size
Finally, total length of related part will be: $8mm + 4 \times 0,05mm = 8,2mm$

• **For micrometer**

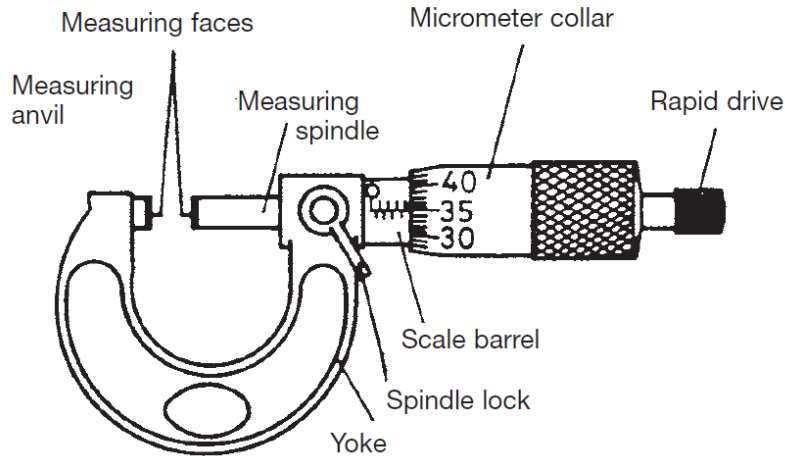


Figure 2 Micrometer

Fig. 2 shows a micrometer where you will open the ‘measuring faces’ in order to set the material into there by rotating the ‘micrometer collar’. After you are sure about that the material has been set, you will use the scale in ‘micrometer collar’ which is divided into 50 lines. Every 50 lines is equal to $0.5mm$. You will rotate it from beginning point of zero, then you will observe where the ‘scale barrel’ and ‘micrometer collar’ are when the material begins to fall.

Example: Assume that you set the material into the place of ‘measuring faces’, the ‘scale barrel’ (it is divided by the division of $0,5mm$) shows: $8,5mm$
While you rotate the ‘micrometer collar’ from beginning zero, you’ve detected the fall point as: 30 lines: since 50 lines = $0.5mm$, then 30 lines = $0,3mm$
Finally, total length of related part will be: $8,5mm + 0,3mm = 8,8mm$

1. Transform some numbers having a certain units below into the desired forms. An example is given to you. Calculate the others clearly. ($k = 10^3, d = 10^{-1}, c = 10^{-2}, \mu = 10^{-6}, n = 10^{-9}, p = 10^{-12}$)

($\mu = micro, n = nano, p = pico$)

Ex: $0,12m = ? km$

Answer: $0,12m = 0,12 \cdot 10^{-3} \cdot 10^3 m = 0,12 \cdot 10^{-3} km = 12 \cdot 10^{-2} \cdot 10^{-3} km = 12 \cdot 10^{-5} km = 1,2 \cdot 10^{-4} km$

As a result: $? km = 1,2 \cdot 10^{-4} km$

• $100m = ? km$

• $0,1mm = ? \mu m$

- $120\text{dm} = ?\text{km}$
- $0,123\text{mm} = ?\mu\text{m}$
- $1234567\mu\text{m} = ?\text{m}$
- $12\text{cm} = ?\mu\text{m}$
- $2,34\text{mm} = ?\text{nm}$
- $0,128\mu\text{m} = ?\text{pm}$
- $0,128\text{pm} = ?\text{mm}$

2. The following theoretical values of the densities of some materials are given to you with in terms of a unit scale. Transform them into the form of $\frac{\text{g}}{\text{cm}^3}$. For this purpose, an example is given to you. Calculate the others clearly.

- **Al:** Aluminum density: $2700\text{kg}/\text{m}^3$

$$2700 \frac{\text{kg}}{\text{m}^3} = \frac{2700 \cdot 1000\text{g}}{\text{m} \cdot \text{m} \cdot \text{m}} = \frac{2700 \cdot 1000\text{g}}{10^2\text{cm} \cdot 10^2\text{cm} \cdot 10^2\text{cm}} = \frac{27 \cdot 10^5\text{g}}{10^6\text{cm}^3} = 2,7 \frac{\text{g}}{\text{cm}^3}$$

- Hard Rubber (Hard Gummi) density: $950\text{kg}/\text{m}^3$
- Wood (Holz) density: $0,6\text{kg}/\text{dm}^3$

• Zn: Zinc density: $6,92 \text{ kg/dm}^3$

• Fe: Iron density: 7800 kg/m^3

• Ms: Brass: $8,5 \text{ kg/dm}^3$

• Cu: Copper density: 8930 kg/m^3

• Pb: Lead density: 11342 kg/m^3

3. Now, you know the theoretical densities thanks to previous part. If you find the dimensions (length, width, height) of the elements, then you can calculate the densities. Find them, then compare your measured results with the theoretical densities found in the previous part.

• Al: Aluminum:

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Hard Rubber (Hard Gummi):

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Wood (Holz):

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Zn: Zinc:

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Fe: Iron:

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Ms: Brass:

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Cu: Copper:

length = _____ *cm*

width = _____ *cm*

height = _____ *cm*

mass = _____ *g*

Calculated _ density = _____ g/cm^3 , *Theoretical _ density* = _____ g/cm^3

• Pb: Lead:

length = _____ cm

width = _____ cm

height = _____ cm

mass = _____ g

Calculated _density = _____ g/cm³ , Theoretical _density = _____ g/cm³

Hint: A density is found by

$$d = \frac{\text{mass}}{\text{Volume}} = \frac{m}{V} \tag{1}$$

where mass is found by using the scales device and Volume (V) is found by

$$\text{Volume} = V = \text{length} \cdot \text{width} \cdot \text{height} \tag{2}$$

5. Results and Discussion

Discuss the results

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