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INSTITUTE OF APPLIED TECHNOLOGY

Mechanical Workshop

Module 2: Measurements

PREPARED BY

IAT Curriculum Unit

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Module 2: Measurements

Module Objectives

After the completion of this module, the student will be able to:

1. Take linear measurements to accuracy of ± 0.5 mm using a 30-centimeter steel rule.
2. Read inside, outside and depth/thickness measurements to accuracy of ± 0.02 mm using Vernier calipers.
3. Read outside diameter measurements to an accuracy of ± 0.01 mm using a micrometer.
4. Clean, care for and store steel rules, calipers and micrometers.

Module Contents

1. Steel Rules
2. Vernier Calipers
3. Micrometers

Introduction to Measurements

The science that deals with all theoretical and practical aspects of measurement is called **metrology**.

System of measurement

The main two systems of measurements are:

1. The METRIC system:

The basic unit of length in the metric system is the meter.

2. The IMPERIAL system:

The basic unit of length in the Imperial system is the yard.

The METRIC system nowadays is used in most countries.

1. Steel Rules

Most metric rules are divided into millimeter or half millimeter graduations.

They are numbered every 10 mm as shown in Fig. 2.1.

The measurement is determined by counting the number of millimeters.

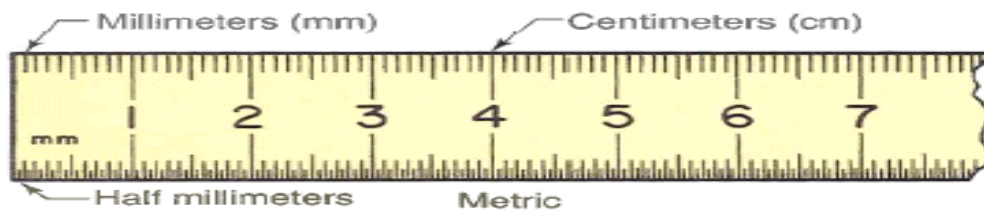


Fig. 2.1: metric rules

Using the steel rule

Always look straight down at 90° to the rule. Using the datum edge to help you measure correctly. If you look from the side, you can get inaccurate measurements. See Fig. 2.2.

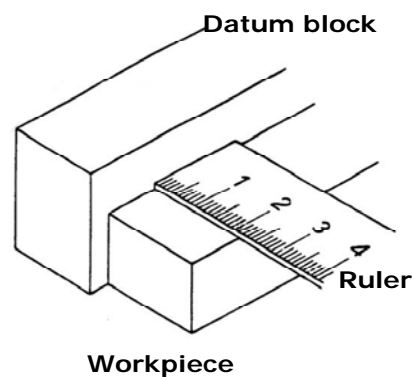


Fig. 2.2: Using the steel ruler

Other uses of steel rule

The edge of the rule is ground flat. You can use the edge of the rule to check that the workpieces edges are flat. See Fig. 2.3.a & Fig. 2.3b.

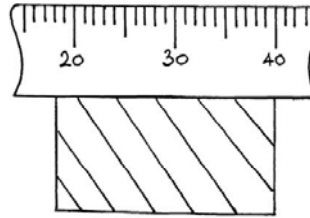


Fig. 2.3.a:
No gap between the workpiece and
RULE means the workpiece edge is
FLAT.

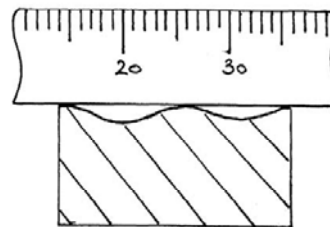


Fig. 2.3.b
Gap between the workpiece and the
RULE means the workpiece edge is NOT
FLAT.

Care of the steel rule

The steel rule is an accurate instrument, treat it with care.

1. Keep the rule clean and lightly oiled.
2. Protect it from damage.
3. Never use it as a screwdriver.
4. Never use the end as a scraper.
5. Never bend or twist a steel ruler.

Practical task 1

You will be given a V-Block similar to the one shown in Fig.2.4, use the steel rule to measure the dimensions shown in Fig. 2.5. Record your measurements in the table below.



Fig.2.4: V-Block

NOTE:

The accuracy of your readings should be in a range of 0.5 mm.

Table of measurements:

Dimension	A	B	C	D	E	F
Dimension in (mm)						

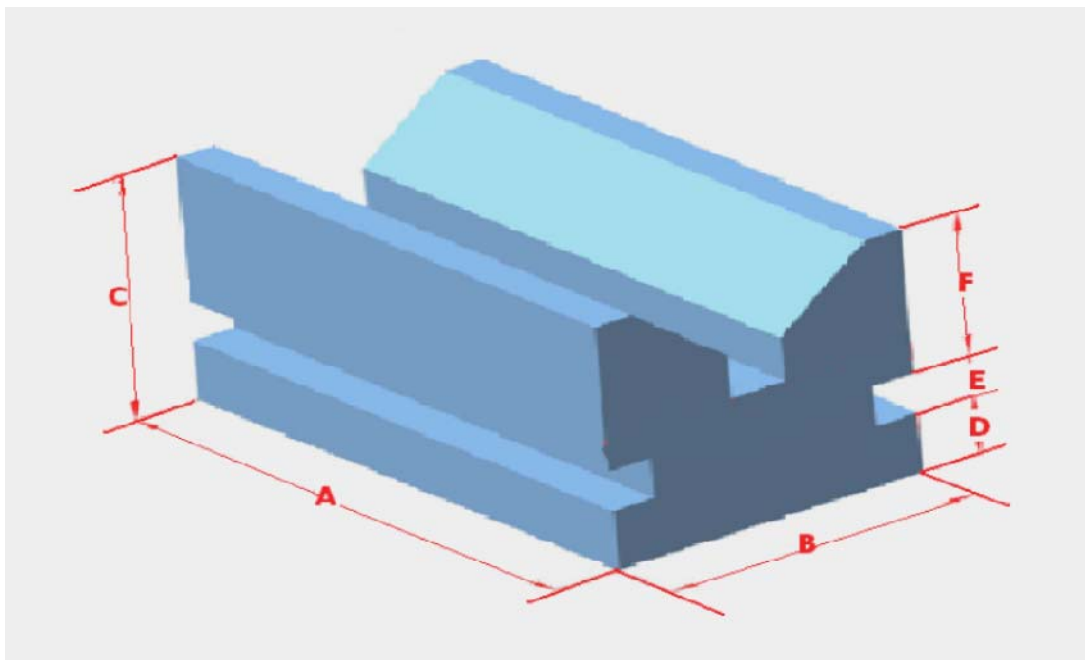


Fig.2.5: dimensions A to F to be measured on a V-Block.

2. Vernier Calipers

The Vernier caliper is a measuring instrument with a sliding scale used to carry out accurate measurements of inside, outside, and depth dimensions.

The accuracy of Vernier calipers

The Vernier consists of a main scale engraved on a fixed ruler and a Vernier scale engraved on a movable jaw. The movable Vernier scale is free to slide along the length of the fixed ruler. This main scale is presented in centimeters with the smallest division in millimeters. The actual length of the Vernier scale is 9 mm. The 9 mm are divided into 10 divisions. According to the number of divisions the accuracy values are determined.

- The Vernier caliper with 10 divisions in Vernier scale is accurate to $(1/10) \pm 0.1$ mm.
- The Vernier caliper with 20 divisions in Vernier scale is accurate to $(1/20) \pm 0.05$ mm.
- The Vernier caliper with 50 divisions in Vernier scale is accurate to $(1/50) \pm 0.02$ mm.

The Vernier caliper has 6 parts: as illustrated in Fig. 2.6;

1. **Outside jaws:** used to measure external lengths.
2. **Inside jaws:** used to measure internal lengths.
3. **Stem:** used to measure depths.
4. **Main scale**
5. **Vernier scale**
6. **Screw clamp:** used to block the movable jaw to allow the easy transferring a measurement.

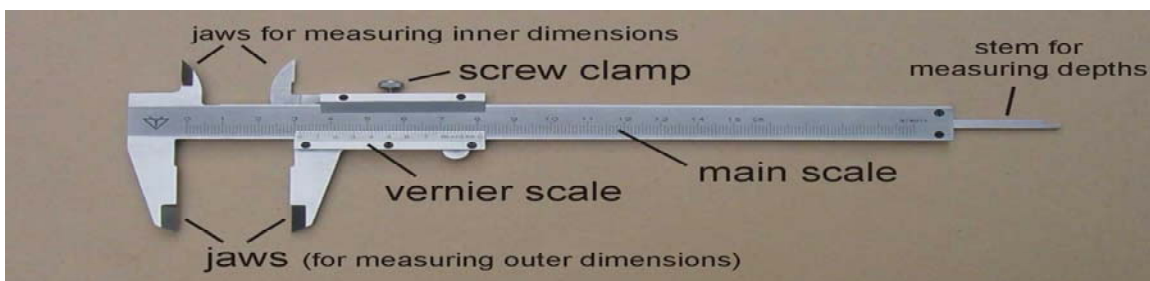


Fig.2.6 The main parts of Vernier caliper

Types of Vernier calipers:

A - **Standard** Vernier caliper. See Fig.2.7.a.



Fig.2.7.a

B - **Dial** Vernier caliper. See Fig.2.7.b.



Fig.2.7.b

C - **Digital** Vernier caliper which is easier to read than the other two types. See Fig.2.7.c.



Fig.2.7.c

Using Vernier Calipers

Vernier calipers can be used to measure:

A- the outside diameter or width of an object. See Fig. 2.8.a.



Fig. 2.8.a

B- the inside diameter or width of an object. See Fig. 2.8.b.

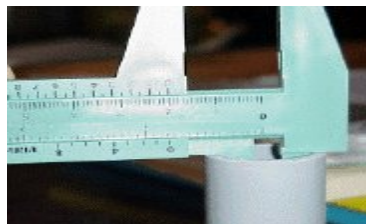


Fig. 2.8.b

C- the depth of an object. See Fig. 2.8.c.



Fig. 2.8.

Reading Vernier Calipers

In Fig. 2.9 shown below, the Vernier scale (below) is divided into 10 equal divisions and thus the least count of the instrument is 0.1 mm. Both the main scale and the Vernier scale readings are taken into account when measuring. 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), 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.

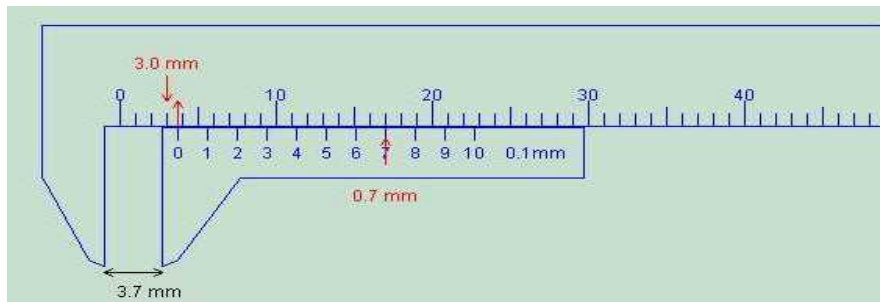
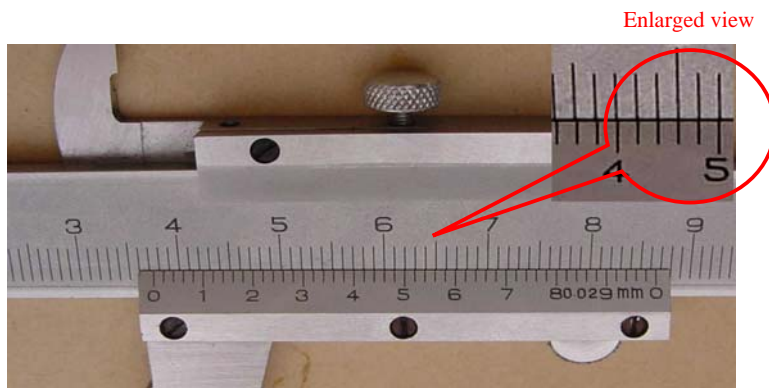


Fig.2.9 The reading here is 3.7 mm.

Example of Vernier reading:



The reading is: $37 \text{ mm} + 0.46 \text{ mm} = 37.46 \text{ mm}$.

Practical task 2:

You will be given a drill chuck as the one shown in Fig. 2.10. Use the Vernier caliper to measure the indicated dimensions 1 to 7 and record your readings in the table below.

*NOTE:
Use a Vernier caliper with 0.02 mm accuracy.*

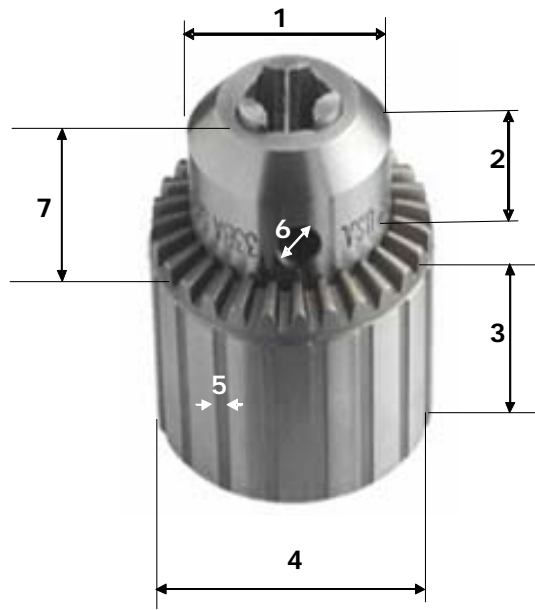


Fig. 2.10 a drill chuck

No.	Dimension in (mm)	Comment	
1			
2			
3			
4			
5			
6			
7			

3. Micrometers

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. It is a screw with an accurately constant pitch. The micrometers in our laboratory have a pitch of 0.50 mm (two full turns are required to close the jaws by 1.00 mm). The rotating thimble is subdivided into 50 equal divisions. The thimble must be rotated through two revolutions to open the jaws by 1 mm.

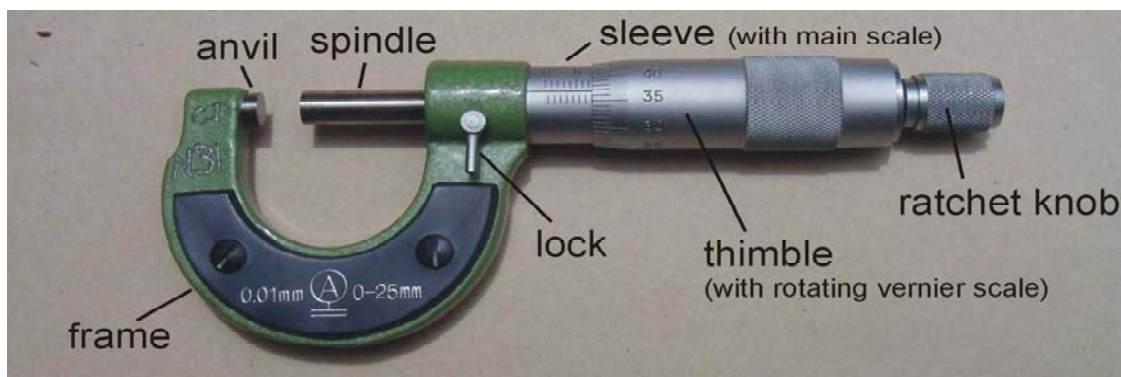


Fig.2.11: The micrometer

Reading the micrometer:

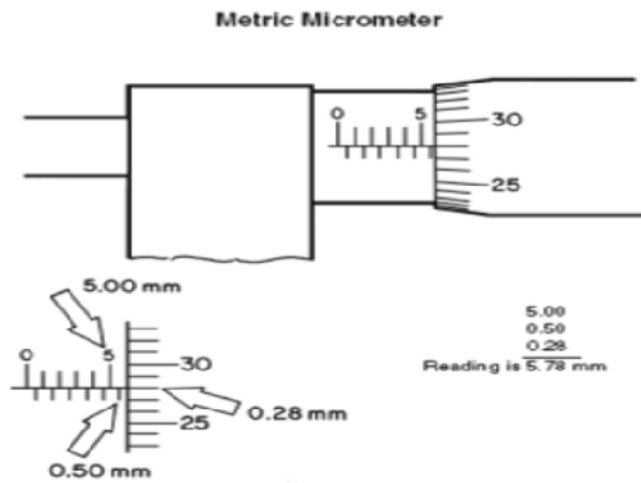


Fig 2.12 Reading the micrometer

Examples of micrometer reading:

The reading in Fig.2.12.a is **7.72 mm.**



Fig.2.13.a

The reading in Fig.2.13.a is **7.38 mm.**



Fig.2.13.b

Practical task 3:

You will be given a workpiece similar to the one shown in Fig.2.14. Use the micrometer to measure the dimensions shown in Fig. 2.15. Record your measurements in the table below.

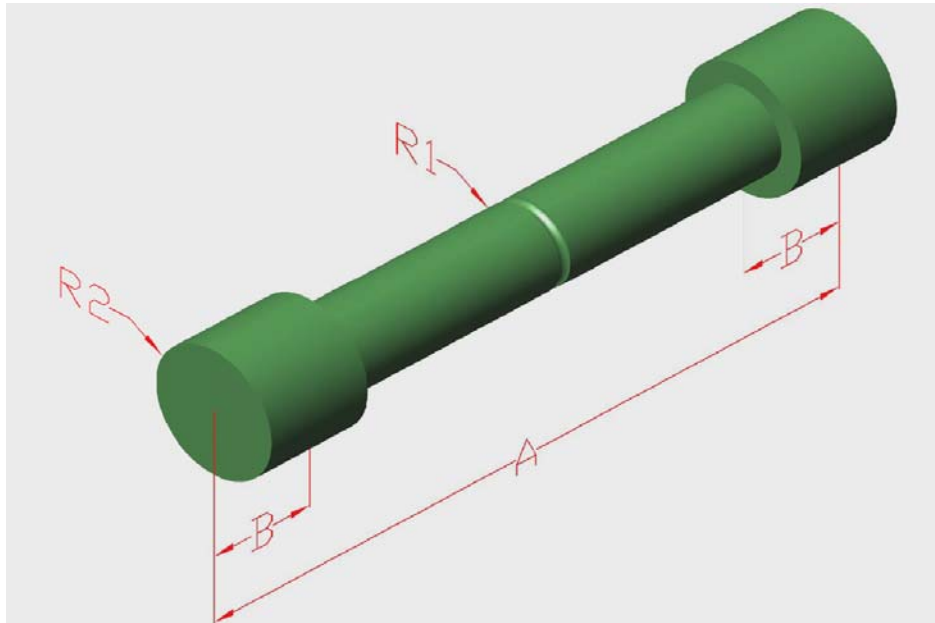


Fig.2.14 a copper work piece

NOTE:
The accuracy of the micrometer is 0.01 mm

Table of measurements

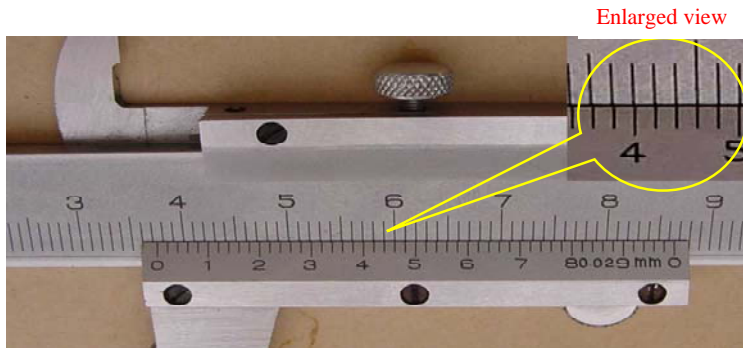
Dimension	R1	R2	A	B
Dimension in (mm)				



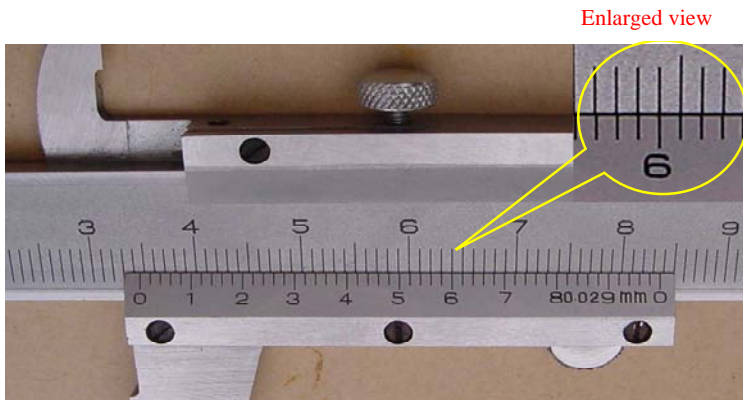
Student's notes

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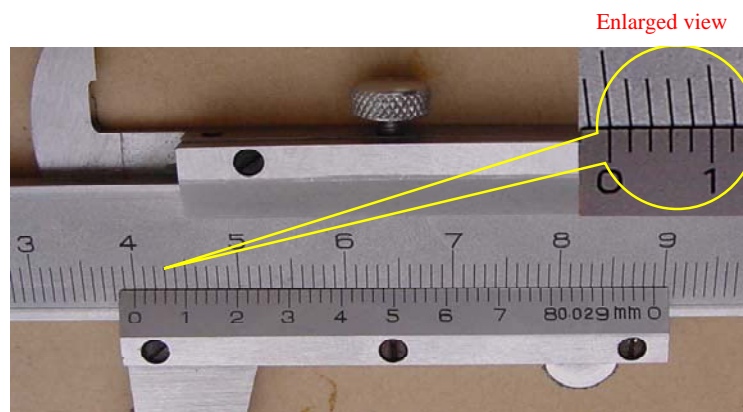
Work Sheet No. (1)



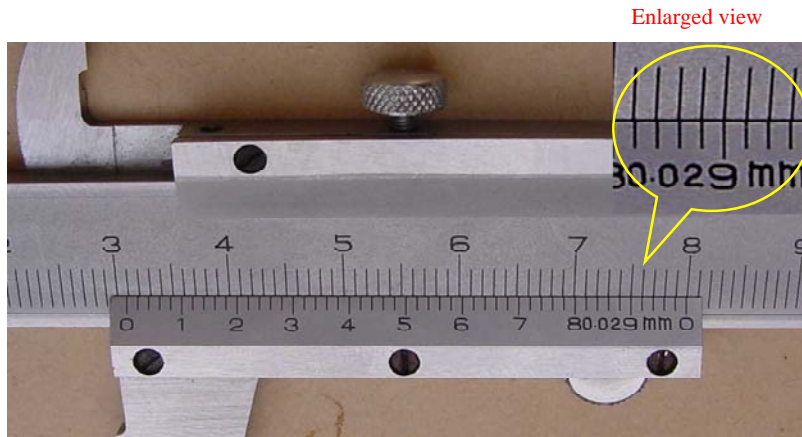
The reading is mm.



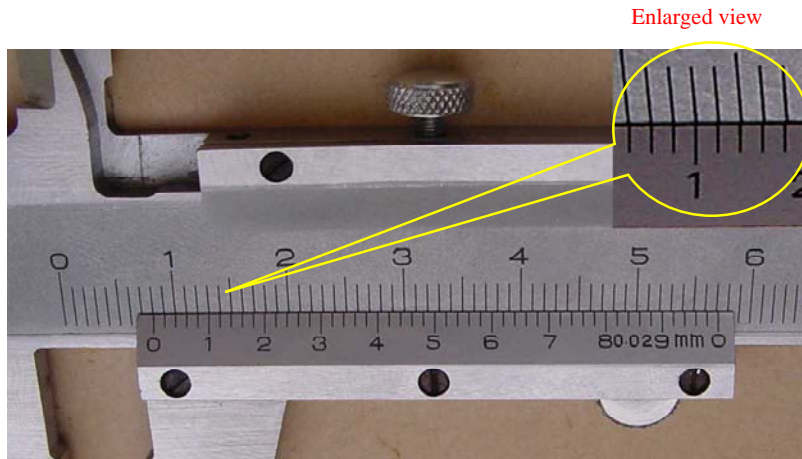
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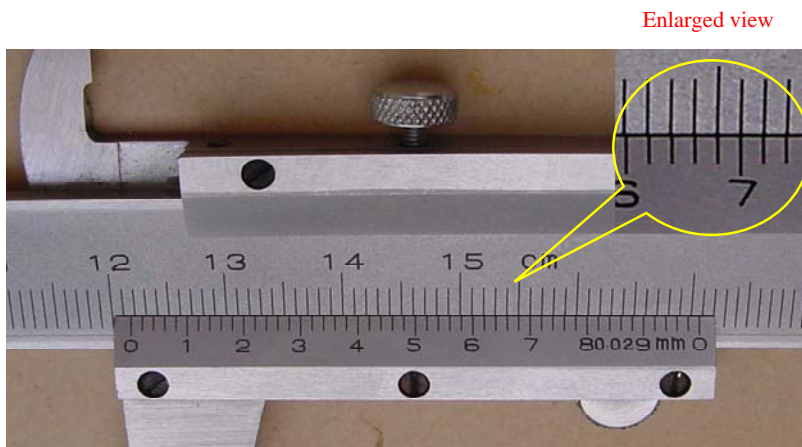
The reading is mm.



The reading is mm.



The reading is mm.



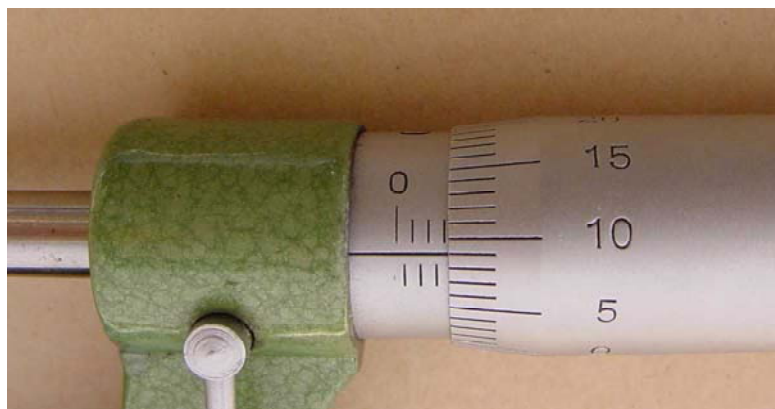
The reading is mm.



The reading is mm.



The reading is mm.



The reading is mm.