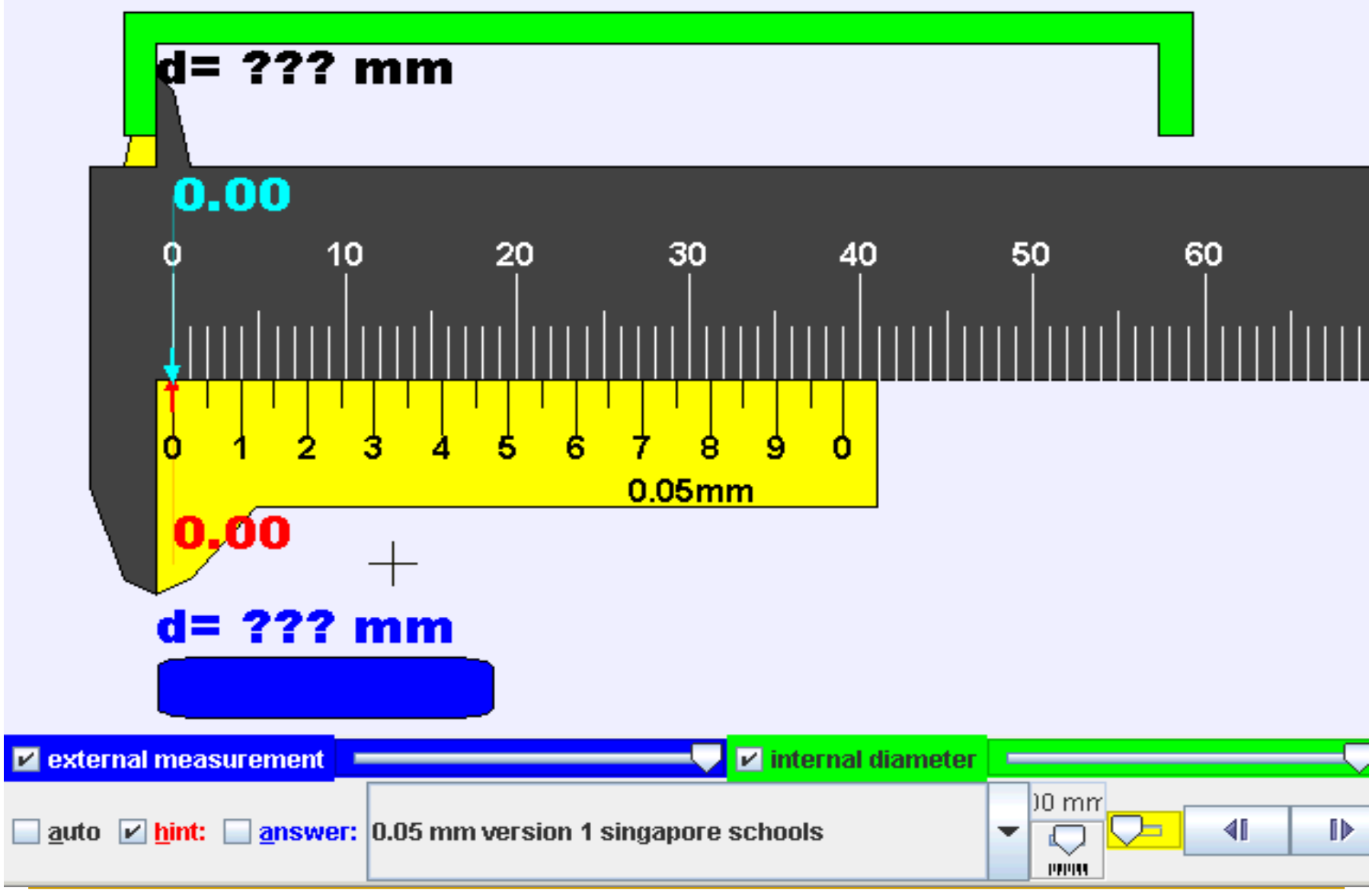
# Engaging Starter



Pakistan School
Kingdom of Bahrain

# Welcome to the new session of Grade 9th Physics

Chapter: 01

" Physical Quantities and Measurement"

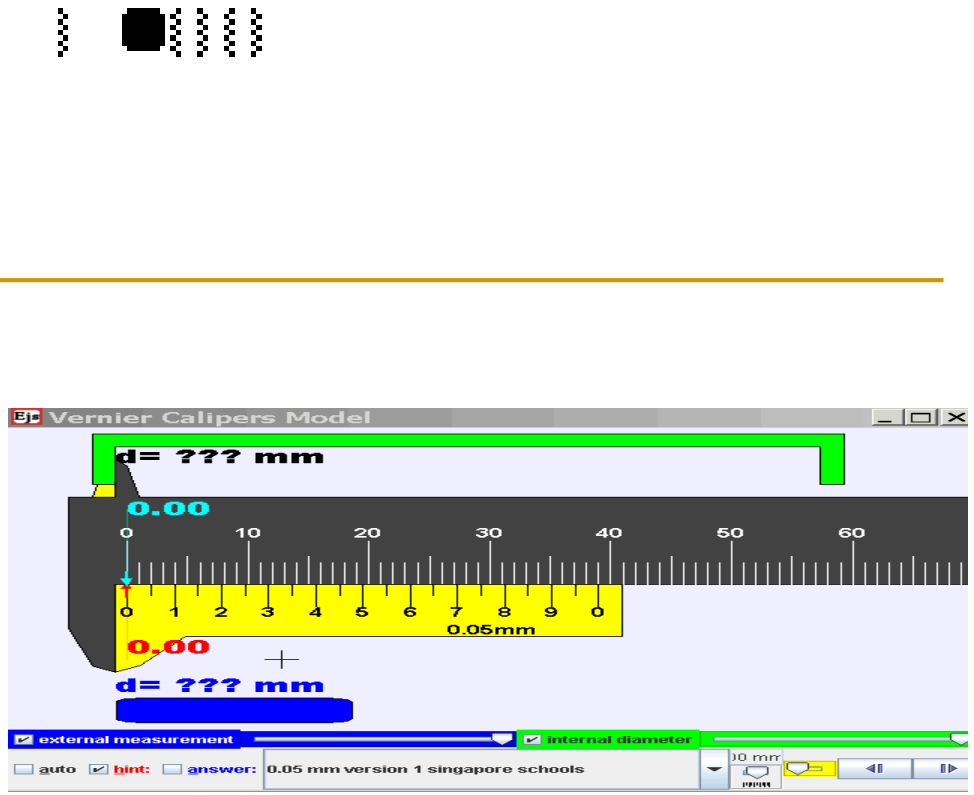
Topic:1.6 Measuring Instruments

# Learning Objectives: By the end of the session, students will be able to:

1. Define measuring instruments.

2. Describe the working of vernier callipers.

# Measuring Instruments



# Reference from the Book

## 1.6 MEASURING INSTRUMENTS

Measuring instruments are used to measure various physical quantities such as length, mass, time, volume, etc. Measuring instruments used in the past were not so reliable and accurate as we use today. For example, sundial, water clock and other time measuring devices used around 1300 AD were quite crude. On the other hand, digital clocks and watches used now-a-days are highly reliable and accurate. Here we shall describe some measuring instruments used in Physics laboratory.

### THE METRE RULE

Figure 1.3: A metre rule

A metre rule is a length measuring instrument as shown in figure 1.3. It is commonly used in the laboratories to measure length of an object or distance between two points. It is one metre long which is equal to 100 centimetres. Each centimetre (cm) is divided into 10 small divisions called millimetre (mm). Thus one millimetre is the smallest reading that can be taken using a metre rule and is called its least count.

While measuring length, or distance, eye must be kept vertically above the reading point as shown in figure 1.4(b). The reading becomes doubtful if the eye is positioned either left or right to the reading point.

### THE MEASURING TAPE

Measuring tapes are used to measure length in metres and centimetres. Figure 1.5 shows a measuring tape used by blacksmith and carpenters. A measuring tape consists of a thin and long strip of cotton, metal or plastic generally 10 m, 20 m, 50 m or 100 m long. Measuring tapes are marked in centimetres as well as in inches.

**FOR YOUR INFORMATION**

Hubble Space Telescope orbits around the Earth. It provides information about stars.

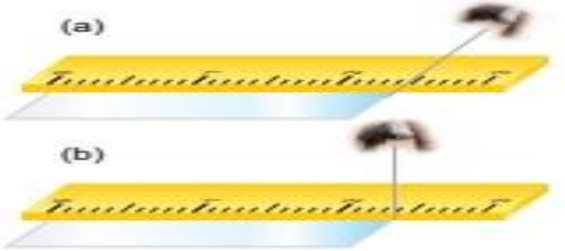



Figure 1.4: Wrong position of th eye to note the reading. (b) Correct position of the eye note the reading from a metre r

Figure 1.5: A measuring tape

## Zero Error and Zero Correction

To find the zero error, close the jaws of Vernier Callipers gently. If zero line of the vernier scale coincides with the zero of the main scale then the zero error is zero (figure 1.7a). Zero error will exist if zero line of the vernier scale is not coinciding with the zero of main scale (figure 1.7b). Zero error will be positive if zero line of vernier scale is on the right side of the zero of the main scale and will be negative if zero line of vernier scale is on the left side of zero of the main scale (figure 1.7c).

### Taking a Reading on Vernier Callipers

Let us find the diameter of a solid cylinder using Vernier Callipers. Place the solid cylinder between jaws of the Vernier Callipers as shown in figure 1.8. Close the jaws till they press the opposite sides of the object gently.

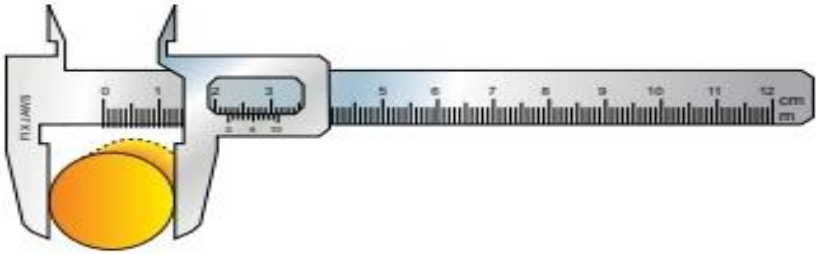


Figure 1.8: A cylinder placed between the outer jaws of Vernier Callipers.

Note the complete divisions of main scale past the vernier scale zero in a tabular form. Next find thevernier scale division that is coinciding with any division on the main scale. Multiply it by least count of Vernier Callipers and add it in the main scale reading. This is equal to the diameter of the solid cylinder. Add zero correction (Z.C) to get correct measurement. Repeat the above procedure and record at least three observations with the solid cylinder displaced or rotated each time.

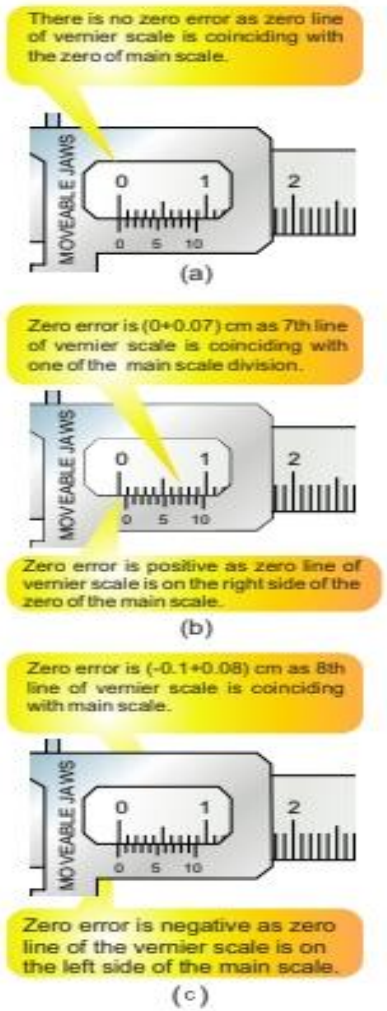



**Figure** 1.7: Zero Error
(a) zero
(b) +0.07 cm
© cm. -0.02

# MEASURING INSTRUMENTS

- Measuring instruments are used to measure physical quantities.
- Scientists, engineers and other humans use a vast range of instruments to perform their measurements.
- Measuring instruments:

METRE RULE
MEASURING TAPE
VERNIER CALLIPERS
SCREW GUAGE

# METRE RULE:

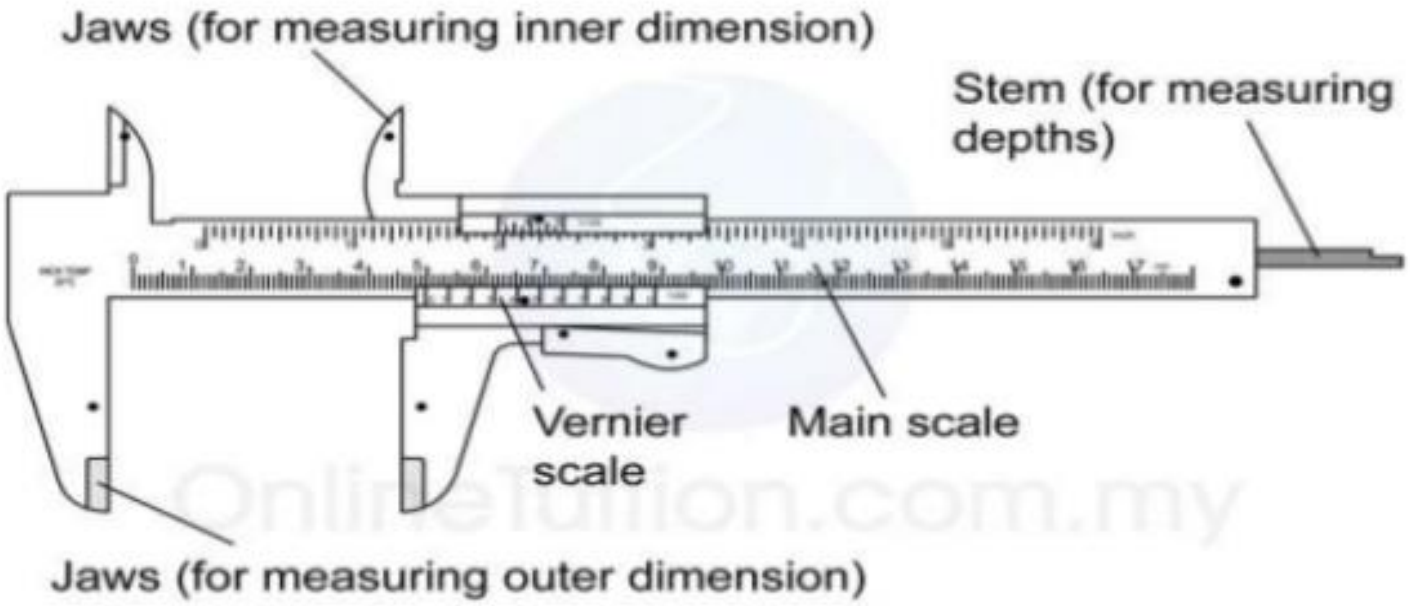
- A metre rule is used to measure length of an object or distance between two points.
- It is one metre long which is equal to 100 centimetres and each centimetre is divided into 10 small divisions called millimetre (mm).
- Metre rule is made up of different materials and in a wide range of size.

# MEASURING TAPE:

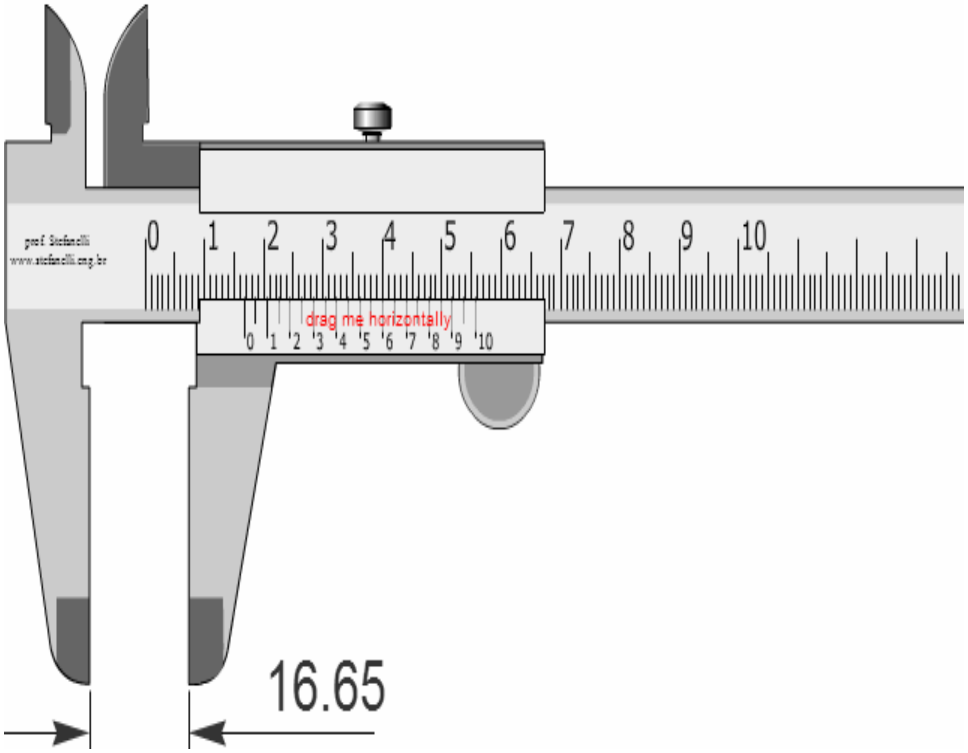
- Measuring tapes are used to measure length in metres and centimetres.
- It is a common measuring tool.
- It is used by blacksmith and carpenters.
- It consists of a ribbon of cloth, plastic, fiber or glass .
- Its design allows for a measure of great length.


# VERNIER CALLIPERS:

- **A vernier calliper is an instrument used to measure the internal or external diameters of an object.**

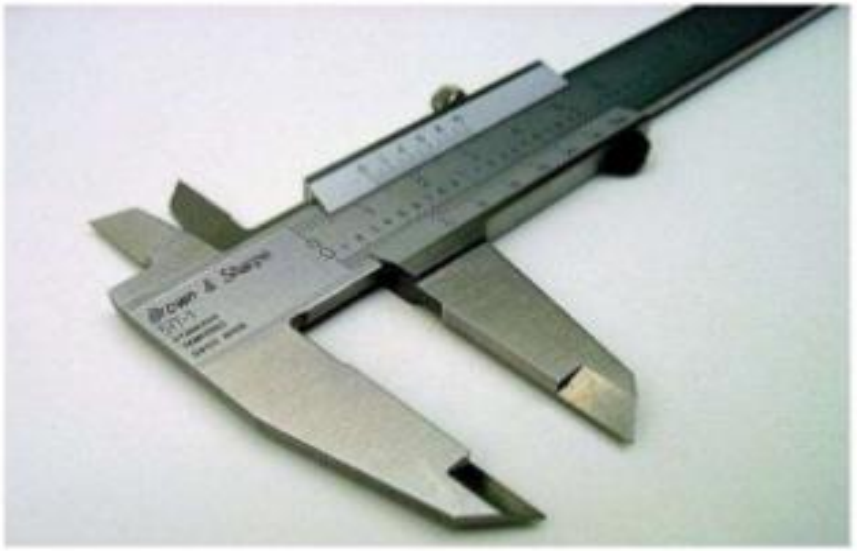


**Definition:** The Vernier Caliper is an instrument used widely to measure lengths accurately up to *0.01 cm*. It enables us to measure lengths much more accurately than a simple ruler and can be used to measure the diameter of a round object, the inside diameter of hollow vessels or pipes and even the depth of vessels.

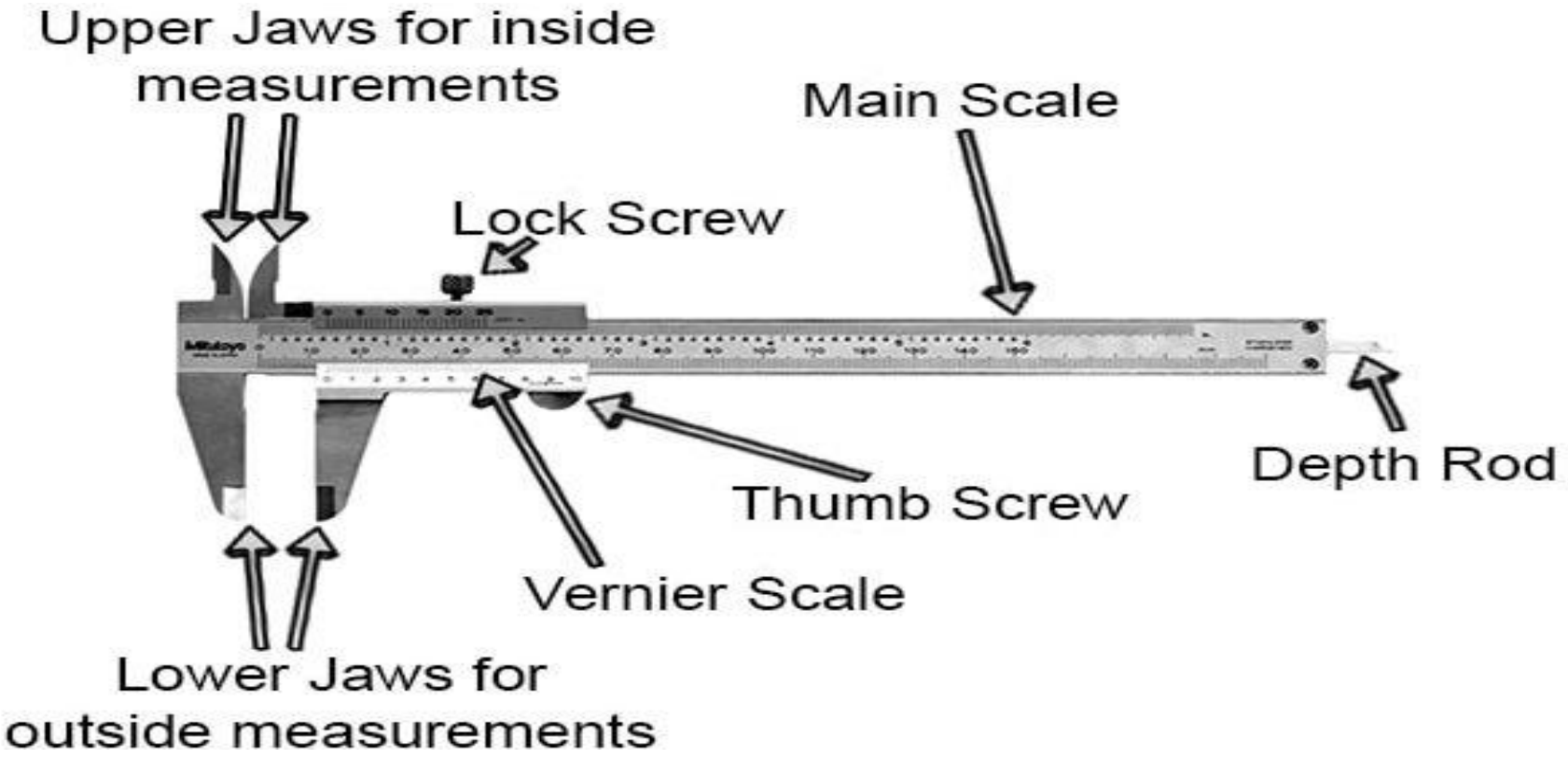


# VERNIER CALLIPERS:

- Vernier callipers consists of two jaws.
- One is a fixed jaw with main scale. It has centimetre and millimetre marks on it.



# Parts of (V.C) Practice & Measurement



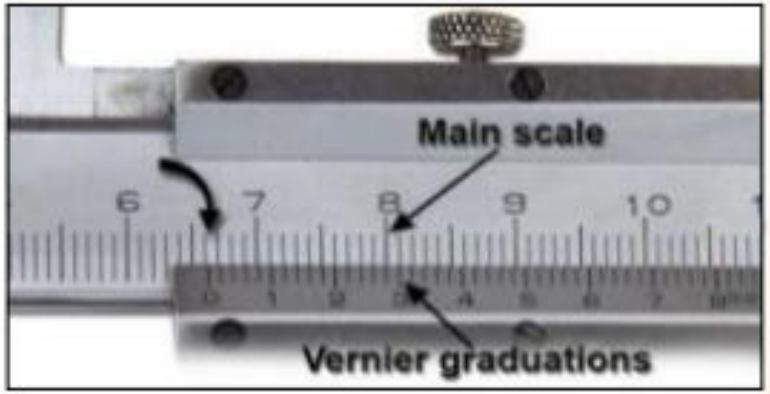
## LEAST COUNT

The "Least Count" of any measuring equipment is the smallest quantity that can be measured accurately using that instrument.

$$\text{Least Count} = \frac{\text{Value of one main scale division}}{\text{Total number of vernier scale division}}$$

$$TR = MSR + (VSR \times LC)$$

TR:- Total Reading
MSR:- Main Scale Reading
VSR:- Vernier Scale Reading
LC:- Least Count



## LEAST COUNT OF VERNIER CALIPER

$$\text{Least Count} = \frac{\text{Value of one main scale division}}{\text{Total number of vernier scale division}}$$

$$\text{Least Count} = \frac{1}{50}$$

$$\text{Least Count} = 0.02 \text{ mm}$$

# ZERO ERROR AND ZERO CORRECTION

- What is zero error?

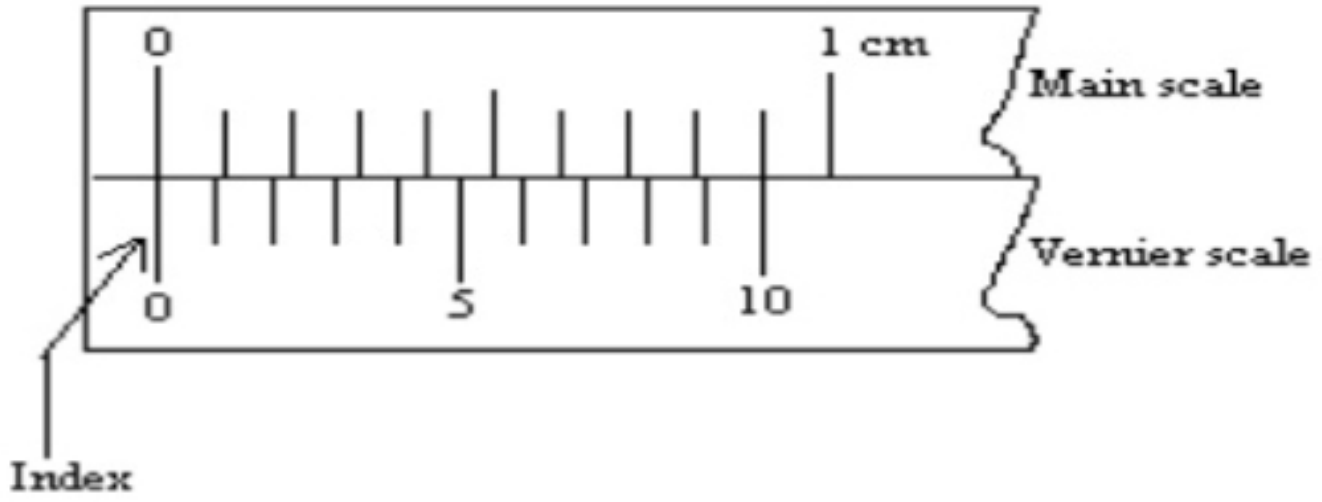
If there is any error in the measuring instrument then it is called zero error of the instrument.

- What is zero correction?

If zero line of vernier scale is not coinciding with main scale the zero error will exist. Knowing the zero error necessary correction can be made to find the correct measurement. Such a correction is called zero error.

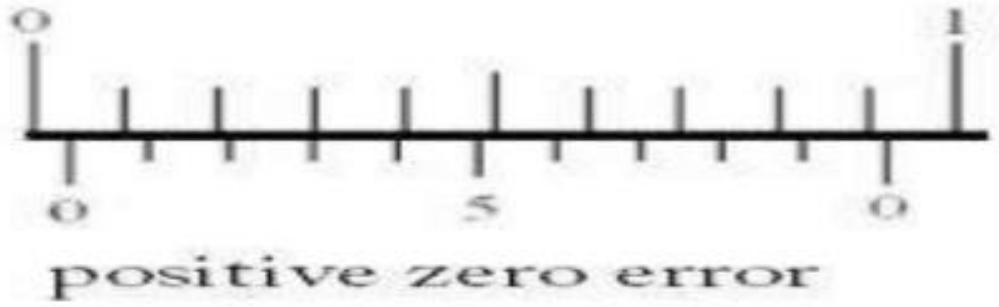
# ZERO ERROR:

- There is no zero error as zero line of vernier scale is coinciding with the zero of main scale.



# POSITIVE ZERO ERROR:

- Zero error is (0+0.03) cm as 3rd line of vernier scale is coinciding with main scale.

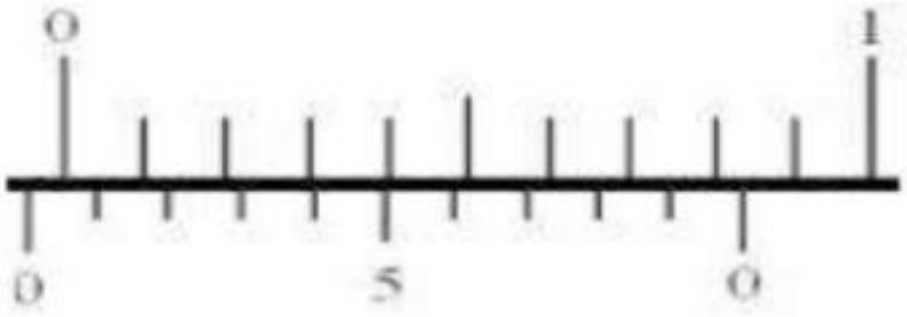


positive zero error

- Zero error is positive if the zero line of vernier scale is on the main scale.

# NEGATIVE ZERO ERROR:

- Zero error is (-0.1+0.05) cm as 5th line of vernier scale is coinciding with main scale.




negative zero error

- Zero error is negative if the zero line of vernier scale is outside the main scale.

## Measuring Internal Diameter

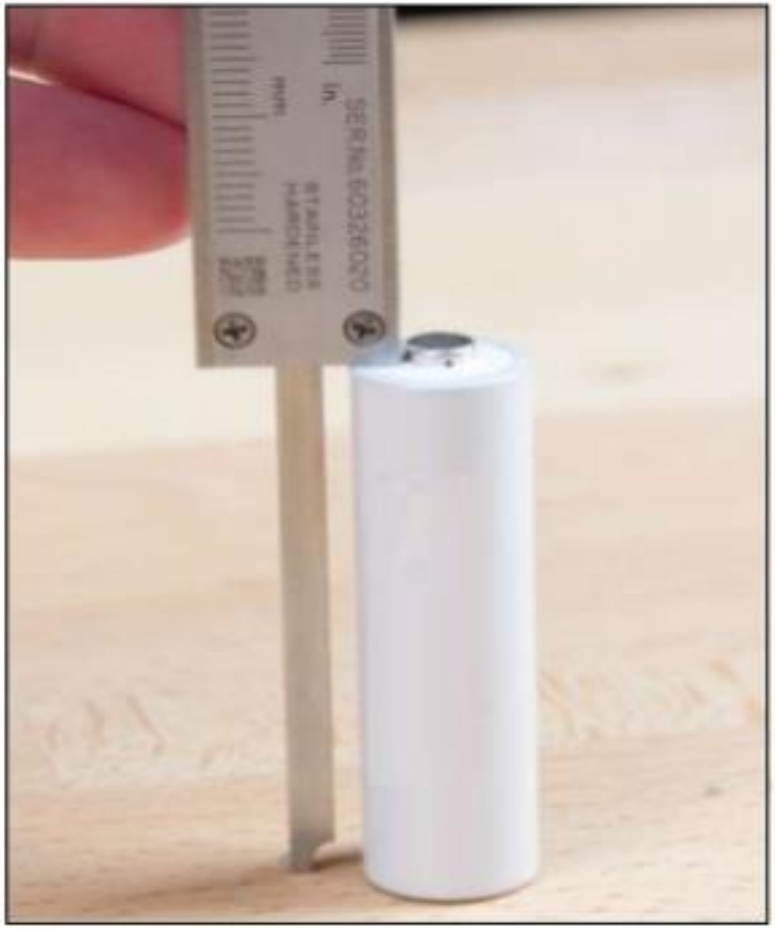
Use the inside jaws of the caliper as shown in fig.

## Measuring External Diameter

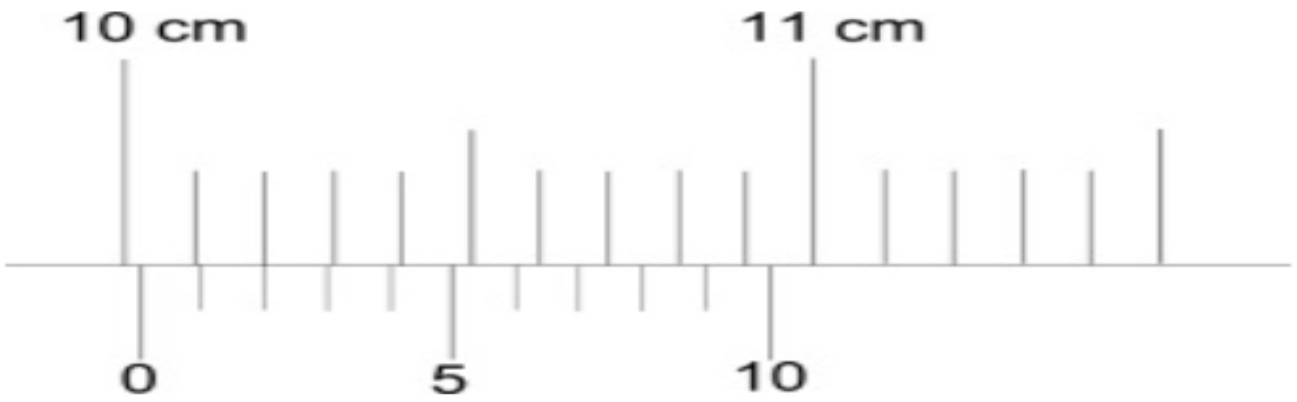
Use the outside jaws of the caliper as shown

## Measuring Depth of a Object

Use the depth gauge of the caliper as shown in fig.



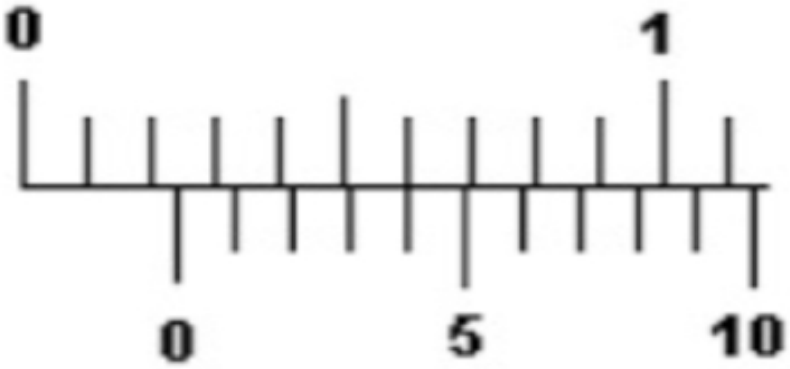
Let's go through another example to ensure that you understand the above steps:




**Main scale** reading: 10.0 cm (Immediate left of zero)

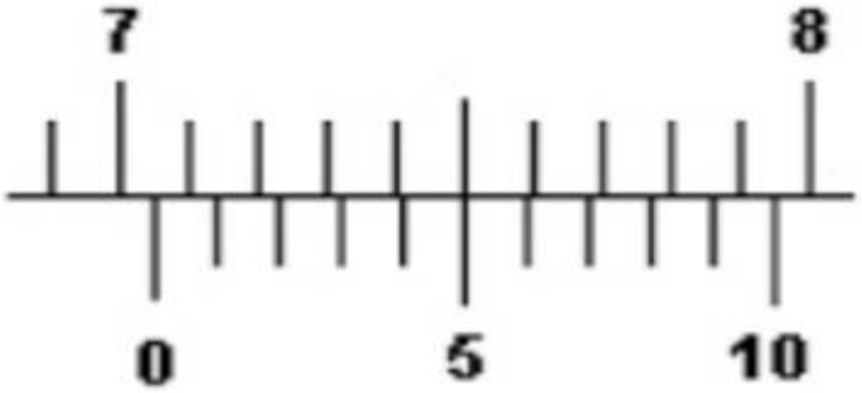
**Vernier scale** reading: 0.02 cm of scale lines)

**Measurement reading**: 10.02 c




$$TR = MSR + (VSR \times LC)$$

$$0.2\text{cm} + 0.04\text{cm} = 0.24\text{cm}$$

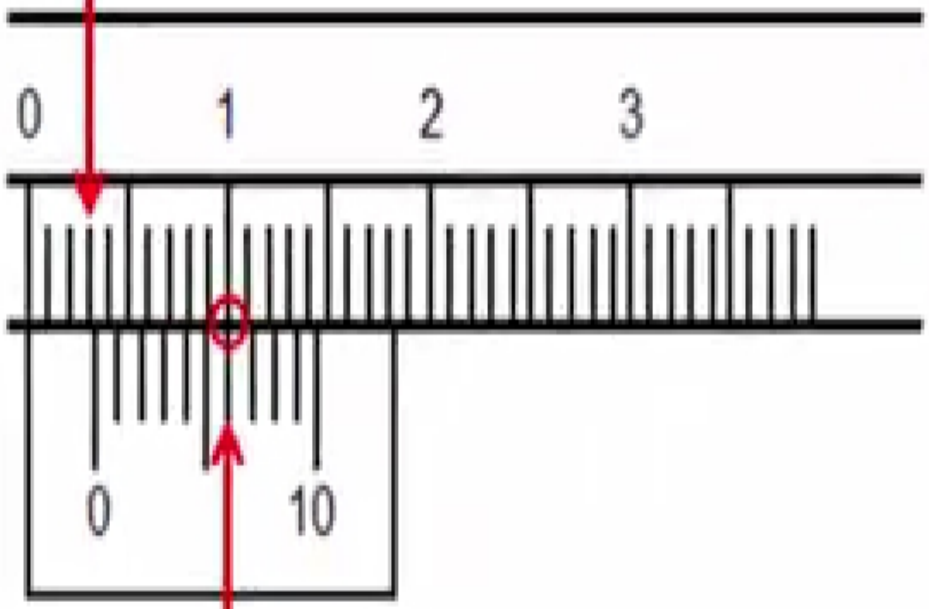



$$TR = MSR + (VSR \times LC)$$

$$7.0\text{cm} + 0.05\text{cm} = 7.05\text{cm}$$

- **Exercise 1**

Reading on main scale = 0.3 cm

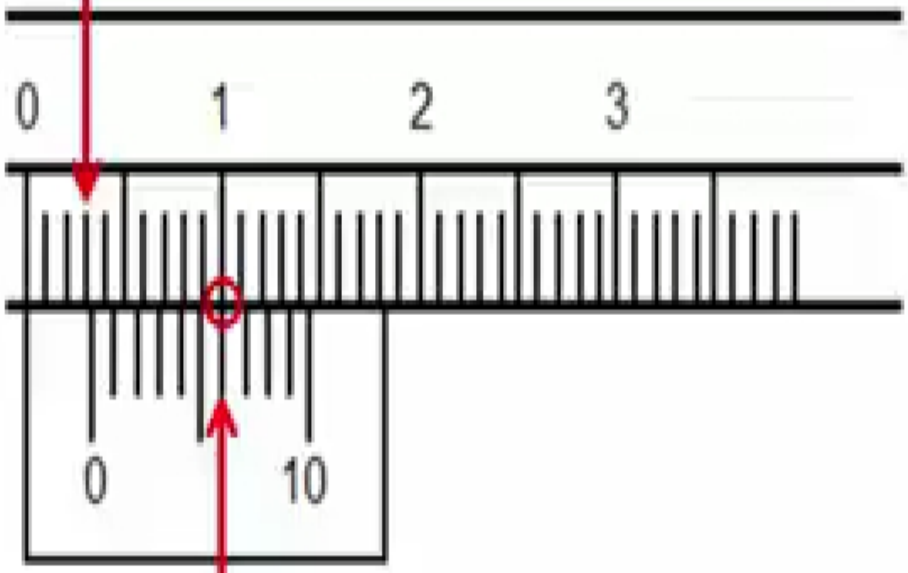



$$TR = MSR + (VSR \times LC)$$

Reading on vernier scale = 0.06 cm

- **Exercise 1**

Reading on main scale = 0.3 cm



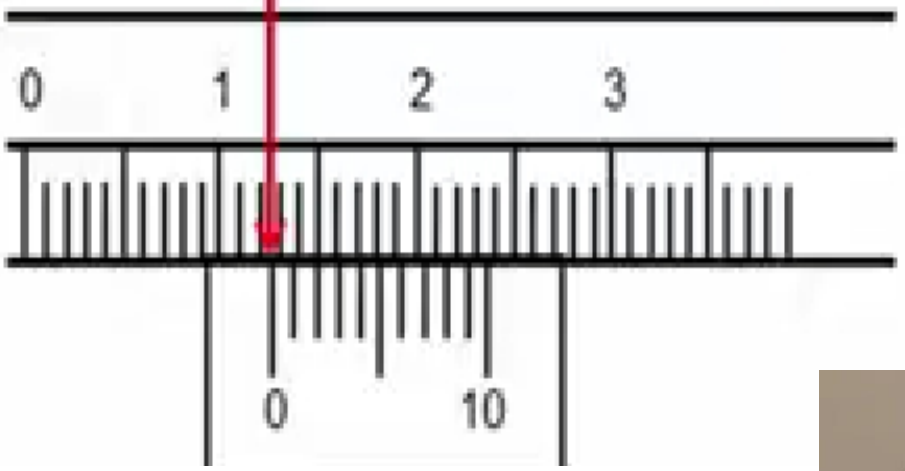

Length = 0.3 cm
+ 0.06 cm
---
0.36 cm
=======

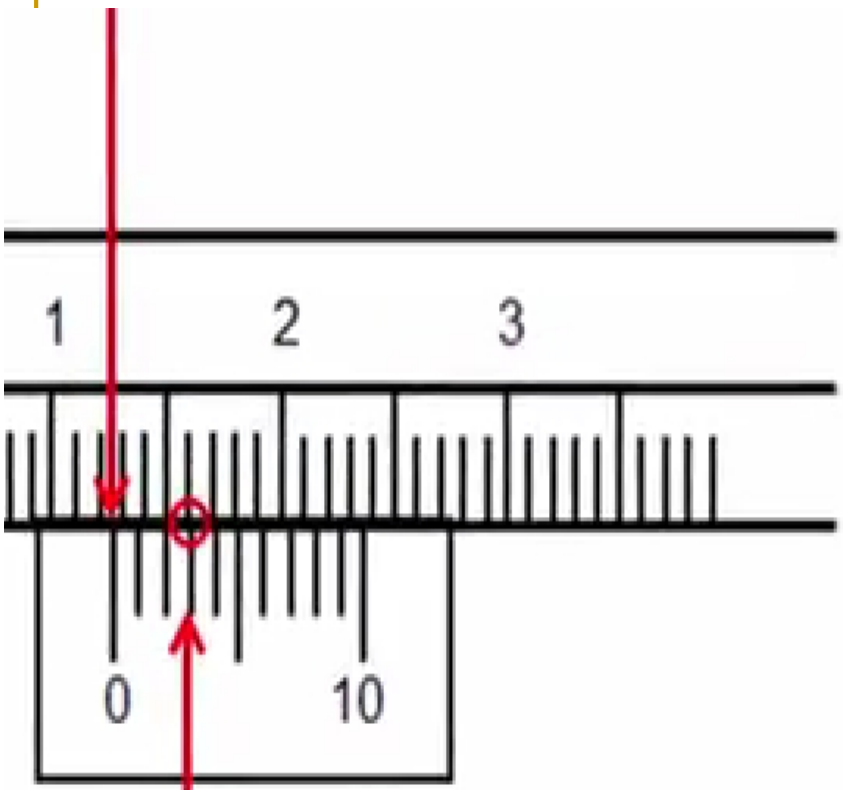
Reading on vernier scale = 0.06 cm

$$TR = MSR + (VSR \times LC)$$

## Exercise 2

Reading on main scale = 1.2 cm

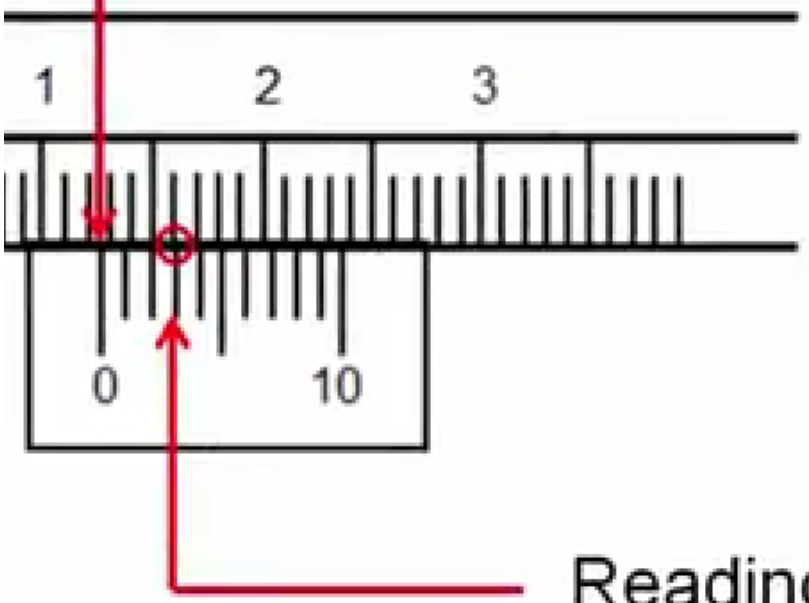



$$TR = MSR + (VSR \times LC)$$

Reading on vernier scale = 0.03 cm

Reading on main scale = 1.2 cm

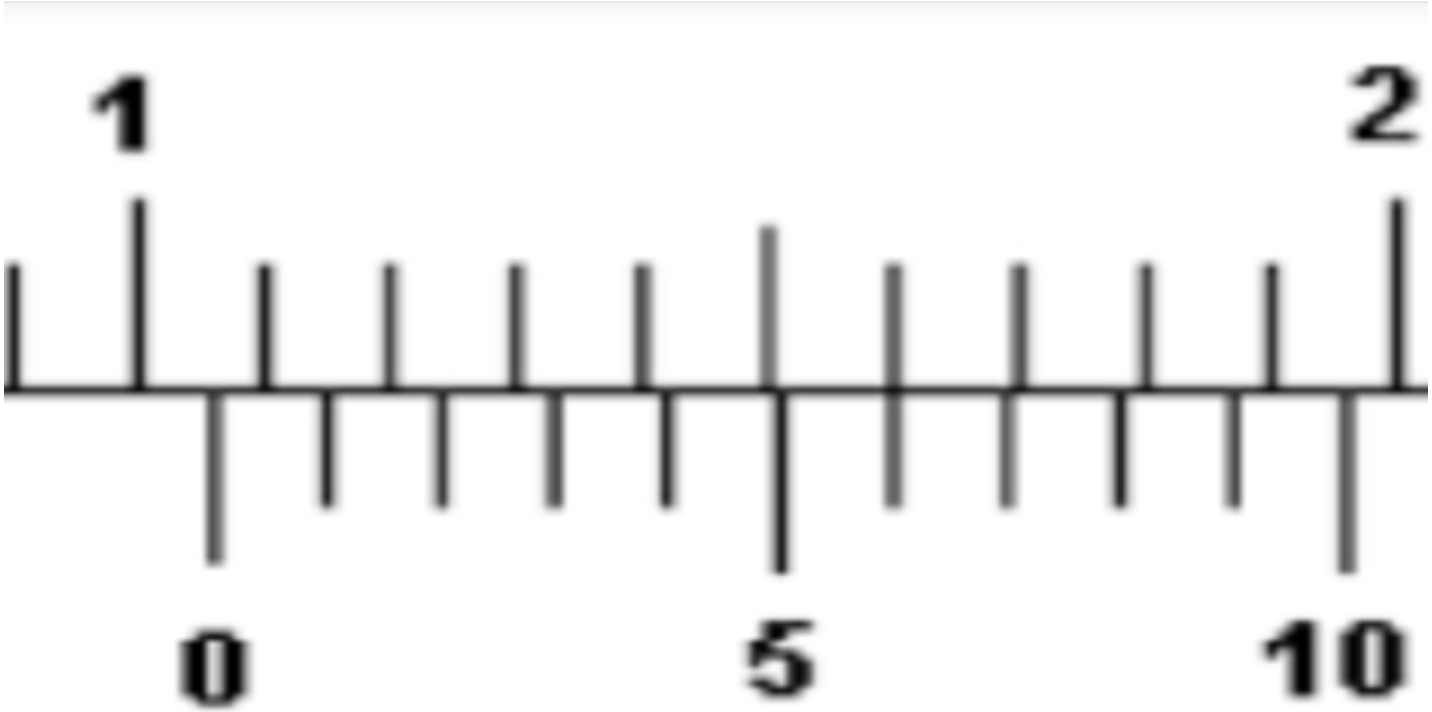



Length = 1.2 cm
+ 0.03 cm
---
1.23 cm
=======

Reading on vernier scale = 0.03 cm

$$TR = MSR + (VSR \times LC)$$

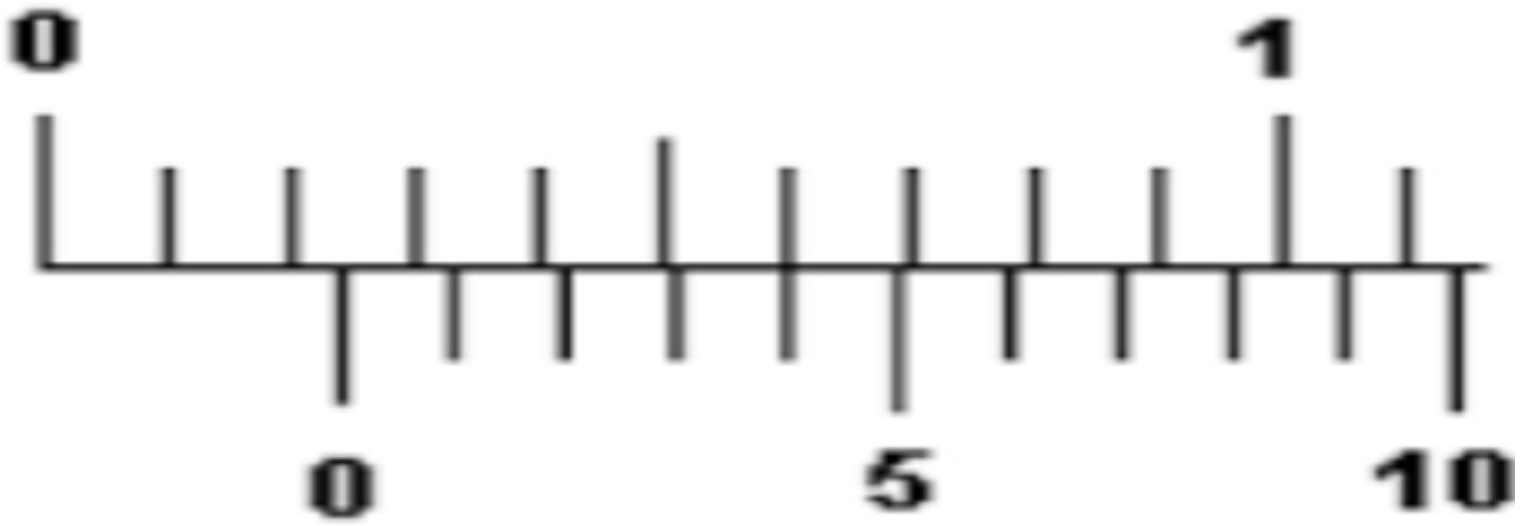
# Practice(01):




**Calculations:**

**TR= MSR + (VSR X 0.01) =**

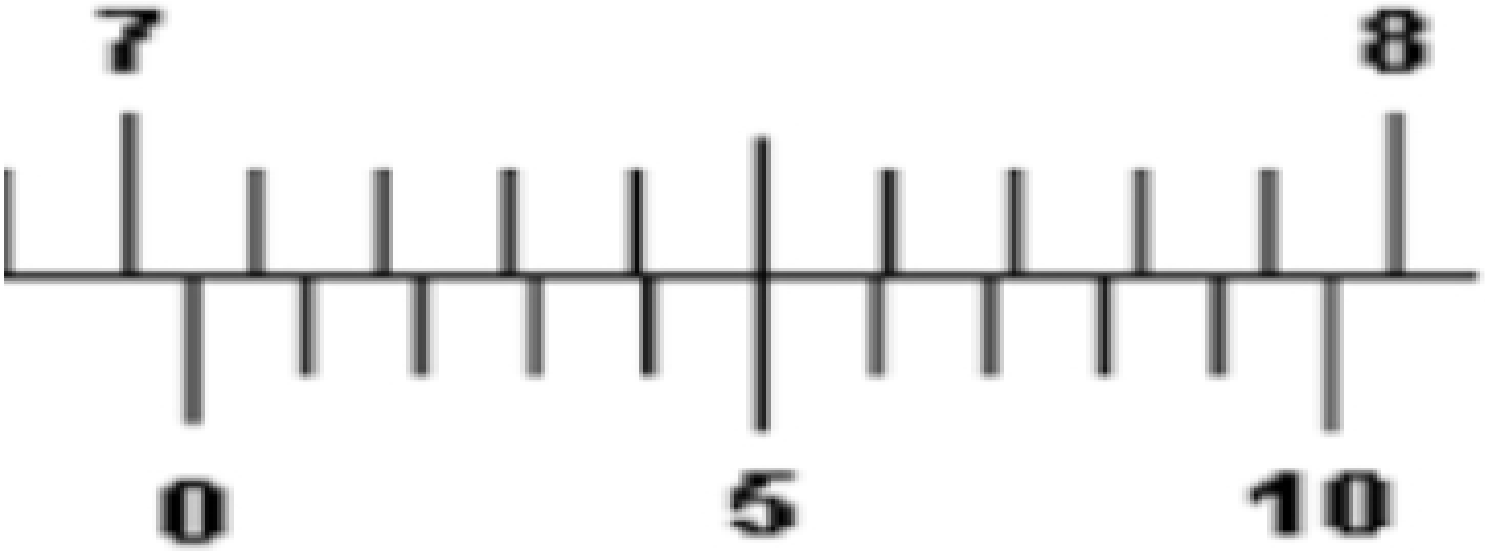
# Practice(02):




**Calculations:**

**TR= MSR + (VSR X 0.01) =**

# Practice(03):




**Calculations:**

**TR= MSR + (VSR X 0.01) =**

# Closure

1. Define measuring instruments.
2. Name any three measuring instruments.
3. Define vernier callipers.
4. How we can find least count of vernier callipers?
5. Differentiate between Measuring tape and vernier callipers.

# Home Work

1. STDS: Should make assignment on measuring instruments by using internet resources.

OR

2. STDS: should draw a labeled diagram of vernier calipers.

OR

3. STDS: should make a chart showing different type of zero errors in any measurement .

# Thank you…..