EXP. (1)

"Reading a Vernier Caliper"

Purpose:
In this experiment you will learn how to read vernier caliper.

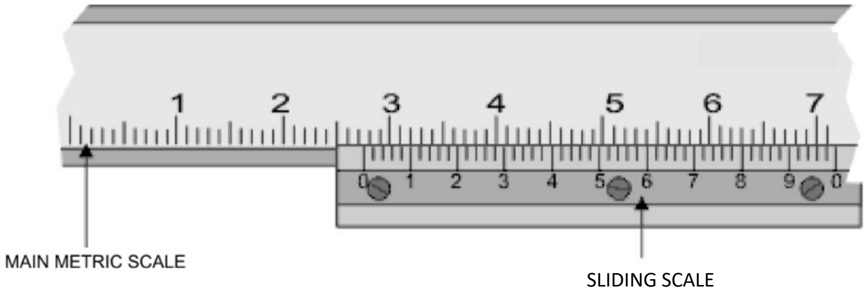
Equipment:

1. Vernier caliper.
2. Ball of various sizes.

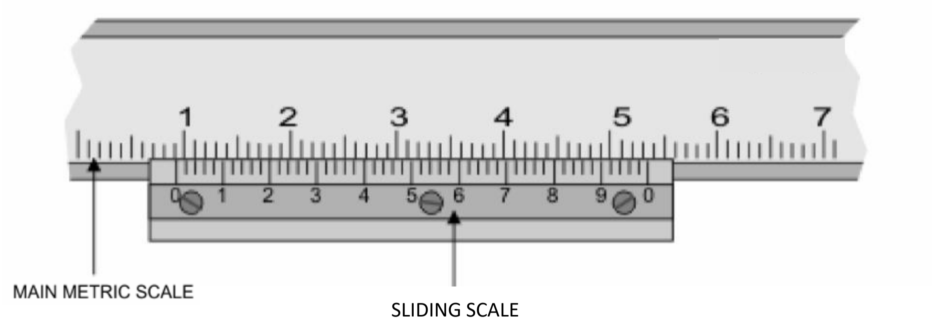
Pre-Lab Questions:

1. What is Vernier caliper?
2. State the dimensions that Vernier caliper can measure.
3. Read the Vernier caliper for the following measurements.

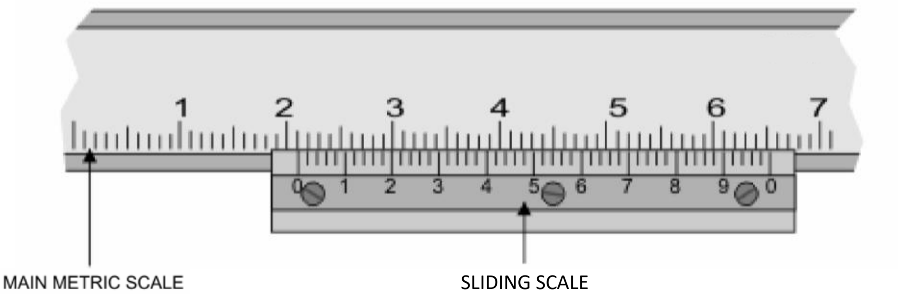
A)



B)



C)



Introduction and Theory:

The **Vernier Caliper** is a precision instrument that can be used to measure internal and external distances extremely accurately. The example shown below is a manual caliper. Measurements are interpreted from the scale by the user. This is more difficult than using a digital vernier caliper which has an LCD digital display on which the reading appears. The manual version has both an imperial and metric scale.

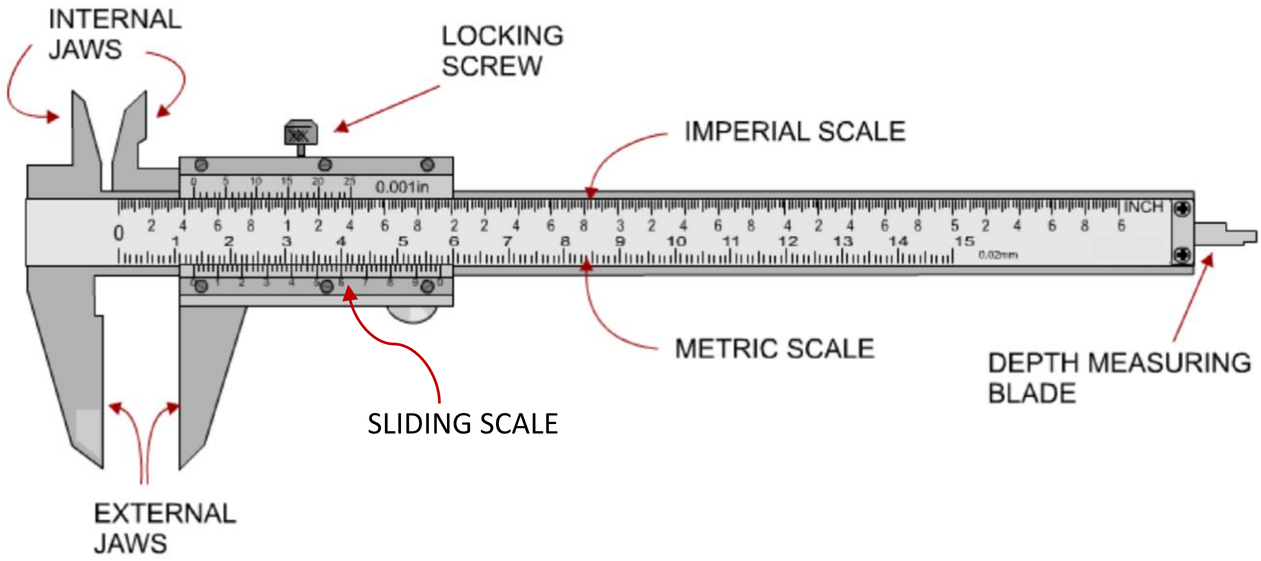
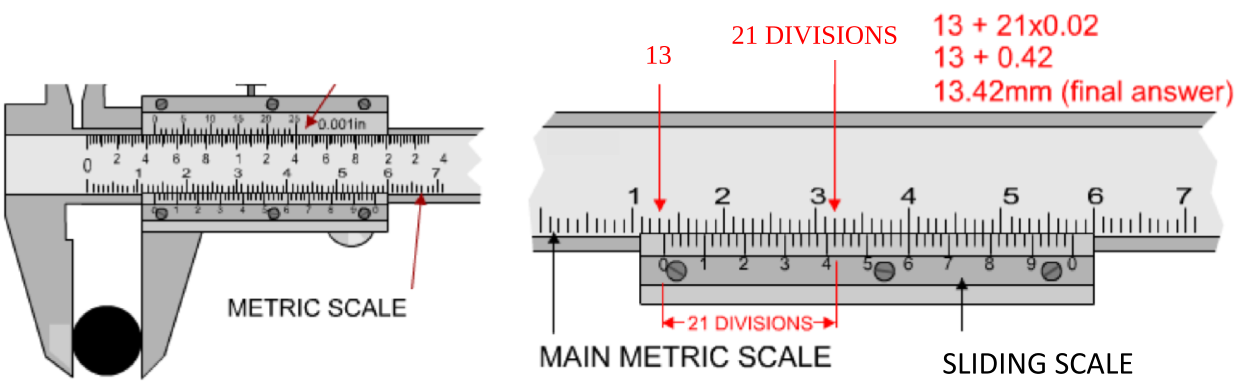


Figure 1: Shows how to read a measurement from the scales.

Example 1: The external measurement (diameter) of a round section piece of steel is measured using a vernier caliper, metric scale.



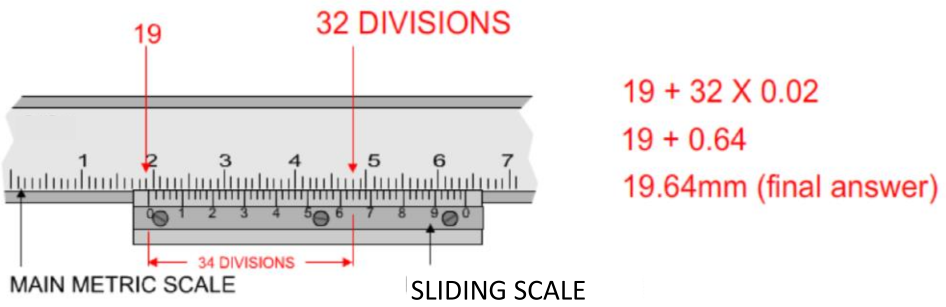
MATHEMATICAL METHOD

A) The main metric scale is read first and this shows that there are 13 whole divisions before the 0 on the hundredths scale. Therefore, the first number is 13.
B) The' hundredths of mm' scale is then read. The best way to do this is to count the number of divisions until you get to the division that lines up with the main metric scale. This is 21 divisions on the hundredths scale.
C) This 21 is multiplied by 0.02 giving 0.42 as the answer (each division on the hundredths scale is equivalent to 0.02mm).
D) The 13 and the 0.42 are added together to give the final measurement of 13.42mm (the diameter of the piece of round section steel)

COMMONSENSE METHOD

Alternatively, it is just as easy to read the 13 on the main scale and 42 on the hundredths scale. The correct measurement is 13.42mm.

Example 2:



Procedure:

Figure 2 below is a sketch of a typical vernier caliper, similar to the type you will use in this course. Most frequently you will use the larger "jaws" **(A)** to measure outer dimensions, such as the width of a block or circular rod (Figure 2a). This instrument can also be used to measure inner dimensions, such as the diameter of a hole, using part **(B)** (Figure 2b), as well as the depth of a hole, using part **(C)** (Figure 2c). The vernier scale is read the same in each case no matter which portion of the caliper is used take your measurement.

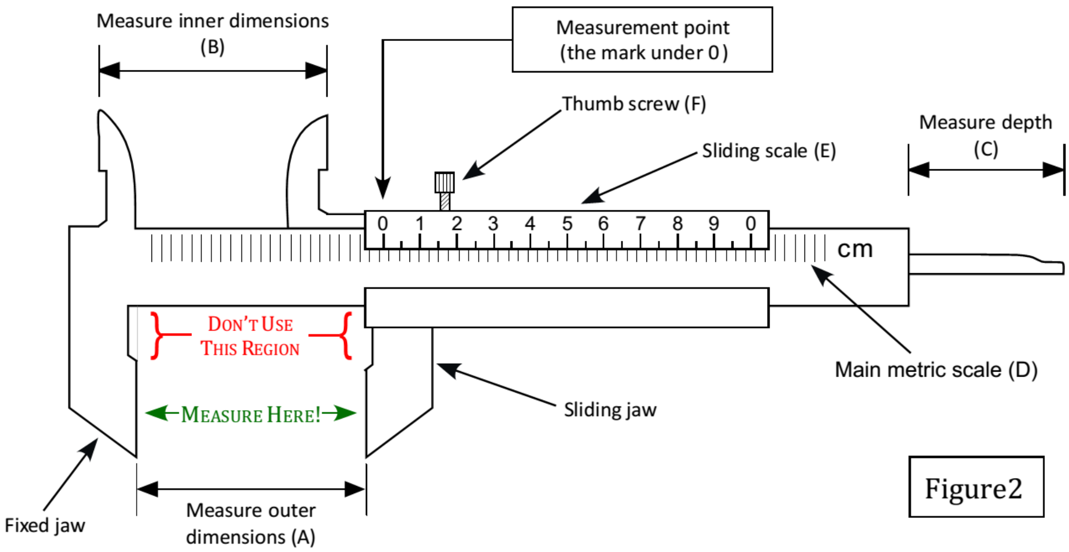


Figure2

Most vernier calipers have both metric and English scales; make sure that you read the correct scale. The main metric scale **(D)** is marked in increments of 1 mm; the sliding scale **(E)** has numbers marking 0.1 mm increments, and small lines marked in 0.02 mm increments.

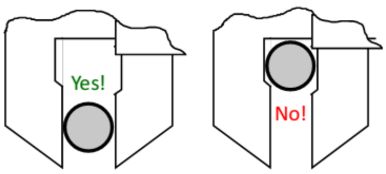


Figure2a
Correctly measure outer dimension

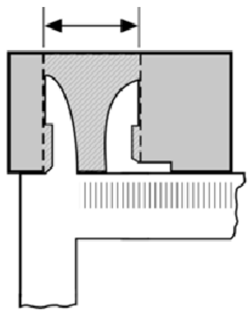


Figure2b
Measurement of diameter inside a hole

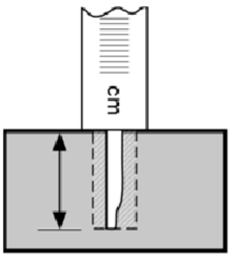


Figure2c
Measurement of hole depth

Measurements are taken as follows:

1. Loosen the thumb screw clamp **(F)**, if necessary, and close the sliding jaw so that it fits snugly on the object to be measured. If the object is circular or spherical, make sure you are measuring at the widest point. When measuring outer dimensions, be sure to use the flat section of the caliper jaws; don't use the region marked in Figure 2. See Figure 2a for the proper placement of a small circular object.
2. Gently tighten the thumb screw clamp, and remove the caliper from the object; the screw will allow you to move the caliper without changing the position of the sliding jaw. Hint: You can make a first approximation of the measurement – within the main metric scale – by laying the caliper on top of a ruler or meterstick and measuring the distance between the jaws.
3. Now look at the scale on the sliding jaw, as shown in the magnified image of this region below:

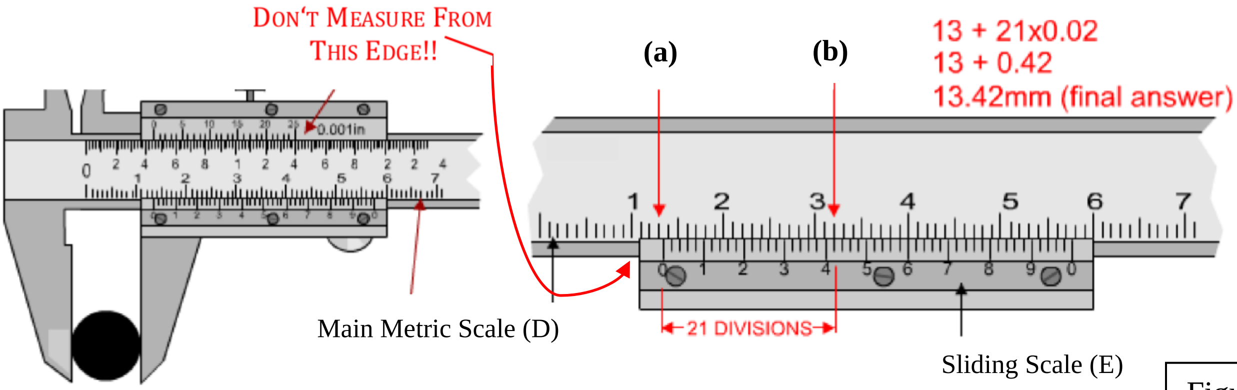


Figure 3:

The measurement up to the first digit after the decimal point is obtained by looking at below the first zero that appears on the sliding scale, as indicated by point **(a)** in Figure 3 above. In this example you will note that this mark falls between the 13 and 14 mm mark on the main metric scale, so we know our measurement falls within this range. Therefore, we'll start our measurement with **13**.

Note: A common mistake is to begin reading from the edge of the sliding scale; make sure your measurements are taken from point **(a)**, the line directly below the first zero on the sliding scale, or your reading will be short by several millimeters.

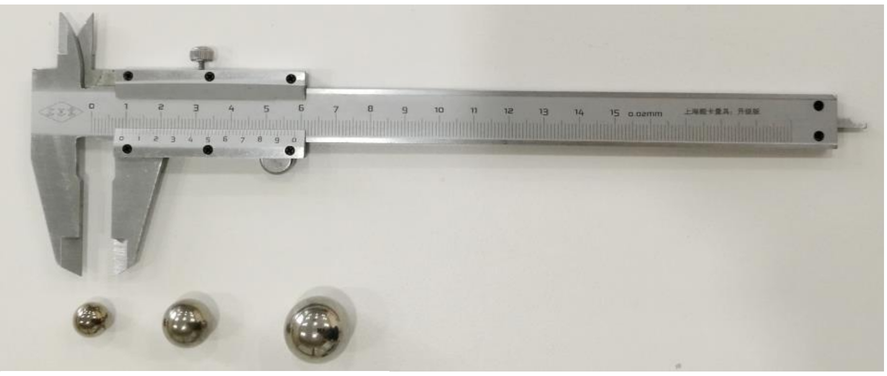
4. The next two digits are read by carefully finding the mark on the sliding scale **(E)** that is best aligned with a mark on the main metric scale **(D)**. Several may look as though they line up, but only one will match best (Hint: Hold the caliper at a slight angle away from you, and close one eye!).

In the example above, we see that the second small mark to the right of 4 on the sliding scale is aligned with a mark on the main metric scale, at point **(b)**. The last two digits of your measurement come from the sliding scale, not the main metric scale! Since the marks on the sliding scale are **0.02 mm** apart, the mark at point **(b)** represents **21x0.02 = 0.42** mm.
Adding our total measurement together, we get **13.42 mm** as our final reading.

It is important to remember that the last digit of your measurement will always be an even number with the calipers you will be using!

Practice using the vernier caliper by measuring several objects found in the lab. Check your measurements with your lab partner; if there is disagreement, check the vernier scale again. Be sure to ask your instructor if you're still unsure as to the correct procedure!

Data collection and Calculations:



Ball 1 Ball 2 Ball 3

Table 1: Measuring various Physical quantities with Vernier caliper.

No.	**Various balls**	**Physical Quantity (mm)**	**Physical Quantity (m)**
1	Ball diameter		
2	Ring thickness	D_{Outer} =	
		D_{Inner} =	
3	Cylinder Depth		

Ring thickness = Outer diameter – Inner diameter

Table 2: Measuring diameter of different ball sizes with Vernier caliper.

No.	**Various balls**	**Diameter (mm) D**	**Radius (mm)**	**Radius (cm)**	**Radius (m) r**	**Volume of Sphere (m^3)** $V_{Sphere} = \frac{4\pi}{3} r^3$
1	Ball 1					
2	Ball 2					
3	Ball 3					

$$V_{Ball,1} = \frac{4\pi}{3} r_1^3$$

$$V_{Ball,2} = \frac{4\pi}{3} r_2^3$$

$$V_{Ball,3} = \frac{4\pi}{3} r_3^3$$