FACULTY OF ENGINEERING

DESIGN AND PRODUCTION ENGINEERING DEPARTMENT

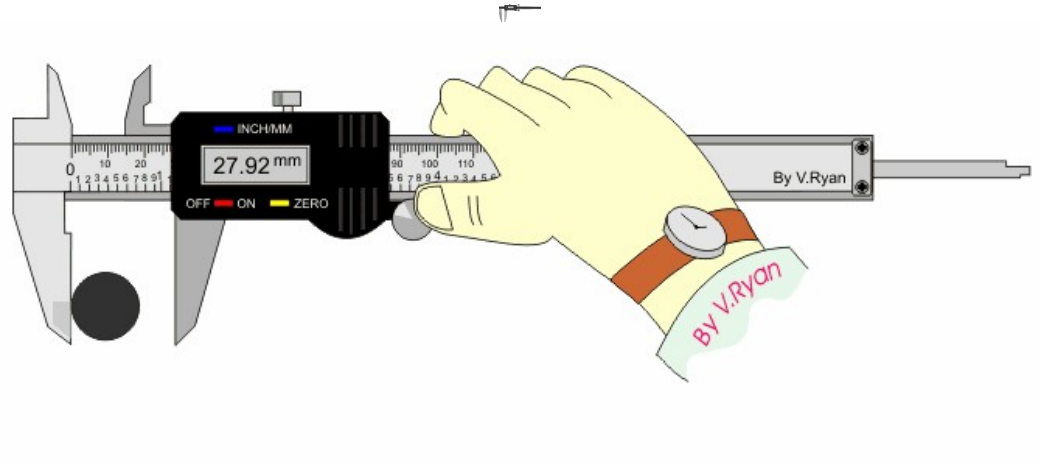
MEASURING INSTRUMENTS

3 rd Year Production

Report On:

(3)

Verniers



Metrology laboratory

Student Name	***Remark***
Class No:	***Signature***
B.N.	

2008/2009

Vernier

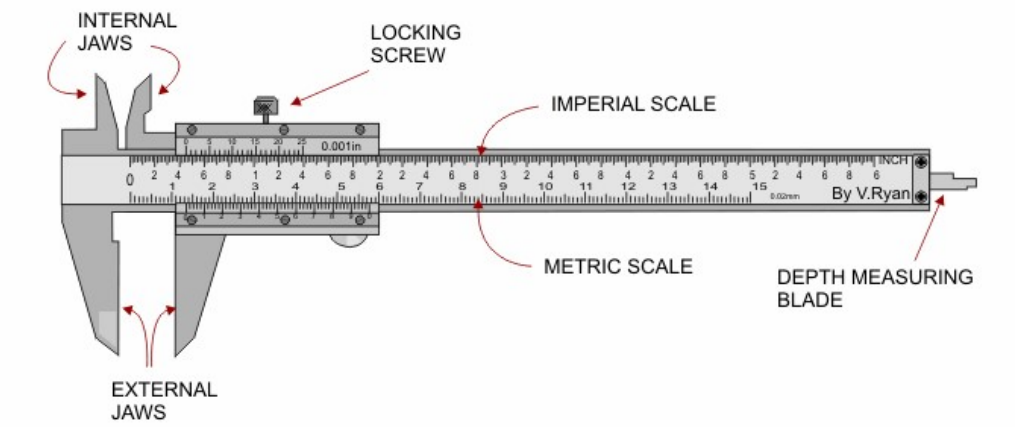
Introduction

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.

Manually operated vernier calipers can still be bought and remain popular because they are much cheaper than the digital version. Also, the digital version requires a small battery whereas the manual version does not need any power source.

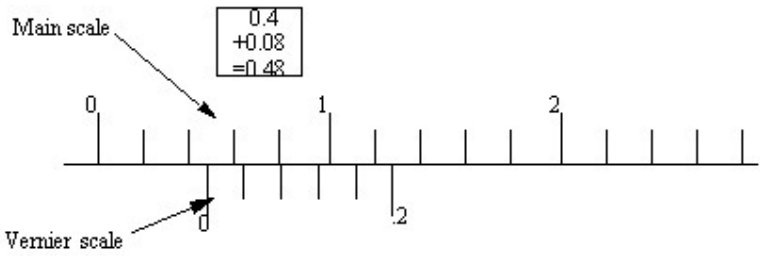
The Vernier-Scale principle was invented in 1631 by Pierre Vernier. The vernier is an additional (auxiliary) sliding scale that is used in place of pointer of indication line on the movable member and it enables the main fixed scale to be read to a small value.

Working of vernier caliper



Vernier scales have normal scale components, but also incorporate a small secondary scale that subdivides major increments.

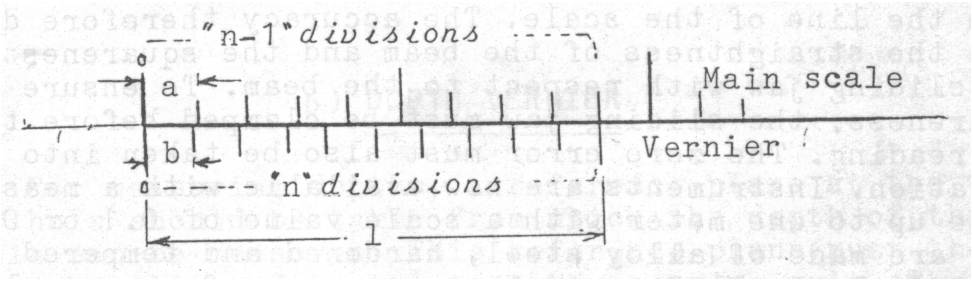
This secondary scale is based on a second scale that is one increment shorter than a main scale. If the secondary scale is compared to the main scale, it will indicate relative distance between two offsets.



The scale pictured above would normally be on an instrument, and the main and vernier scales would slide relative to each other. The `0' on the vernier scale would be used to take the reading from the main scale. In this example the main scale would read a value that is between 0.4 and 0.6. (Note: it is not considered good practice to round this to 0.5)

Principle of Vernier

The auxiliary (vernier) scale consists of (n) equal divisions on one side of the vernier zero. These (n) vernier divisions are equal to (n-1) divisions of the main scale.

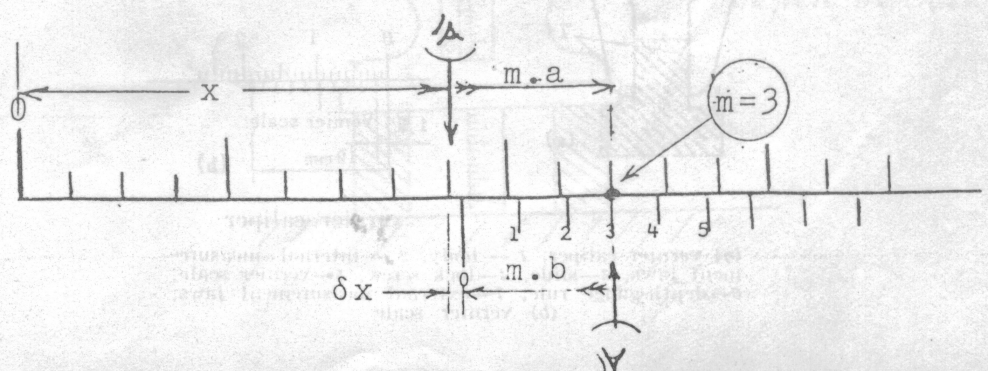


Consequently, one vernier division is equal to (n-1)/n, of the main scale division. Thus, each vernier is shorter than the scale division by (1/n) of the main scale division. This quantity (1/n) of the scale division is called the scale value of vernier.

Therefore, if the distance between two successive graduations on the main scale is equal (a) which is called scale division, i.e.

- Vernier scale value = a (1/n)
- Scale division of vernier (b) = a (1-1/n)
- Length of vernier scale (1) = a (n-1)

Generally, during vernier use the distance (x + δx) between the zero marks of main scale and vernier scale can be read according to the following rule:



The reading (x) of the main scale is first taken up the zero mark of the vernier, then the reading of the vernier scale graduation (m) that coincide with a division on the main scale is noted, which give the fraction (x) of the main scale graduation according to the scale value of the vernier (a/n).

i.e. $\delta x = m (a-b) = m.a (1/n)$

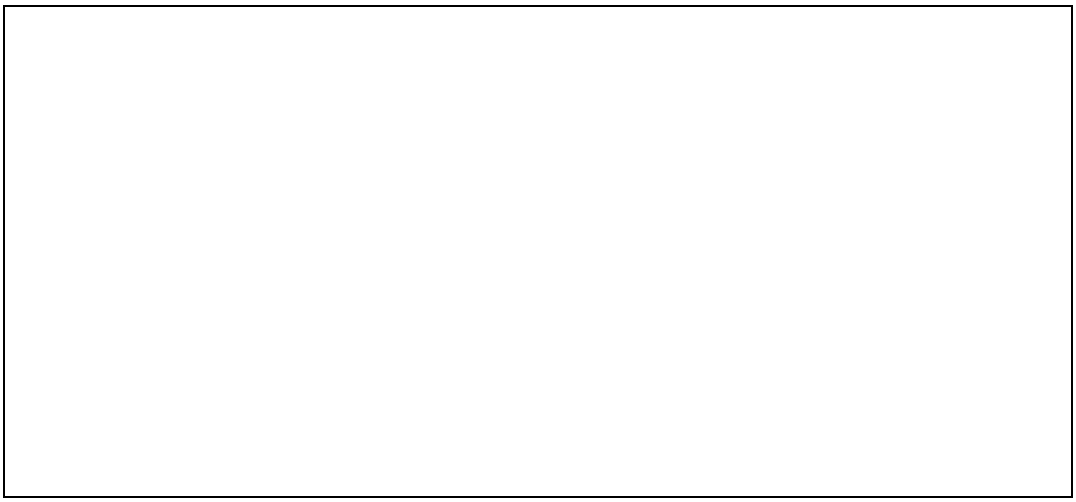
$= m.$ scale value of vernier

Instruments based on the vernier principle

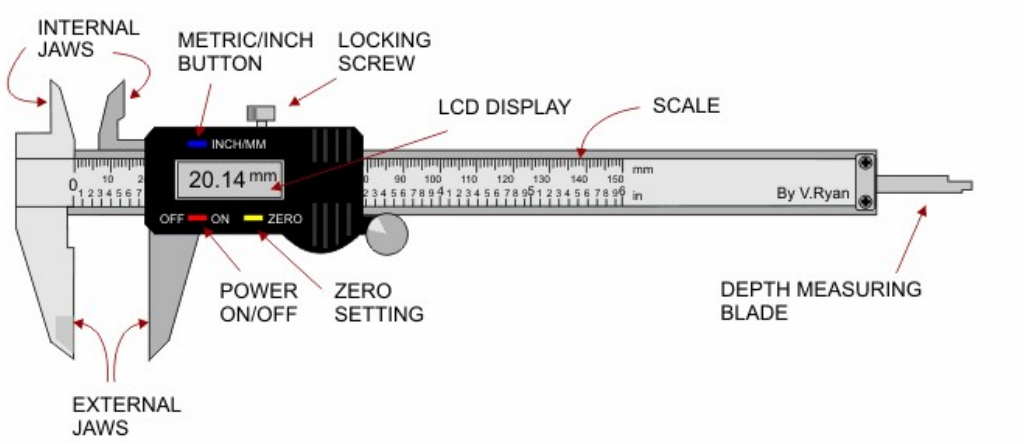
The vernier instruments generally used in workshop and engineering metrology have comparatively low accuracy. The line of measurement of such instruments does not coincide with the line of the scale. The accuracy therefore depends on the straightness of the beam and the squareness of the sliding jaw with respect to the beam. To ensure the squareness, the sliding jaw must be clamped before taking the reading. The zero error must also be taken into consideration. Instruments are now available with a measuring range up to one meter with a scale value of 0.1 or 0.2 mm they are made of alloy steel, hardened and tempered to about 58 Rockwell C, and the contact surfaces are lapinshed. In some cases stainless steel is used.

(a) VERNIER CALLIPERS

Vernier calipers are usually of the internal – external type used for internal and external measurement. Recent constructions are made of the combined type providing means for external, internal and depth measurements.



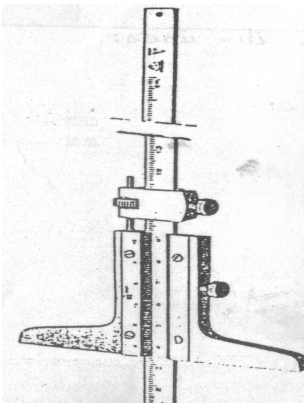
They consist of a beam with a graduated scale made integral with the fixed jaw. A sliding jaw carrying a vernier scale slides on the beam and is provided with some means of locking. Some types of vernier calipers are provided with a fine adjustment clamp attached to the sliding jaw by means of a find adjustment screw to allow for small movement of the sliding jaw. The clamp slides with the sliding jaw on the beam. The combined type external, internal and depth vernier calipers have usually a measuring range of 160 mm with a scale value 0.1 mm. the maximum diameter of work that can be measured conveniently is 80 mm whereas the diameter of the hole whose depth can be measured should not be smaller than 4 mm.



Digital Vernier Caliper

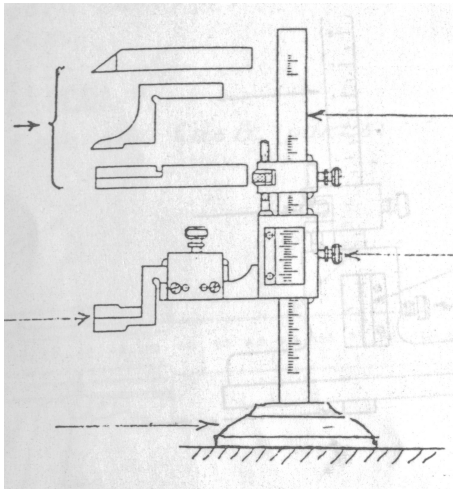
(b) DEPTH VERNIER

For measuring depths, a reference plane at the top of hole should be taken from which the depth of this hole can be measures. This reference plane must therefore be flat and normal to the measuring axis. The reference plane of the combined type (internal, external and depth) vernier calipers, if it is used for depth measurement, is comparatively small. This lead to serious error if the instrument is used for measuring depths of holes having diameter greater than the width of the reference plane, (width of the beam). For bigger holes, depth vernier is used.



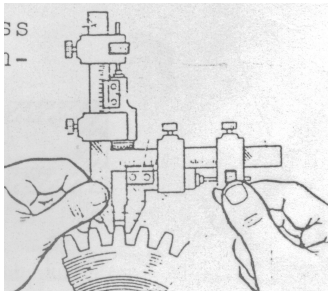
(c) HEIGHT VERNIER

They employ the vernier principle similar to the instruments mentioned before. They consist of a stable cast iron or steel base with accurately lapped lower face and rigid vertical column with a graduated scale, along which the sliding jaw moves. Some types are provided with a fine adjustment screw. Various attachments are often supplies to enable the instrument to be used for scribing or for measuring depth of holes. With a knife type measuring jaw, the instrument can be set to zero reading when the lower surface of the sliding jaw makes contact with the reference plane which can be a surface plane. Otherwise, with straight sliding jaw, a nominal dimension of 5 or 9 cm is usually to begin with.



(d) GEAR-TOOTH VERNIER

It is used to measure the thickness of gear teeth at pitch or chordal thickness of the teeth and the distance from the top of a tooth to the chord. The thickness of a tooth at pitch line and the addendum is measured by an adjustable tongue each of which is adjusted independently by adjusting screw on graduated bars. The effect of zero error should be taken into consideration.



How to read a measurement from the vernier scale

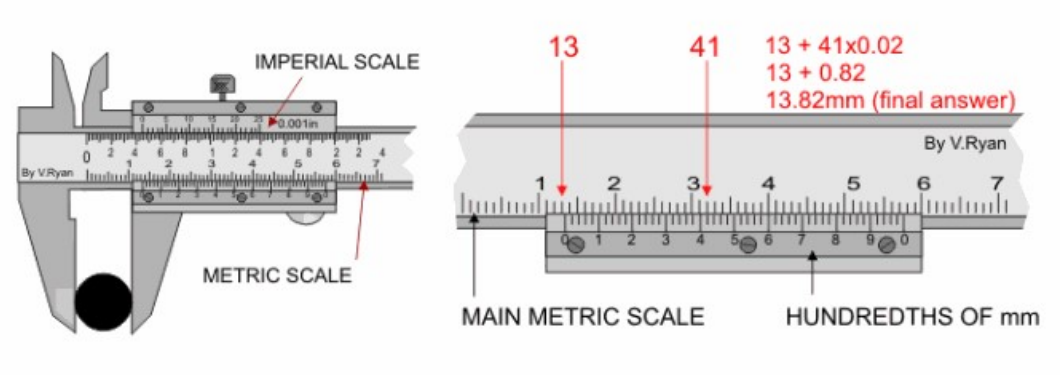
EXAMPLE 1: The external measurement (diameter) of a round section piece of steel is measured using a vernier caliper, metric scale.

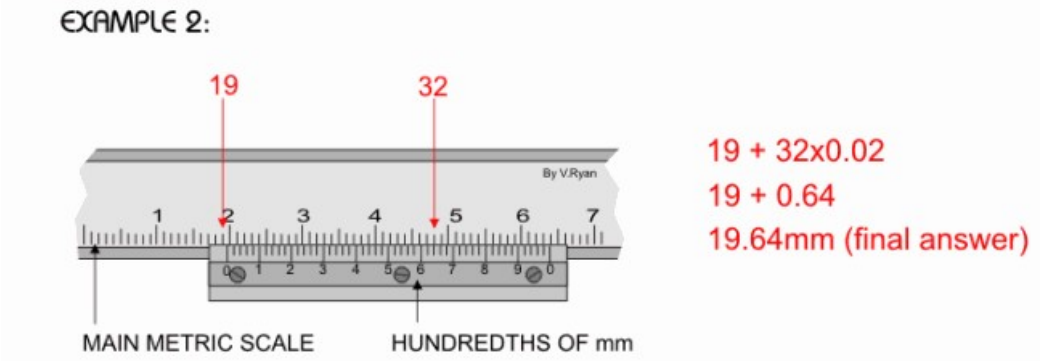
A. The main metric scale is read first and this shows that there are 13 whole divisions before the 0 on the hundredths scale. Therefore, the first number is 13.

B. The' hundredths of mm' scale is then read. Only one division on the main metric scale lines up with a division on the hundredths scale below it, whilst others do not. In the example below, the 41st division on the hundredths scale lines up exactly with a division on the metric scale above.

C. This 41 is multiplied by 0.02 giving 0.82 as the answer (each division on the hundredths scale is equivalent to 0.02mm).

D. The 13 and the 0.82 are added together to give the final measurement of 13.82mm (the diameter of the piece of round section steel).





The experiment

Main Objective:

To study the construction, specifications, purpose and application of different types of vernier.

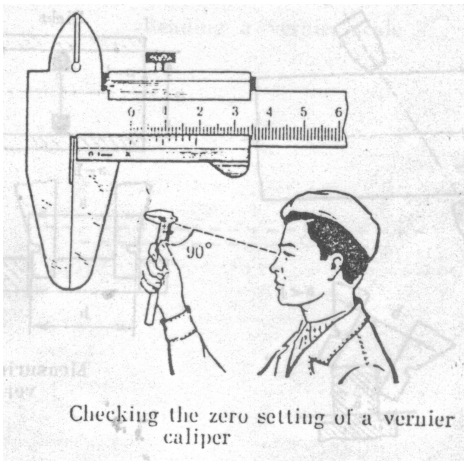
Apparatus:

1. Different types of gauge vernier;
    i. vernier caliper;
    ii. depth vernier;
    iii. height vernier;
    iv. Gear tooth vernier.
2. Magnifying lens.
3. Surface plate.
4. External micrometer (range 0 – 150 mm)
5. Objects to be measured.

Precautions:

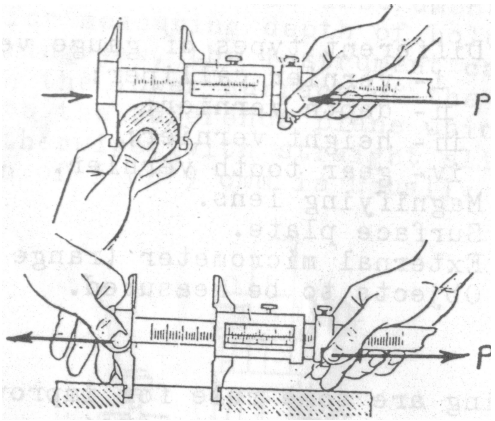
The following are some rule for improving the accuracy of measurement using verniers:

1. Check to see that the measuring surfaces of vernier are free from rust, score, scratches and other defects. Check also that the jaw edges are not broken;
2. Check to see that the vernier slide can move smoothly and easily along the beam;
3. Check the zero setting of the vernier gauge as well as parallelism of the measuring jaws;



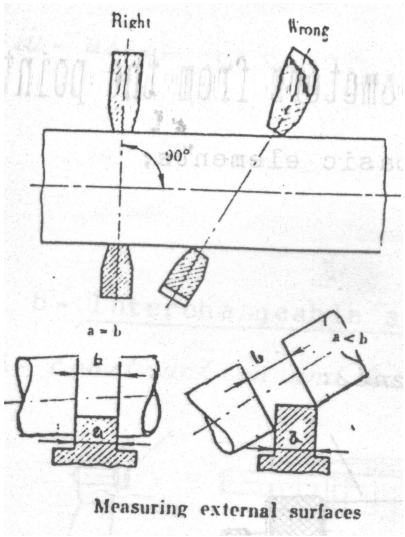
Checking the zero setting of a vernier caliper

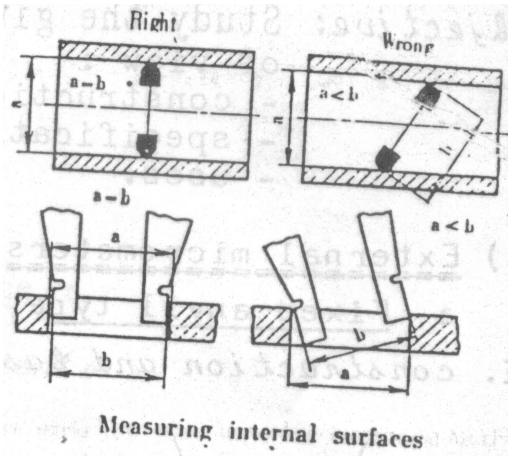
4. The pressure exerted with jaws on the work piece must be appropriate. The jaws must touch the work piece firmly without jamming;
5. The direction of pressure (p) must coincide with the centre line of measuring; to avoided jamming on the sliding surfaces of the vernier caliper;



6. Put the work piece to be measured near to the body of the vernier, as far as possible from the end of measuring jaws;

7. Be sure that the jaws are always at right angle to the work surface. Otherwise the instrument would read higher value the actual one;



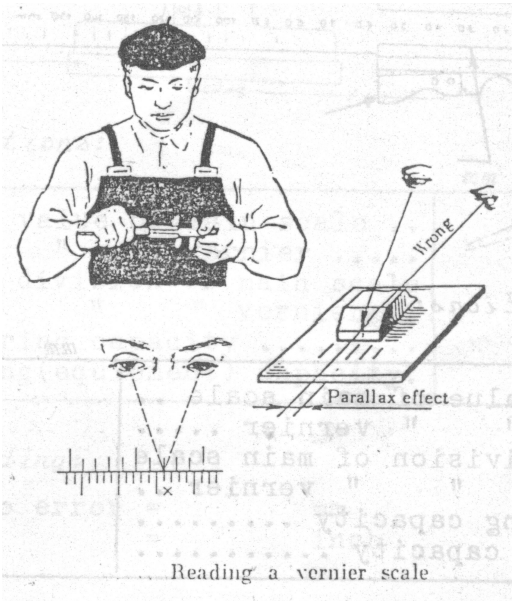


8. When measuring with depth vernier; the base of gauge must be pressed firmly on surface;

9. Be careful when touching the work piece with the measuring point of the height vernier; i.e. not raise the gauge base, which lead to a wrong value;

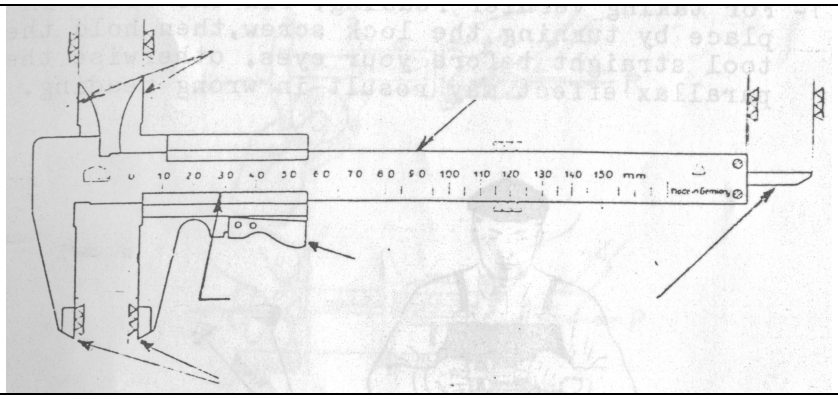
10. Avoided touching the measuring surfaces with bar hands, and avoid holding the measuring gauge in your hand too long;

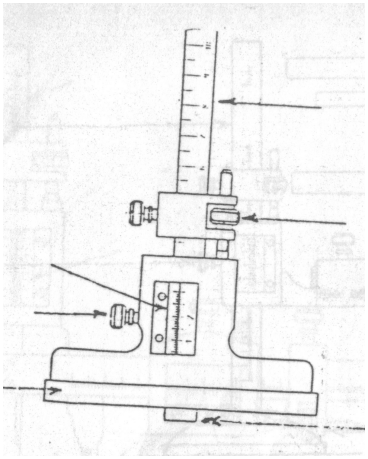
11. For taking vernier reading, fix the slide in place by turning the lock screw, then hold the tool straight before your eyes, otherwise the parallax effect may result in wrong reading.



Reading a vernier scale

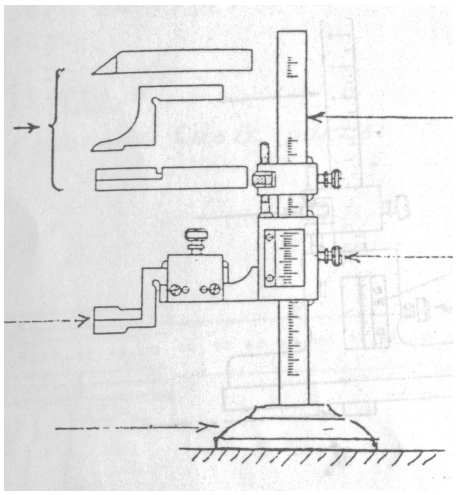
Objective: Study the given verniers according to the following points of view:

<table>
<tr><td colspan="3">Vernier Caliper</td></tr>
<tr><td colspan="3">1-Construction and Basic parts</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td colspan="3">2- Specification</td></tr>
<tr><td></td><td>mm</td><td>inch</td></tr>
<tr><td>Scale value of the main scale
Scale value of the vernier scale</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Scale division of main scale
Scale division of vernier scale</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Measuring capacity
Working capacity</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">3- Zero reading</td></tr>
<tr><td>External measurement
Internal measurement
Depth measurement</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">4- Uses</td></tr>
<tr><td colspan="3"></td></tr>
</table>

Depth vernier		
1-Construction and Basic parts		
		
2- Specification		
	mm	inch
Scale value of the main scale		
Scale value of the vernier scale		
Scale division of main scale		
Scale division of vernier scale		
Measuring capacity		
Working capacity		
3- Zero reading		
Depth measurement		
4- Uses		

Height vernier

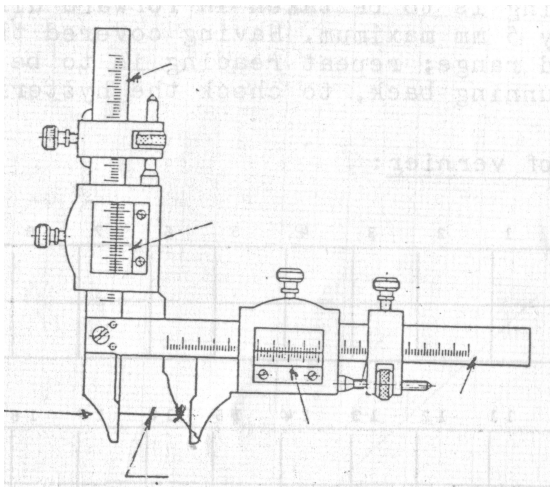
1-Construction and Basic parts



2- Specification

	mm	inch
Scale value of the main scale		
Scale value of the vernier scale		
Scale division of main scale		
Scale division of vernier scale		
Measuring capacity		
Working capacity		

4- Uses

Gear Tooth Vernier		
1-Construction and Basic parts		
		
2- Specification		
	V	H
Scale value of the main scale		
Scale value of the vernier scale		
Scale division of main scale		
Scale division of vernier scale		
Measuring capacity		
Working capacity		
3- Zero reading		
Vertical measurement		
Horizontal measurement		
4- Uses		

Objective: find the graduation error of vernier caliper over the whole scale using external micrometer.

Note: Reading is to be taken in forward direction every 5 mm maximum. Having covered the required range; repeat reading is to be taken by running back, to check the hysterisis.

a) Calibration of vernier:

Reading:

	1	2	3	4	5	6	7	8	9	10
Vernier										
Micrometer										

	11	12	13	14	15	16	17	18	19	20
Vernier										
Micrometer										

	21	22	23	24	25	26	27	28	29	30
Vernier										
Micrometer										

	1	2	3	4	5	6	7	8	9	10
Vernier										
Micrometer										

Backward direction

	1	2	3	4	5	6	7	8	9	10
Vernier										
Micrometer										

Check Linearity

Results & Discussion

Check hysterises

Results & Discussion

Objective

Measure the complete dimensions of the given part using the vernier caliper.

Note:

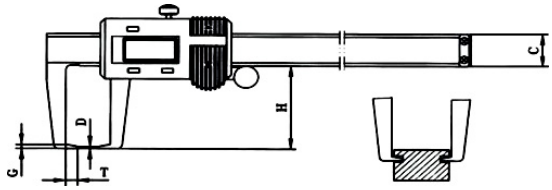
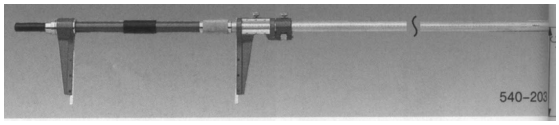
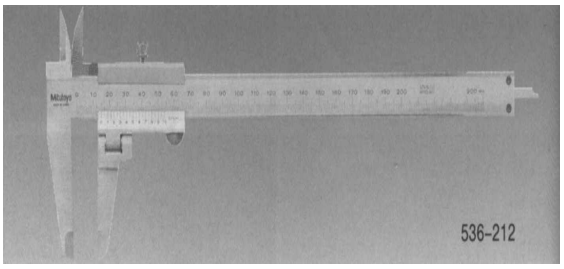
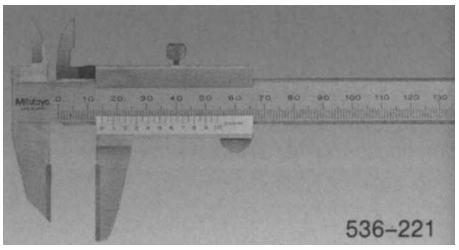
- Follow the rule of improving measuring accuracy as prescribed before.
- Readings must be repeated at least 3 times for each dimension, then compute the average
- Zero error should be taken into consideration, if existed

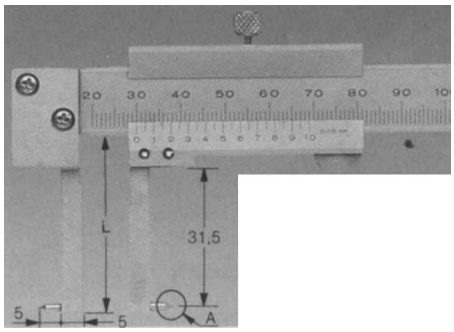
Sketch of given part

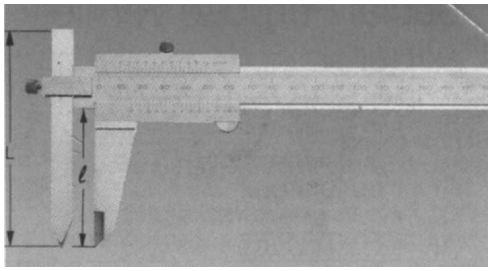
Readings				
Items	Angle Readings			Average
	1	2	3	

Discussion

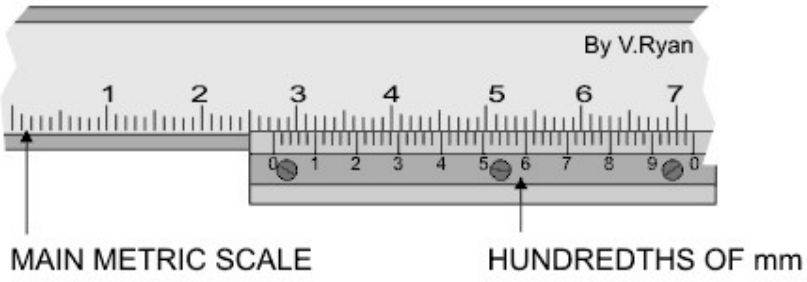
State the purpose of each of the following special purpose Verniers



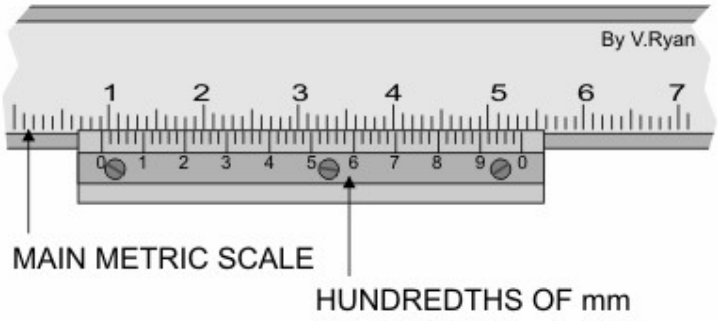


QUESTION 1:



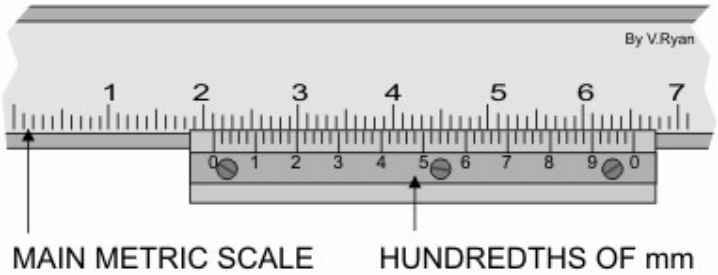
ANSWER:

QUESTION 2:



ANSWER:

QUESTION 3:



ANSWER: