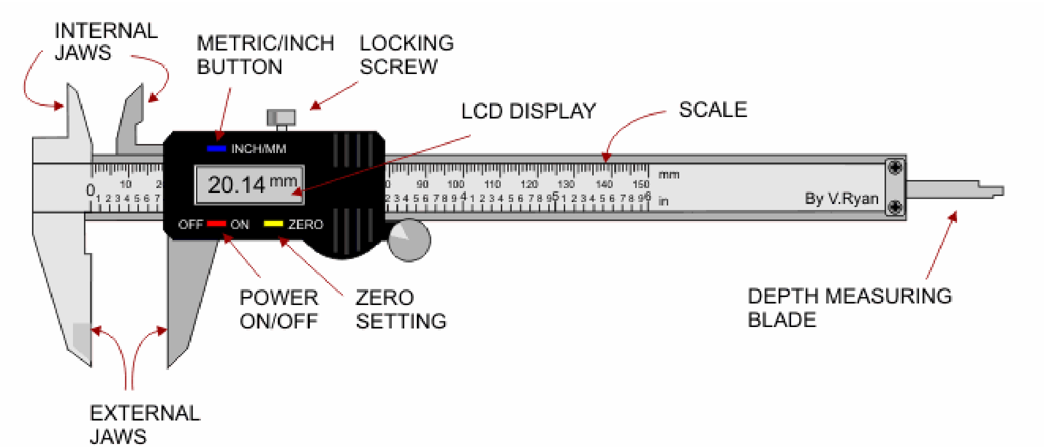
Metrology

Digital Caliper

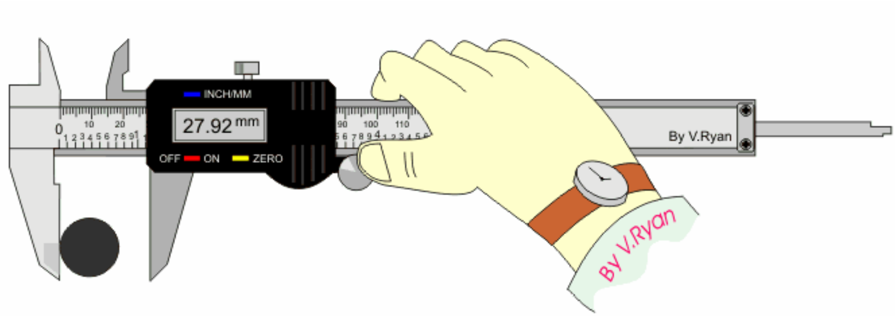


The digital caliper has a long section with measurement markings. On one end, there is a pair of jaws. The outer jaw is fixed with the long section, and the inner jaw slides along the caliper's beam to indicate the measurement. Most calipers have two sets of jaws. One pair measures the exterior of parts; the other pair measures interior dimensions.

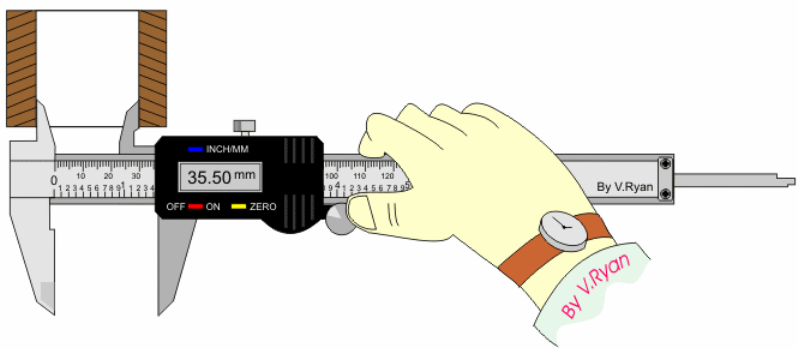
Calipers are versatile because they can measure both outer and inner lengths and diameters, as well as depth measurements. The range of most calipers is five inches or more.

Though they are more accurate than steel rules, calipers should not be used for precise measurements. The greatest sensitivity of most digital calipers is **0.001 inches**. Different operators may apply different amounts of pressure when taking a measurement. This can create a range of readings.

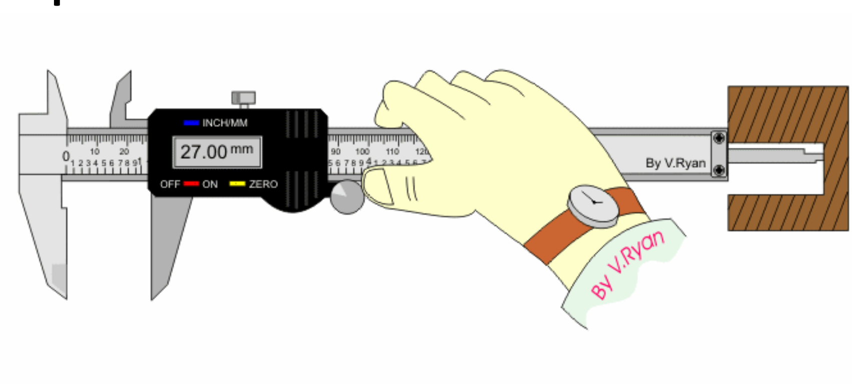
External Measurement



Internal Measurement



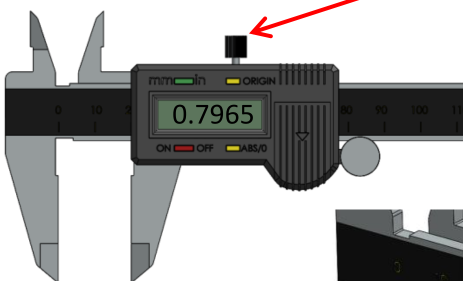
Depth Measurement



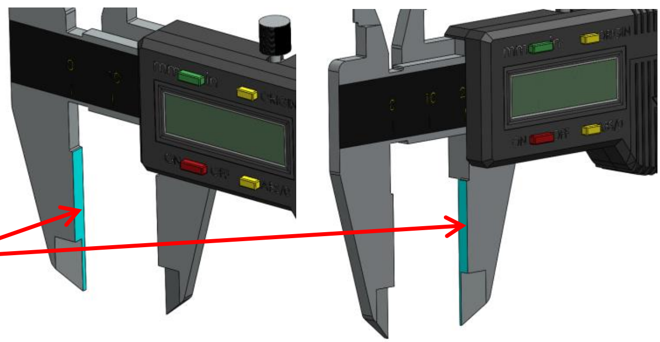
Metrology | Digital Caliper

Before using the digital caliper:

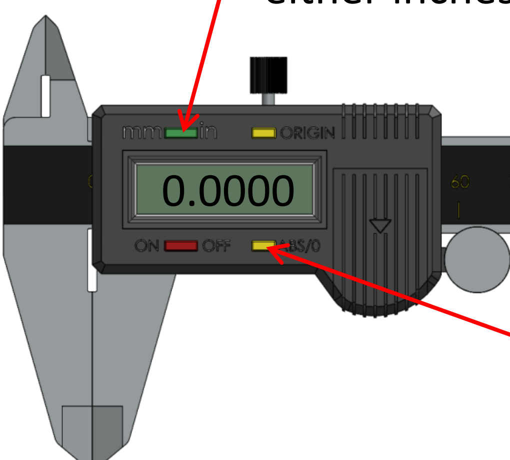
Ensure the locking screw is not tight



Clean the faces of the external jaws to remove any debris.



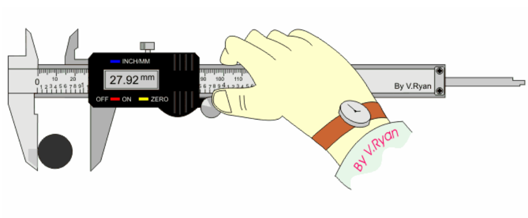
Select which set of units to be used, either inches or millimeters.

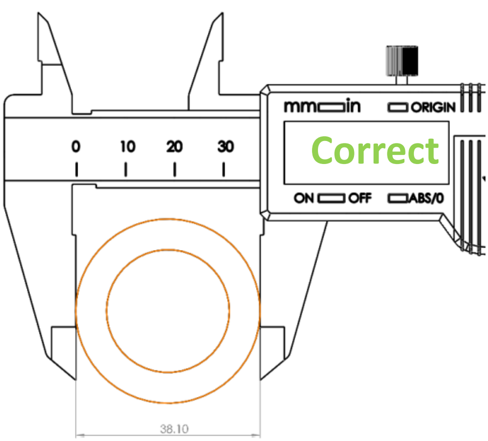


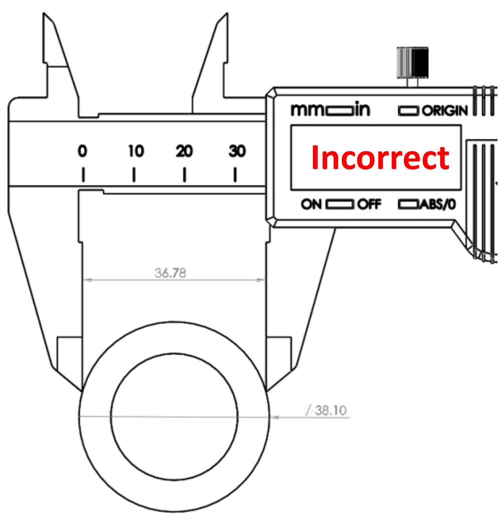
Close the external jaws and ensure it reads **<u>zero</u>**, if not, press the ZERO button to set zero.

External Measurement

Use the external jaws to measure external features like an outside diameter or width of a part or feature. When measuring external features with the external jaws, the operator would ideally read the smallest value attained while maximizing the contact area of the caliper jaws. Always ensure the jaws are gripping the work piece parallel / tangent to the faces being measured.

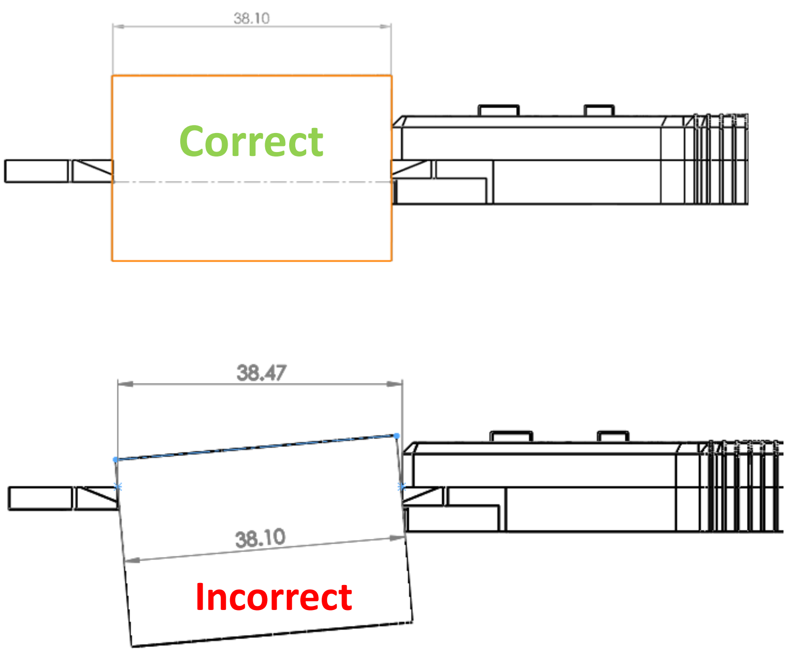






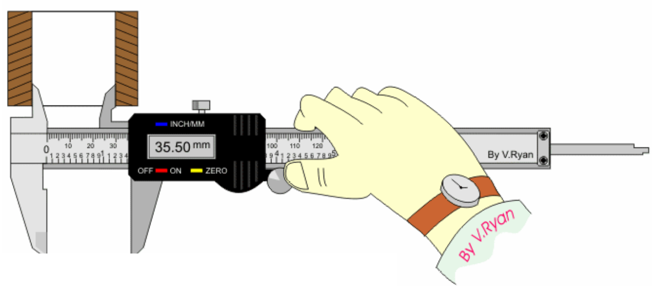
External Measurement

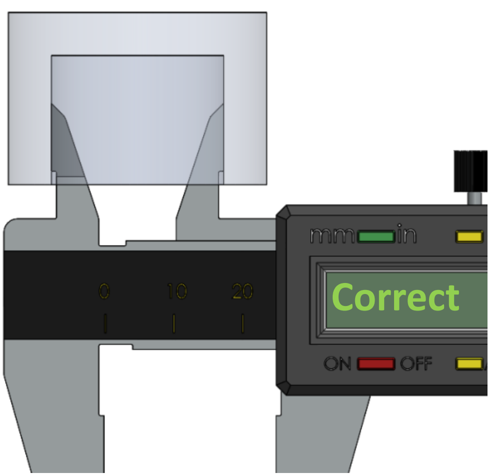
When measuring external features with the external jaws, the operator would read the smallest value attained while maximizing the contact area of the caliper jaws. Ensure the jaws are gripping the work piece parallel / tangent to the faces being measured and that the jaws are not angled, reading the true value.

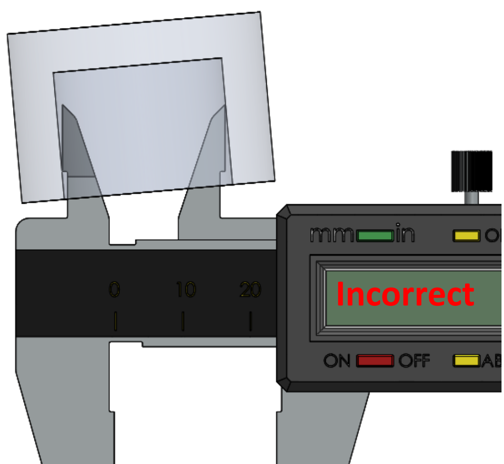


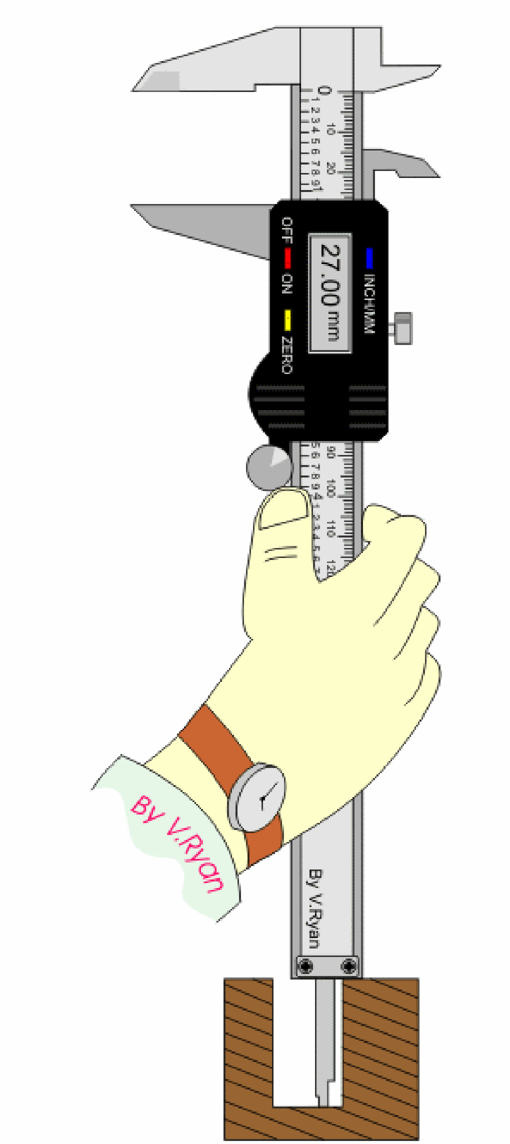
Internal Measurement

Use the internal jaws to measure internal features like an inside diameter or internal width of a part or feature. When measuring internal features with the internal jaws, the operator would ideally read the largest value attained for circular holes, and the shortest value across two flats, while maximizing the contact area of the caliper jaws.





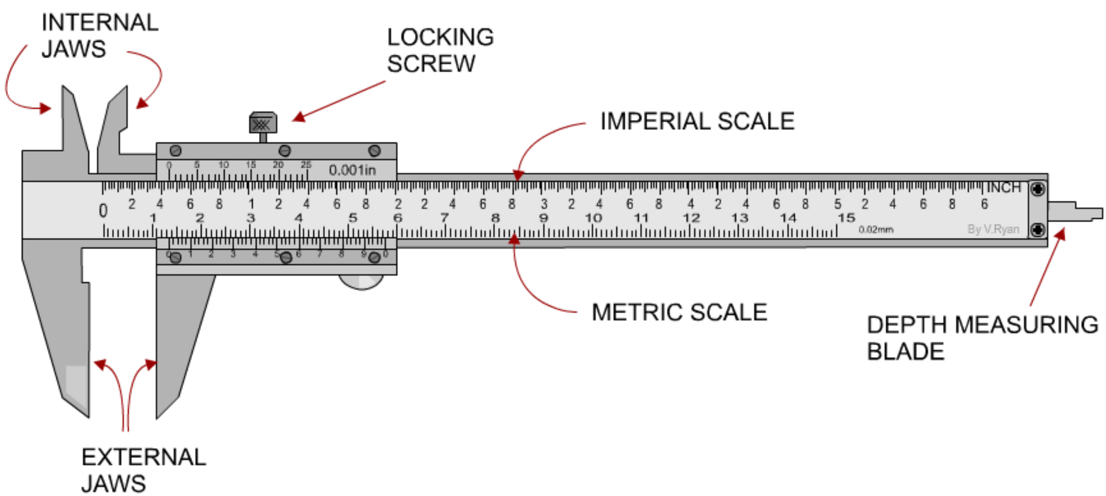




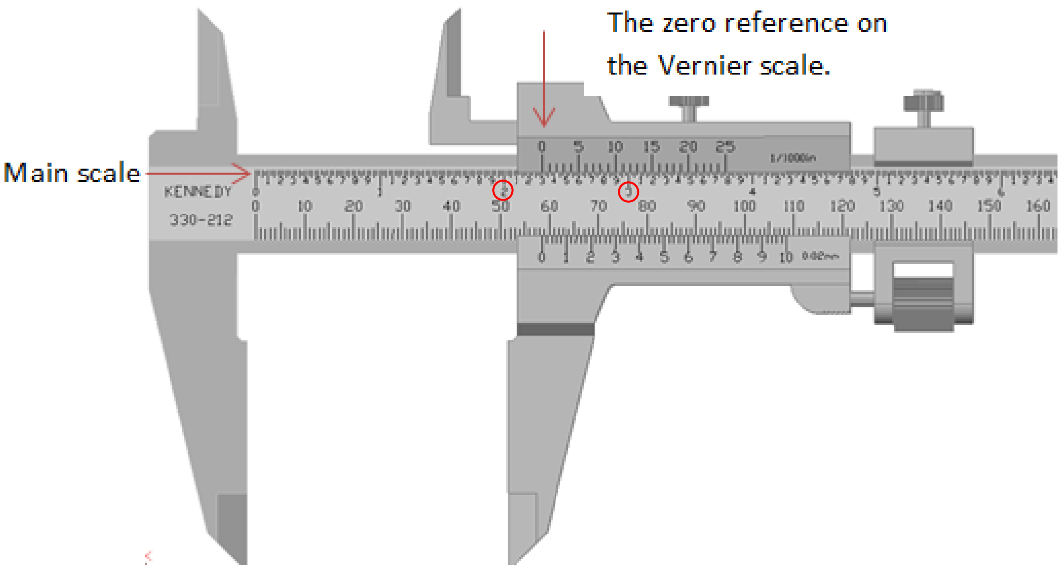
Depth Measurement

Ensure that when using the depth measuring blade to keep the end of the caliper square with your reference plane or face.

Vernier Caliper Anatomy



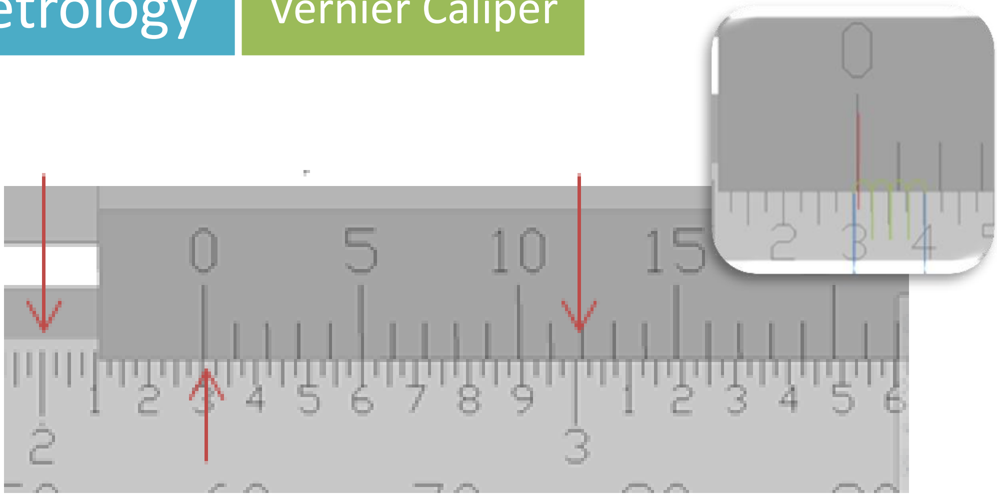
How to read the Vernier Caliper



Step 1

The zero marker is the indicator as to what the value that the Vernier caliper is reading. In this example it falls between the 2 and 3 inch divisions, therefore the dimension is 2.XXX

Result
+ 2.000



Each inch marker is divided into 10 equal segments, each 0.1” in length.

Step 2

Find where the zero marker falls within the 0.1” divisions.

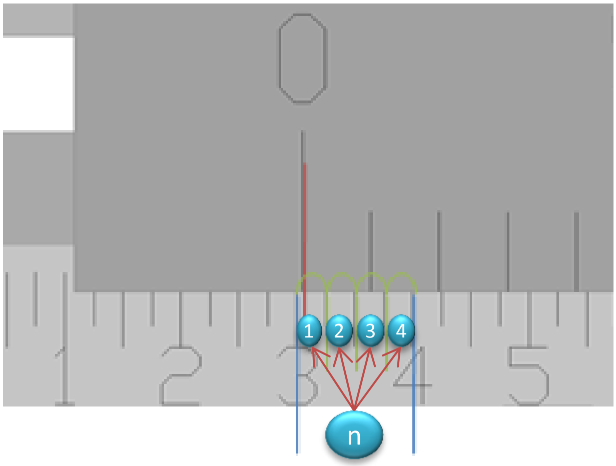
In this case it is observed that the marker is between the 0.3” and 0.4” division.

Therefore, rounding down because we know we have at least 0.3, we add a value of 0.3”

Result
2.000
+ 0.3

Metrology

Vernier Caliper

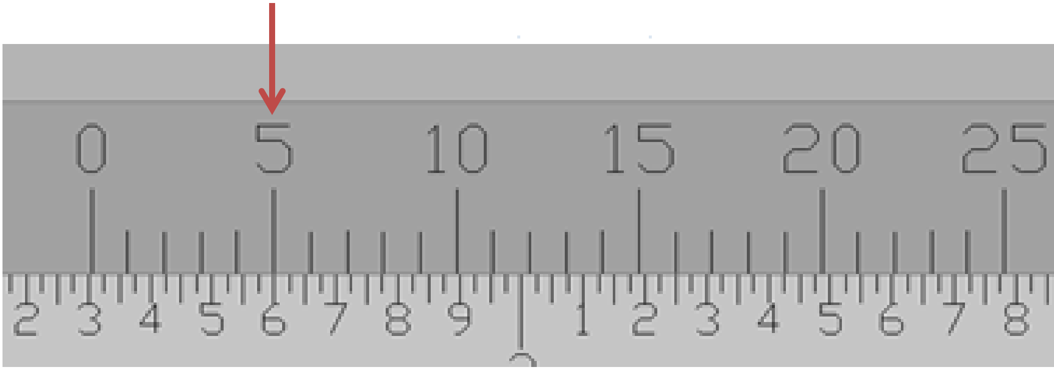


Each 0.1” marker is divided into 4 equal segments, .025” in length.

Step 3

n= # of complete 0.025” segments to the left of the zero marker.
In this case, **n=0**, therefore (n) X 0.025” = 0.0000

Result
2.000
+ 0.3
+0.000



The last step is to determine how much of the previous incomplete 0.025" segment needs to be added.

Step 4

Find two lines, one from the main scale, and one from the Vernier scale that are perfectly collinear (inline).

In this example it is observed that the 5 from the Vernier scale lines up with the 6 from the main scale. Add the value from the Vernier scale, in this example, $\frac{5}{1000} = 0.005"$

Result

2.000

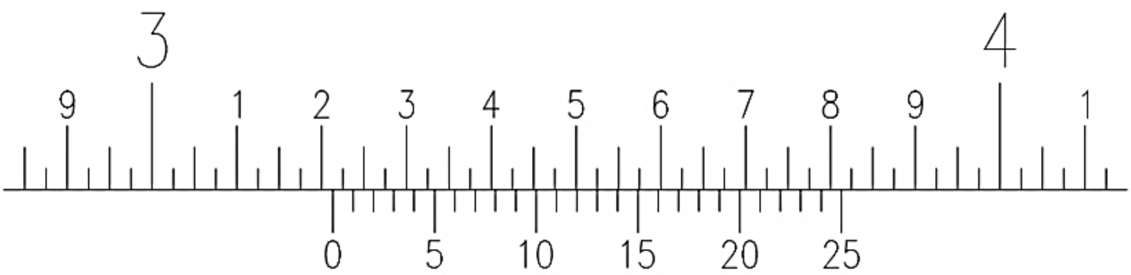
+ 0.3

+0.000

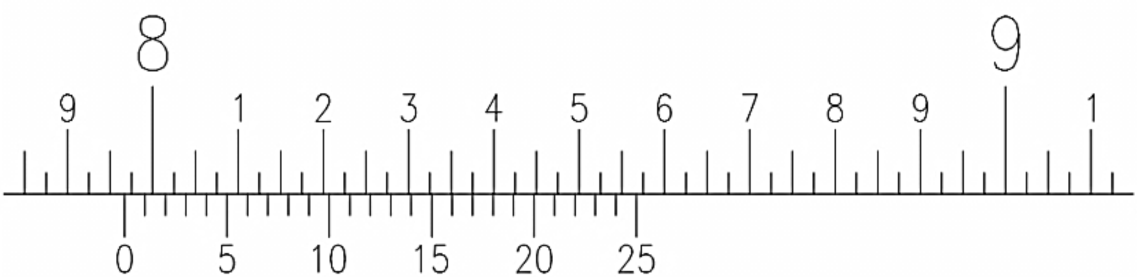
+0.005"

Total = 2.305"

Example 1

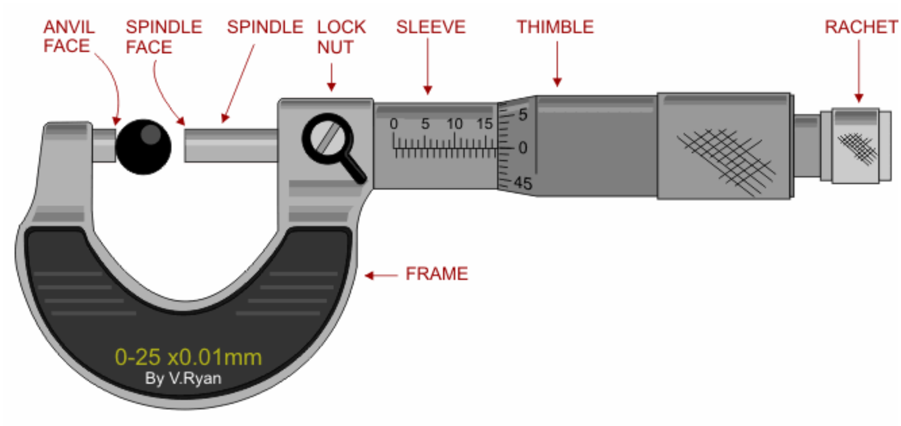


Example 2



Check with your instructor to verify your answers when finished.

Micrometer



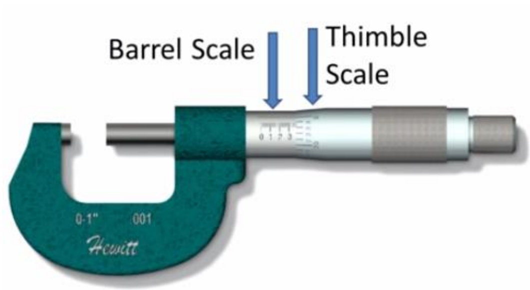
The most common measuring device in the shop is the micrometer. The micrometer is a U-shaped device with a threaded spindle on one end and a small anvil on the other. The operator turns the spindle to gradually advance its end toward the anvil on the opposite side and close in on the part.

The typical micrometer only has a range of one inch (25.4mm), as shown above. Consequently, you would need different micrometers to measure distances between 0 and 1 inches, 1 and 2 inches, and so on.

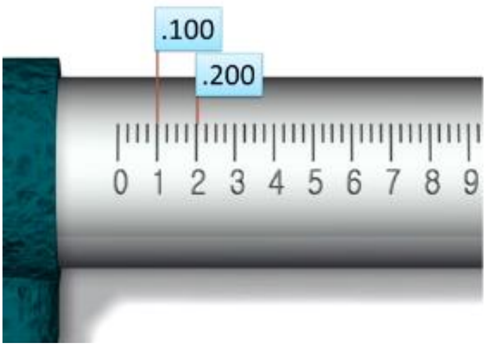
A micrometer offers a balance of versatility and accuracy. A regular manual micrometer has a sensitivity that equals digital calipers (0.001). Manual micrometers with a Vernier scale provide sensitivity to **0.0001** inches.

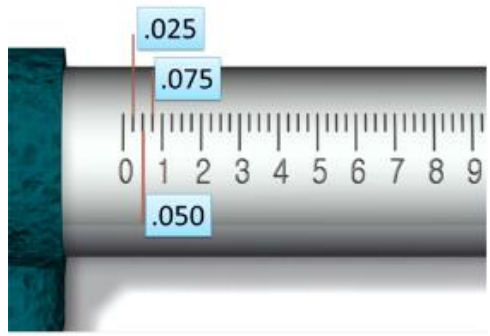
Metrology | Micrometer

Standard micrometer with 0.001” precision



Barrel Scale





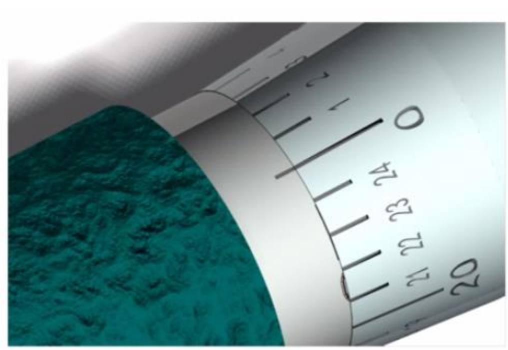
The Micrometer barrel scale has divisions = 0.1”

If 1 inch range than 10 x 0.1”

0.100” divisions are divided into four equal 0.025” segments.

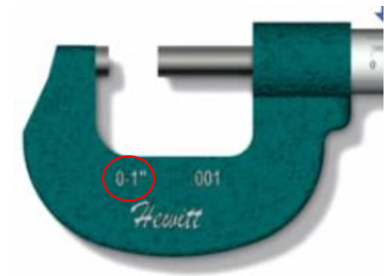
.025” .050” .075” .100”

Thimble Scale



The Thimble scale has a range of 0.025”. The thimble scale is a larger representation of the 0.025” division that is exposed on the barrel scale.

Standard micrometer with 0.001” precision



Step 1

Determine the range of the micrometer. As this is a 0 – 1”, the value we read will be between 0 and 1, therefore, we know the first digit in our addition process to be zero. 0.000

Step 2

Read largest value exposed on barrel scale.

In this case we can see the 3, divide this value by 10 = 0.3

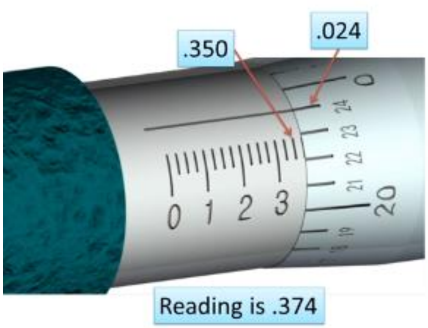
0.000 +0.3

Step 3

n= # of complete 0.025” segments visible on the barrel scale.

n = 2 so we add (n) X 0.025” = **0.050”**

0.000 +0.3 +0.05



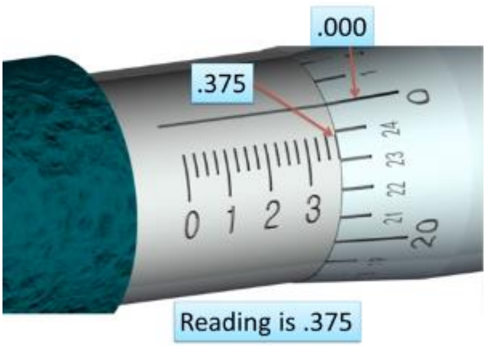
Step 4

Read value from thimble scale inline at the center of the barrel scale. In this case 24 lines up so we add $\frac{24}{1000}$ = 0.024

0.000 +0.3 +0.05 + 0.024 = **0.374”**

Standard micrometer with 0.001" precision

Example 1



0.000

+

0.3

+

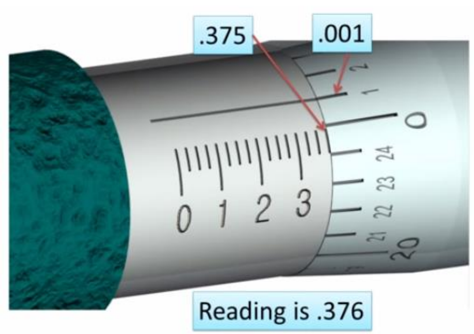
3 x 0.025"

+

$$\frac{0}{1000} = 0.000$$

= 0.375"

Example 2



0.000

+

0.3

+

3 x 0.025"

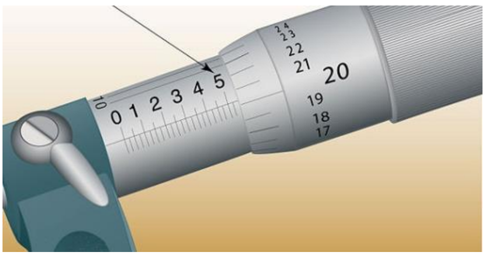
+

$$\frac{1}{1000} = 0.001$$

= 0.376"

Standard micrometer with 0.0001” precision

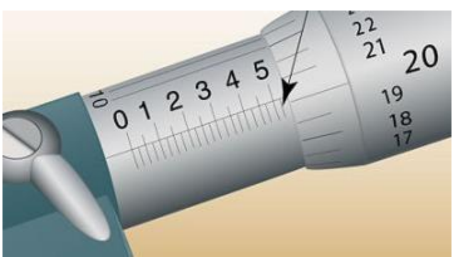
This micrometer has the addition of a Vernier scale to read values as small as **0.0001”**



Step 1

0 – 1” Micrometer

Read Barrel Scale First : **0.500**



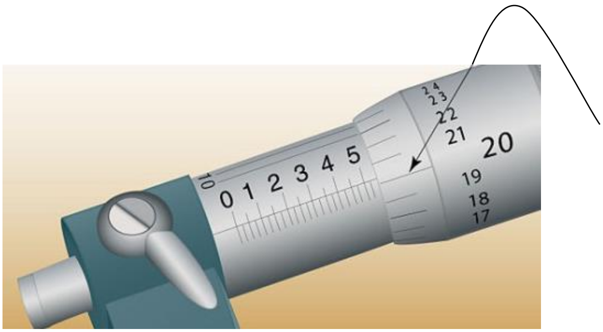
Step 2

n= # of complete 0.025” segments visible on the barrel scale.

n = 1 so we add (n) X 0.025” = **0.025”**

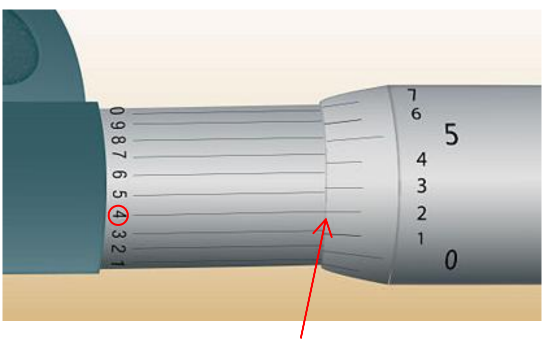
Standard micrometer with 0.0001” precision

This micrometer has the addition of a Vernier scale to read values as small as **0.0001”**



Step 3

Thimble Scale reads between 20 and 21 so rounding down, we add $\frac{20}{1000}$ = **0.020”**



Step 4

Find two lines that are collinear and add value from Vernier Scale, in this case, 4

$\frac{4}{10000}$ = **0.0004”**

Summary

Barrel Scale = **0.500”**

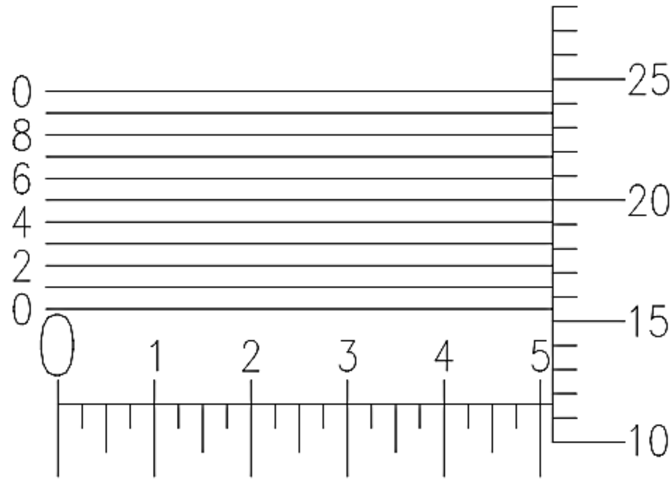
Barrel Scale (1) x 0.025” Divisions = **0.025”**

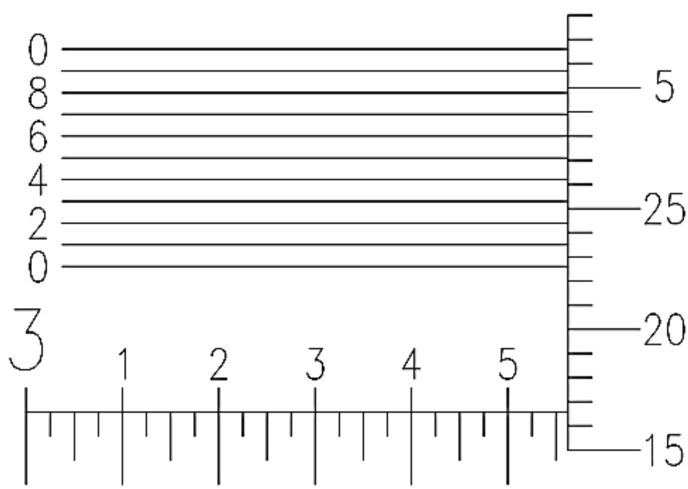
Thimble Scale = **0.020”**

Vernier Scale = **0.0004”**

0.5 + (0.025) + 0.02 + 0.0004 = **0.5454”**

Micrometer Examples 0.0001” precision





Check with your instructor to verify your answers when finished.

Go to lab manual to continue with gyroscope inspection.