MENG 436
Metrology & Quality Control
Summer 2020

King Abdulaziz University
Faculty of Engineering
Mechanical Engineering Dept.

LINEAR MEASUREMENTS
Part C
Micrometer Instruments

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Principle of Micrometer

Source of amplification

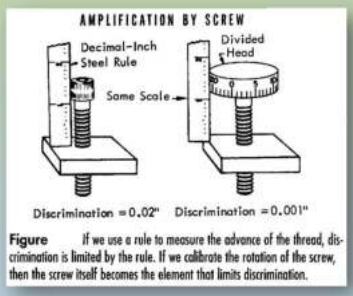

Figure If we use a rule to measure the advance of the thread, discrimination is limited by the rule. If we calibrate the rotation of the screw, then the screw itself becomes the element that limits discrimination.

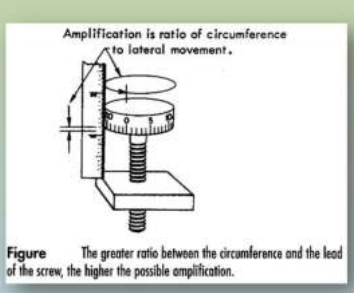

Figure The greater ratio between the circumference and the lead of the screw, the higher the possible amplification.

- **Obtained by dividing the circumferential distance of the screw head on a larger scale.**
- **Amplification** $= \frac{Scale\ Spacing}{Scale\ Value} = \frac{Circumference}{Pitch}$

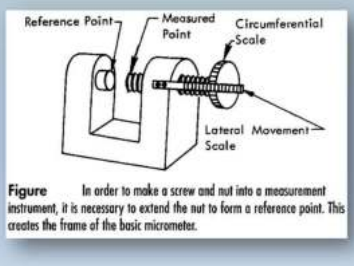

Figure In order to make a screw and nut into a measurement instrument, it is necessary to extend the nut to form a reference point. This creates the frame of the basic micrometer.

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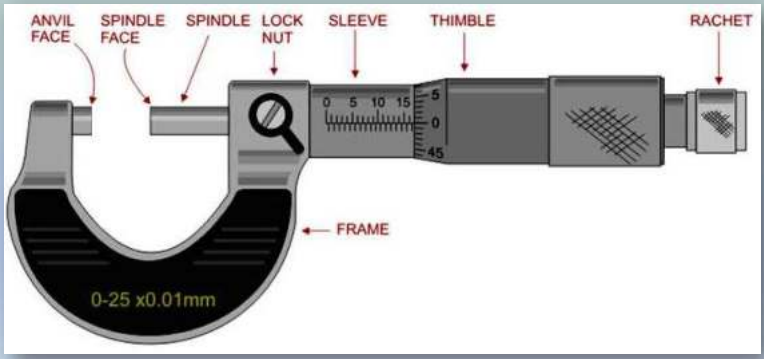
Elements of Micrometer

- Micrometer is one of the most widely used precision instruments.
- It is primarily used to measure external dimensions like diameters of shafts, thickness of parts, etc. to an accuracy of reading from 0.01 mm to 0.001mm.
- Micrometer essential parts are shown below.



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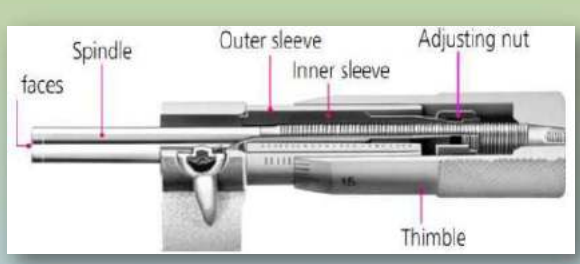
Elements of Micrometer

1) Anvil and spindle

- The precision ground thread on the spindle is the basis for a micrometer's high accuracy.



- The spindle does the actual measuring and possesses the threads of 0.5 mm pitch.
- There should be no backlash between the spindle screw and nut.
- The anvil and spindle faces usually tipped with tungsten carbide to reduce wear caused by repeated use.
- To ensure an accurate measurement, the anvil and spindle faces must be accurately ground and lapped to be both flat and parallel.

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Elements of Micrometer

2) Frame

- Micrometer frame is shaped to permit measurements of cylinder of diameter equal to the measuring range of micrometer.
- Micrometer frame should be provided with finger grips of heat insulating material.

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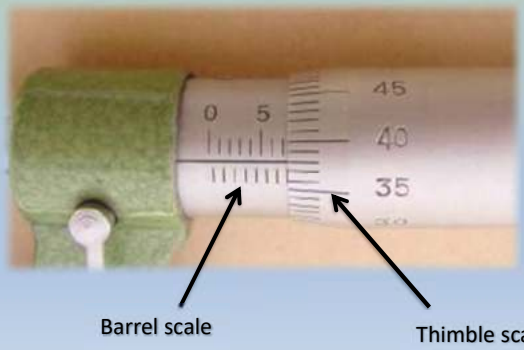
Elements of Micrometer

3) Thimble and barrel

- Thimble is tubular cover fastened with the spindle.
- The tapered edge of the thimble is divided into 50 equal parts (graduations) in the case below.



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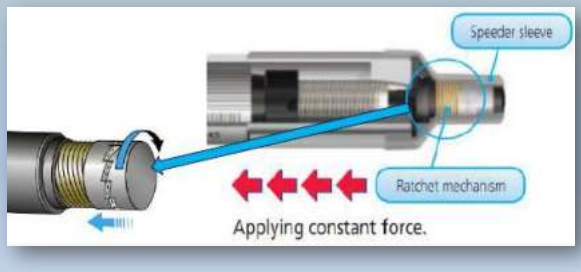
Elements of Micrometer

4) Ratchet

- The ratchet is a small extension to the thimble.
- It slips when the pressure on the screw exceeds a certain amount applying a constant measuring force.
- It produces uniform reading and prevents damage or distortion of the instruments.



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Types of Micrometer

External Micrometers

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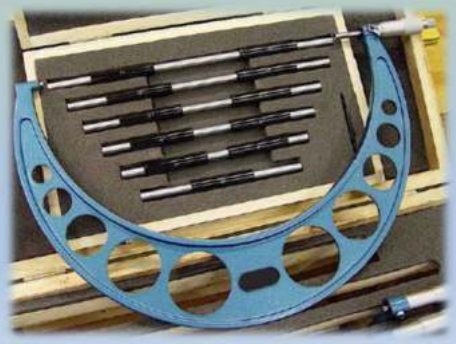
Types of Micrometer

External Micrometers

- When micrometers become big, they are offered in sets with single micrometer and multiple changeable anvils to suite a wide measuring range.



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Types of Micrometer

Digital Readout Micrometers

- Digital micrometer is also capable of giving direct reading up to 0.001 mm and a range of 25 mm or 1".
- Operation is very simple with push button controls for "Zero" reset and indication "hold".

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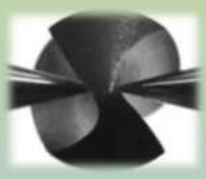
Types of Micrometer

Point Micrometer

- Pointed spindle and anvil for measuring drill web thickness, small grooves and other hard to reach dimensions.
- Available in steel or carbide 15° or 30° points.



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Types of Micrometer

Screw Thread Micrometer

- Screw thread micrometers are used for measuring pitch diameter of screw threads.
- The extreme point of the cone is rounded so that it will not bear on the root diameter at the bottom of the thread, and similarly clearance is provided at the bottom of the groove in the V-anvil.

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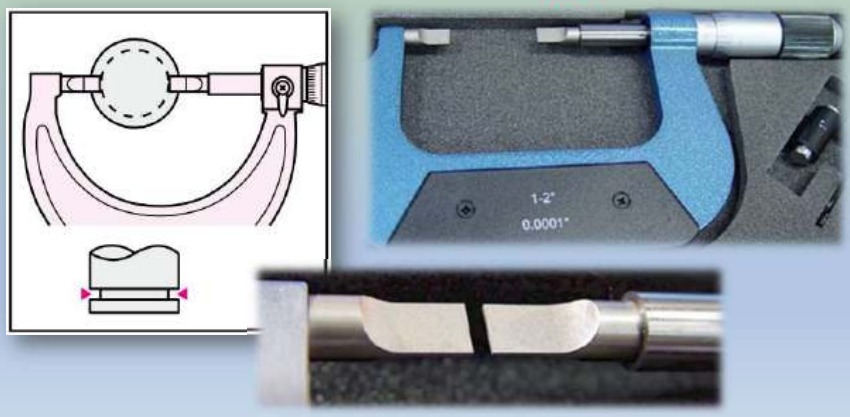
Types of Micrometer

Blade Micrometer

- Blade micrometers are used to measure groove diameters on shafts or other narrow recessed features.
- Available in steel or carbide blades of varying thickness.



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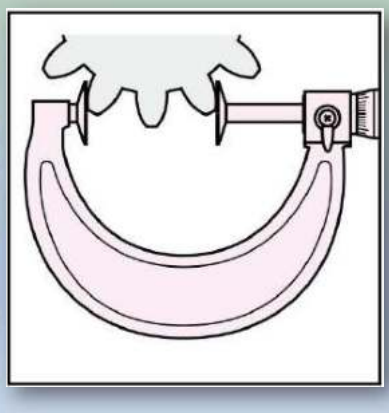
Types of Micrometer

Disc Micrometer

- Disc micrometers are used for root tangent measurement of spur and helical gears.
- Available with rotating or non-rotating discs.



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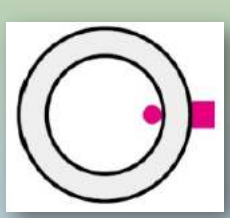
Types of Micrometer

Tube Micrometer

- Used for pipe wall thickness measurement.

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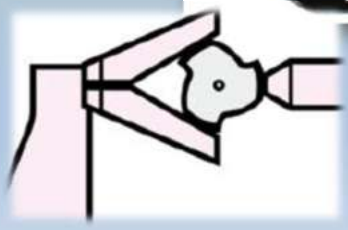
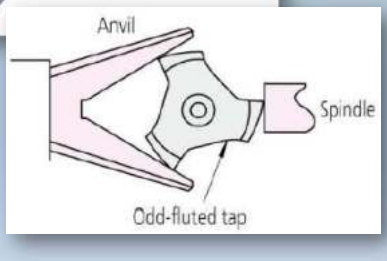
Types of Micrometer

V-Anvil Micrometer

- Used for checking out of roundness, odd-fluted taps, milling cutters, reamers, etc.

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Types of Micrometer

External Micrometers – Changeable anvils

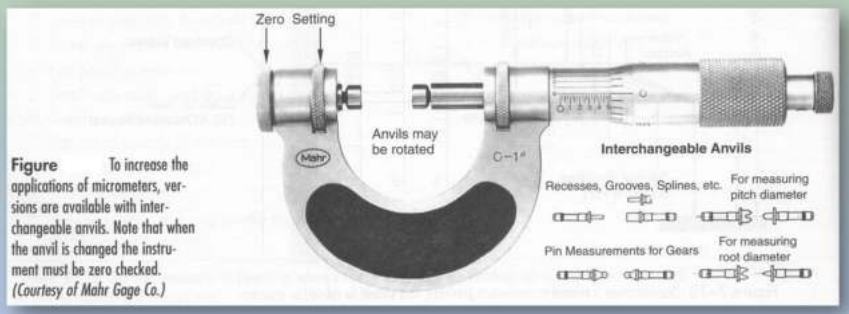

Figure To increase the applications of micrometers, versions are available with interchangeable anvils. Note that when the anvil is changed the instrument must be zero checked. *(Courtesy of Mahr Gage Co.)*

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Types of Micrometer

Limit Micrometer

- **Used as a GO-NO-GO gauge by setting the upper and lower limits.**

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Types of Micrometer

Sheet metal Micrometer

- These micrometers reach over the edge of sheet metal and take measurements away from the edge towards the center.

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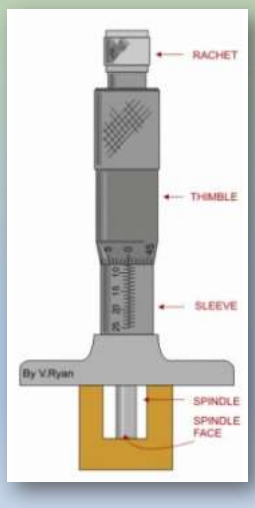
Types of Micrometer

Depth Micrometer

- Used for depth and height measurements.



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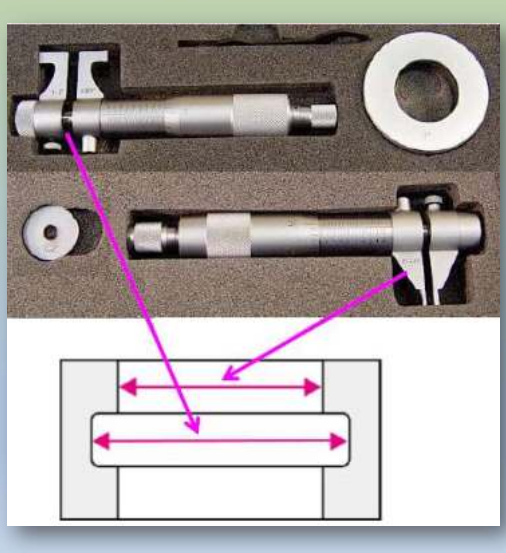
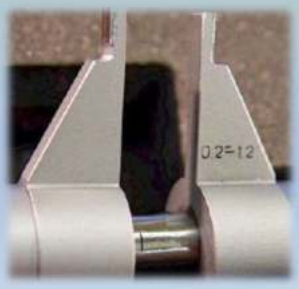
Types of Micrometer

Inside Micrometer





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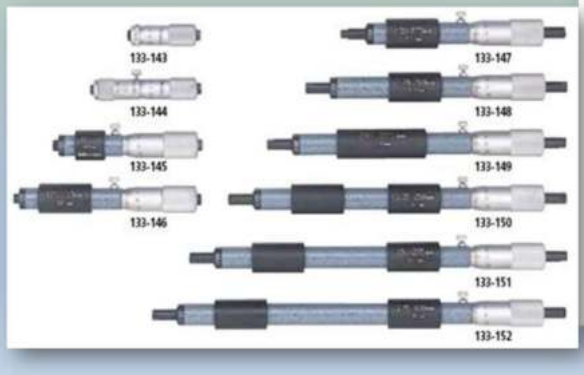
Types of Micrometer

Inside Micrometer

- Dimension from the micrometer head is noted down and lengths of extension rod and collar are added up.



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Types of Micrometer

3-Point Micrometer

- 3-Point micrometer has 3-anvils which are at 120º to each other and move radially.
- Used for measurement of internal diameters.

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Types of Micrometer

Bench Micrometer

- The stable position of the instrument during the measurements permits a more precise locating of the work and the heavy base adds to the rigidity of the instrument.
- Bench micrometers are usually equipped with both large-diameter thimbles, permitting a finer pitch thread for higher sensitivity.

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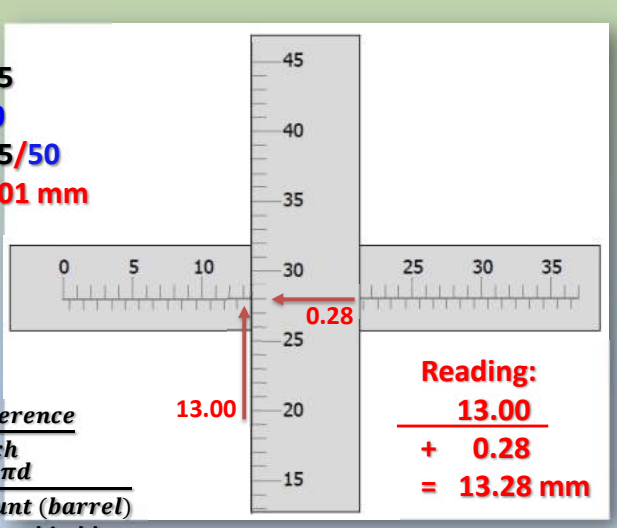
Reading a Micrometer

Metric micrometer

For the micrometer
Least count (barrel) = 0.5
Thimble divisions = 50
Least count = 0.5/50
= 0.01 mm



Reading:
13.00
+ 0.28
= 13.28 mm

Amplification $= \frac{Circumference}{Pitch}$

$= \frac{\pi d}{Least\ count\ (barrel)}$

where *d* is the diameter of the thimble

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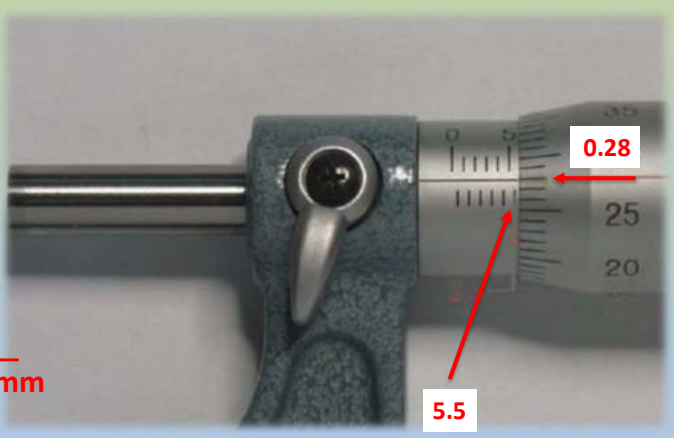
Reading a Micrometer

Exercise 1



5.50
+ 0.28
= 5.78 mm

Assume a diameter of thimble, *d* = 14 mm

Amplification $= \frac{\pi(14)}{0.5} \cong 88\ times$

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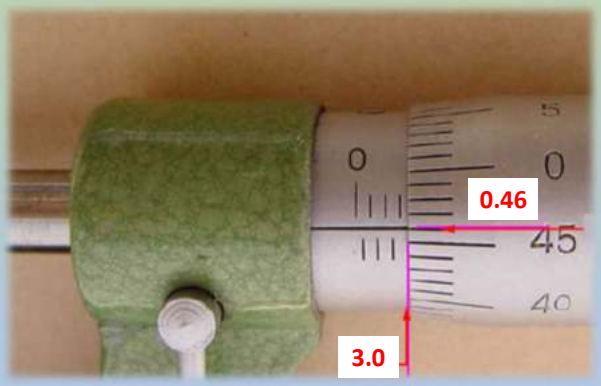
Reading a Micrometer

Exercise 2



3.00
+ 0.46
= 3.46 mm

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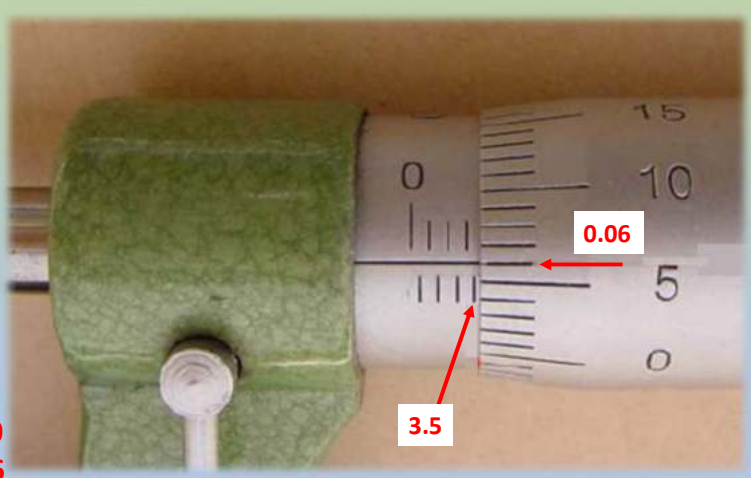
Reading a Micrometer

Exercise 3



3.50
+ 0.06
= 3.56 mm

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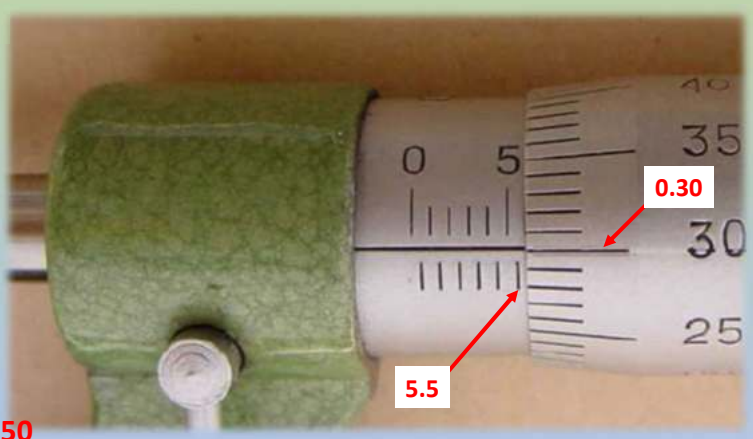
Reading a Micrometer

Exercise 4



5.50
+ 0.30
= 5.80 mm

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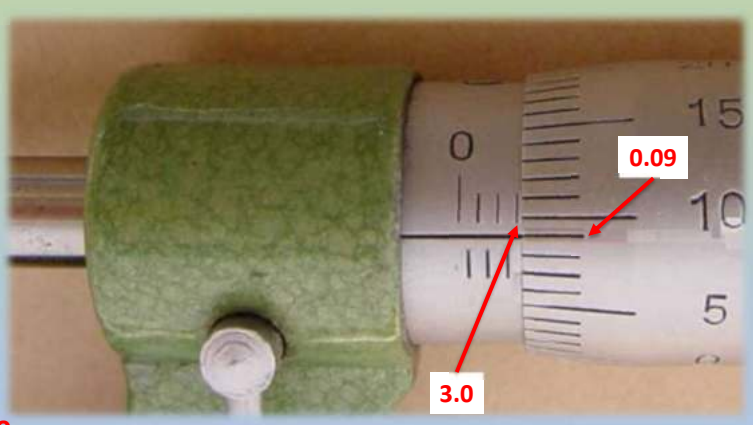
Reading a Micrometer

Exercise 5



3.0
+ 0.09
= 3.09 mm

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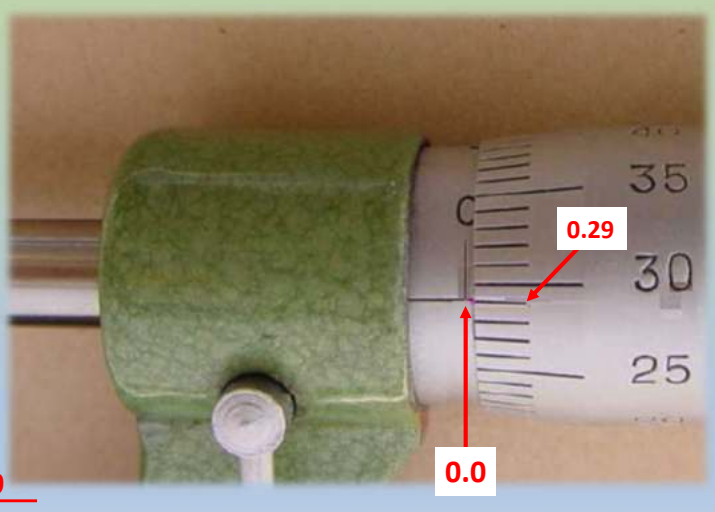
Reading a Micrometer

Exercise 6



0.0
+ 0.29
= 0.29 mm

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Reading a Vernier Micrometer

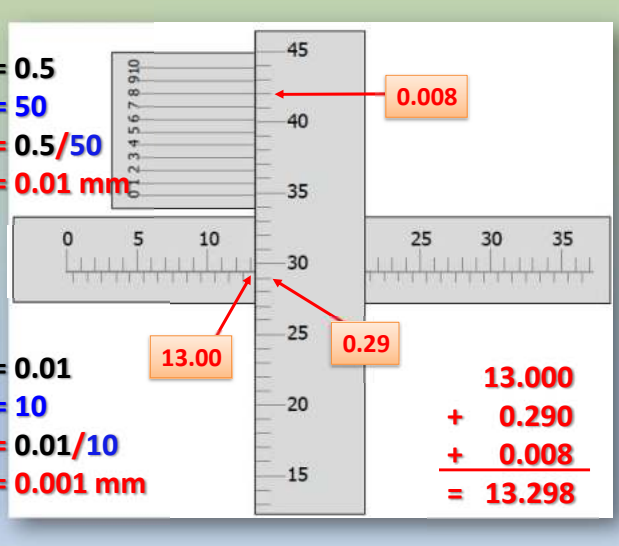
Metric Micrometer

For the micrometer:

Least count (barrel) = 0.5
Thimble divisions = 50
Least count (thimble) = 0.5/50
= 0.01 mm

For the Vernier:

Least count (thimble) = 0.01
Vernier divisions = 10
Least count (Vernier) = 0.01/10
= 0.001 mm



13.000
+ 0.290
+ 0.008
= 13.298

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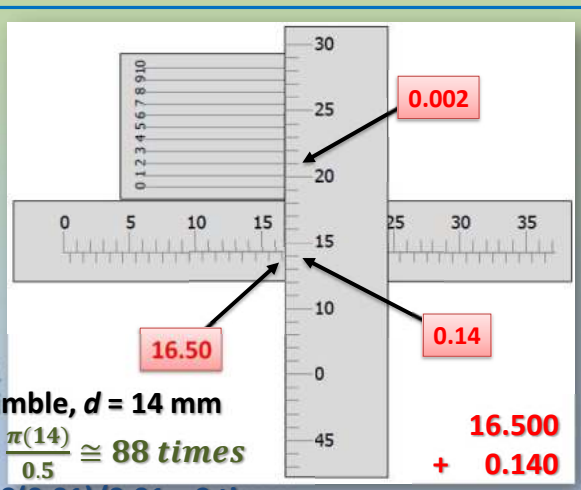
Reading a Vernier Micrometer

Metric Micrometer



To find the amplification:

Assume a diameter of thimble, d = 14 mm

Amplification (thimble) = $\frac{\pi(14)}{0.5} \cong 88\ times$

Amplification (Vernier) = 9(0.01)/0.01 = 9 times

Total amplification = 88 x 9 = 792 times

16.500
+ 0.140
+ 0.002
= 16.642

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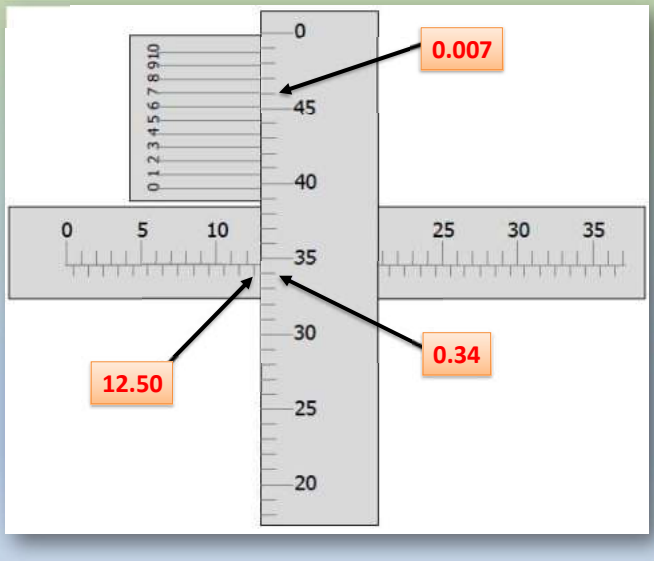
Reading a Vernier Micrometer

Metric Micrometer



12.500
+ 0.340
+ 0.007
= 12.847

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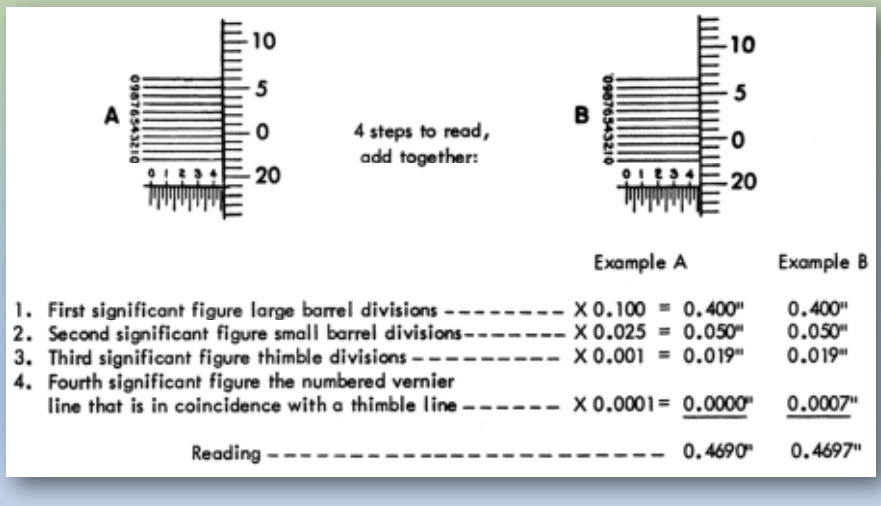
Reading a Vernier Micrometer

Imperial Micrometer



	Example A	Example B
1. First significant figure large barrel divisions ---------- X 0.100 =	0.400"	0.400"
2. Second significant figure small barrel divisions---------- X 0.025 =	0.050"	0.050"
3. Third significant figure thimble divisions ---------- X 0.001 =	0.019"	0.019"
4. Fourth significant figure the numbered vernier line that is in coincidence with a thimble line ------ X 0.0001 =	0.0000"	0.0007"
Reading ----------	0.4690"	0.4697"

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Alignment Error With Micrometer

Measuring large sizes

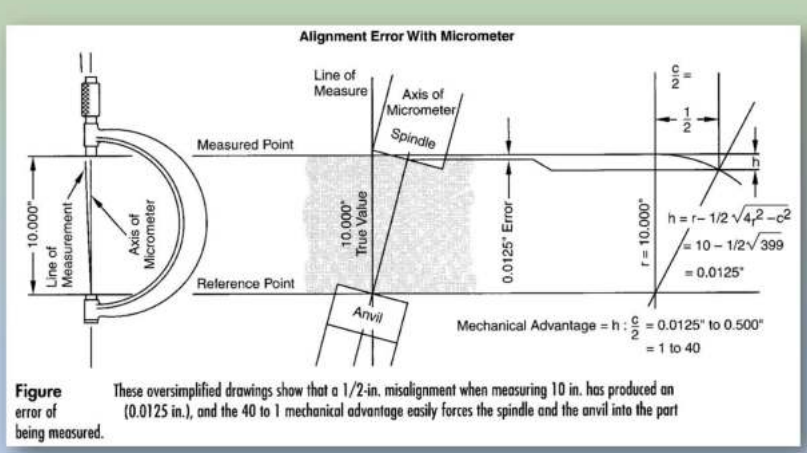

Figure These oversimplified drawings show that a 1/2-in. misalignment when measuring 10 in. has produced an error of (0.0125 in.), and the 40 to 1 mechanical advantage easily forces the spindle and the anvil into the part being measured.

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Alignment Error With Micrometer

Measuring small sizes

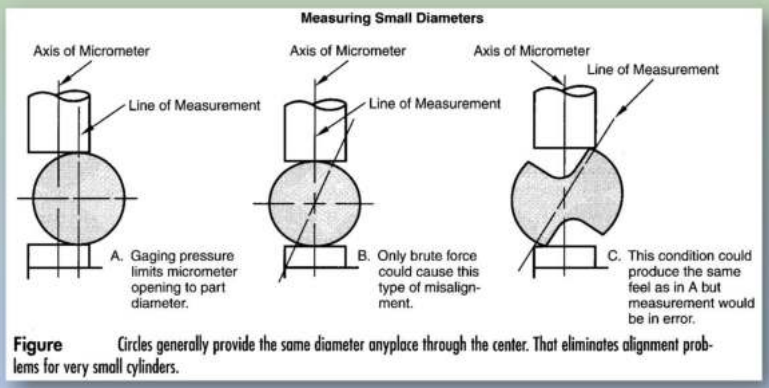

Figure Circles generally provide the same diameter anyplace through the center. That eliminates alignment problems for very small cylinders.

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Best Wishes . . .

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