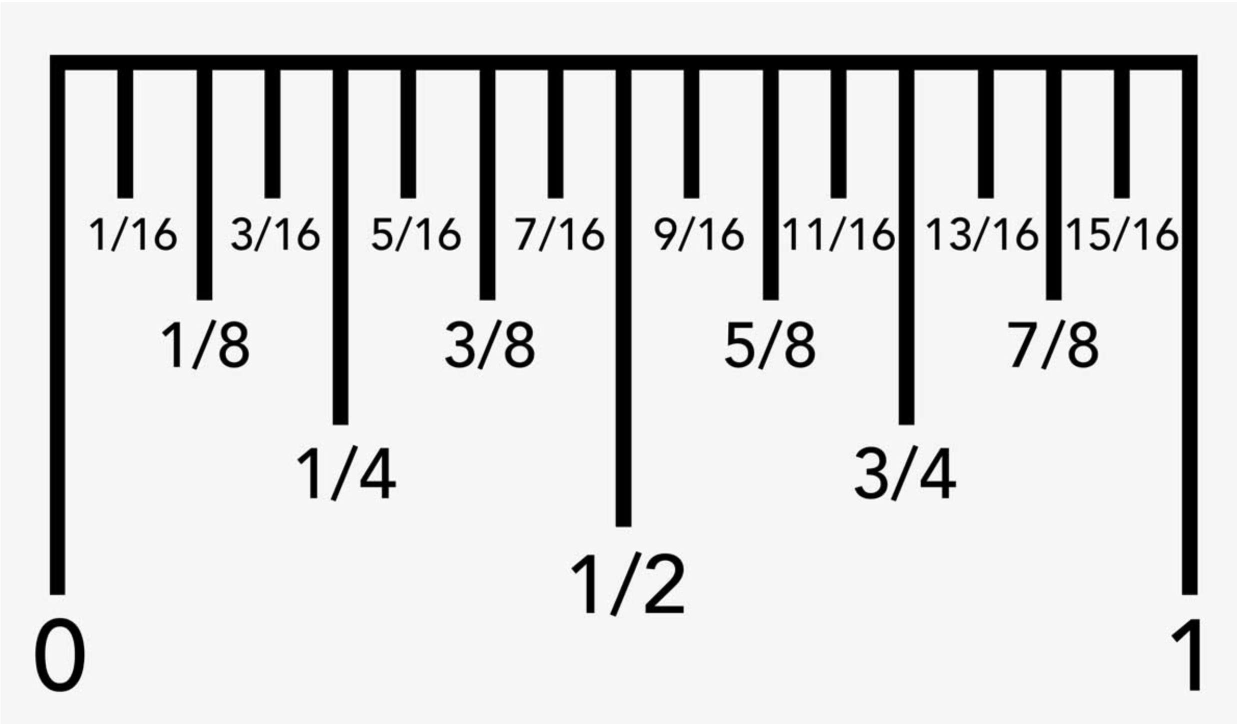
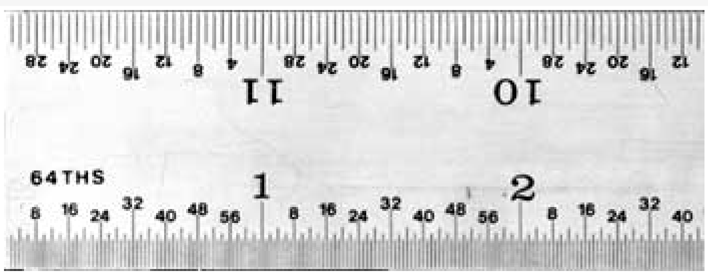
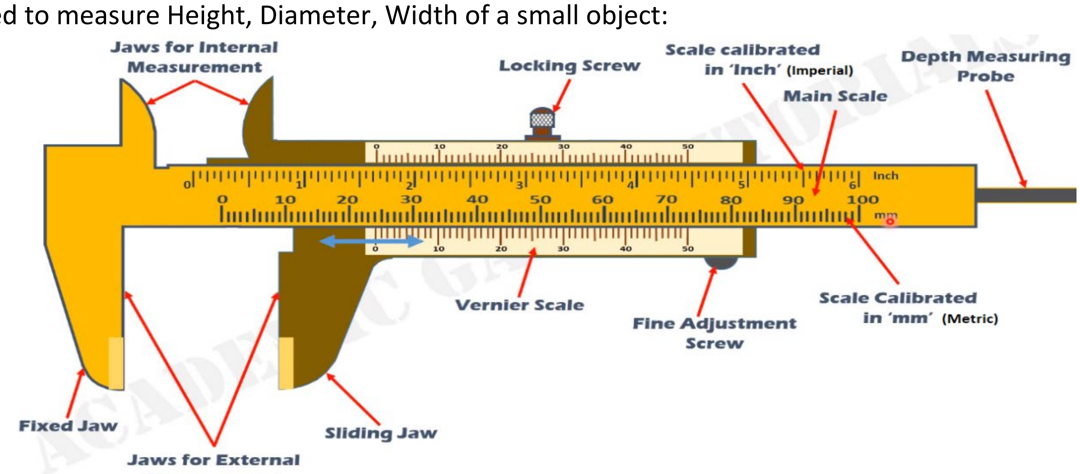
Precision Measuring Tools:

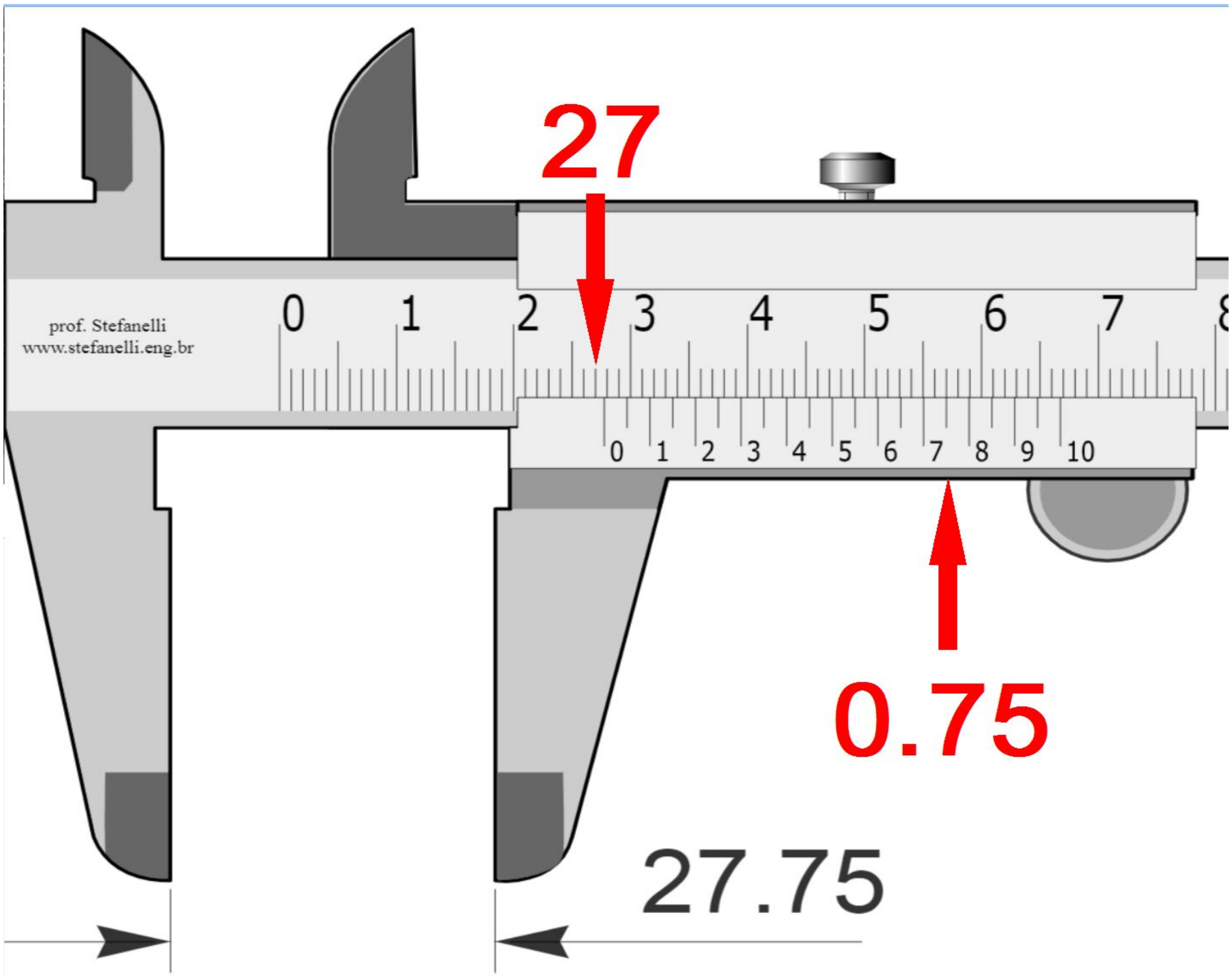
- Precision Ruler:

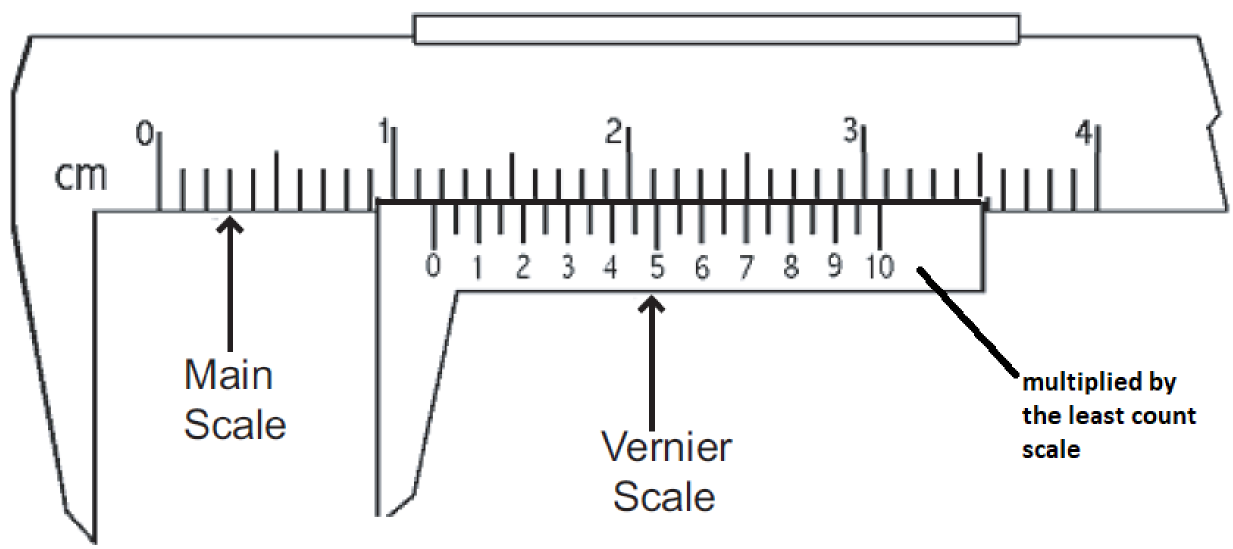




- Vernier Sliding Caliper:
  Used to measure Height, Diameter, Width of a small object:







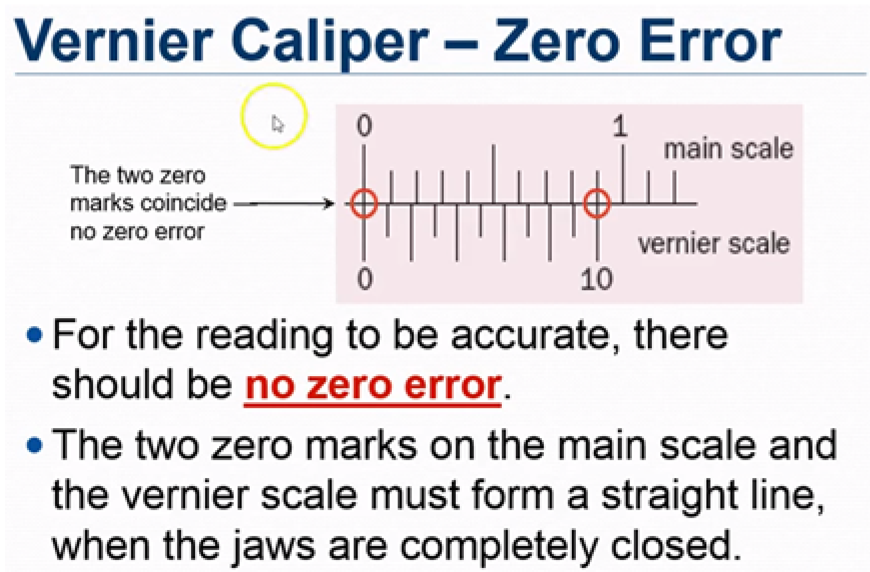
- The least count of the Vernier Scale:

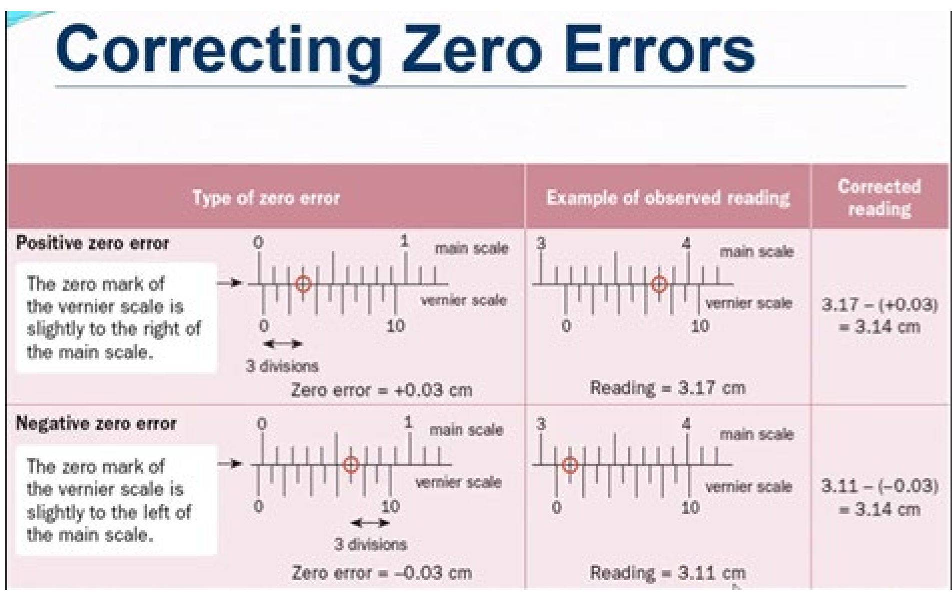
50 Divisions of vernier scale = to 49 divisions of main scale

Least Count= 1 main scale division or ratio – 1 vernier scale division or ratio = 1 mm – 49/50mm=1mm – 0.98mm=0.02mm
0.02mm is the least value that can be measured by vernier caliper

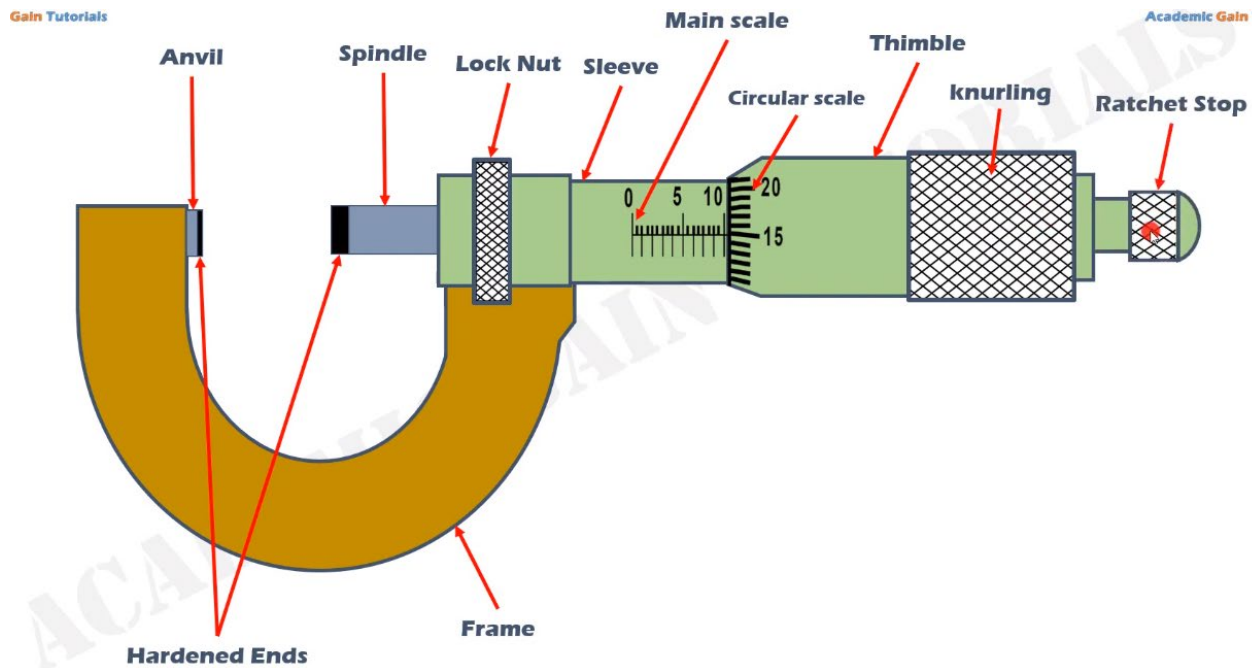
- Dimension to be measured = Main Scale Reading + (Vernier Scale Count x Least Count)

- Zero Errors:

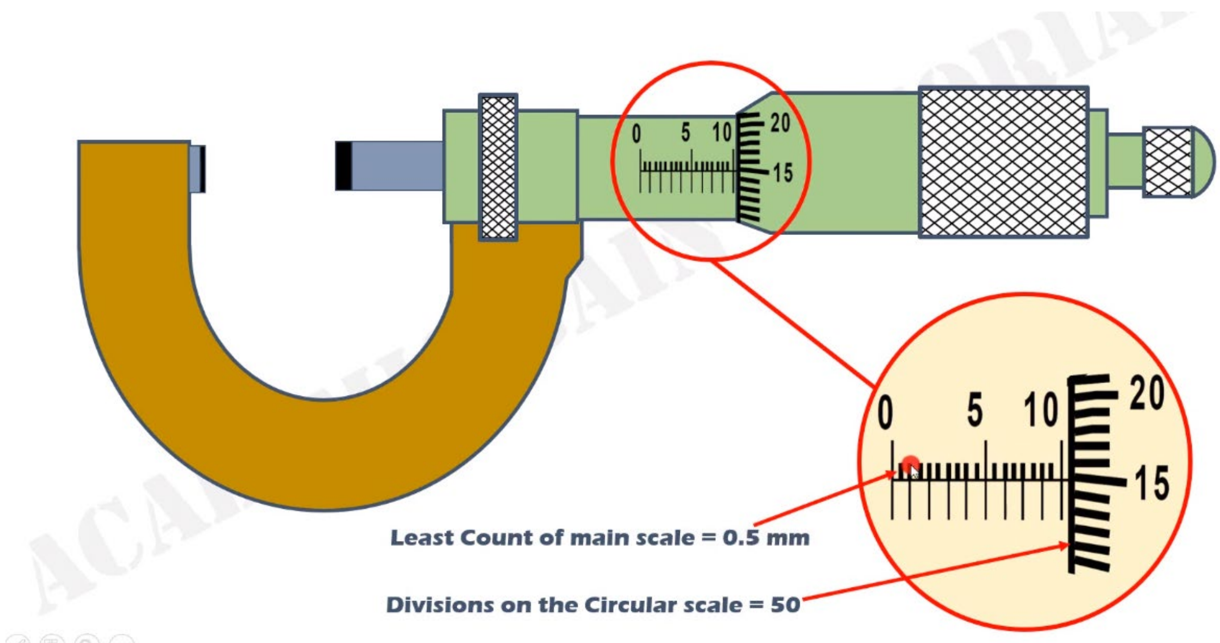


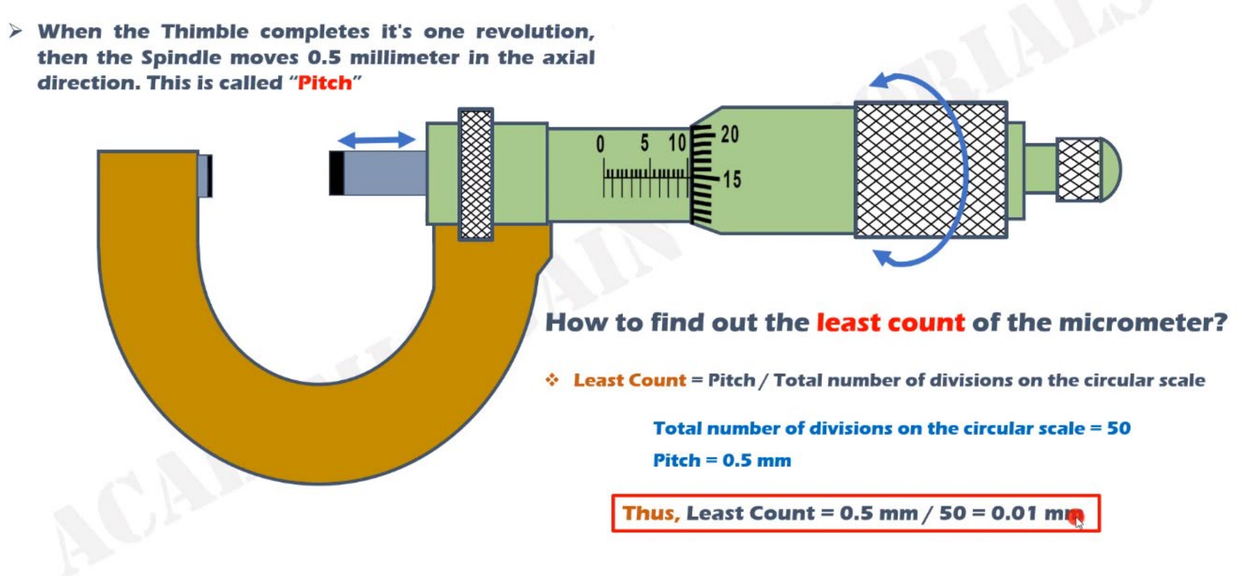


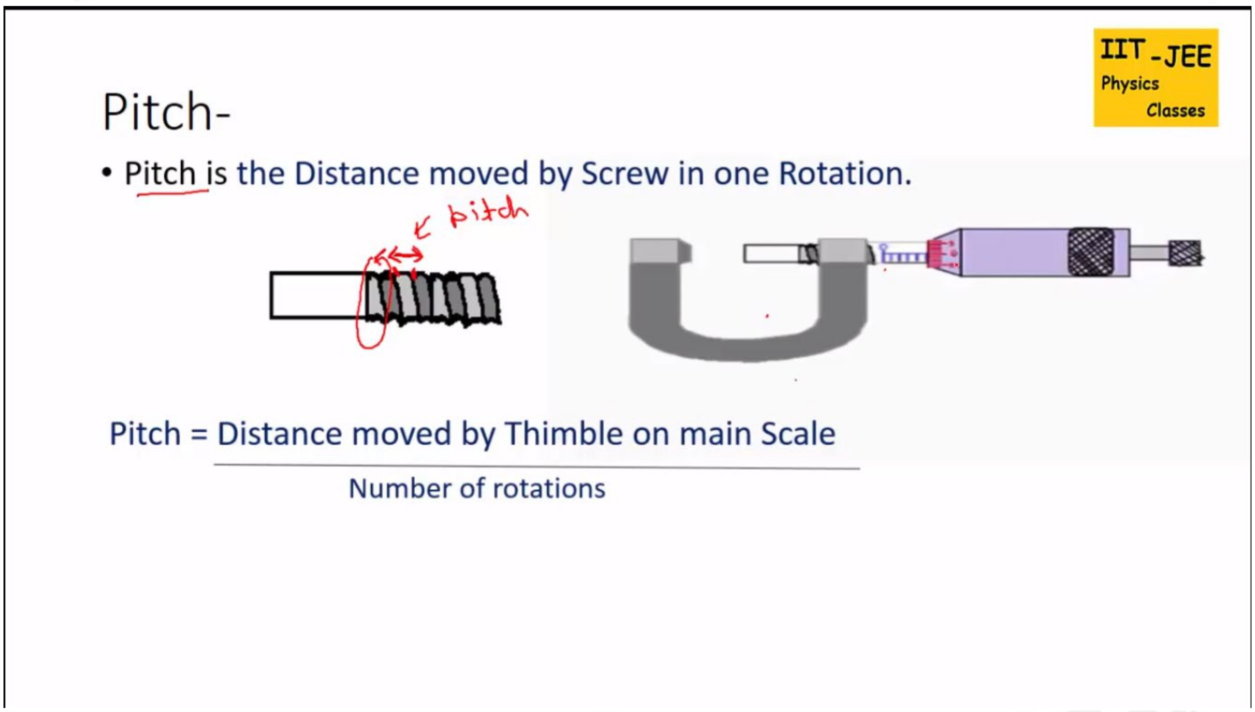
- Micrometer Instrument:



Thimble: used to adjust for hard movement of the spindle.
Ratchet Stop: used to adjust Spindle movement slightly.



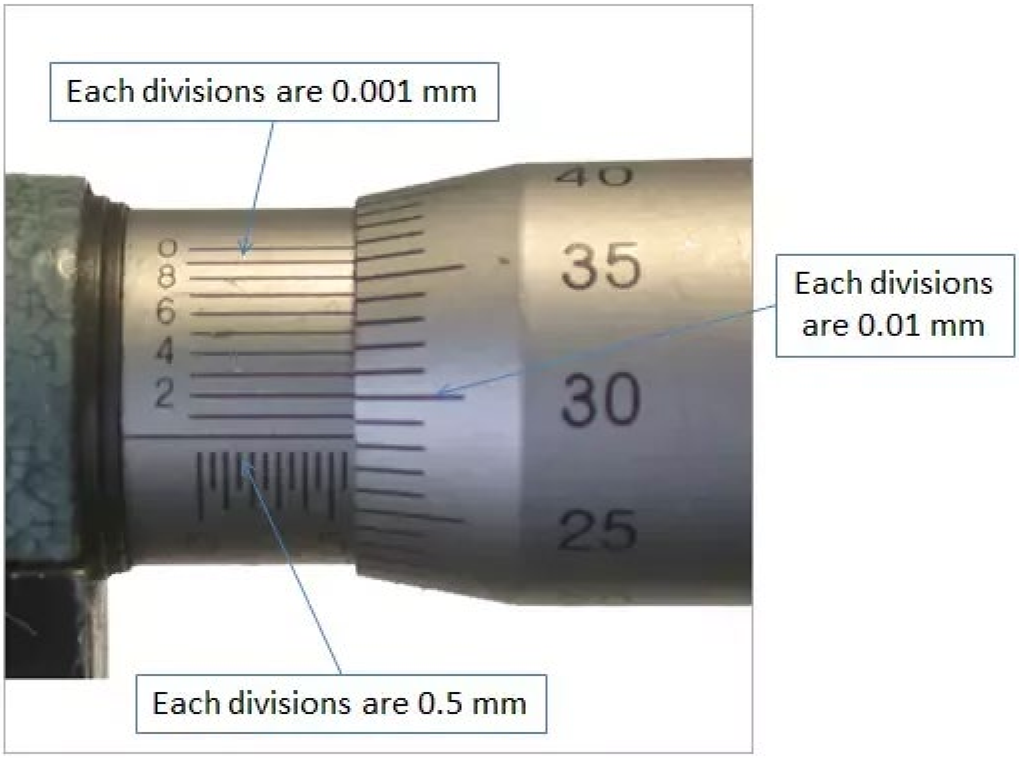




❖ **Dimension to be measured = Main Scale Reading + (Circular Scale Reading X Least Count)**

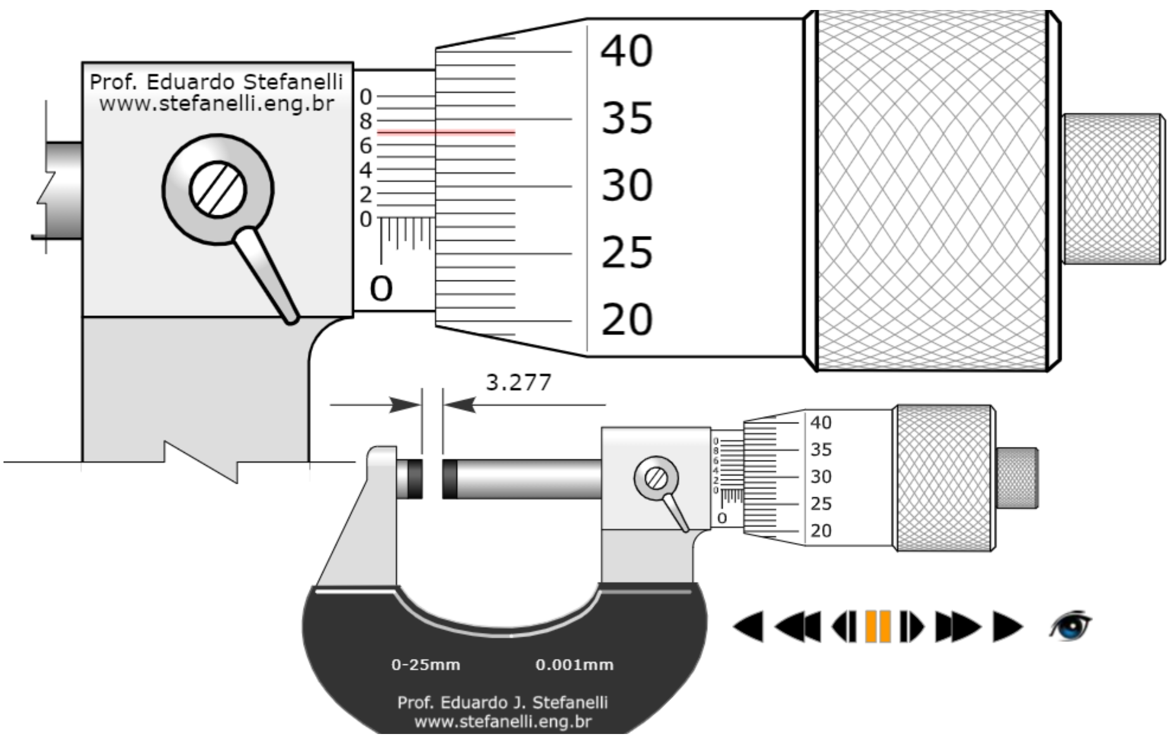
Note :

For more accurate micrometers we have a 3rd scale which can measure up to 0.001:



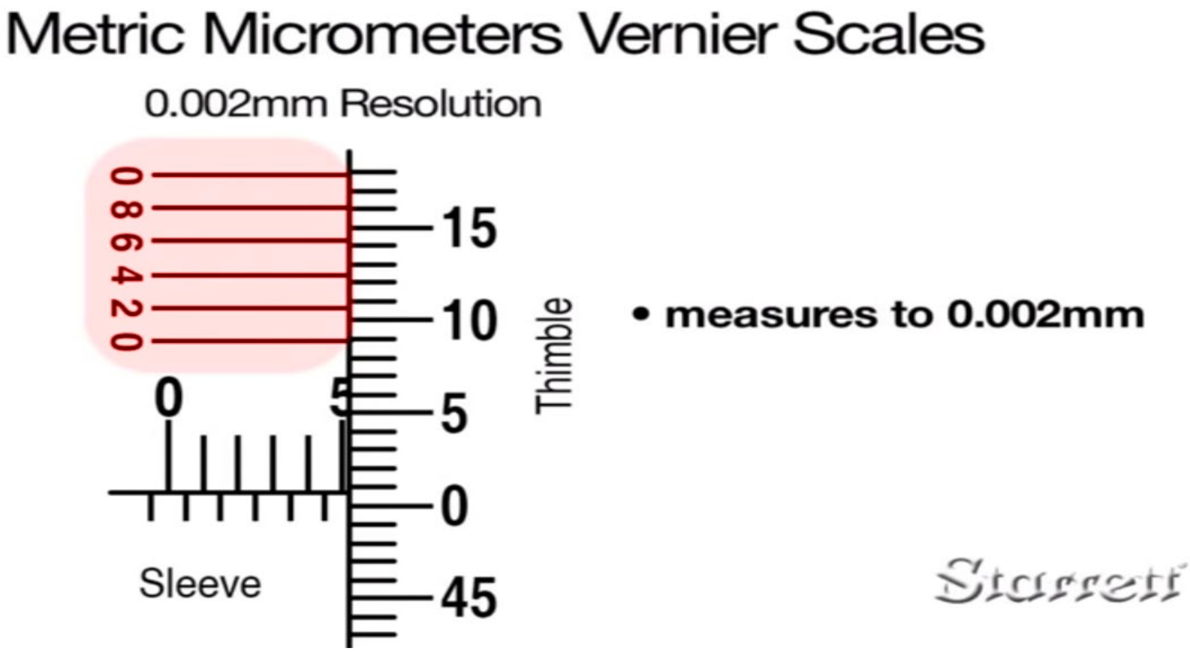
So, to calculate Dimension to be measured = Main scale reading + (circular scale reading x 1st least count) + (circular scale reading x 2nd least count)

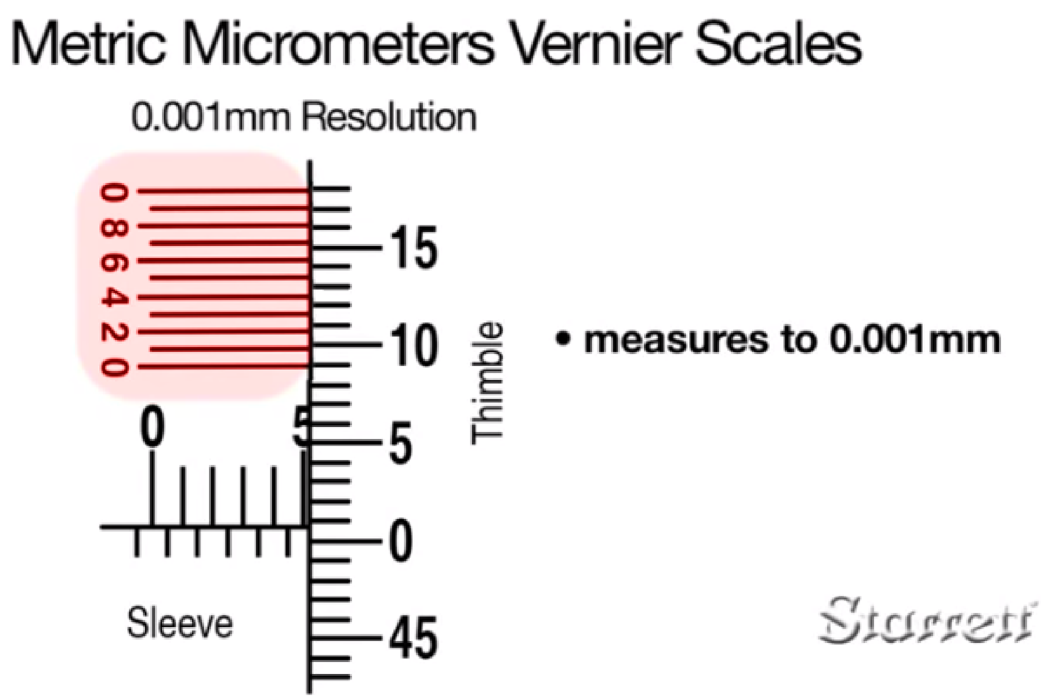
In our case:



Dimension to be measured =3mm+(27x0.01)+(7x0.001)= 3.277mm

To practice more go to:
https://www.stefanelli.eng.br/en/virtual-micrometer-thousandth-millimeter-simulator/#swiffycontainer_2 (for thousands millimeter micrometer)
https://www.stefanelli.eng.br/en/simulator-virtual-micrometer-hundredths-millimeter/
(Hundredths millimeter micrometer)
We have two types:

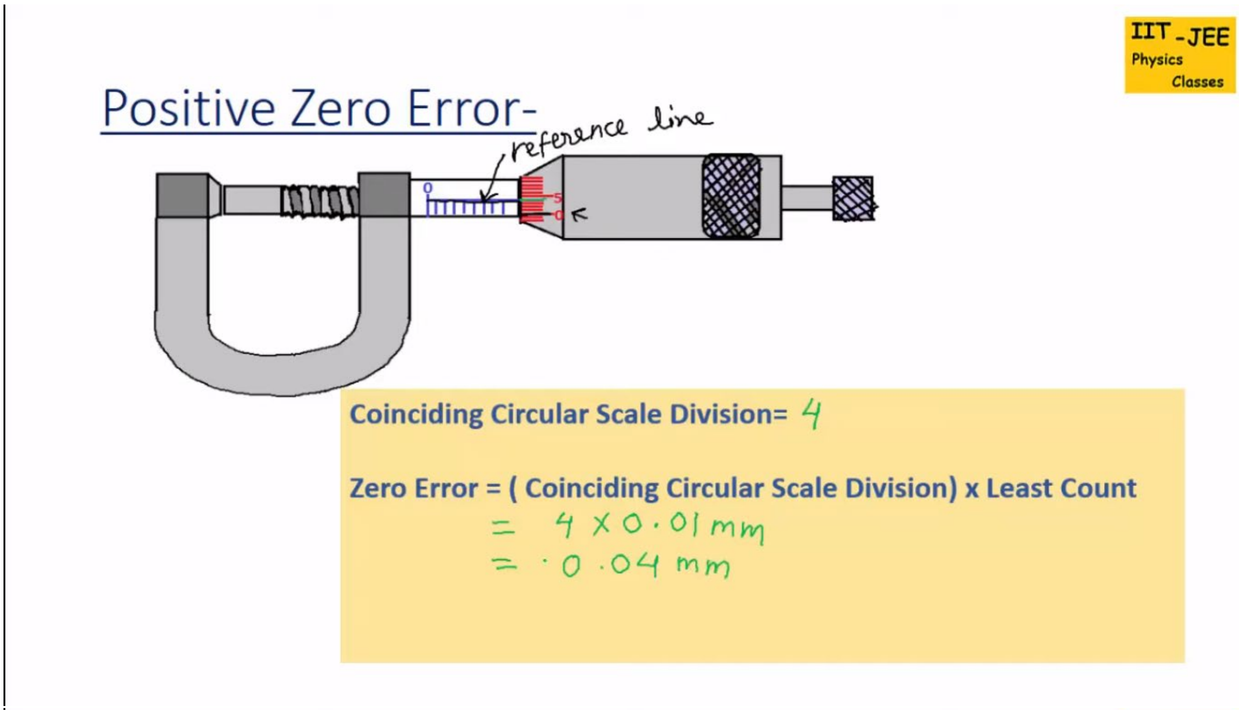


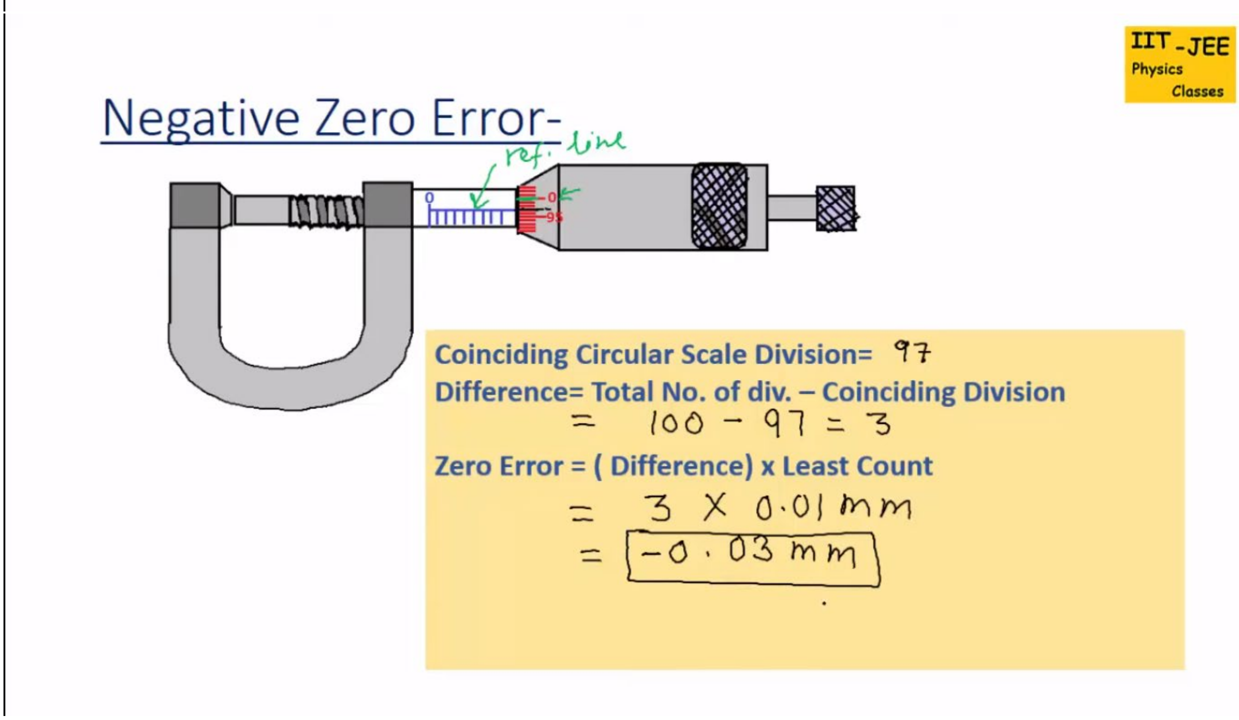


Errors:

Least count is the lowest limiting value of the measuring instrument. Suppose the least count of a screw gauge is given 0.01 cm , so we can measure length up to 0.01 cm, below that we can't measure the length. Hence maximum possible error is 0.01 cm. it is nothing but least count. So least count is considered as maximum possible error.

1- Zero Error:





Vernier caliper vs Micrometer:

Caliper can measure up to (0.02 mm -20um-0.001’’-1mils) if it’s accurate in normal conditions it can measure up to 0.1 mm or 100 um range while micrometer can measure up to (0.001mm-1microns) if it’s accurate and in normal conditions (0.01 mm or 10 um)
Caliper can take interior measure while micrometer can’t you will need an interior micrometer and its scale is small.

2- Errors due to temperature:
   - when taking small measurements in um you have to consider a the temperature expansion coefficient of the material
   $dl = L0\ \alpha\ (t1 - t0)$

   dl = change in object length (m, inches)

   L0 = initial length of object (m, inches)

   α = linear expansion coefficient (m/m°C, in/in°F)

   t0 = initial temperature (°C, °F)

   t1 = final temperature (°C, °F)

   The final length of the object can be calculated as

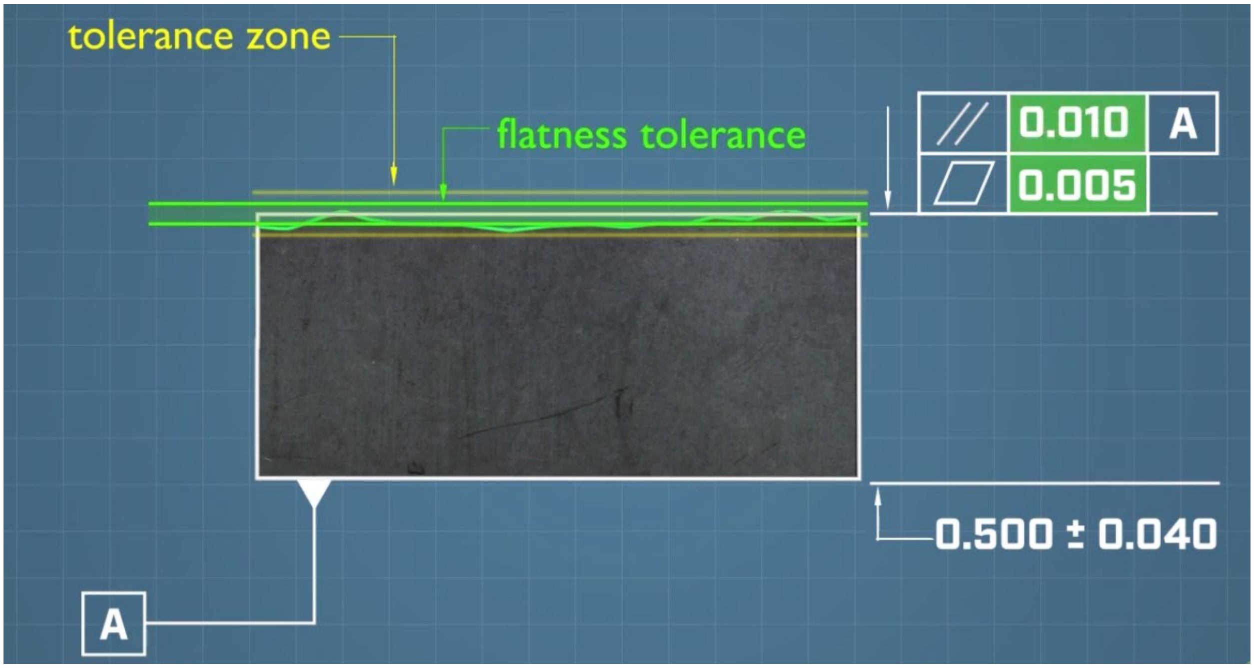
   $L1 = L0 + dl$

   $= L0 + L0\ \alpha\ (t1 - t0)$ (2)

   where

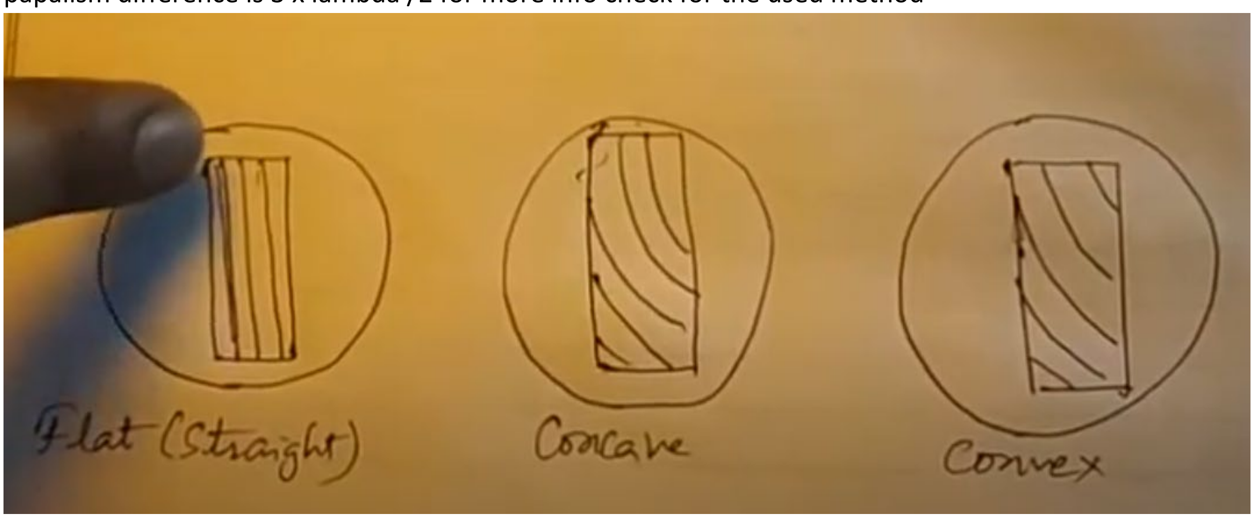
   L1 = final length of object (m, inches)

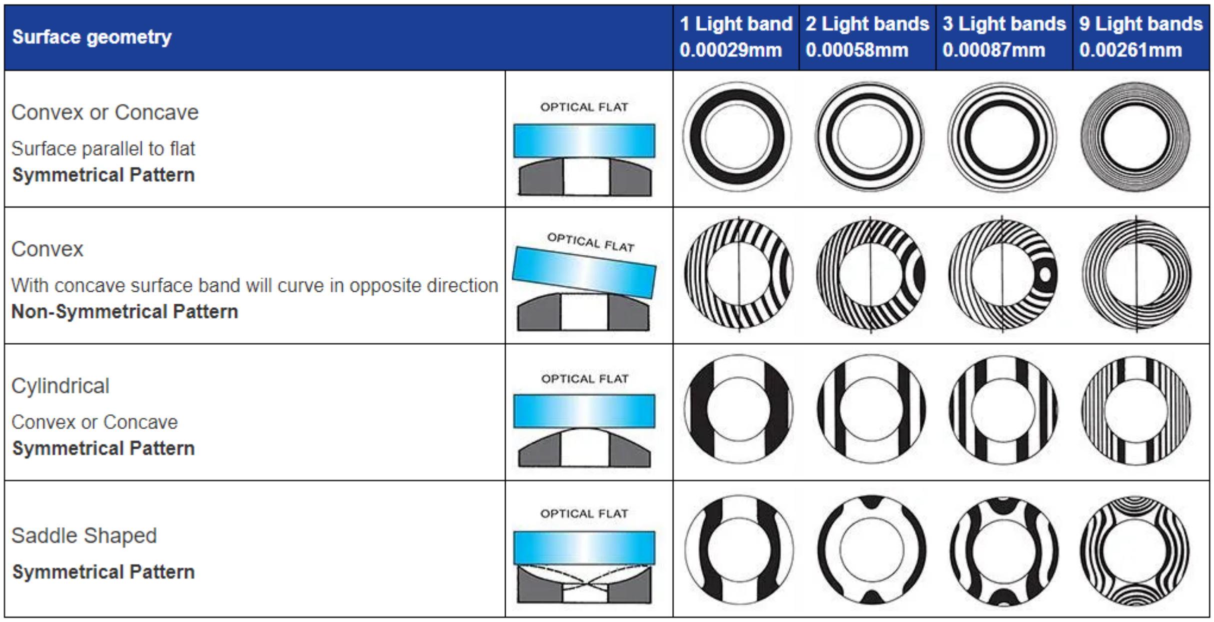
   3-error due to flatness and papalism:



Here we have acceptable papalism tolerance = 0.010 and flat tolerance as we can see is smaller 0.005 which will help us achieve better paralism.

To measure both we can use optical parallel to measure both with a known monochromatic source light with a know wavelength so we take the number lines and multiply by lambda /2 this will give us the flatness and according to shape of line we can know the nature of surface and for papalism we take the number of red lines on first side spindle side and on anvil side whichc should be 1 and we subtract the two for example we have 4 line on spindle and 1 on anvil so the papalism difference is 3 x lambda /2 for more info check for the used method





Surface geometry		1 Light band 0.00029mm	2 Light bands 0.00058mm	3 Light bands 0.00087mm	9 Light bands 0.00261mm
Convex or Concave Surface parallel to flat **Symmetrical Pattern**	OPTICAL FLAT				
Convex With concave surface band will curve in opposite direction **Non-Symmetrical Pattern**	OPTICAL FLAT				
Cylindrical Convex or Concave **Symmetrical Pattern**	OPTICAL FLAT				
Saddle Shaped **Symmetrical Pattern**	OPTICAL FLAT				

https://www.kemet.co.uk/products/flatlapping/monochromatic-light-source
https://www.youtube.com/watch?v=G_G8KWbFzXk&t=415s

Notes:

- always store in case clean with soft piece of cloth and alcohol , and leave the teeth slightly open or put a piece of cloth or paper.