Rulers, Verniers, Micrometers and Measurement Uncertainty

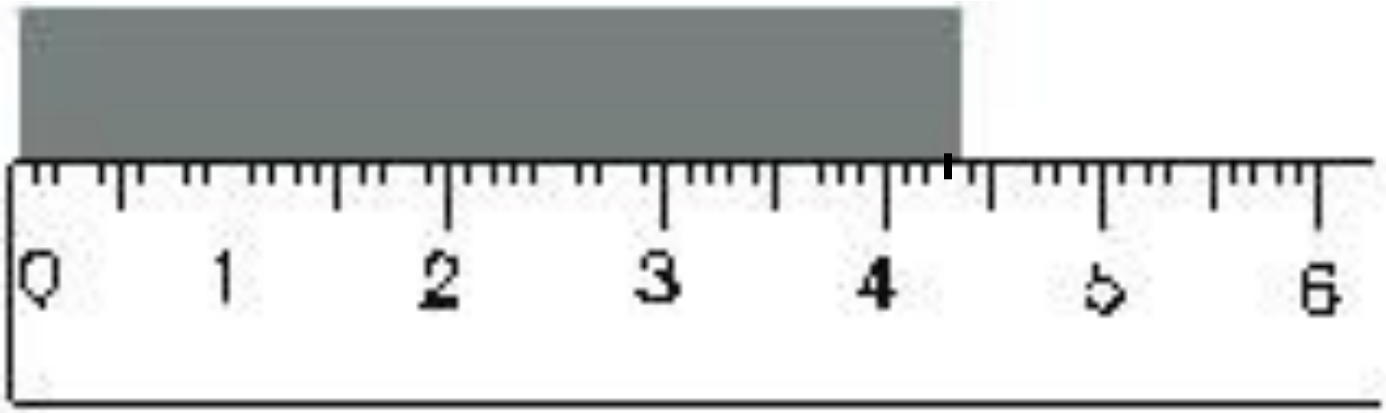
Reading and understanding

The ruler

For an uncertainty of about 1%

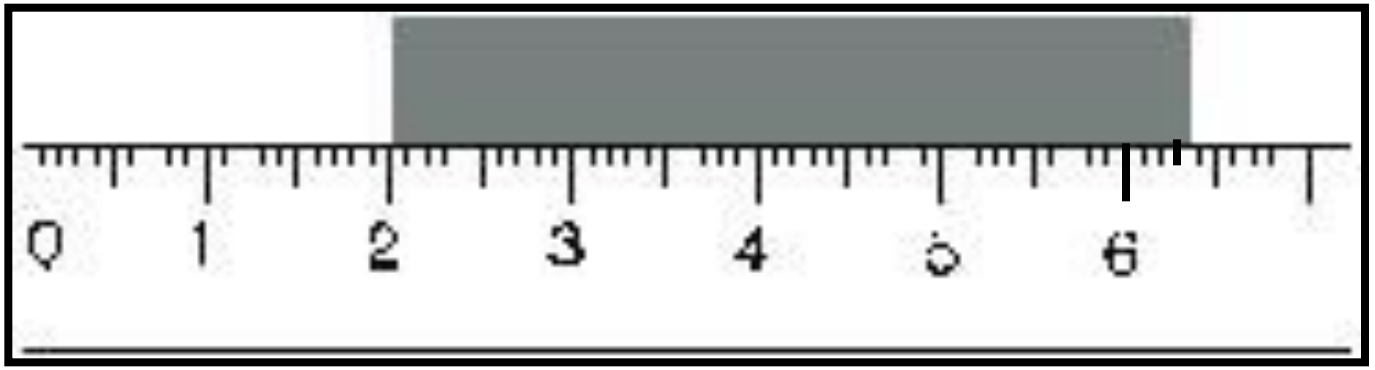
- a) a ruler, marked in mm, is useful for making measurements of distances of about 10cm or greater.

Reading a ruler



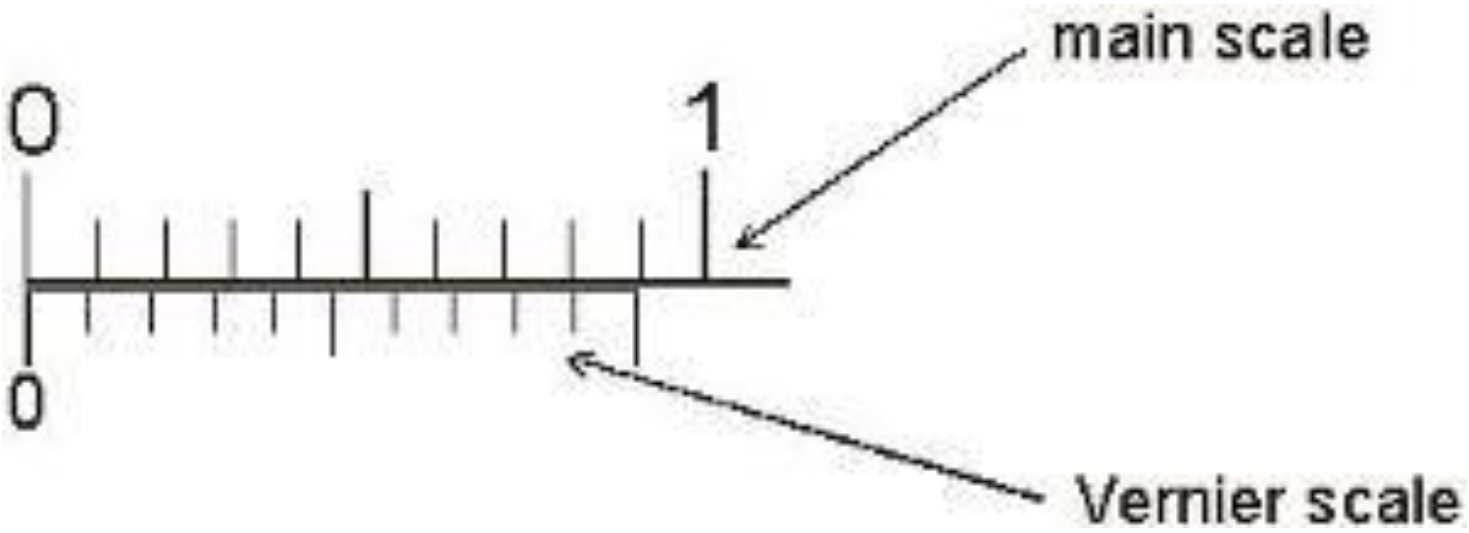
- THE READING IS SLIGHTLY OVER 4.3
- Should the result be stated as 4.3± ½ a division
- NO the measurement is made at 2 ends!!

Reading a ruler

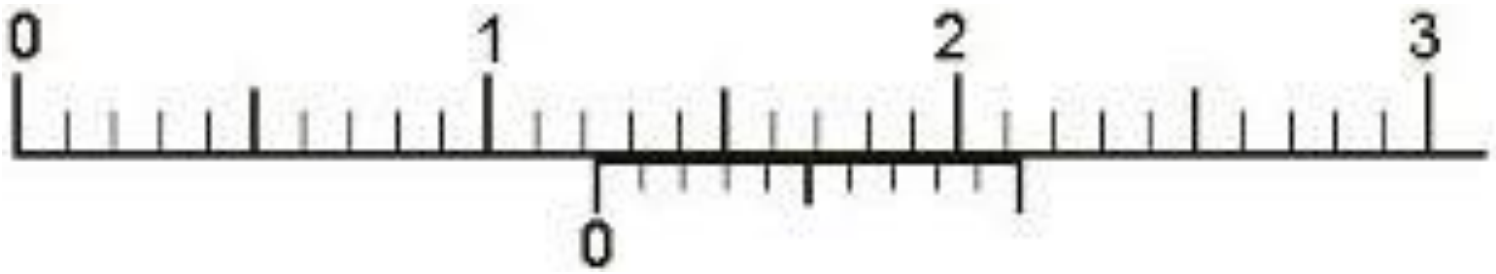


- Every measurement is really a subtraction
- 6.3(±0.05)cm - 2.0 (±0.05)cm = 4.3 (±0.1)cm

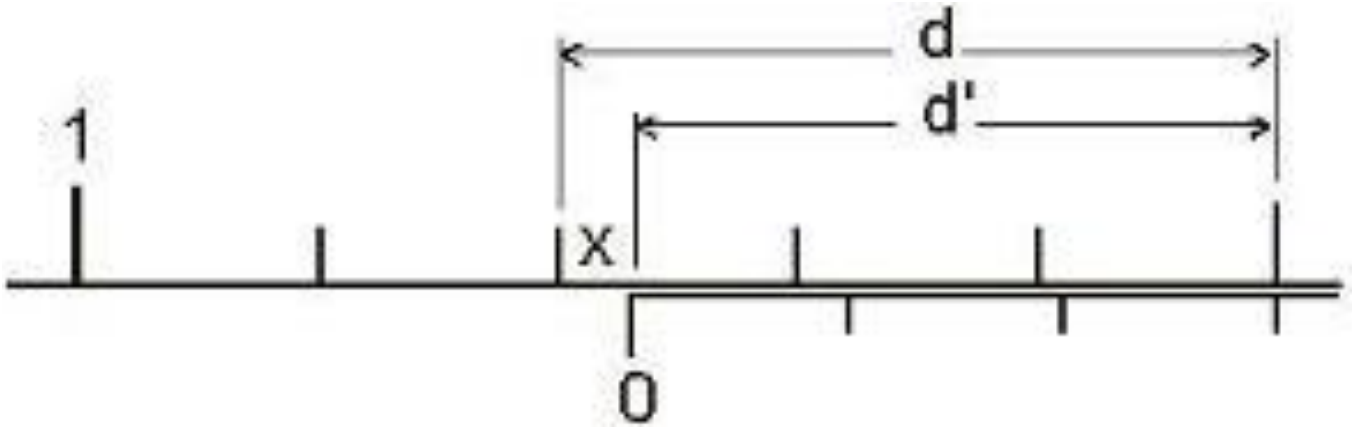
Reading a Vernier



- Note 10 divisions on the vernier scale cover nine divisions on the main scale
- The vernier works because of this discrepancy.



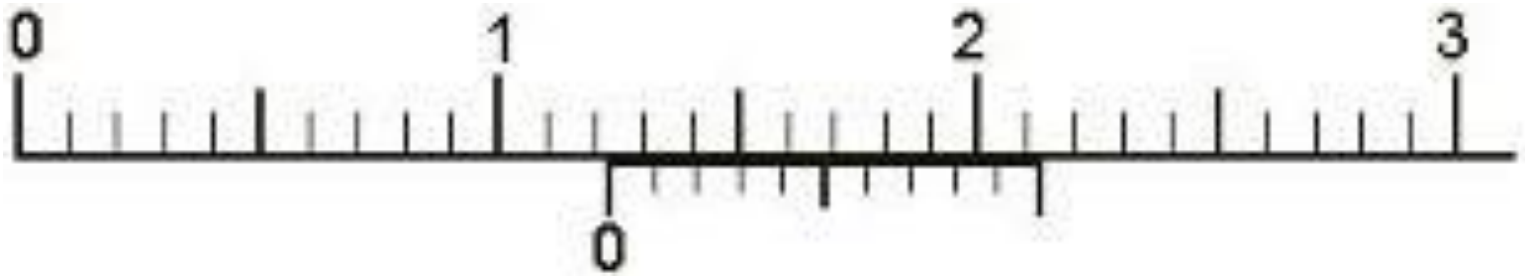
On this cm scale the reading is 1.23cm



The vernier part of the reading is really a subtraction:

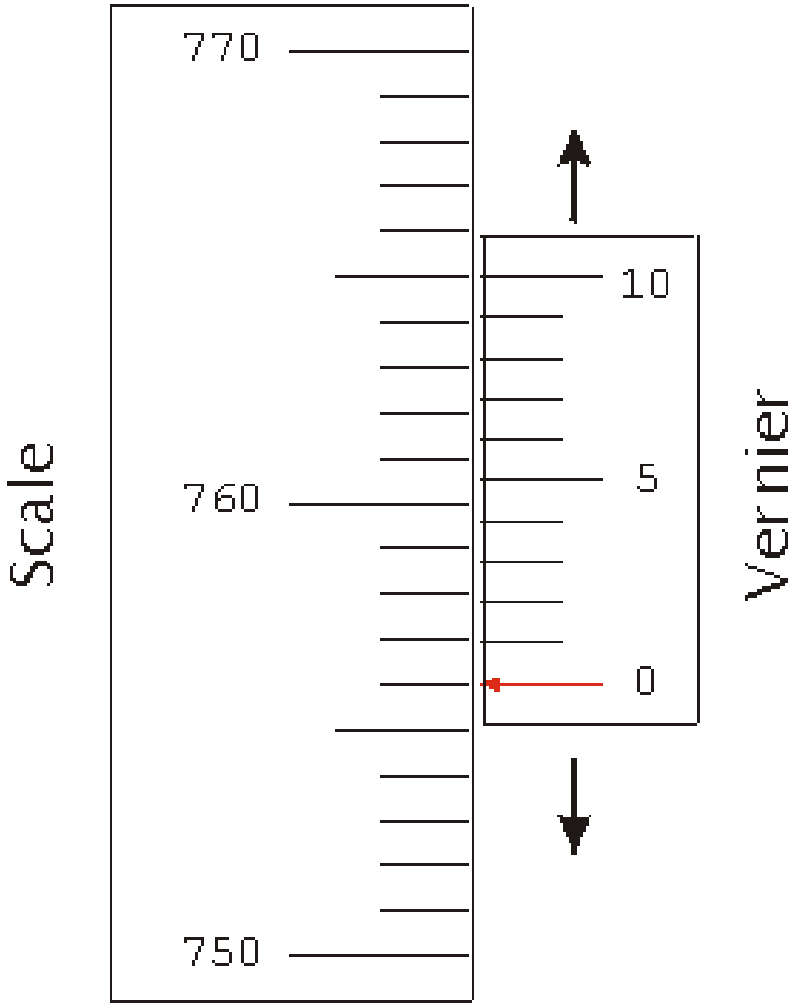
$$x = d - d'$$

$$x = 3mm - 3(0{\cdot}9)mm = 3(0{\cdot}1)mm$$



The level of precision depends on the ***difference*** between the size of the smallest division on the **main scale** and the size of the smallest division on the **Vernier scale**.

Main scale (1mm) - Vernier scale (0.9mm) = 0.1mm
The reading above is 1.23 ± 0.01 cm



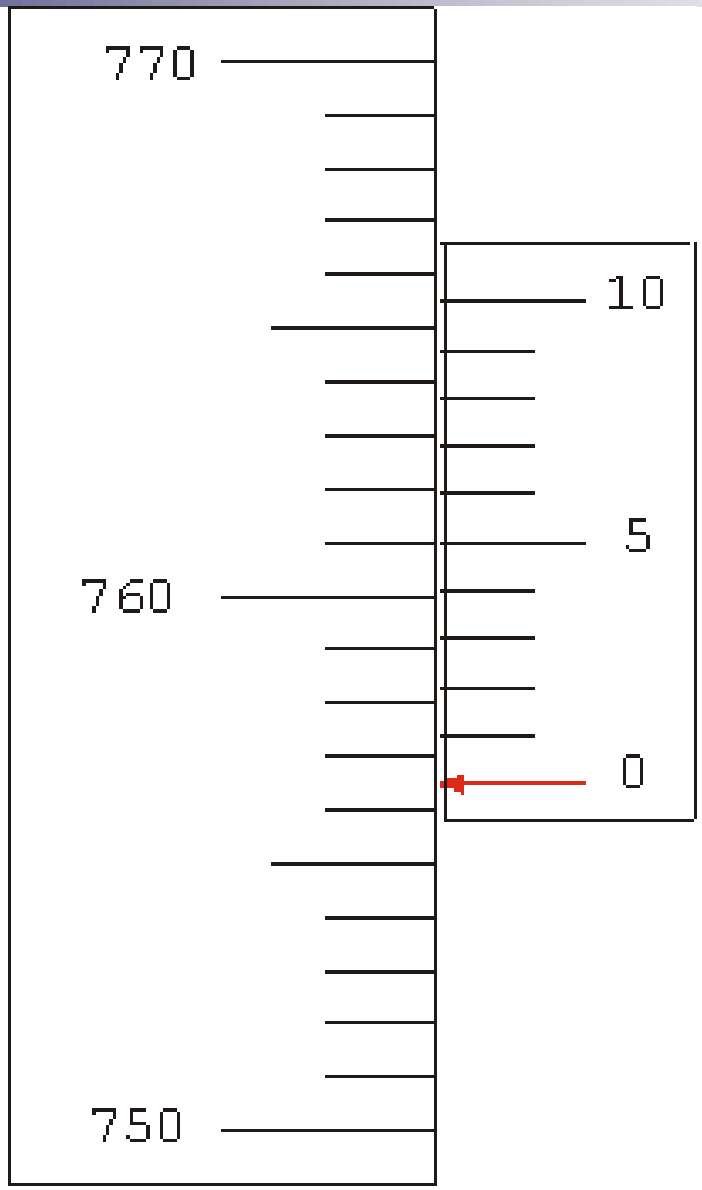
756.0

What is the uncertainty?

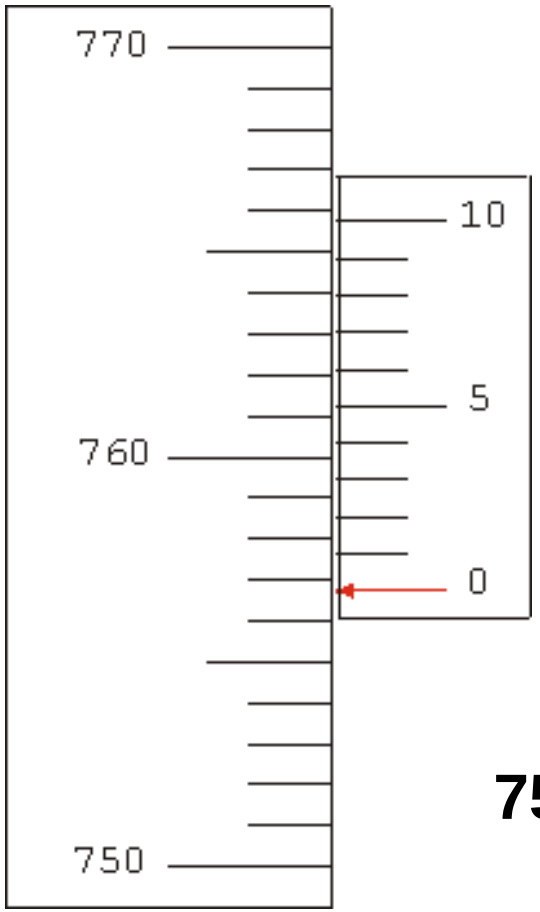
Smallest measurement on the main scale- Smallest measurement on the Vernier

1 - 0.9 = 0.1

The reading is written 756.0 ± 0.1

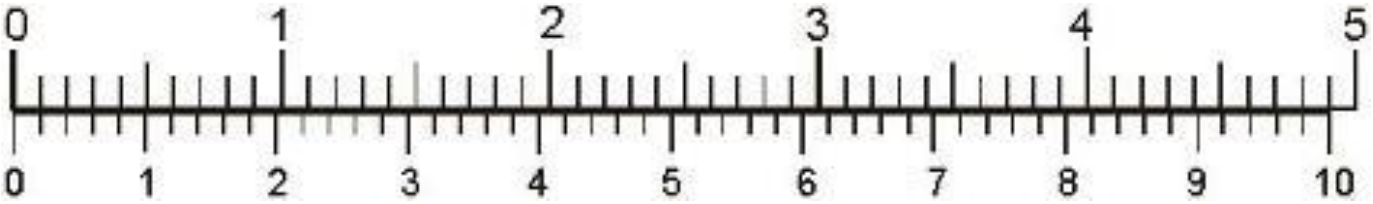


756.5 ± 0.1



756.7 ±0.1

Different Verniers



What will the precision of this scale be?

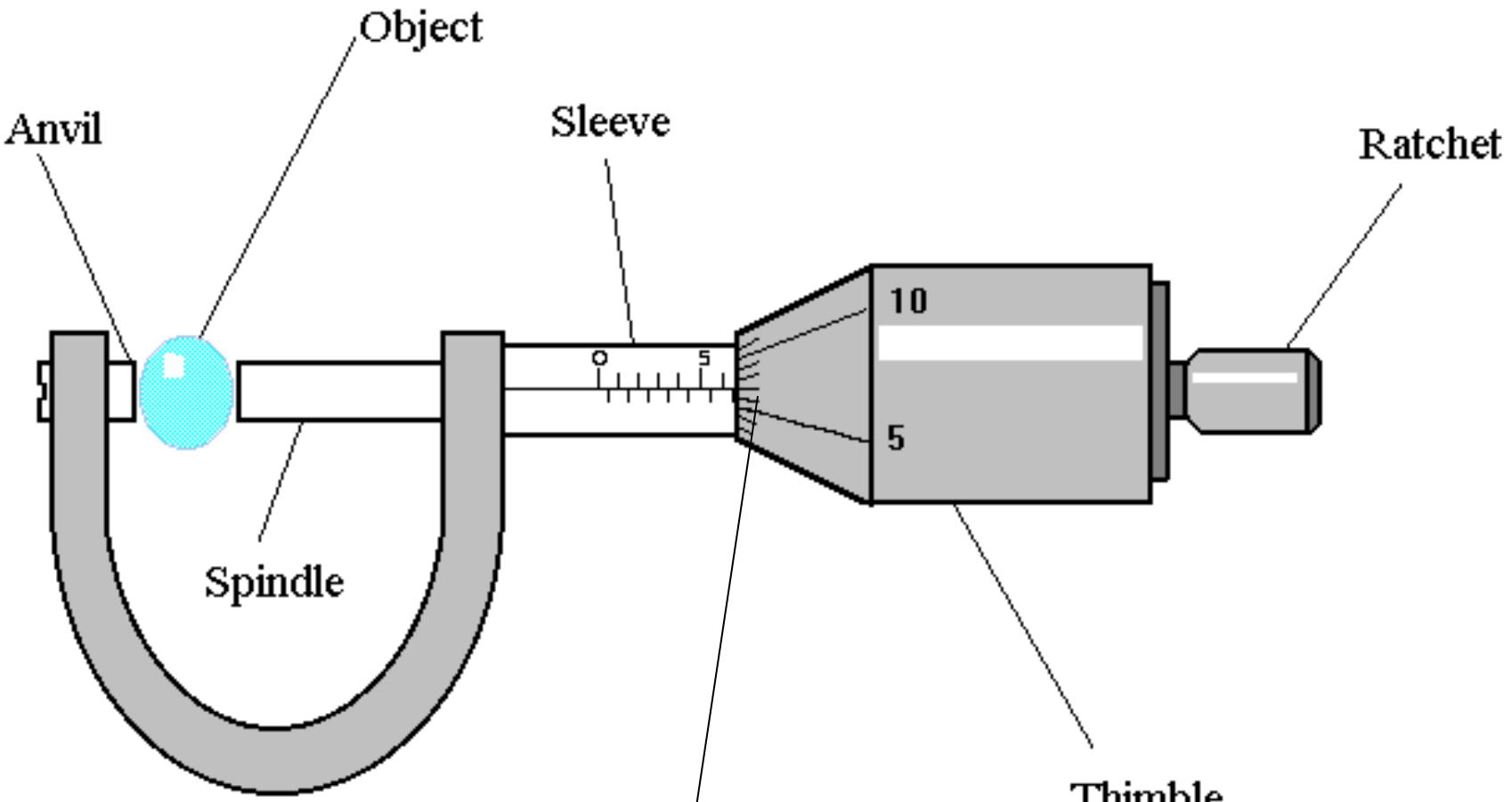
main scale smallest division = 1mm

vernier scale smallest division 49/50 mm

1-49/50 = 1/50 mm = 0.02mm
All measurement are to ± 0.02mm

The Micrometer

Reading the micrometer

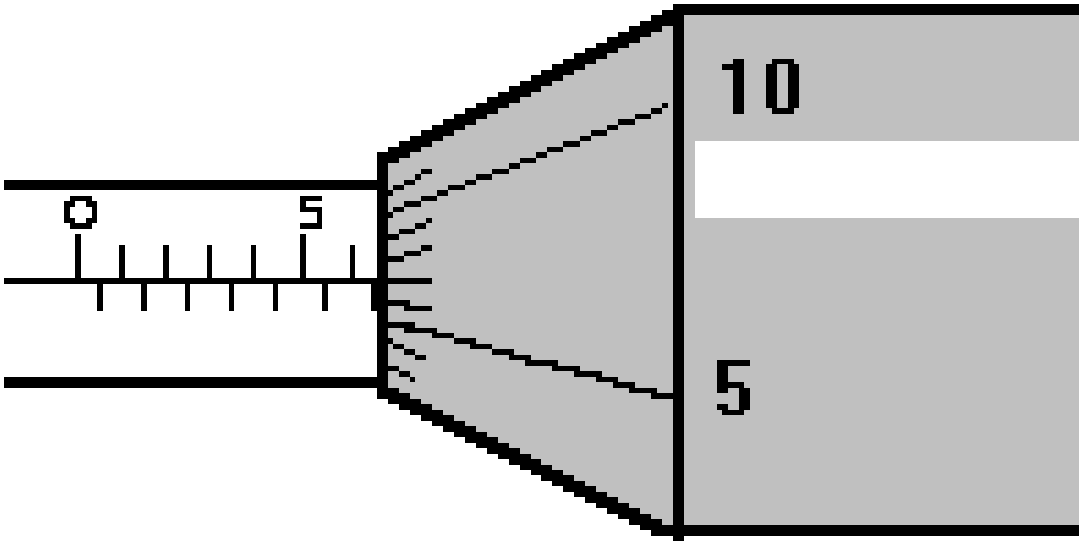


Each mark here is = 0.01mm

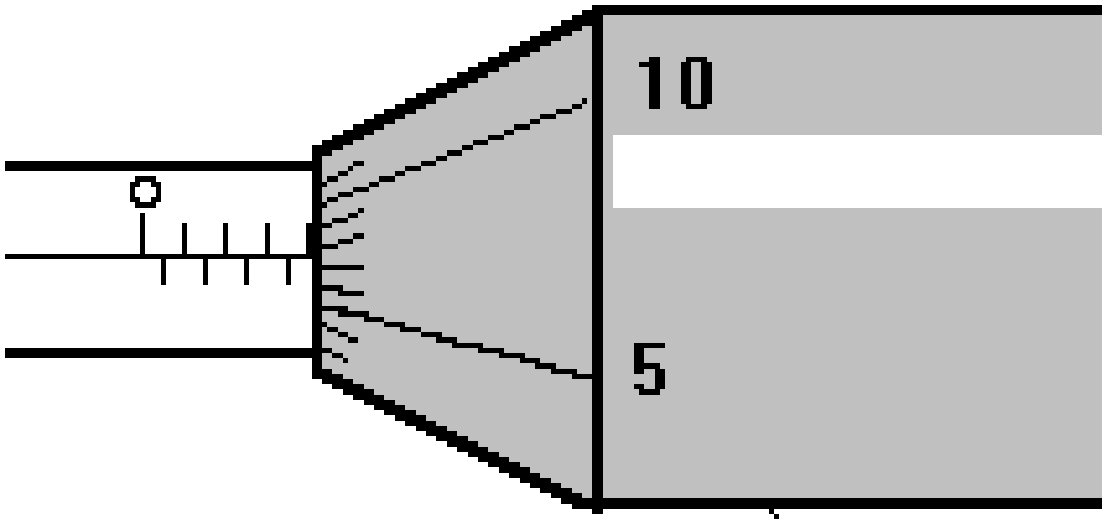
Reading = **6.57 mm**

Using the micrometer

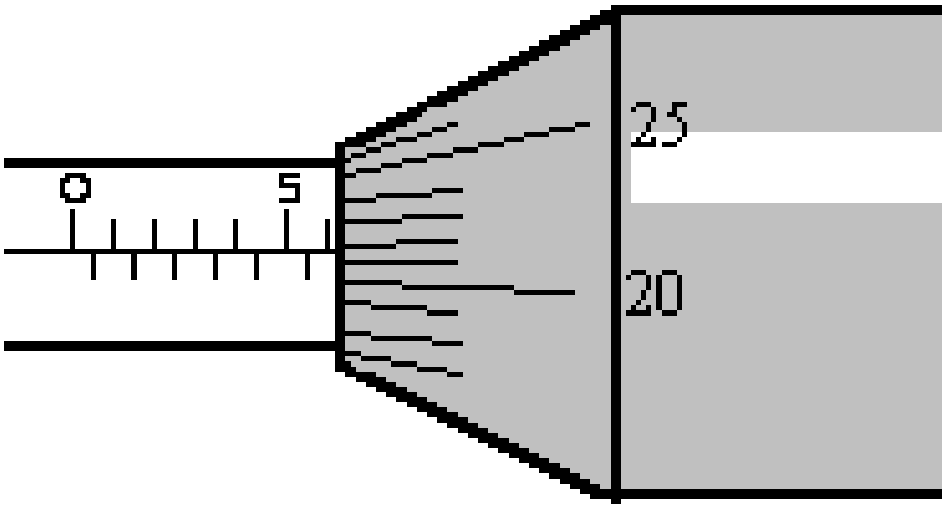
- Do not over tighten the micrometer
- Do not store with closed Jaws
- When measuring the diameter of a wire take readings across several points at 90 degrees to each other.



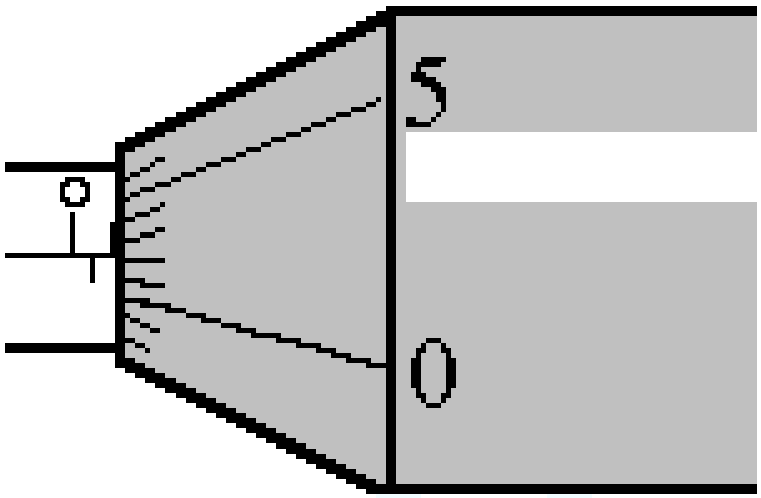
6.57mm



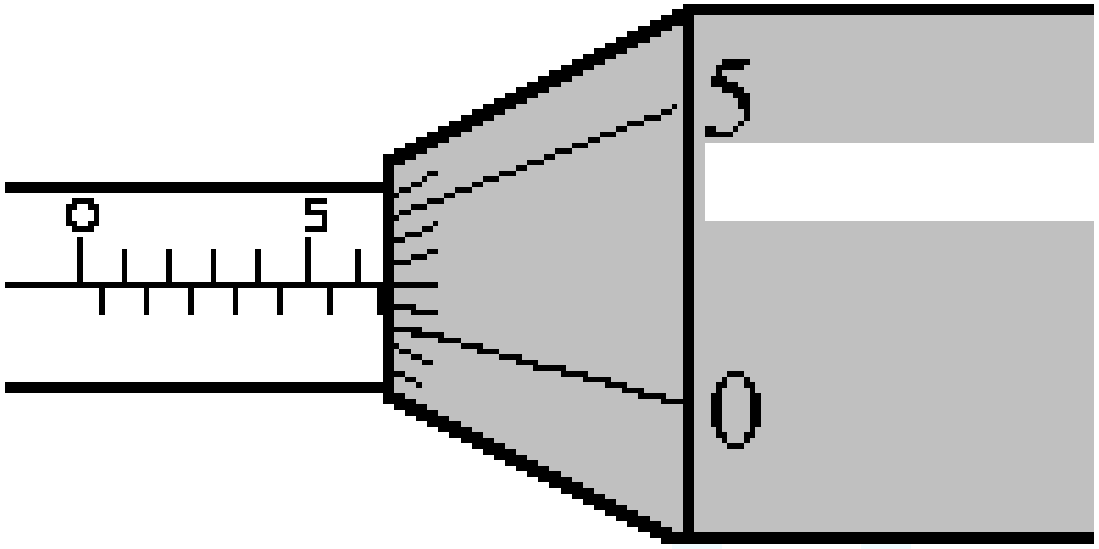
4.07mm



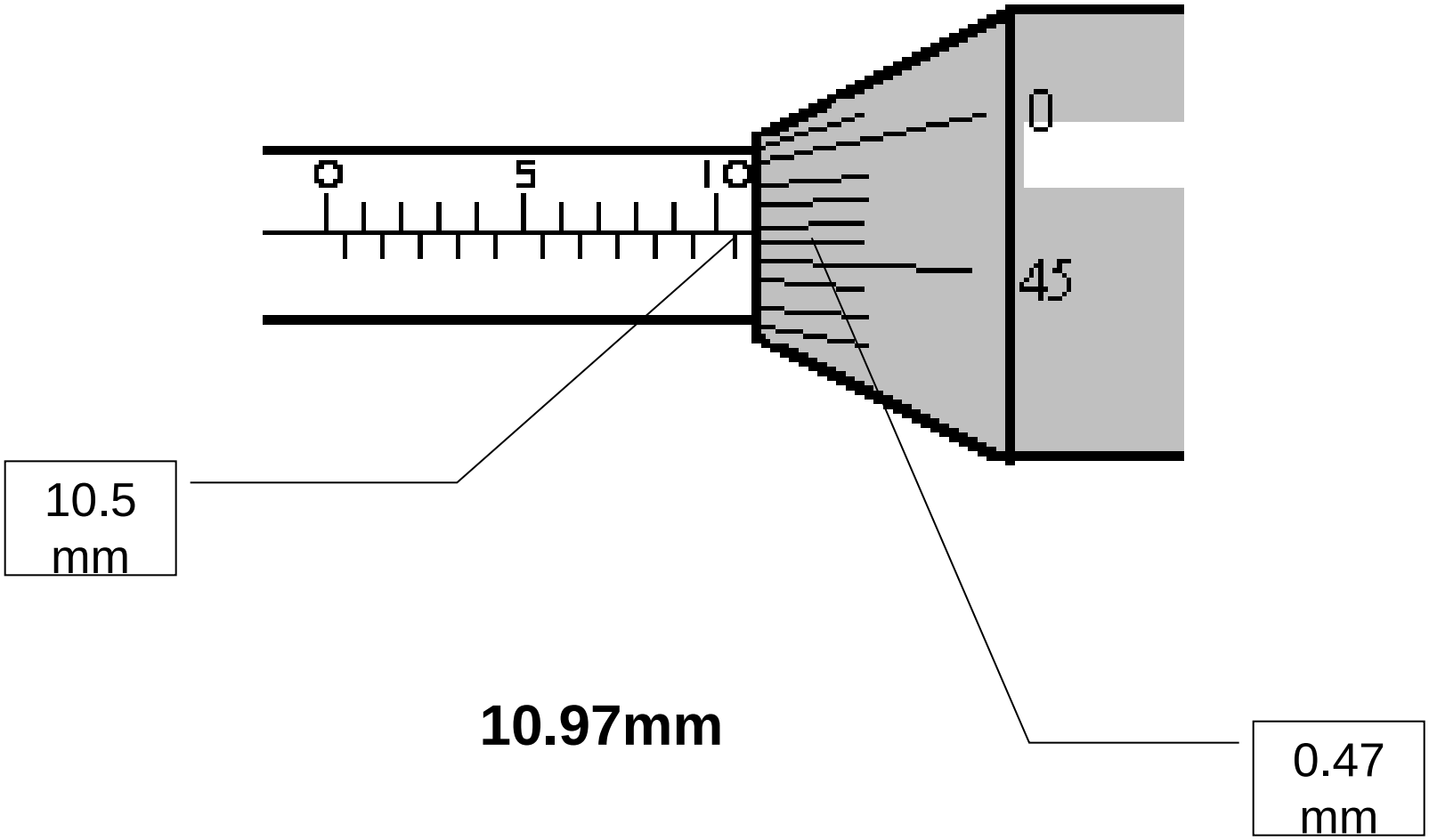
6.22mm



1.02mm



6.52mm

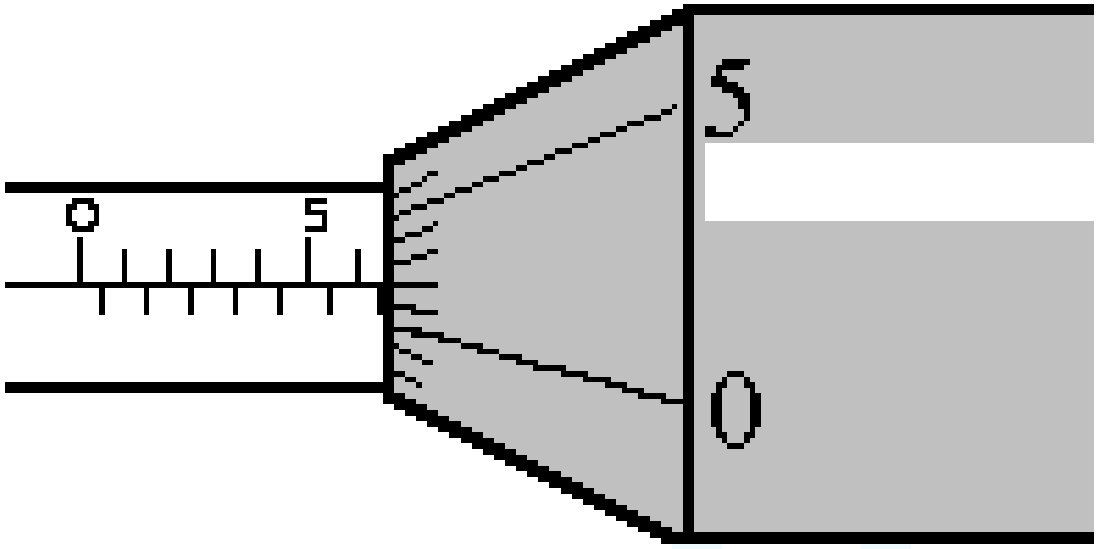


10.97mm

Micrometer Uncertainty

- The micrometer may not close on zero.
- We take a zero point reading which we add to our reading.
- This affects the uncertainty of our micrometer reading

If the zero reading was -0.01mm



This reading is 6.52mm

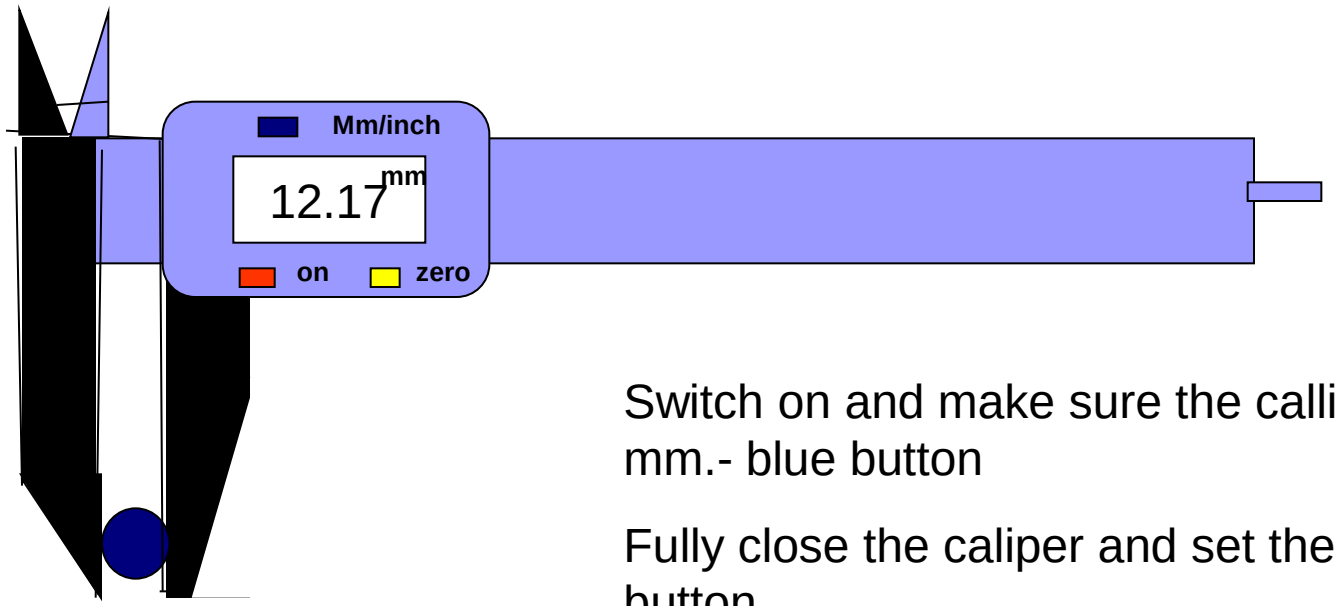
6.52 ± 0.005mm + (-0.01) ± 0.005mm = **6.52±0.01mm**

Digital micrometers and vernier callipers

- The uncertainty of a correctly set digital micrometer is 10 times less than that of a simple micrometer.

- Similarly the uncertainty of digital callipers is 10 x less than that of a simple vernier calliper

The digital calliper

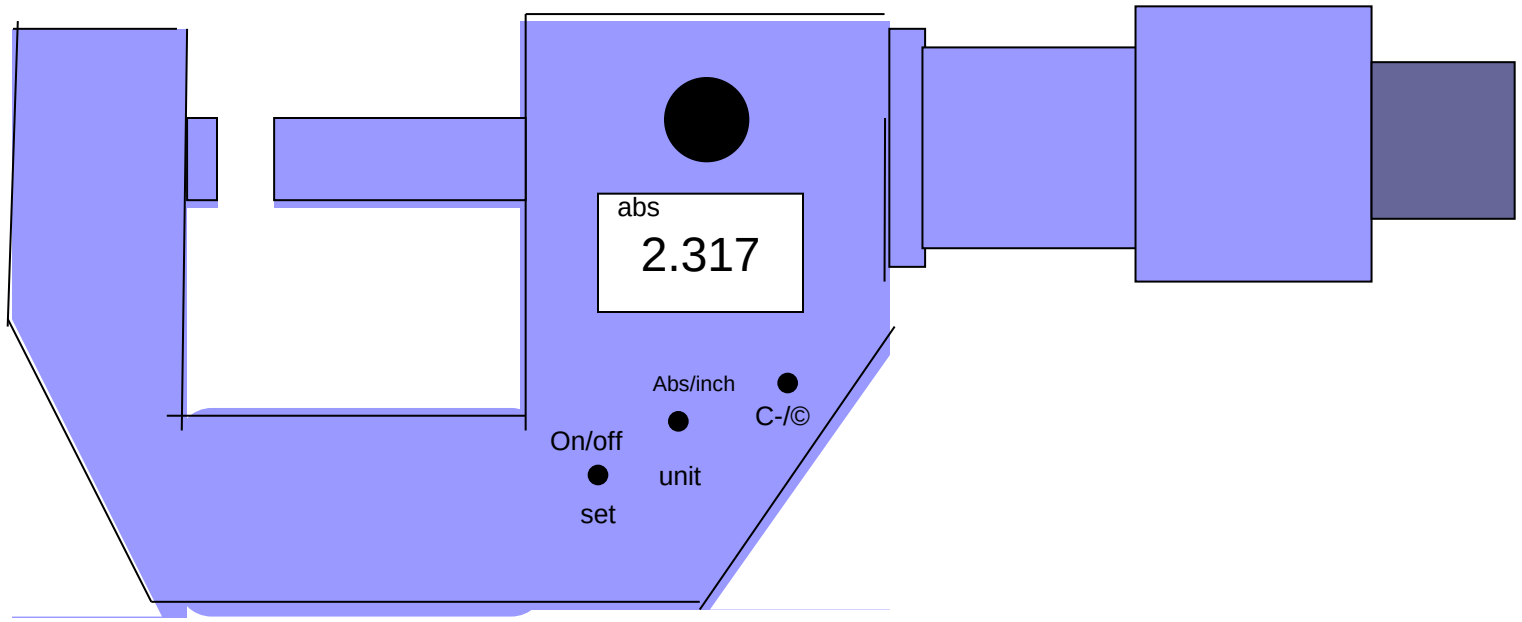


Switch on and make sure the callipers are set in mm.- blue button

Fully close the caliper and set the zero-yellow button

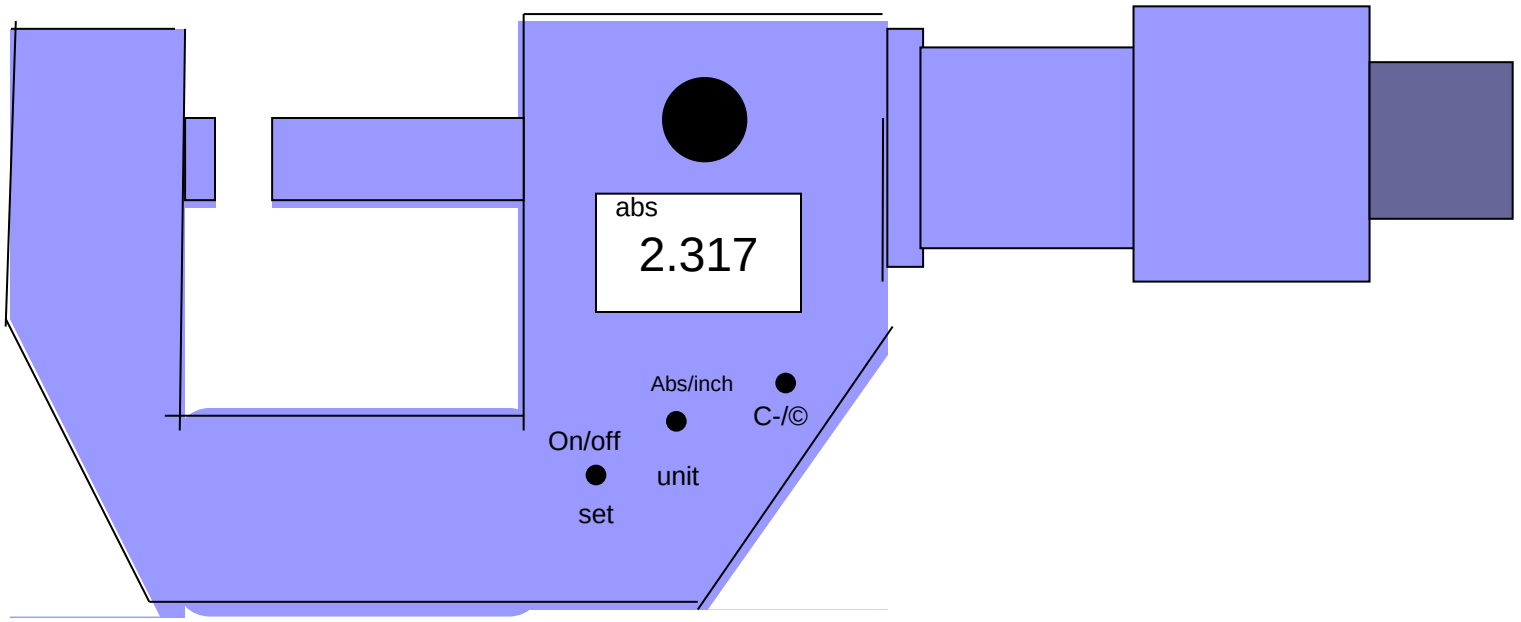
The uncerainty on a single reading is 0.01mm

The digital micrometer



The uncertainty on this single reading is 0.001mm

The digital micrometer



Using **only the ratchet** close the caliper.

Press the on off button for more than 2 seconds until “**set**” appears in the window above the number. The micrometer now reads zero.

Make sure that the unit is not reading in inches