The Vernier & Micrometer

From your experience in using a ruler and meter stick, it is evident that we are very much limited by our eyesight. How can we hope to measure accurately something as small as 0.01 cm or smaller? For such measurements, the lines on the instrument would be so close that they would run into each other. Two devices have been invented to make these fine measurements possible. They are Vernier Caliper and Micrometer Caliper.

1. Vernier Caliper

The vernier caliper is a slide-type caliper used to take inside, outside, and depth measurements. The vernier caliper has two metric scales and two English scales (See Figure 1 below).
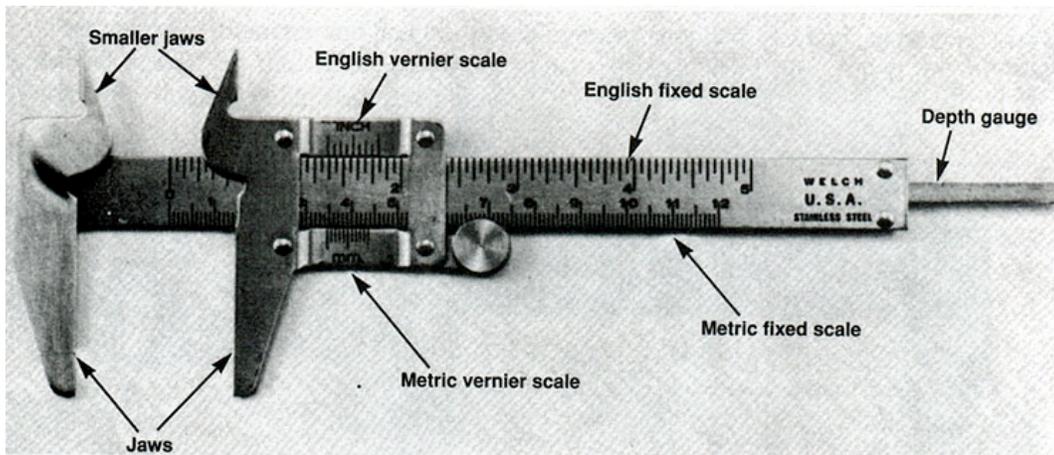

Figure 1

Consider the metric scales. One of them is fixed and located on the lower part of the beam. It is divided into centimeters and subdivided into millimeters. The other metric scale is called the vernier metric scale and is the lower scale on the slide. This scale is made with nine millimeters contains ten divisions (See Figure 2 below).
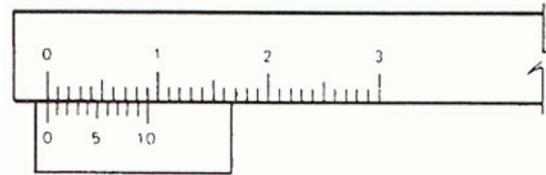

Figure 2

Each division on the vernier scale equals 0.9 of a division on the fixed scale. The part of the reading from the vernier scale is in tenths of a millimeter, which means that the precision of the instrument is 0.1 mm or 0.01 cm.

In practice the object to be measured is placed between jaws and the vernier is placed against the end of the object as shown in Figure 3. By sight we can see that the object is larger than 7.7 cm and smaller than 7.8 cm. In order to find the second decimal place we look at the vernier scale and find the calibration line that just lines up with a line on the fixed scale is the eighth line from zero line. Therefore the dimension of the object being measured is 7.78.
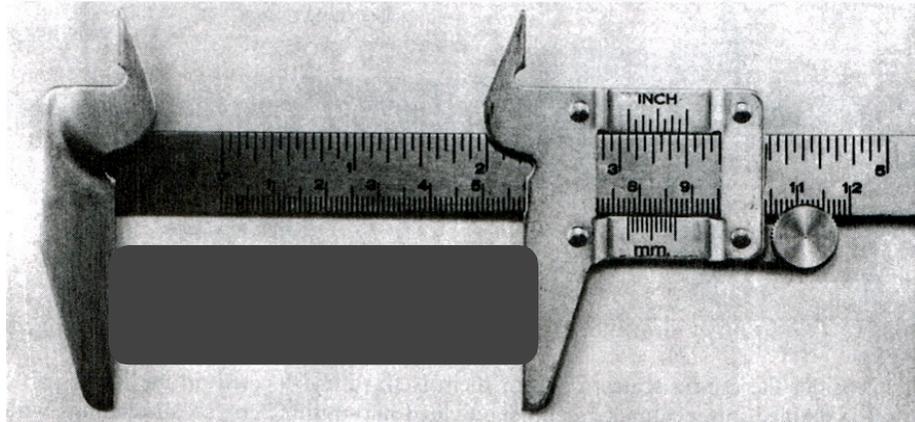

Figure 3

2. Micrometer Caliper

The micrometer caliper is used to make very fine measurements beyond the hundredths of a centimeter. As its name implies, distances are measured to 0.000001 m or 10^{-6} m (recall the SI prefix for an order of magnitude of –6 is micro) which is equal to 0.0001 cm. This device uses the uniformity in the spacing of threads on a bolt. If a nut is threaded on the bolt and the bolt is rotated one complete evolution, the end of the bolt will have moved a linear distance equal to the width of a thread. If instead of a nut, we attach a rotating scale as well as place a calibrated line (also called the fixed scale) along the length of the bolt, then it becomes possible to measure small fractions of a rotation (and small fractions of the width of a thread).
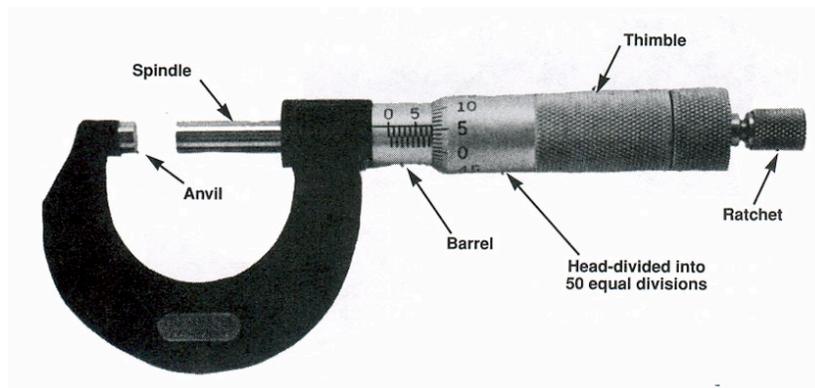

Figure 4

As shown in Figure 4 the basic parts of a micrometer are labeled. The object to be measured is placed between the anvil and spindle. Turn the thimble until the object fits snugly. <u>Do not force the turning of the thimble, since this may damage the very delicate threads on the spindle located inside the thimble.</u> Some calipers have a ratchet, which helps protect the instrument by not allowing the thimble to turn when forced.

The barrel is graduated in millimeters and it also has graduations in halves of millimeters, which are indicated by the lower set of graduations on the barrel. The threads on the spindle are made so it takes two complete turns of the thimble for the spindle to move precisely one millimeter. The head (rotating scale) is divided into fifty equal divisions—each division indicating 0.01 mm, which is the precision of the instrument. Since our eye can still estimate another decimal place between marks on the rotating scale (or 0.001mm, which is 0.000001 m), this device is called a micrometer.

Rules for reading a micrometer in millimeters:
1. Find the <u>whole number</u> of mm in the measurement by counting the number of mm graduations on the barrel to the left of the head.
2. Find the <u>decimal part</u> of the measurement by reading the graduation on the rotating scale that is most nearly in line with the centerline on the barrel, and multiply this reading by 0.01. If the head is at or immediately to the right of the half mm graduation, add 0.50 mm to the reading on the rotating scale.
3. Estimate one more decimal place.
4. Add the numbers found in steps above.

Example: Read the measurement on the micrometer below.

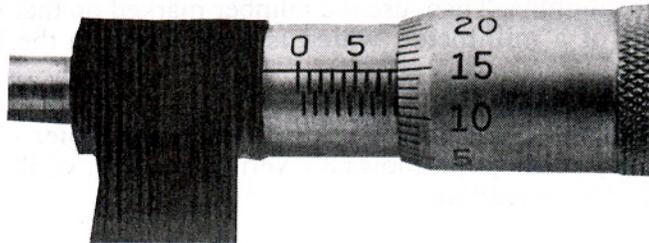Figure 5

Steps: 1. The barrel reading is   8.00   mm
          2. The rotating scale reading is   0.65   mm   (Note that the head is
          3. The estimate decimal place is   <u>0.000 mm</u>   past the half mark.)
          4. The total measurement is   8.650 mm