EXP. 2 Vernier Caliper

1. Section Purpose

To measure lengths, external diameters of any round matters as well as the depths of any in-carved holes

2. Theory

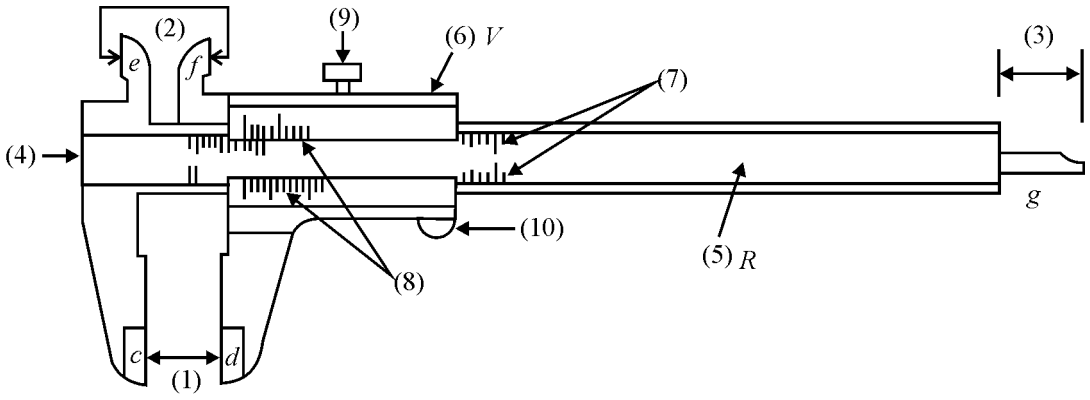

Illustration 1. Vernier Caliper

(1) External Diameter Measurement Side

(2) Internal Diameter Measurement Side

(3) Depths Measurement Side

(4) Level Measurement Side

(5) Main Ruler (Body) (6) Vernier

(7) Main Scale (8) Vernier Scale

(9) Fixed Screws (10)Sliding button

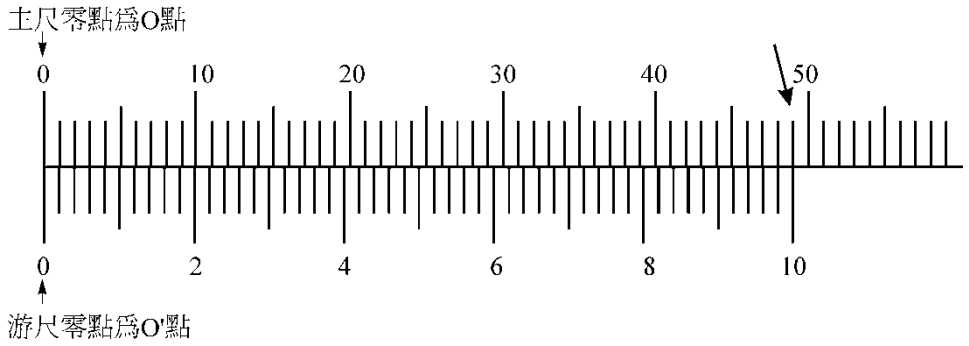

Illustration 2. Main and Vernier Scales

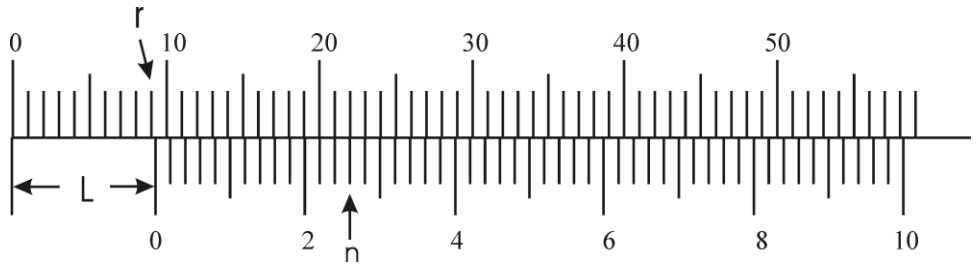

Illustration 3. 0.02 mm Vernier Caliper

(1) As shown in illustration 1, R is the main scale, while *V serves as the vernier part on the main. An ideal Vernier Caliper should make O' of V and O of R completely overlap when e, f, or c, d are seamless. As indicated in Illustration 2, for a vernier caliper of 1/50mm., v will be the 50th mark on the scale, whose reading will be 10 and is supposed to be aligned with graduation at 49mm. of R and therefore one of the graduations of V is* 49/50 mm, showing that the graduations difference on the main and vernier is 1/50 mm.

(2) Depending on different scenarios, when we measure the lengths, clamp with c and D or support with e and f, or push upward with g. The distance between 2 starts is $\overline{OO'}$ and its distance is *L. As shown in Illustration 3, the intended result is gained. On the main scale (R), the closest graduation's reading on* the vernier to the leftmost is r. Next, examine the positions of each aligned graduations with your eyes. If a certain graduation on R is aligned with the Nth graduation on V, the distance between $\overline{OO'}$ will be:

$$L = r + \left(\frac{1}{50}\right) \times n \tag{1}$$

For your conveniences, we'll divide the 50 marks on the vernier caliper into 10 units and the reading relation of v and n on the newly-adjusted unit will be:

$$v = n \times 10/50 \text{ ,}$$

corollary,

$$L = r + \left(\frac{1}{50}\right)\left(\frac{50}{10}\right)v = r + \frac{v}{10} \tag{2}$$

From the example in Illustration 3, we can tell that the reading to the left most of zero on the main scale is $r = 9$, and meanwhile, 2.6 on the vernier and 22mm on the main are aligned, therefore,

$$v = 2.6$$

$$\therefore \quad L = 9 + \frac{2.6}{10} = 9.26$$

the reading will be 9.26 mm. the designs of any vernier calipers allow their users to gain the lengths of the target directly from the 2 graduations aligned.

3. Instruments Required

Vernier Caliper x 1/ Objects to be measured

4. Steps to the Experiment

(1) Correct the start (zero): make e, f, c, d seamless. If *O* and *O' fail to be aligned, measure the distance C' of O* and *O' when they are seamless. If O' is on the right side of O, then set C≡+C'; if O' is on the left, then set C≡ - C'.*

(2) To acquire the external diameter of the object to be measured, use the Vernier caliper c and d to clamp it. Record the reading on the main r, and that on the vernier v. Apply Formula 2 to acquire L_0 plus the reading C at the start (zero) shown in step 1, then the actual length will be $L_0 = L - C$. After that, record the first value as x_1.

(3) Repeat the measurement in Step 2 for 9 times at the positions of the external diameter to be measured and record the results gained respectively as x_2, $x_3 \cdots x_{10}$.

(4) Acquire the errors and percentage error in *a.m*, *di*, *s*.

(5) Record the gained external diameter value as $X=a.m(mm)\pm$percentage error.

(6) Use *e* and *f* to measure its internal diameter and repeat step 2 to 4 and then record the gained data as

$$Y = a.m(mm) \pm \text{percentage error}$$

(7) Use *g* to push upward the inner part of the object to be measured and measure its depth. Repeat step 2 to 4 and then record the gained data as

$$H = a.m(mm) \pm \text{ percentage error}$$

(8) Acquire the volume *V of the target and its percentage error*.

(9) Compare the s, errors and percentage errors of *X, Y, H.*

5. Questions

(1) What could happen when measuring the depth, external and internal diameters with a vernier caliper?

(2) The Illustration (a) below is a vernier caliper. As you can see, it indicates the aligned parts of the main and vernier scales, and Illustration (b) clearly demonstrates what it is like when using it to measure a coin

(a) How accurate it is ? _____ (b) What's the diameter of the coin being measured?