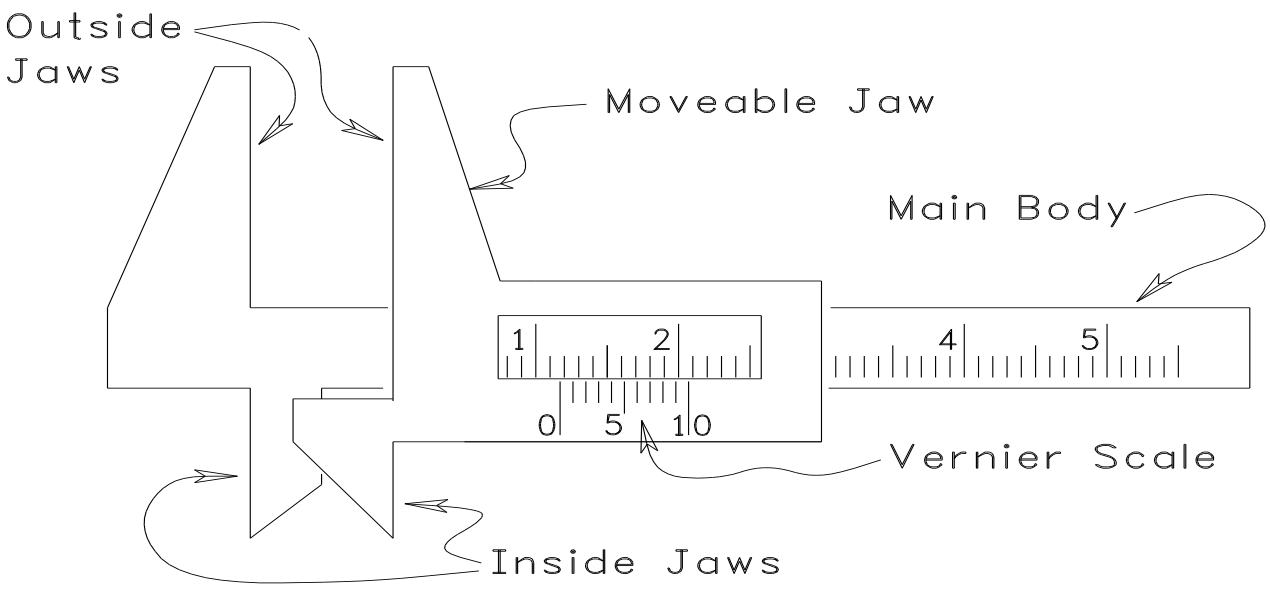
VERNIER CALIPERS



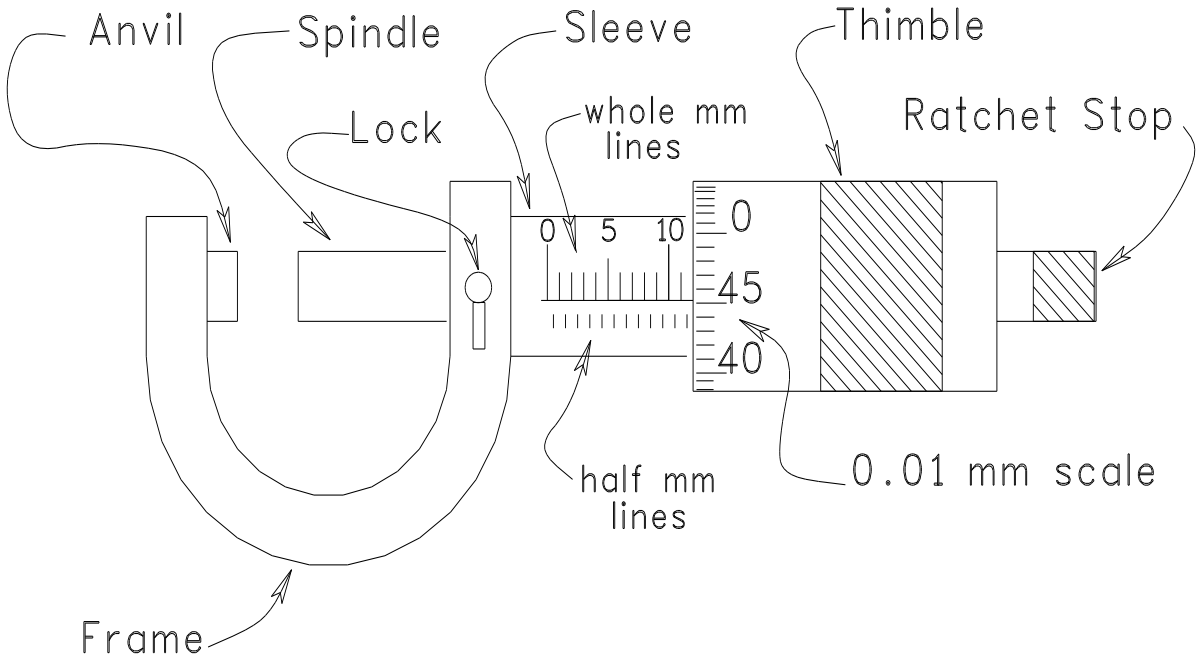
When using a calipers, it is important NOT to over tighten the jaws and bend the calipers. Just snug the jaws against the object being measured. Be careful that the object being measured is laying straight in the jaws with the dimension being measured being parallel to the main body of the calipers. Before starting to make measurements, check to see that the calipers reads zero when it is closed. If it does not read zero, estimate the zero offset in the readings and make whatever corrections this indicates to your readings. To insure consistent measurements, one must always tighten the jaws to the same tension. Repeat a measurement a few times to estimate the variations in your measurement.

Frequently vernier calipers has a larger set of "jaws" for measuring the outside dimensions (like length) of an object, and a second set of smaller jaws for measuring the inside dimension (like the diameter of a hole.)

Reading a vernier calipers is not difficult once one understands the trick. For example, consider a calipers with a cm scale. On the main body will be a scale graduated in cm and 0.1 cm. Just above or below the scale on the main body, there will be eleven lines on the moving jaw. The spacing between these lines is slightly smaller than the spacing of the 0.1 cm lines on the main body. These lines are referred to as the vernier scale.

The first step in making a reading of the calipers is to determine the coarse reading. In this example, read the cm and 0.1 cm using the scale on the main body and the "0" line of the vernier scale. [In the above figure, this is 1.1 cm.] Note, if the "0" line on the vernier is between two lines on the main body, always choose the smaller of the two readings. As a check on reading the vernier scale, estimate the 0.01 cm reading by the position of the "0" line of the vernier. [In the figure, this looks about 3/4 of the way between 1.1 and 1.2 cm so the estimated answer is about 1.17 cm.] Finally read the vernier. Find the line on the vernier scale that best lines up with a line of the scale of the main body. The "number" of this vernier line is the number of 0.01 cm to be added to the course reading. [In the figure, line 7 lines up best, so add 7 x 0.01 cm to the 1.1 cm to get a final reading of 1.17cm.]

MICROMETER



When using a micrometer, it is important NOT to over tighten the screw, just snug it up. To help prevent over tightening and insure a consistent degree of tightening, many micrometers have a small secondary knob (called a ratchet stop) on the end that starts slipping at a fixed amount of torque. To insure consistent measurements, one must always tighten the screw to the same tension. Repeat a measurement a few times to estimate the variations in your measurement.

Some micrometers have a locking mechanism, this is used when comparing parts. Make sure that the lock is disengaged before starting to use the micrometer.

Before starting to make measurements, check to see that the micrometer reads zero when it is closed. If it does not read zero, estimate the zero offset in the readings and make whatever corrections this indicates to your readings. Be careful that the object being measured is laying straight in the jaws of the micrometer.

To make a measurement with a micrometer, tighten the spindle against the object being measured, using the ratchet stop if available. As the thimble is rotated to move the spindle in (or out), various lines on the spindle get covered (or uncovered.) [For the micrometer in the figure, one complete rotation of the thimble moves the thimble along the sleeve by 0.5 mm. Thus as the thimble and spindle are turned in toward the anvil, alternately, whole mm and half mm lines on the sleeve are covered with each revolution.]

To read the micrometer, first take the coarse reading by determining the whole or half mm line on the sleeve that is closest to the thimble. [In the figure, this line is the 11.5 mm line.] Next the 0.01 mm scale on the thimble is read at the long line running the length of the sleeve. Multiply this value by 0.01 mm and add it to the coarse reading. [In the figure the 0.01 scale reads 45.3, so the final reading is 11.5 mm + (45.3 x 0.01 mm) = 11.953 mm. Note that the "3" in 45.3 was estimated by eye.]

PHOTOGATE

The photogate timers are used for several different experiments and have several different modes of operation. The photogate is an infrared (IR) light source and an IR detector separated by several inches. The signal from the photogate changes when the light path is either blocked or unblocked. The timer can be started and/or stopped with either the switch mounted to the timer, or by blocking or unblocking the light path in either the primary or secondary photogates.

Check that the power supply for the photogate timer is plugged into a wall plug and into the timer. Turn the unit on using the left most switch, and select the required mode of operation. (GATE, PULSE, or PENDulum; see below) Normally have the MEMORY switch in the ON position. (If the MEMORY switch is in the OFF position, the timer will continue to add new data to the old.)

Select the required time resolution using the upper right switch. Select 0.1 ms or 1 ms, this also selects the maximum time that can be measured 1.999 or 19.99 seconds respectively. Note the timer will display false readings if the maximum time is exceeded!

As an aid to determining where an object will start blocking the photogates, each gate has a red LED that glows when the photogate is blocked.

Before starting a measurement press, RESET to clear the unit's display and memory.

In the **GATE** mode, the timer measures the time that a photogate is blocked or the time the manual start/stop switch is held down. Usually this mode is used to measure how long it took for an object to pass through the gate and thus can measure a nearly instantaneous velocity. **Note:** Because the light detector in the gates is not infinitely narrow, a 1 cm wide object will not block the gate for the travel of a whole centimeter. On must measure the distance between the blocked and unblocked positions.

In the **PULSE** mode, the timer measures the time between two successive blocking of the photogates or pushing the start/stop switch. Usually this mode is used to measure the time it takes for an object to go from one photogate to the next. This gives travel time from which an average velocity can be measured.

In the **PEND**ulum mode, the timer measures the time between blockings or switch closures, EXCEPT that one blocking or closure is skipped after the unit is started. This mode is used to measure the complete cycle of pendula and other systems that might pass through the gates twice in each cycle of motion. The pendulum, for example passes through the gate twice, once going left and then once going right to return to its original position, speed and direction of motion.

To make two measurements in rapid succession, put the **MEMORY** switch in the ON position. Press RESET and then take the two measurements. The first measurement will be on the display. RECORD it immediately. Then move the MEMORY switch to READ and the total of the first and second measurement will be displayed. Record this number then subtract the first reading to get the second measurement.