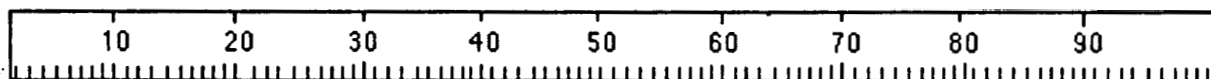


## Using the Metric Ruler

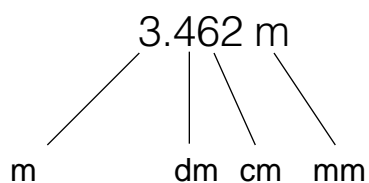
The standard unit for length in the metric system is the meter. The meter can be divided into smaller parts and multiplied into larger units.



When measuring with millimeters (mm), count the number of lines (each line equals 1 millimeter).

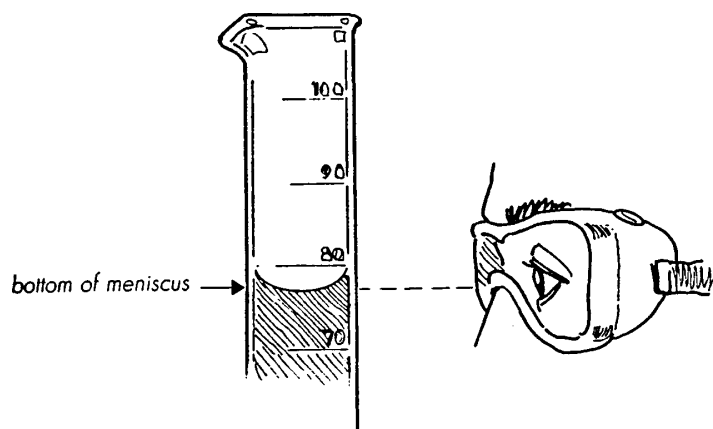
When measuring with centimeters (cm), count the number of whole numbers. Put a decimal after the whole number. Count the number of lines that follow the whole number if the object extends beyond it. Write the number after the decimal and label the number correctly.

To measure in meters, determine if you have more or less than 1 meter. If the length is less than 1 meter, the decimal goes before the number. If the length is greater than 1 meter, the decimal goes after the first number. Then determine the number of decimeters (dm), centimeters (cm), and millimeters (mm). These numbers are written in order as illustrated:



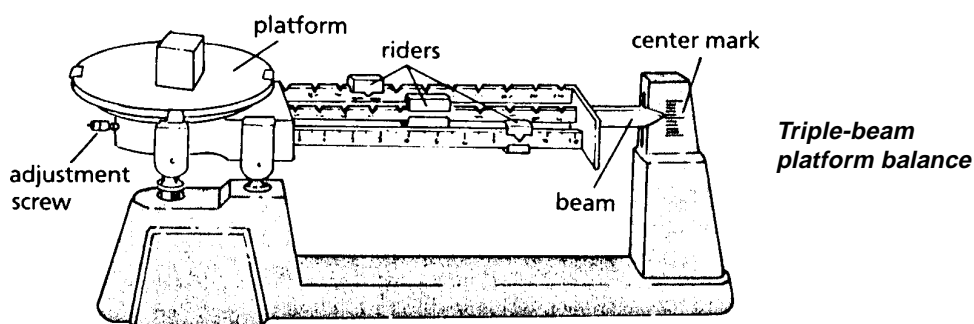
## Using a Graduated Cylinder

Place the graduated cylinder on a flat surface and view the height of the liquid in the cylinder with your eyes directly opposite the top of the liquid surface. The liquid (if water or a solution containing water) will tend to curve downward. This curve is called the *meniscus*. Always read the bottom of the meniscus. Read the graduated cylinder to the appropriate number of significant digits. For example, if the cylinder has heavy or extended markings at 10, 20, 30 . . . , there are most likely smaller divisions or short fine lines at every milliliter mark. The graduated cylinder can then be read to the tenth of a milliliter, such as 31.5 mL or 30.0 mL.



## Using the Balance

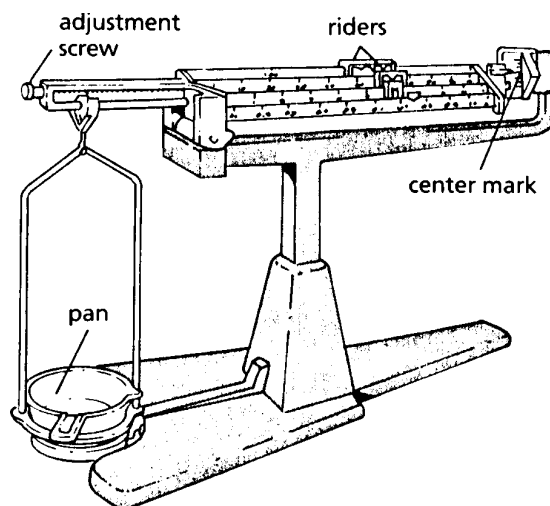
Two types of balances are commonly used in high school laboratories. The two balances shown below are a triple-beam platform balance and a four-beam pan balance.



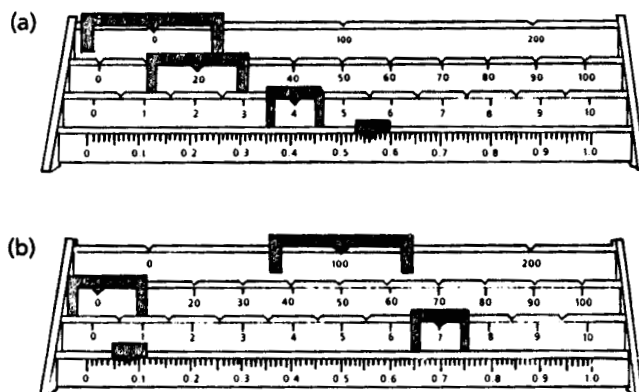
*Four-beam pan balance*

The proper use of the balance is described in the following steps:

1. Check to see if the balance is properly adjusted. To adjust, set all riders at zero with all objects removed from the pan or platform. The pointer should swing an equal distance at each side of the zero. If it does not, use the adjustment screw to obtain equal swing of the pointer.
2. Place a piece of premeasured paper or a premeasured container on the platform or pan; then place the object to be measured. Allow all hot objects to cool before measuring their masses.
3. Move the rider of greatest mass along this beam one notch at a time until it causes the pointer to drop. Then move the rider back one notch. Repeat this procedure with each succeeding rider of smaller mass. Make sure each rider is securely in each notch. The front beam, which is marked off in the smallest increments, is not notched. Slide the rider on this beam until it swings an equal distance on each side of the zero scale.



4. When the pointer is zeroed, sum up the masses shown on the beams. The mass of the object is equal to the sum of the masses shown on the beams minus the premeasured mass of the paper or container.



*Sample readings of a four-beam balance*

## How to Read a Thermometer

Thermometers should be handled carefully because they are tubes of glass filled with either mercury or colored spirits. When pushing them into a stopper, use the same precautions you would for glass tubing. Use some lubricant and gently push.

Laboratory thermometers should NOT be shaken like our home variety. To lower the temperature, just cool them. Usually they are either partial or whole immersion thermometers. This means that the bulb may be either partially submerged in the liquid or must be totally submerged in the liquid to accurately register the temperature.

Place the thermometer in the material whose temperature is to be measured. The thermometers used in laboratory experiments do not need to be shaken down. If you are measuring the temperature of a material while it is being heated, make certain that you do not let the thermometer rest on the bottom of the container and that the bulb is submerged in the material itself.

To read the temperature indicated on a thermometer, your eye should be at the level of the liquid in the thermometer. Read the thermometer to the appropriate number of significant digits. For example, a thermometer on which the heavy or extended lines are marked 10, 20, 30 . . . , should be read to the nearest 0.1 degree. On this thermometer each degree is marked, hence you can estimate to the tenth of a degree. If a reading falls exactly on the second fine line above 30, it would be read as 32.0. If it falls exactly on the heavy or extended line marked 30, it is read as 30.0.

Some thermometers may have fine lines every two degrees. Then the thermometer can be read to the nearest 0.5 degrees.

First examine the scale that is etched on its side. In the drawing below, each degree is divided into smaller divisions. The number of divisions sometimes varies, so it is important to first look the scale.

Always check the scale of any thermometer you use to make certain you read it as many significant digits as appropriate.

