III MEASURING APPARATUS

A. DEMONSTRATION DEVICES

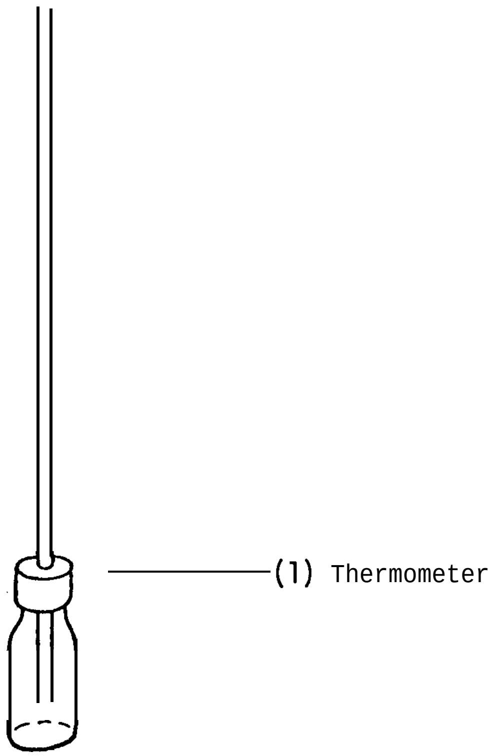
These devices demonstrate thermal expansion of liquids and solids,

B. VOLUMETRIC MEASURES

These are all measures of liquid volume and range from single volume measures like volumetric flasks to multiple measures such as measuring cylinder. Also included under this heading is the specific gravity bottle.

A. DEMONSTRATION DEVICES

Al. Demonstration Thermometer



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Thermometer	1	Pill Bottle (A)	7 cm high, 3 cm diameter
	1	Pill Bottle Cap (B)	To fit pill bottle (A)
	1	Glass Tubing (C)	25 cm long, 0.5 cm outside diameter, 0.3 cm inside diameter

b. Construction

(1) Thermometer

Make a hole in the pill bottle cap (B) (or a suitably sized cork) through which the glass tubing (C) is inserted.

Be certain the seal is airtight (it may be necessary to use glue to insure an airtight seal).

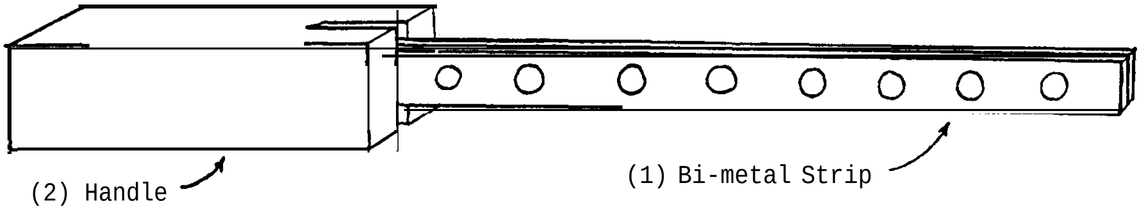
Fill the bottle (A) completely with water or other liquid. Force the cap or cork down onto the mouth of the bottle so that some liquid is forced up into the tube and the rest of the excess liquid spills over the side of the bottle where it is wiped away. Some liquid must rise up far enough into the tube so that it can be seen.

C. Notes

(i) This thermometer is used simply to demonstrate the expansion of a liquid as it is used in standard thermometers. Putting the demonstration thermometer into a 60°C water bath will cause the level of the water in the tube to rise about 2 cm.

(ii) Be certain to eliminate all air bubbles from the bottle unless it is desirable to show the effect of having air trapped in the bottle.

A2. Bi-Metal Strip

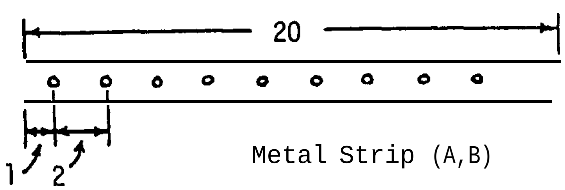


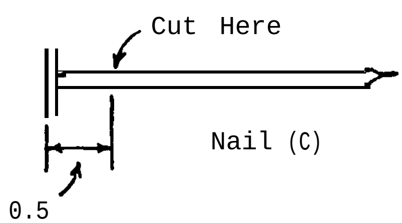
a. Materials Required

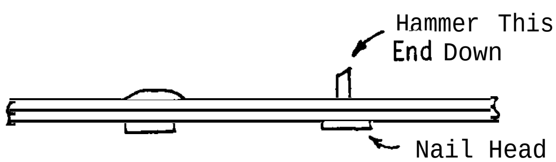
Components	Qu	Items Required	Dimensions
(1) Bi-metal Strip	1	Steel Strapping (A)	20 cm x 1.2 cm x 0.8 cm
	1	Aluminum Sheet (B)	20 cm x 1.2 cm x 0.6 cm
	9	Nails (C)	#4 d (0.2 cm diameter with large heads)
(2) Handle	1	Wood (D)	1.5 cm x 2.0 cm x 10 cm

b. Construction

(1) Bi-metal Strip





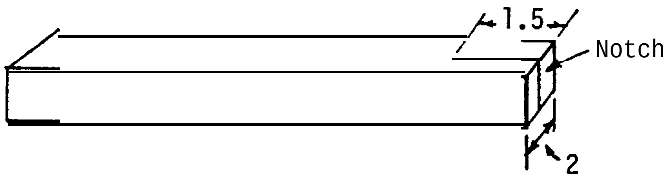


Side View

Hold the two pieces of metal (A,B) tightly together, and drill nine holes through both at 2 cm intervals beginning 1.0 cm from one end. These holes must be very slightly larger in diameter than the nails (C) used.

Cut the head off each nail (C) with a hacksaw, chisel, or tin snips so that the portion with the head is about 0.5 cm long. Push the nails through the holes in the two strips (A,B) and hammer down the cut ends to rivet the two strips together. It is best to begin by riveting the strip at its center and moving out toward each end at the same time. The strips should be firmly held together all along their length.

(2) Handle



Make a narrow notch in one end of the wood (D) the width of a saw blade. This notch ought to be about 1.5 cm deep. Insert the end of the bi-metal strip into this notch to complete the device.

c. Notes

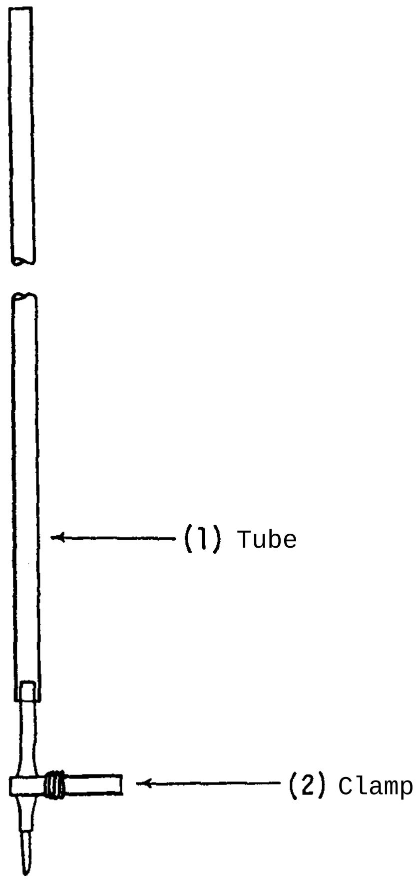
(i) This device is used to demonstrate the fact that metals expand when they are heated. When the bi-metal strip is held in a flame, it will bend in the direction of the steel since the aluminum expands more than does the steel.

(ii) Different combinations of metals (e.g., copper and steel, brass and aluminum, etc.) can be used with the same results.

(iii) The metal strips may be soldered together as opposed to riveted. Melt a thin layer of solder onto the surface of one of the two strips. Lay the other strip on top of it and hold the soldering iron down on both strips until the solder melts between the two strips. Keep the two strips pressed together with a screwdriver or other object to prevent them from coming apart before the solder cools. Repeat this process until the two strips are soldered all along their lengths. (Note: This procedure will not work if aluminum is used as one of the metals unless special solder is used.)

B. VOLUMETRIC MEASURES

B1. Burette

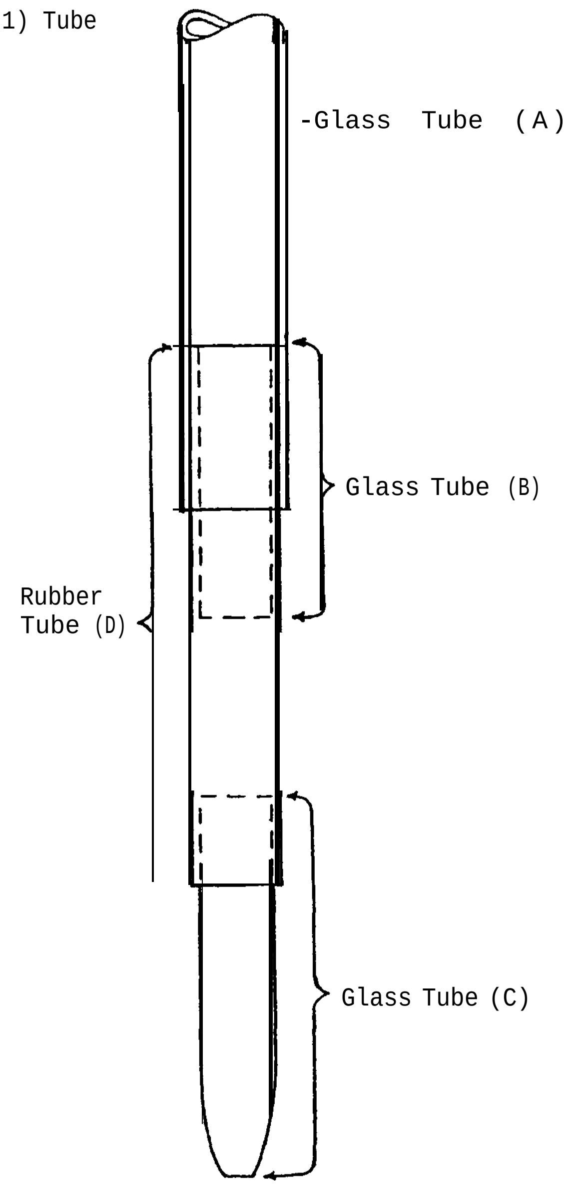


a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Tube	1	Glass Tube (A)	45 cm long, 1.3 cm outside diameter, 1.1 cm inside diameter
	1	Glass Tube (B)	4 cm long, 0.7 cm outside diameter, 0.5 cm inside diameter
	1	Glass Tube (C)	9 cm long, 0.7 cm outside diameter, 0.5 cm inside diameter
	1	Rubber Tubing (D)	10 cm long, 1.0 cm outside diameter
(2) Clamp	1	Pinch Clamp (E)	IV/A4

b. Construction

(1) Tube



Detail

Insert the glass tubing (B) into the end of the rubber tubing (D) so that the ends of both pieces of tubing are even. Insert this end into one end of the large glass tubing (A) for a distance of about 1 - 1.5 cm. If the seal between the rubber and large glass tubing is not watertight, use thin rubber sheeting (e.g., balloon material) to fill in the gas. Seal this joint with glue to insure a watertight fit. Draw out one end of the remaining piece of glass tubing (C) in a flame to form a narrow neck. Break off the neck, and fire polish the end of the tube. Insert the wide end of this tube into the end of the rubber tubing (D) for a distance of about 2 cm. Check the tube now for watertightness.

(2) Clamp

Use the clamp (E) to regulate flow in the burette. Be sure the clamp is large and strong enough to completely shut off flow from the burette.

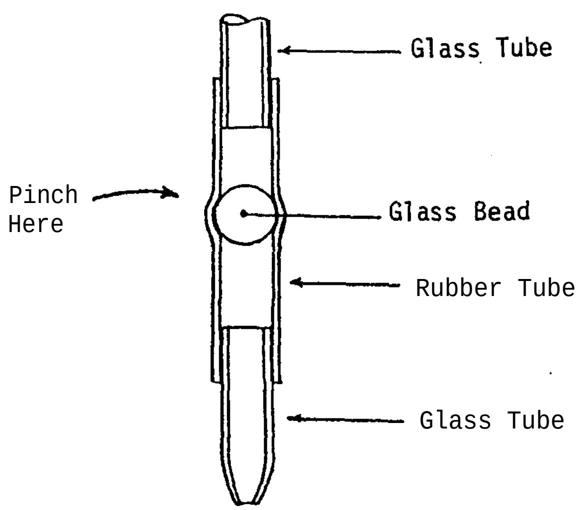
c. Notes

(i) The most common use of the burette in chemistry is in doing titrations.

Quite often they are used in pairs, and must always be supported by a stand.

(ii) Each burette needs to be fitted with a scale. Attach a long, thin strip of paper to the burette tube with transparent tape. Fill the burette from a known source (e.g., a plastic syringe) one milliliter at a time and mark the level of the meniscus on the paper. Place the "0" mark in such a way that several milliliters of liquid will still remain in the burette when "0" is reached as this will insure greater accuracy.

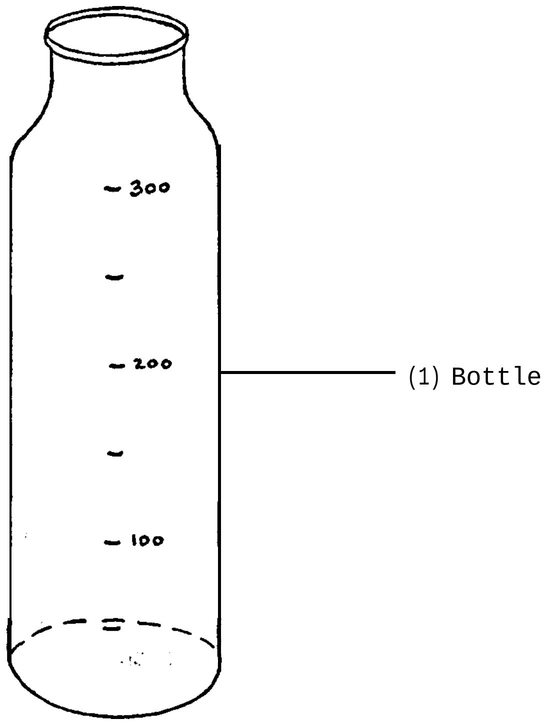
(iii) A glass bead just slightly larger than the internal diameter of the rubber tubing may be used in place of the pinch clamp. Push the bead into the rubber tubing before inserting the glass nozzle. The bead will seal the rubber tube. To dispense liquid from the burette, squeeze the tube between thumb and forefinger at the location of the head.



Cross Section

(iv) Because of the use of rubber tubing in this burette, it is not suitable for use with strong corrosives that attack rubber.

BZ. Measuring Glass



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Bottle	1	Glass Bottle (A)	Variable

b. Construction

(1) Bottle

Use a glass bottle (A) with straight sides and a flat bottom. Make graduations by calibrating the bottle using a known source. The graduations may be tape, paint, or scratches on the glass itself.

c. Notes

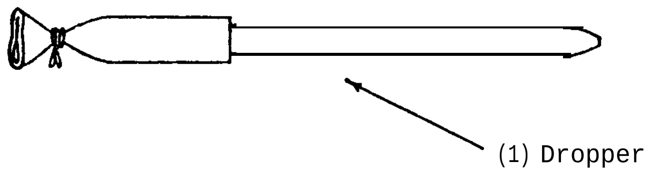
(i) Inaccuracies may occur due to transfer of liquid from the known source, failure to wait for liquid to "settle" before making calibration marks, and human error in marking exact height of liquid. However, for most purposes these measuring glasses are adequate.

(ii) Graduations may be made every 10, 25, 50, or 100 ml, depending on the size of the bottle and the uses to which it is to be put.

C. Notes

(iii) If the bottle is narrow enough in diameter, the graduations may be made closer together (i.e., every milliliter), but the accuracy will not approach that of a commercially made graduated cylinder.

B3. Dropper



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Dropper	1	Dropper	BIOL/II/A6

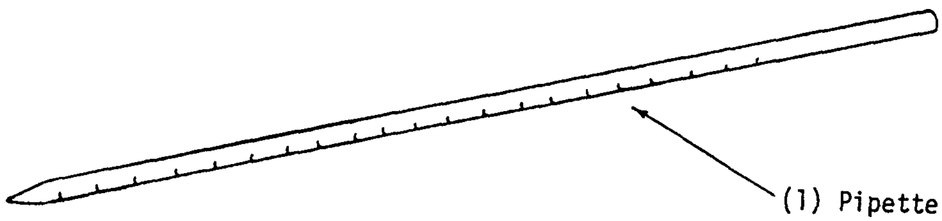
b. Construction

(1) Dropper	Construct the dropper as described in BIOL/II/A6.

c. Notes

(i) Since commercial droppers are usually readily available and inexpensive, this item is as easily purchased as it is improvised.

B4. Pipette



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Pipette	1	Transfer Pipette	BIOL/VII/A5

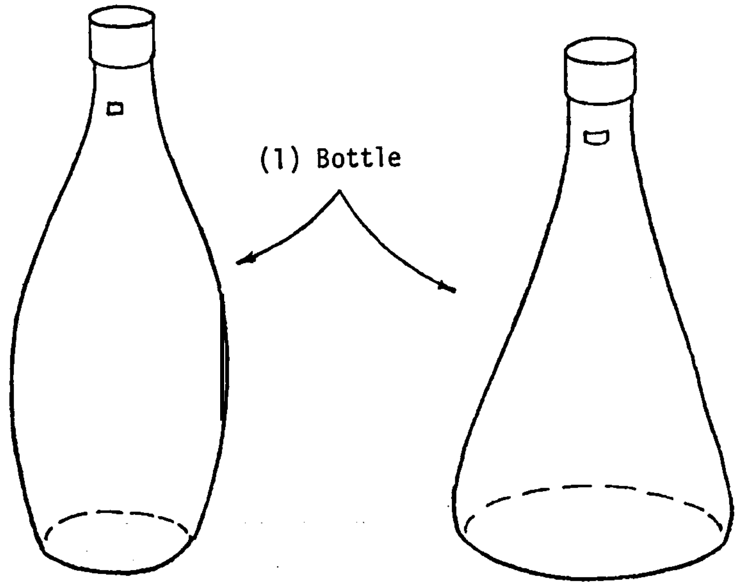
b. Construction

(1) Pipette	Construct the pipette as described in BIOL/VII/A5.

c. Notes

(i) The pipette is used to transfer and precisely measure quantities of liquids.

B5. Volumetric Flasks



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Bottle	1	Transparent Glass Bottle (A)	Variable
	1	Bottle Cap (B)	To fit bottle (A)

b. Construction

(1) Bottle	Select any common glass bottle (A) with a narrow neck.
(2) Cap	Use a cap seal (B) which will be airtight to prevent leakage and evaporation.

c. Notes

(i) The flasks must be calibrated from a known source. Put a single calibration mark on the neck of the bottle to indicate its capacity. This may be done with paint, tape, a scratch mark, etc.

B6. Specific Gravity Bottle

a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Bottle	1	Pill Bottle (A)	5 cm high, 3 cm diameter
	1	Rubber or Cork Stopper (B)	To fit bottle (A)
	1	Glass Tube (C)	8 cm long, 0.5 cm outside diameter, 0.3 cm inside diameter

b. Construction

(1) Bottle

Simply insure that there are airtight seals between the stopper (B) and bottle (A), and between the glass tube (C) and cork (B).

c. Notes

(i) To use the specific gravity bottle, first remove the stopper and tubing and fill the bottle to the brim with the liquid to be measured. Reinsert the stopper, making sure liquid flows completely out of the end of the tubing and that there is no air trapped in the bottle. Wipe away the excess liquid on the outside of the bottle. Accurately weigh this amount of liquid and subtract the mass of the empty specific gravity bottle. Compare the mass of the liquid to that of an equal volume of water (found in the same way) to find the specific gravity of the liquid.

(ii) A screw-top bottle may be used instead of the stopper arrangement. Punch a hole in the top and seal the joint between the tubing and top with waterproof cement.