V. THE MULTIPURPOSE SYRINGE

The purpose of this chapter is to illustrate some of the multiple uses to which a syringe may be applied. The syringe devices are therefore grouped according to the concepts they are intended to illustrate.

A. AIR PRESSURE APPARATUS

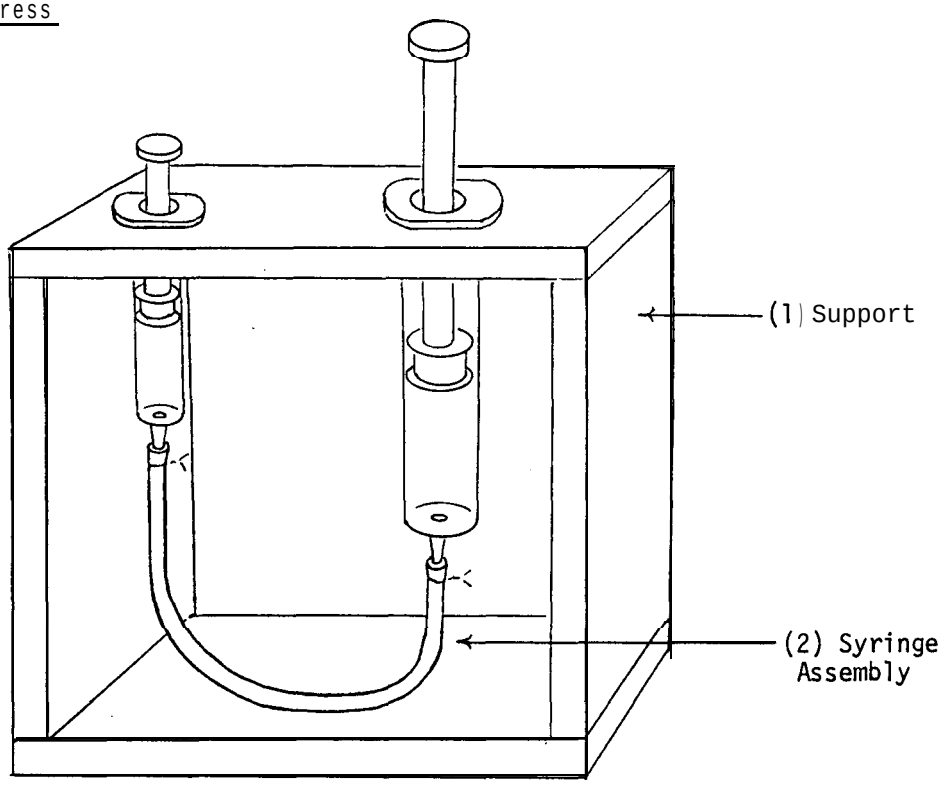
The devices in this section are all concerned with varying air pressure in the syringe.

B. SPECIFIC GRAVITY APPARATUS

The syringes in this section are used in one way or another to determine the specific gravity of solids and liquids.

A. AIR PRESSURE APPARATUS

Al. Hydraulic Press



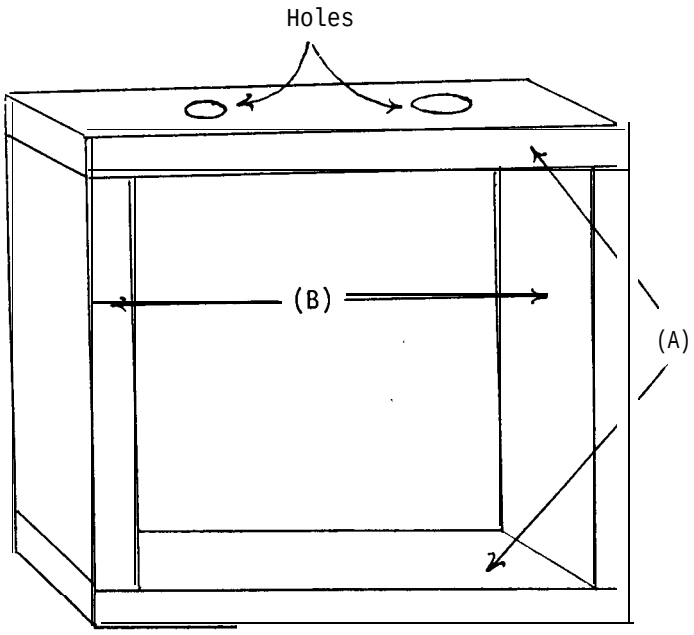
a. Materials Required

Components	QU	Items Required	Dimensions
(1) Support	2	Wood (A)	20 cm x 5 cm x 2 cm
	2	Wood (B)	17 cm x 5 cm x 2 cm
(2) Syringe Assembly	1	Plastic Disposable Syringe (C)	10 cc capacity
	1	Plastic Disposable Syringe (D)	60 cc capacity
	1	Rubber Tube (E)	20 cm long, 0.5 cm diameter
	2	Fine Wire (F)	5 cm long

b, Construction

(1) Support

Nail the two shorter pieces of wood (B) to the ends of one of the longer pieces (A) in upright positions. Before



nailing the last piece (A) into position across the top of the support, two holes must be drilled in it. These holes must be slightly larger in diameter than the barrels of the syringes used. Make these holes about 10 cm apart.

(2) Syringe Assembly

Attach one end of the rubber tube (E) to the nozzle of the larger syringe (D). Wrap one piece of wire (F) around this joint to seal it as tightly as possible. Withdraw the plunger of this syringe halfway to fill it with water through the end of the rubber tube, Try to eliminate as many of the air bubbles from the syringe as possible,

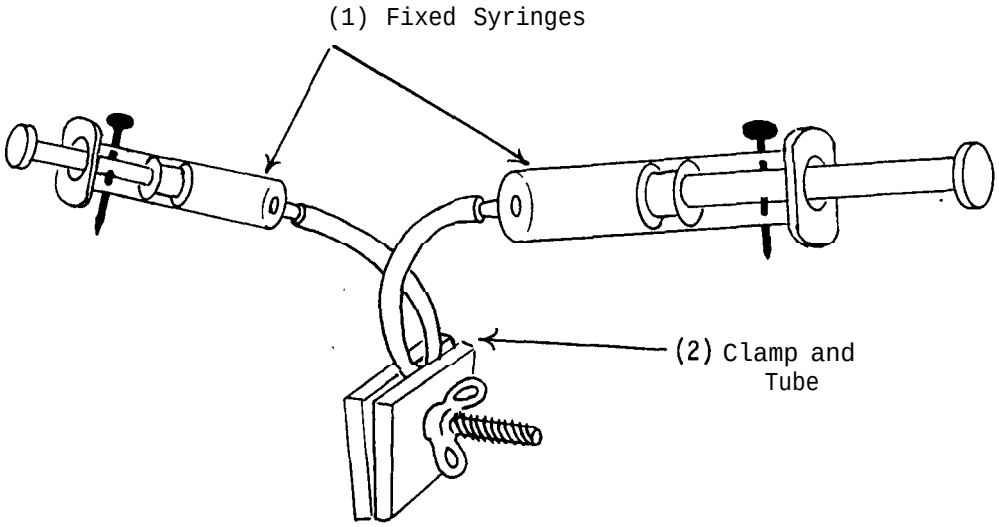
Holding the free end of the rubber tube so that no water can escape, run the end of the tubing through. the hole in the support and put-the large syringe into position. Put the barrel only of the small syringe (C) into position, and connect the end of the rubber tubing to the

nozzle. Again, use the wire (F) to make the junction tight. Push the plunger of the large syringe down until the water rises in the small syringe and is about to run over. Insert the plunger of the small syringe now and push down, and a minimum of a air should be trapped in the system.

C. Notes

(i) The lifting power of the hydraulic press may be felt by exerting a gentle downward pressure on each syringe simultaneously with both hands. The load on the smaller syringe will lift the plunger of the larger syringe, even when the load on the latter is felt to be greater than that on the smaller syringe.

AZ. Vacuum Apparatus

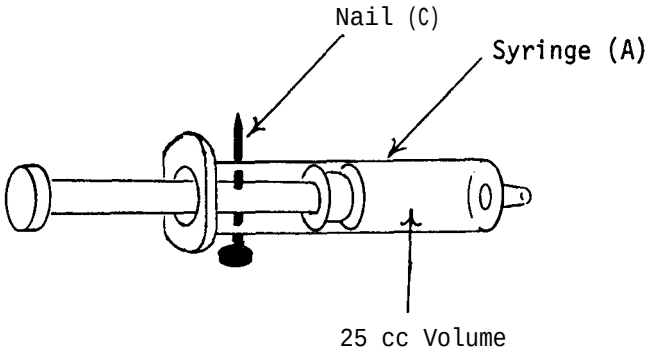


a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Fixed Syringes	1	Plastic Disposable Syringe (A)	35 cc capacity
	1	Plastic Disposable Syringe (B)	10 cc capacity
	2	Nails (C)	4 cm long
(2) Clamp and Tube	1	Plastic Tube (D)	20 cm long, 0.5 cm diameter
	1	Screw Clamp (E)	CHEM/IV/A5

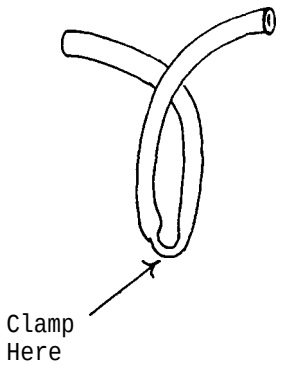
b, Construction

(1) Fixed Syringes



Use a drill of a slightly larger diameter than that of the nails (C) to carefully make holes through the barrel and plunger of the plastic syringe (A), When the nail (C) is inserted through these holes, the plunger should be held in a position such that the volume in the syringe is 25 cc. Similarly, prepare the second syringe (B) so that the volume is held at 5 cc capacity when the nail is in place.

(2) Clamp and Tube .



Connect the two syringes with the length of plastic tube (D). Be certain the connections between the nozzles and tubing are tight. Also, the tubing must be flexible enough to allow the clamp to close it off completely while, at the same time, it should be elastic enough not to collapse as pressure in the system becomes lower. The clamp (E) will close off air flow through the tube most easily when the tube is doubled over against itself.

c. Notes

(i) To use this piece of equipment to create a vacuumin, the larger syringe (A), first fix the volume of the air in the syringe (A) at 25 cc using the nail to hold the plunger in position. Connect the clamp and tubing to it. Depress the plunger in the smaller syringe (B) completely, then fasten the syringe to the tubing, and close the clamp. Now, open the clamp and withdraw the plunger in the smaller syringe. This will extract air from the larger syringe. Fix the plunger of the smaller syringe with the nail, and reclose the clamp. Remove the smaller syringe from the tubing.

The extraction procedure may be repeated f ive or six times in succession in order to produce very low pressures.

(ii) After one or more extractions, the reduced pressure in the large syringe may be determined by holding the syringe under water and removing the clamp from the tube. Water will rise in the syringe until the trapped air is once again at atmospheric pressure. Note the volume of the trapped air.

If

The volume of air finally trapped above water = V_2
The pressure of air finally trapped above water = P_2
(Where P_2 = atmospheric pressure)

And if

The volume of same mass of air prior to contraction = V_1
(Where V_1 = volume of syringe)
The pressure of same mass of air prior to contraction = P_1

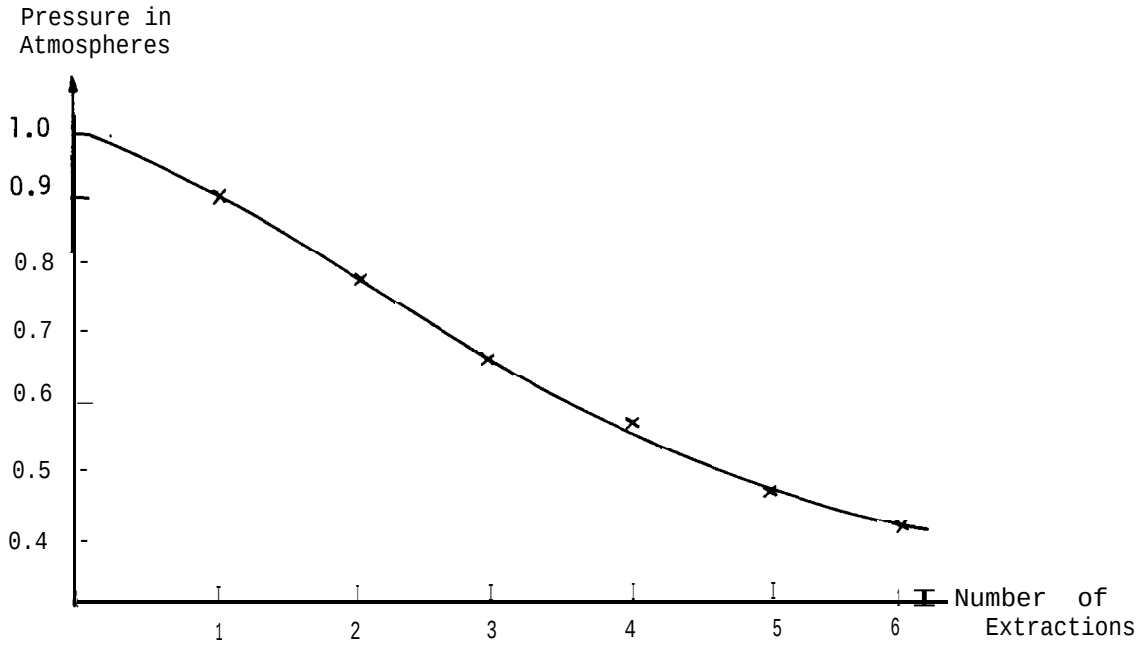
Then

The pressure of the vacuum created is given by

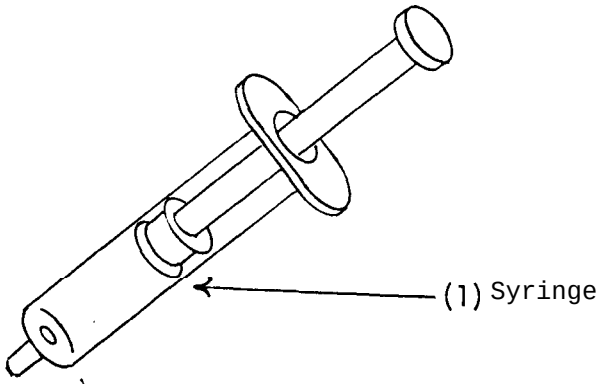
$$P_1 = \frac{P_2 V_2}{}$$

(iii) In a typical experiment (results indicated below) five extractions reduced the pressure in the large syringe to 0.5 atmosphere pressure.

No. of Extractions	V_2 cc	V_1 cc	P_1 Atmospheres
1	25	23	0.92
2	25	19.5	0.78
3	25	16.5	0.66
4	25	14.5	0.58
5	25	12.0	0.48
6	25	10.5	0.42



A3. Elasticity Device



a, Materials Required

Components	Qu	Items Required	Dimensions
(1) Syringe	1	Plastic Disposable Syringe (A)	Size can be variable

b. Construction

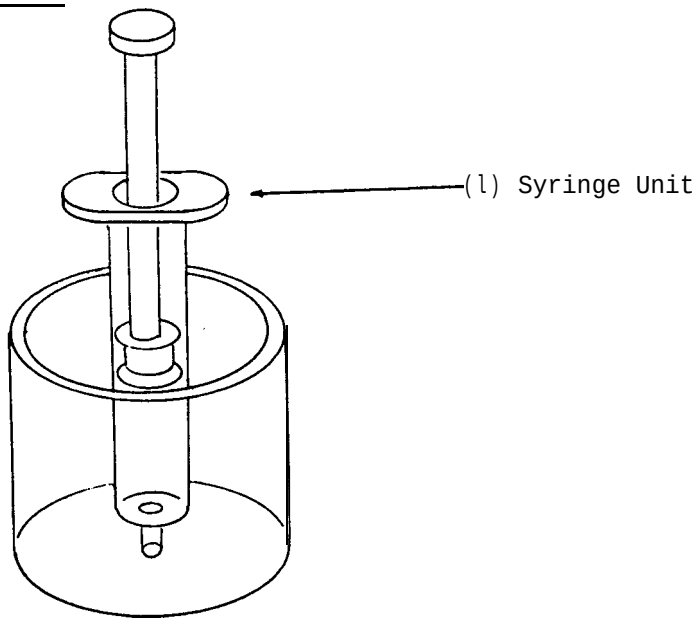
(1) Syringe — Place a finger over the air outlet to seal the air in the tube.

c, Notes

(i) With a sealed syringe, elasticity of air may be felt by pushing down or pulling out the plunger. In either case, if the syringe is airtight, the plunger will be pushed or pulled back to its original position by the air trapped in the syringe:

(ii) It is of interest to replace the air in the syringe by water in order to compare the elasticity of water with that of air,

A4. Gas Expansion Device ©



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Syringe Unit	1	Plastic Disposable Syringe (A)	Size can be variable
	2	Beakers (B)	Approximately 250 ml

b. Construction

(1)Syringe Unit

Any size syringe (A) may be used, but one approximately 10 - 15 cc in capacity is convenient, Fill one beaker (B) with hot water and the other with cold water.

C.Notes

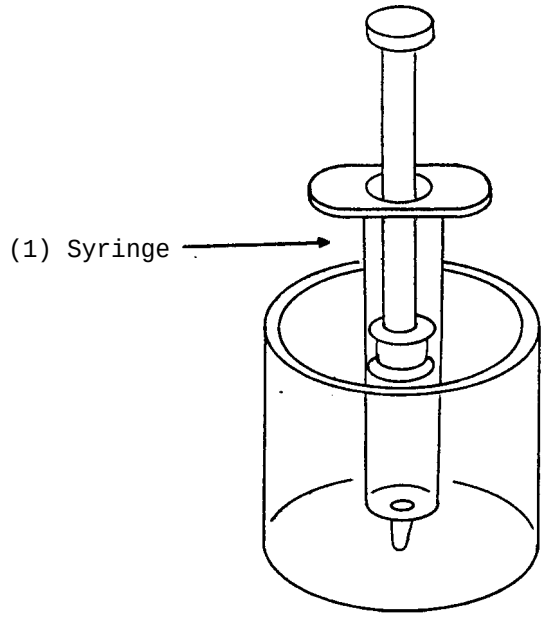
(i) After the syringe has been filled with suitable gas (e.g., air) it is placed in the cold water bath for several minutes. It is then removed, emptied of any water which may have entered through the open nozzle, adjusted to a volume of 5 or 10 cc, and placed in the hot water bath, As the gas expands, bubbles will leave the syringe. After the bubbling has ceased, remove the syringe and place

@From Andrew Farmer, "The Disposable Syringe: Additional Experiments," School Science Review, CLXXVIII (1970), pp 59-60.

it back in the cold water bath. As the gas contracts, water will enter the syringe, and the amount of water entering serves as a measure of the expansion of the gas. Quantitative data on gas expansion can be obtained by using the same gas and syringe and varying the temperature of the hot water bath, or by using the same syringe and hot water bath and varying the gases.

B. SPECIFIC GRAVITY APPARATUS

Bl. Volume Determinator



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Syringe	1	Plastic Disposable Syringe (A)	Size can be variable
	1	Beaker (B)	Approximately 250 ml

b. Construction

(1) Syringe

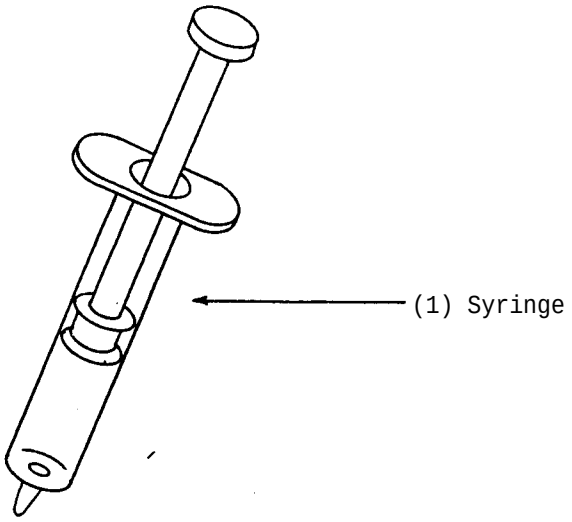
Choose a plastic, disposable syringe (A) with a barrel capacity large enough to hold the object whose volume is to be measured, Fill the beaker (B) about one half full of water.

C. Notes

(i) Use this apparatus by placing the object whose volume is to be measured into the syringe. Replace the plunger and depress it until it almost touches the object in the bottom of the syringe. Hold the syringe so that the end of it is under water in the beaker. Draw enough water into the syringe to cover the object by withdrawing the syringe plunger. Find the difference between the

original syringe reading and the final syringe reading. This indicates the volume of water drawn into the syringe. Note the apparent volume of water in the syringe (that is the volume of the object and the water combined) and subtract from this the volume of water known to have been drawn into the syringe. The resultant va indicates the volume of the object.

B2. Specific Gravity Device



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Syringe	1	Plastic Disposable Syringe (A)	35 cc capacity

b.Construction

(1) Syringe

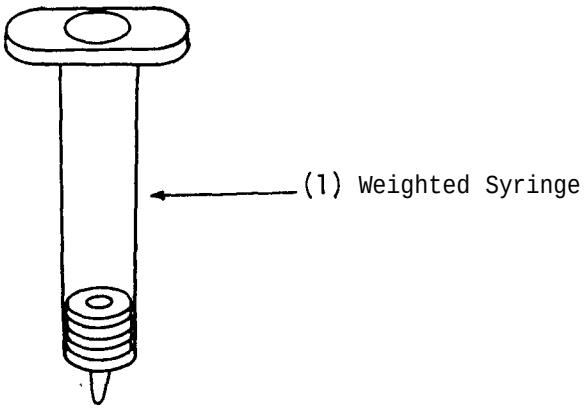
Use the syringe (A) with no modification except to remove the needle, as usual.

c. Notes.

(i) To determine the specific gravity of a liquid, simply draw up 25 cc of the liquid, and find the mass of the liquid plus syringe. Subtract the mass of the empty syringe from this total to find the mass of the liquid. Divide the mass of the liquid by 25 to obtain the specific gravity.

(ii) If the liquid should leak from the syringe, simply seal the nozzle of the syringe with a nail. Remember to add the mass of the nail into the calculations.

B3. Hydrometer



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Weighted Syringe	1	Plastic Syringe Barrel (A)	35 cc capacity
	6-8	Metal Washers (B)	Slightly less wide than the barrel

b. Construction

(1) Weighted Syringe

Place enough washers (B) in the syringe barrel (A) to cause it to sink to the 25 cc mark when placed in water. Seal the nozzle by heating it until it melts shut.

C. Notes

(i) For use as a hydrometer, the syringe barrel must be calibrated. Use a graduated cylinder (CHEM/III/B2) to make the calibrations. Note the water volume in the cylinder before and after the syringe barrel is placed in it. The difference of these two values indicates the volume of water displaced by the syringe. By this means it is possible to indicate a displacement value for each reading on th syringe. The following table was created for the syringe under test.

Scale on Syringe	Volume of Water Displacement
cc	cc
20	27.2
21	28.6
22	29.2
23	30.4
24	31.5
25	33.0
26	34.5
27	36.1
28	37.5
29	38.4
30	39.6

Weigh the syringe (and its washers), and then place it in the liquid whose density is to be determined.

'(ii)

If

V = The volume of liquid observed to be displaced

M - The mass of the syringe and washers

Then

M = The mass of liquid displaced

$M_{/V}$ = The density of the liquid displaced