LABORATORY SAFETY AND ASSESSMENT FORM

SECTION: GENERAL CHEMISTRY	LABORATORY: _____	EXPERIMENT TITLE:	
PERSONNEL INVOLVED: Undergraduates, laboratory staff and Instructor			
SUBSTANCES INVOLVED*	**QUANTITY USED IN EXPERIMENT**	**HAZARD (FROM MSDS)**	**PRECAUTIONS AND FIRST AID**

*Identify all chemical reagents that you will use in the experiment.

Signed (Instructor): _____ Date: _____

DETERMINATION OF THE MOLECULAR WEIGHT OF A VOLATILE LIQUID

The molecular weight of a volatile liquid or condensable vapor may be measured, under known conditions of temperature and pressure, by using the weight of a given gas sample. By applying the Ideal Gas Law, the determination of the molecular weight is computed through this equation:

$$PV = nRT \qquad \text{(Equation 1)}$$

where: n = number of moles of the gas
P = barometric pressure in atmosphere units
V = volume of the vapor in liter units
T = temperature in the Kelvin (or absolute) scale
R = the ideal gas constant (0.08205 L-atm / mole-K)

If $n = \frac{wt}{MW}$ where: wt = weight
MW = molecular weight

Then equation (1) becomes:

$$PV = \left(\frac{wt}{MW}\right) RT \qquad \text{(Equation 2)}$$

The experimental molecular weight of the gas is thus computed as:

$$MW = \frac{wtRT}{PV} \qquad \text{(Equation 3)}$$

A small amount of the volatile liquid sample is introduced into a weighed flask. The liquid is vaporized when the flask is placed in boiling water. The barometric pressure and temperature readings of the water are then recorded.

Objective

- To determine the molecular weight of a volatile liquid using the ideal gas equation.

Apparatus and Materials

liquid sample	balance	600-mL beaker
boiling chips	Bunsen burner/hot plate	thermometer
Aluminum foil	clamps with iron stand	barometer
graduated cylinder	125-mL Erlenmeyer flask	

Procedure

1. Weigh a clean and dry Erlenmeyer flask and a circular foil approximately 6 cm in diameter (Label this as Wt_2).

2. Pour 5.0 mL of the unknown liquid into the flask. Cover the flask with foil and make a tiny pinhole prick at the center of the foil.

3. Fill a beaker with water then, add some boiling chips. Suspend a thermometer into the water. Place the Erlenmeyer flask with its contents into the beaker of water. Refer to the setup below:

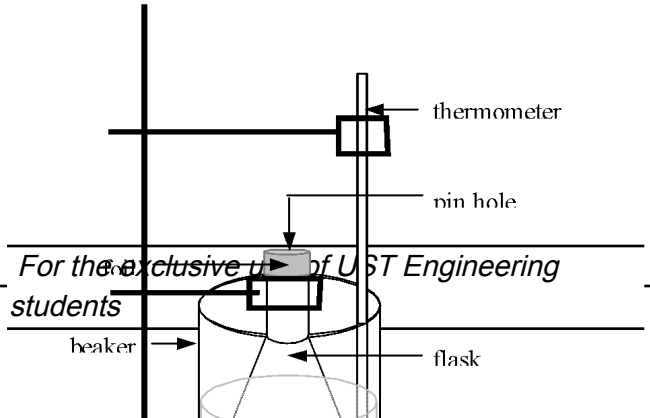

Figure 1.1. The experimental setup for determining the weight of a volatile liquid.

Note: For space consideration/ availability of iron clamp, one iron clamp may be used either for the Erlenmeyer flask or for the thermometer.

Heat the water bath to boiling or until all the liquid in the flask has completely vaporized. Record the temperature of the bath and note the barometric pressure as well.

4. Remove the flask from the water and dry the outer parts. Allow the flask and its contents to cool. Then weigh the flask, foil, and any condensed vapor in the flask (Label this as $\mathbf{Wt_1}$).

5. Remove the aluminum foil. Fill the flask with water to overflow. This allows one to determine the capacity of the flask (and the volume of the vapor) by measuring the volume of water it can hold.

6. Using all these data, evaluate the molecular weight of the condensed vapor.

Treatment of Results

1. Express the following quantities obtained in the experiment to the desired unit:

   (a) Barometric pressure: _____ mm Hg to atm
   (b) Temperature: _____ ^{o}C to K
   (c) Volume of vapor: _____ mL to L

2. Calculate the molecular weight of the volatile liquid using equation (3).

Questions:

1. Write the equation that relates the pressure, volume, temperature, and number of moles of an "ideal gas". From the equation derive the formula to be used in the determination of the molecular weight of the volatile liquid.

2. Explain how each of the following procedural errors may affect the results of this experiment:
(a) Some of the liquid samples did not vaporize before the flask was removed from the water bath.
(b) The flask, containing the condensed vapor, was not dried before the final weighing.

3. Why is it necessary to make a tiny pinhole prick at the center of the foil before heating the sample? What happens to the calculated molecular weight if the hole is "too big" or "too small"?

4. All of the liquids used in this experiment have appreciable vapor pressures. How does this property of the liquids affect the calculated molecular weight?

DATA SHEET

Experiment No. 1
DETERMINATION OF THE MOLECULAR WEIGHT OF A VOLATILE LIQUID

Name: _____ Instructor: _____

Sec.: _____ Group No.: _____ Date: _____

Barometric pressure	_____	mmHg
Temperature of boiling water	_____	°C
$W_{(flask + foil + vapor)}$ (Wt_1)	_____	g
$W_{(flask + foil)}$ (Wt_2)	_____	g
Capacity of the Erlenmeyer flask	_____	mL

Computations

Properties of the Gas:

Pressure	_____ atm
Temperature	_____ K
Volume	_____ L
Weight	_____ g
Molecular Weight	_____ g / mol (as computed in the experiment)
Molecular Weight	_____ g / mol (Refer to your instructor for the true value)
Percent Error	_____ ((computed value - true value) / true value) 100