Name: _____ Section: _____

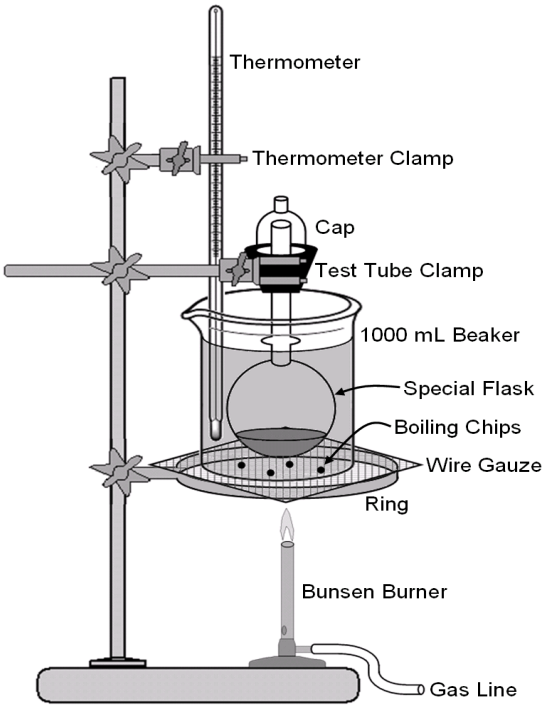
Experiment #11: Molecular Weight of an Unknown Volatile Liquid

This experiment will allow you to determine the molecular weight of a volatile liquid. The liquid will first be vaporized, then by measuring the mass, volume, temperature and pressure of this gas, you can use the Ideal Gas Law to calculate the molecular weight.

Procedure

Obtain a special flask with its stopper, cap, and plastic weighing dish. Set the flask in the plastic dish to keep it from rolling off the table. Obtain an unknown liquid assigned to you by your instructor and record its number on the data sheet.

Place the pointed rubber stopper in the clean, dry flask. Weigh on the analytical balance and record its mass. It is important to keep track of your stopper and not confuse it with a lab neighbor since they all have different masses. With a disposable pipet or medicine dropper, transfer about 5 mL of the unknown liquid into the flask. DO NOT WEIGH THE FLASK AT THIS TIME! You will weigh the flask after the excess liquid has vaporized). Set up the apparatus as shown in the figure below. Fill the 1000 mL beaker with about 700 mL of DI water and add 3 to 5 boiling chips. Place the flask in the water and set the cap on the neck of the flask while clamping the cap in position. The flask must not rest on the bottom of the beaker. Add water as needed so the round flask is submerged completely under water up to the narrow neck.



Heat the water to a gentle boil. Carefully watch the level of liquid inside the flask while it gradually disappears as the vapor escapes through the capillary cap. After all the liquid has disappeared, keep the flask in the boiling water for another minute. Read and record the temperature of the boiling water during this time. Shut off the burner and allow the water to stop boiling for approximately 30 seconds. Raise the flask and cap assembly from the water and quickly replace the cap with the original stopper into the neck of the flask.

Remove the flask from the hot water and immerse it into a tub of cool water or hold it under cold water from the tap. Notice that the volatile gas that had filled the flask now condenses back to liquid. After cooling the flask about 4 – 5 minutes, momentarily remove the stopper to allow air to enter the flask. Thoroughly dry the outside of the flask and again loosen the stopper a moment to equalize the pressure. Weigh and record the mass of the flask and its contents.

Refill the flask with approximately 5 mL more of your liquid and repeat this procedure. It is not necessary to clean the flask or to pour out the liquid in the flask before you start. If you suspect water has entered the flask, consult your instructor.

Record the atmospheric pressure in the room. A barometer is an instrument that is filled with mercury in an upside-down tube, above which is a vacuum and below a pool of mercury. To correctly read the pressure from the barometer in the room, first look at the bottom of the instrument and adjust the mercury level to just touch the triangular metal point. Next, while at eye level, adjust the top of the barometer so that the slider stops at the top of the meniscus. You may need to use a step stool to maintain eye level. Notice for mercury the meniscus is convex, the opposite of water which is concave. Read the barometer in millimeters of mercury on the right side (left side is inches of Hg). The atmospheric pressure is generally between 730 to 760 mm Hg (or torr) in our area. A common mistake is to miss the 700 mm Hg value since the instrument leaves out the 100's place between the intervals so the other numbers are clear to read.

Notes: The volume of the flask is written or etched on the front of the flask.

Upon completion of the experiment, return all the equipment.

Do not rinse the flask.

Remove the boiling chips from the 1000 mL beaker.

Do not dump the boiling chips into the sink.

******DO NOT PUT WATER IN THE FLASK AT ANY TIME******

Name: _____ Section: _____

Data and Calculations

Unknown Number _____

Atmospheric pressure _____ torr = _____ atm

	Trial 1		Trial 2
1. Mass of dry flask with stopper	_____	=	_____
2. Mass of flask, stopper, & condensed liquid	_____		_____
3. Mass of condensed liquid	_____		_____
4. Temperature of boiling water	_____		_____
5. Volume of flask (see flask)	_____	=	_____
6. Molecular weight of sample)	_____		_____

(These values must be within 5 % of each other. If not, a third trial must be run.)

7. Average Molecular Weight* _____

**Average only those values within the limit*

SHOW CALCULATIONS:

Name: _____ Section: _____

Questions (to be completed while in the laboratory)

1. Obtain the mass percent composition information of your unknown from your instructor. Solve for the empirical formula, and then using your determined molecular weight, solve for the molecular formula of your compound.

Empirical Formula _____

Molecular Formula _____

2. Determine your percent error using your experimental molecular weight and the theoretical molecular weight determined via your molecular formula.

3. Write the ideal gas law equation for molecular weight.

Name: _____ Section: _____

Post-lab Questions

4. It was found that 0.801 gram of vapor exerted a pressure of 744 torr at 100 ^{o}C when confined to a 260 mL flask. If this vapor came from a volatile liquid, what is the molecular weight of the liquid?

5. Based on this experiment:

   A. How do you experimentally determine the temperature of the unknown when it is a gas?

   B. How do you experimentally determine the pressure of the unknown when it is a gas?

6. What is the purpose of cooling the flask?

7. Why will air rush into the cooled flask when the stopper is removed?

Name: _____ Section: _____

8. How would each of the following procedural errors affect the calculated molecular weight in this experiment? Give your reasoning in each case.

   A. All of the liquid was not vaporized when the flask was removed from the water bath.

   B. The flask was not dried before the final weighing with the condensed vapor inside.

   C. The flask was left open to the atmosphere while it was being cooled, and the stopper was inserted just before the final weighing.

   D. The flask was removed from the bath after all of the liquid had vaporized but before the vapor had reached the temperature of the boiling water.