

Experiment 8

Molecular Weight of a Volatile Compound

Purpose and Goals

- To determine the molecular weight of an unknown volatile compound using the ideal gas law
- Use a method developed by J.R. Dumas to determine the vapor density of the unknown

Ideal Gas Law

$$PV = nRT$$

Molecular Weight

- The number of moles is expressed as w/MW

$$n = \frac{w}{MW}$$

- Final equation

$$MW = \frac{RT}{PV} w$$

!!!CAUTION!!!

- All unknown compounds are flammable
- Run experiment under a hood because the vapor may be toxic

Procedure

- This experiment should be done individually
- An unknown compound and its elemental percentage analysis will be provided
- Weigh and record a clean, dry Erlenmeyer flask to 0.1 g
- Collect the flask, 10cm² aluminum foil, and 15cm Al wire. Weigh and record to .001 g

Procedure

- Heat the water bath until boiling
- Boil until **NO** vapor is coming from the pinhole, then turn off burner
- Allow to cool 5°C or more, remove from the bath and place on a clean towel

Procedure

- Dry and weigh (.001g) the flask assembly after it is allowed to reach room temperature
- Record the weight once it stays constant
- Record the Barometric pressure
- Unroll the Al foil and inspect for water droplets
- If droplets are present the experiment must be done again

Calculations

- Weight of the condensed liquid (same as weight of vapor)

- Volume of vapor = Volume of flask
$$= \frac{\text{weight of water}}{\text{density of water}}$$

- Molecular wt. of unknown liquid using equation 1

$$PV = \frac{w}{MW} RT$$

Sample calculation

$$\begin{aligned} MW &= \frac{RT}{PV} w \\ &= \frac{(0.0821 \frac{L \cdot atm}{mole \cdot K}) * 372.78 K}{.989 atm * .2610 L} (1.012g) \\ &= 120 \frac{g}{mole} \end{aligned}$$

Calculations cont.

- Empirical formula from the elemental percentage analysis
- From Empirical formula find the empirical formula weight

Empirical vs. Molecular

- Compare the E. formula weight to your approximate Mol. Wt. & identify the Mol. Formula
- Molecular formula C_6H_6
- Empirical formula CH

Calculations cont.

- From the Molecular Formula calculate the Molecular Weight
- Percent error from the true Molecular wt. and your calculated molecular weight