Experiment 7: Analysis of a Chemical Mixture Using the Ideal Gas Law

Reading: Chapter sections 10.4-10.6 of your textbook and this lab handout.

Ongoing Learning Goals:

- To use a scientific notebook as a primary record of procedures, data, observations, and example calculations
- To make scientific measurements
- To apply balanced chemical equations and stoichiometric relationships to quantitative measurements
- To evaluate the uncertainty (error) in scientific measurements, and understand the causes of the underlying uncertainty
- To present your formal results through a laboratory report along with proper citations

Additional Learning Goals for Experiment 7:

- To quantitatively measure gas quantities and relate those measurements to reaction stoichiometry using the ideal gas law.
- To use reaction stoichiometry to determine the percent composition of a chemical mixture.

Introduction:

In this experiment, you will quantitatively collect the gas produced from a reaction to determine the composition of a mixture of NaCl and $NaNO_2$.

When excess sulfamic acid—HSO_3NH_2—is added to a mixture of sodium nitrite and sodium chloride salts, the $NaNO_2$ reacts to form nitrogen gas according to the equation below while the NaCl is unreactive.

$$NO_2^-\,(aq) + HSO_3NH_2\,(aq) \rightarrow HSO_4^-\,(aq) + H_2O\,(l) + N_2\,(g)$$

The N_2 gas will be collected quantitatively at atmospheric pressure and room temperature to calculate the number of moles produced. From this result, we can determine the percent composition by mass of $NaNO_2$ and NaCl in the mixture of salts.

Procedure:[1] **(Please work with your assigned partner)**

1. Log in to the computer, open Logger Pro, and turn on the power strip. You will use the Vernier temperature probe to measure the temperature in step 12.
2. Weigh approximately 0.18 g of sulfamic acid onto a tared weigh paper.
3. Slide these crystals into the assigned 50-mL Erlenmeyer flask.
4. Measure 10 mL of deionized H_2O in a graduated cylinder and add to the sulfamic acid. Do not mix.
5. Measure approximately 0.11 g of an assigned unknown mixture of NaCl/$NaNO_2$ directly into a dry dram vial. Record the number of this unknown mixture.
6. Add 1 mL of deionized H_2O into the dram vial using the provided syringe. Do not mix.

[1] Adapted from Chemistry in the Laboratory, C.W.J. Scaife and O.T. Beachley, Jr., Saunders, 1987.

7. Gently slide the dram vial into the 50-mL flask. Do not mix. **CAUTION: Sulfamic acid and sodium nitrite must never be mixed together as solids. In the presence of traces of water the solids react to evolve nitrogen and heat so rapidly as to be dangerous.**
8. Lower the buret to get the water level just below the 50.00 mL line. See Figure 1.
9. Keeping the Erlenmeyer flask upright, plug with stopper (connected to the tubing coming from the top of the inverted buret). See A in Figure 1.
10. Adjust the water meniscus of the buret to be level with the water meniscus in the leveling bulb *while gently pressing down the stopper on the Erlenmeyer flask with two fingers and your thumb on the base*. Record this initial volume.
11. Still holding the flask and the stopper, gently rock the dram vial on its side against the flask wall. Do not tip the dram vial or flask towards the stopper to avoid liquid blocking the tube. Pressure of the N_2 gas produced in this reaction will lower the H_2O level in the burette.
12. The reaction is complete when all the bubbles have popped and the flask has returned to room temperature. At that time do the following:
    (a) Re-adjust the measuring tube until the meniscus of H_2O in the buret and leveling bulb are lined up (at the same level). Record this final volume.
    (b) Record the temperature of the water in the leveling bulb using a Vernier digital thermometer.
    (c) Record vapor pressure of H_2O at the nearest posted chart. You may need to interpolate this value. Report with given number of significant figures and cite the source.
    (d) Record the barometric pressure provided on the front chalkboard.
13. Repeat steps 2-12 two more times. Calculate, as outlined in Error Analysis handout, the Average, SD, SDOM, % error, and % precision for the composition of $NaNO_2$ and NaCl in your unknown mixture.

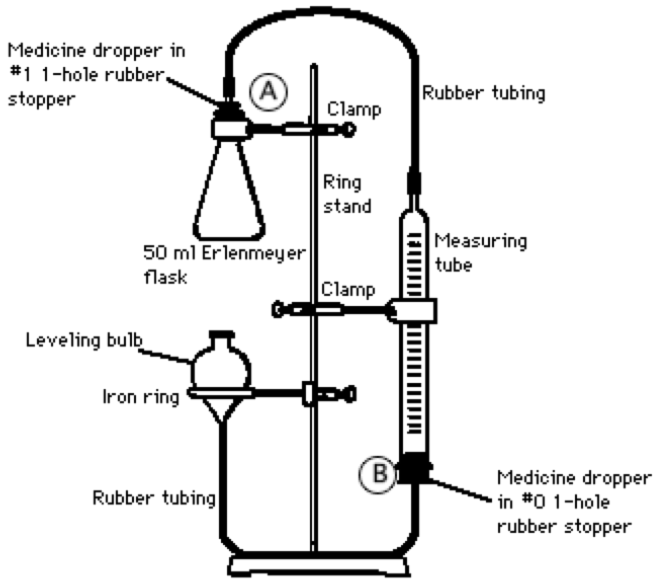

Figure 1. Apparatus for measuring the gas produced from the reaction of a NaCl/$NaNO_2$ mixture with sulfamic acid. An inverted buret is used as the measuring tube.

What should be in your laboratory notebook?

1. The title for the experiment, names of partner(s), and the date.
2. A record of all masses, temperatures, volumes, pressures, observations, etc.
3. Sample calculations (see Supplemental Report Sheet)
4. Citations in the proper format.

Laboratory report: Use the **Report Form** for Experiment 7.

Supplemental Report Sheet

Parameter	Trial #1	Trial # 2	Trial # 3
Sulfamic acid, g			
Unknown mixture, g			
Initial volume, mL			
Final volume, mL			
Temp of water in leveling bulb, °C			
Temp of water in leveling bulb, K			
P_{total} = Barometric pressure, mm Hg			
P_{water} = Vapor pressure H_2O, mm Hg			
ΔV = Volume of N_2 gas collected, mL*			
ΔV = Volume of N_2 gas collected, L			
P_{total} = Barometric pressure, atm			
P_{water} = Vapor pressure H_2O, atm			
$P_{nitrogen}$ = Pressure N_2 gas, atm*			
Moles N_2 collected*			
Moles $NaNO_2$*			
$NaNO_2$ reacted, g*			
Mass% $NaNO_2$ in unknown mixture*			
NaCl in unknown, g*			
Mass% NaCl in unknown mixture*			

Final Results for Unknown # _____

Material	Average mass %	Standard Deviation	SDOM*	% Error*	% Precision*
$NaNO_2$					
NaCl					

***Show example calculation in your lab notebook**