Carbonation Release

Prelab Assignment

Read the entire experiment. Submit your completed prelab questions on Labflow before you begin the lab, according to the deadline set in the syllabus. Determine the data you will be collecting and prepare appropriate tables.

Experimental Overview

This experiment has 2 parts. In Part I, you will react sodium bicarbonate with acetic acid and monitor the pressure change. In Part II, you change the temperature of the reaction product and monitor the pressure. As this experiment is for your final lab report, you need to develop appropriate tables and graphs to best relate your findings.

Introduction

When a gas is produced during a chemical reaction, the pressure of the reaction system will change depending on how much gas is produced. This is one way to determine how much of the reactants have reacted. The relationship between pressure, volume, temperature and amount of gas (in moles) is given by the Ideal Gas Law.

$$P V = n R T$$

In the Ideal Gas Law, P is pressure (in atm), V is volume (in L), n is moles, R is the Universal gas constant (in L atm $mol^{-1} K^{-1}$) and T is temperature (in K). There are considerations that add correction terms to this ideal law, but this equation fits the majority of systems we encounter under normal atmospheric pressure and classroom temperatures.

Application

The composition of gases in Earth's atmosphere strongly affects the surface climate and environment of the planet. Dinitrogen, N_2, and dioxygen, O_2, are the major components of the atmosphere. Water vapor is commonly included as a major component as well. Minor components such as argon, carbon dioxide, neon, and methane are also present.[1]

Many physical properties are similar between these molecules, such as how pressure and temperature influence them in the gas phase. The density of dinitrogen and dioxygen gas will behave similarly when the temperature is adjusted. However, other physical properties cause gas molecules to behave quite differently. For example, water vapor can absorb sunlight more effectively than dioxygen and dinitrogen, which causes water vapor to increase in temperature more readily when exposed to sunlight.[2]

Concentration is also a key consideration for atmospheric components. If the effect of a minor component in the atmosphere is significant, a small modification to the concentration can result in a large impact on the atmospheric environment. Gaseous concentrations usually change due to chemical reactions that consume or produce a particular gas molecule.

For example, carbon dioxide is generated by many chemical reactions. One of the most significant sources is through the combustion of organic molecules. Once produced, carbon dioxide often becomes a component of Earth's atmosphere, although under the right conditions CO_2 can dissolve slightly in seawater.[3] Depending on the chemistry in the seawater, dissolved carbon dioxide can react to become carbonate ions (Figure 1) or be removed as an atmospheric component.[3]*

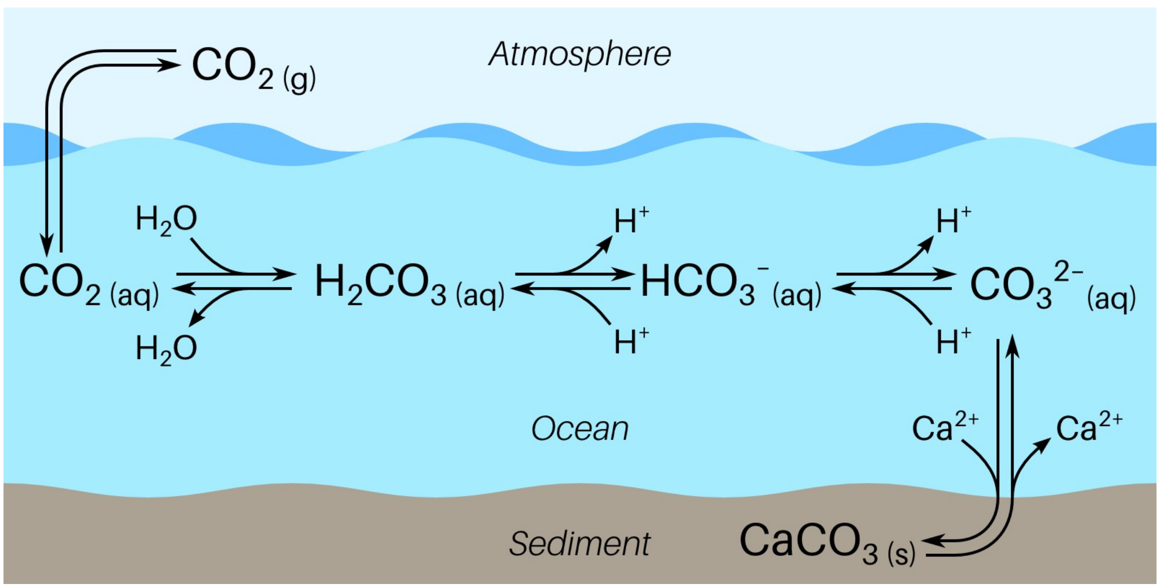

Figure 1 - Carbon Dioxide Equilibrium Reactions with Seawater

Understanding the similarities and differences of gases, as well as how changes can occur is important to evaluating how Earth's atmosphere can impact the surface environment. Some of the physical properties of gases and the production of gas molecules from a reaction will be studied during this experiment.

* These conversions are equilibria and can proceed in the reverse directions as well.

References

1. Hart, M. H. The Evolution of the Atmosphere of the Earth. *Icarus*. **1978**, 33, 23-39.
2. Horvath, H. Atmospheric Light Absorption–A Review. *Atmos Environ*. **1993**, 27, 3, 293-317.
3. Millero, F. J. Thermodynamics of the carbon dioxide system in the oceans. *Geochim. Cosmochim. Acta.* **1995**, 59, 4, 661-677.

Procedure

1. Prepare for the experiment.
    a. Obtain and wear goggles.
    b. Use the *Chemicals Utilized table* to help keep track of materials obtained that will be disposed of at the end of the experiment.
    c. Record procedural notes and observations during the experiment.
    d. Obtain any necessary equipment from your instructor.

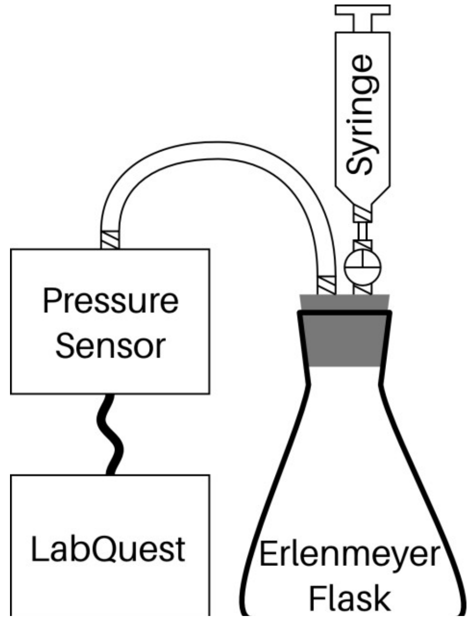

Figure 2- Experimental Setup

PART I

2. Monitor pressure changes during a reaction. (Prepare the experimental setup. See Figure 2)

***Note:** Use only the recommended amounts of materials to prevent seal failure of the experimental setup.

   a. Measure out a sample of sodium bicarbonate with a mass corresponding to Trial 1 in Table 1. Record this mass in the experimental mass column.
   b. Transfer the sodium bicarbonate sample into a 250 mL Erlenmeyer flask.
   c. Seal the flask with a rubber stopper with Luer lock connections.
   d. Measure out the target amount of acetic acid using a syringe. Do not have extra space containing air in the syringe, this will artificially increase the pressure when the acetic acid is added. Record the actual amount of acetic acid used for the trial.
   e. Connect the syringe to the Luer lock on the Erlenmeyer flask stopper. Do not add the acetic acid until the next step.

Table 1: Calculated and Experimental Reagent Amounts

Trial	Target $NaHCO_3$ Mass (g)	Actual Sodium Bicarbonate Mass (g)	Target 5% Acetic Acid (mL)	Actual 5% Acetic Acid (mL)
1	0.20 ± 0.01		3.0 ± 0.1	
2	0.15 ± 0.01		2.3 ± 0.1	
3	0.10 ± 0.01		1.6 ± 0.1	

3. Monitor the pressure change during the reaction.
    a. Set up the LabQuest to collect 10 samples per second, for 200 seconds.
    b. Begin recording pressure data on the LabQuest.
    c. Add the acetic acid solution to the Erlenmeyer flask.
    d. If necessary, swirl the flask slightly to make sure all of the sodium bicarbonate reacts.
    e. The data collection can be stopped after the pressure levels off for multiple seconds.
    f. Record the peak pressure measured for the trial and any other observations. Save your data by exporting the data to a flash drive as a .txt file.
4. Repeat the experiment for Trial 2.
    a. Dispose of the waste in the flask properly and rinse out the inside with deionized water.
    b. Repeat steps 2 and 3 for Trial 2 in Table 1.
5. Repeat the experiment for Trial 3.
    a. Dispose of the waste in the flask properly and rinse out the inside with deionized water.
    b. Repeat steps 2 and 3 for Trial 3 in Table 1.
    c. **Do not break the seal** on the flask when finished, proceed to Part II.

PART II

6. Monitor temperature effects on captured gas.
    a. Prepare an ambient temperature water bath in a 1 L beaker, and connect a temperature probe to the LabQuest for monitoring the water bath temperature.
    b. If the water is below 25 °C, place the flask filled with gas from step 5 in the water bath. Submerge the flask so the exterior surface is surrounded with water.
    c. Record the pressure and temperature from the LabQuest for the current conditions of the system.
    d. Cool the water bath slowly by adding small amounts of ice and stirring. Record 4 additional sets of conditions between 0 and 25 °C (approximately 5 °C intervals).
    e. Also record the current atmospheric pressure in the laboratory.
7. Clean all glassware and equipment. Dispose of all waste properly. Refer to the *Chemicals Utilized* table to determine the correct quantities of disposed materials and record these values on the waste sheets. Be sure to clean up any materials spilled during the experiment. Please leave the laboratory in better condition than at the start of the experiment.

Chemicals Utilized Table

Chemical Name	Amount	Waste Type

Make sure to record your observations and label all recorded values!

Reminders: Make sure to discuss the table and figure you present. Tell what is important about the data presented.

Relate the data you collected to molecular-level events.

<u>Assignment</u> This lab will be used to write a full lab report. Instructions for the full lab report are posted. You are expected to complete all sections according to the posted report guide.

For help with this report, you can use your previous experiments to aide you in developing your lab report. The writing development pages are intended to provide guidance to this process. The following sections have been fully-developed during one of your lab reports this semester. Look to these experiments for the guides to developing your report:

2: References
6: Data Tables
7: Figures (Graphs)
9: Analysis/ Conclusions

All full reports must include correctly formatted references.

The OU Writing Center is an excellent source of assistance. Feel free to get help from these experts.

<u>Submission Details:</u>

Submit your complete report to Canvas in the **"Lab Report 10 for Peer Review" assignment by 8:00 am, on the date of your Peer Review**.

Your Lab Instructor will assign you 2 other papers within your section to Peer Review during your lab meeting. You will have your normal Lab meeting time to complete the Peer Review Activity.

Final reports are due in the "Lab 1315-10 Final Report" assignment by the syllabus date.