A Guided Inquiry Twist on Two Traditional Gas Labs

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The two labs discussed in my poster can be found below in both a guided inquiry format and a traditional format.

The Alka Seltzer PV=nRT Challenge

A Traditional Approach

Introduction

When an Alka Seltzer tablet dissolves in water, it fizzes and releases carbon dioxide gas. The purpose of this lab is to use the ideal gas law to calculate the volume of carbon dioxide released from a single tablet of Alka Selzer.

Procedure

1. Obtain an Alka Seltzer tablet and determine its mass. Handle it with forceps so that oils from your hand don't transfer to the tablet and so that the tablet doesn't rub off on your hand.
2. Measure out about 35 ml of tap water and place in a 150 ml beaker. Place a watch glass on the beaker and then determine the mass of the beaker, watch glass and water.
3. Place the tablet in the water, cover it with the watch glass and let the reaction run for about 15 minutes (while waiting, do steps 4 and 5, then answer the questions below).
4. Go to the barometer and measure the atmospheric pressure.
5. Record the temperature of the room.
6. When the reaction is complete, measure the mass of the beaker, solution and watch glass again.
7. Calculate the mass of CO_2 that was evolved and then calculate the volume this CO_2 would occupy in a balloon under the same conditions.

Write-Up

Turn in one answer sheet for each group at the end of class. This should contain a neat data table, your calculations and answers to the following questions. Your grade will be based on the accuracy of your calculations, the ease of following your work, the number of sig. figs. in your data and answers to the questions.

1. Would you get the same volume of CO_2 if you had used 40 ml of water instead of 35? Why or why not?
2. If we had only let the reaction run for 10 minutes, would your volume of CO_2 be bigger or smaller than what you calculated after 15 minutes? Explain.
3. What was the purpose of placing the watch glass on the beaker?

The Alka Seltzer PV=nRT Challenge

A Guided Inquiry Approach

Objective

When an Alka Seltzer tablet dissolves in water, it fizzes and releases carbon dioxide gas. The purpose of this lab is to use the ideal gas law to design and conduct an experiment that will enable you to calculate the volume of carbon dioxide released from a single tablet of Alka Selzer.

Materials

- Alka Seltzer tablet
- forceps
- 150 ml beaker
- water
- balance
- 50 ml graduate
- barometer
- thermometer
- watch glass (not essential, but bonus points will be awarded if used to improve the quality of your data)

Write-Up

By the end of the period, you and your lab partner should turn in one copy of your procedure, data and calculations. Your work should be concise, thorough and clear. You will not be penalized for "bad" data or for "wrong" results; instead, you will be graded on your procedure and whether it will, in theory, lead you to an accurate volume of CO_2; the organization of your data table; the accuracy of your calculations; consistent use of units; and the ease of reading and following your work.

Flic Your Bic for R

Adapted from Darrell Beach and Craig Calvin, Culver Academy, Culver IN

A Guided Inquiry Approach

Objective: Design and conduct an experiment to determine the value of the ideal gas constant. Please report R in units of $mmHg \cdot L \cdot mol^{-1} \cdot K^{-1}$, $kPa \cdot L \cdot mol^{-1} \cdot K^{-1}$, and $atm \cdot L \cdot mol^{-1} \cdot K^{-1}$ and calculate your percent error.

Materials and other Useful Information

- lighters filled with butane, C_4H_{10}
- 100 ml graduate
- pneumatic trough and water
- balance
- thermometer
- barometer
- ideal gas law
- Dalton's law of partial pressures
- table containing the partial pressure of water at various temperatures

Write-Up

Only one lab write-up is required per lab group. Your work should be concise, thorough and clear. You will not be penalized for "bad" data or for "wrong" results; instead, you will be graded on the clarity of your written procedure; the organization of your data table; the accuracy of your calculations; the thoroughness of your procedure and whether it will, in theory, lead you to an accurate value for R; consistent use of units; and the ease of reading and following your work.

Flic Your Bic for R

Adapted from Darrell Beach and Craig Calvin, Culver Academy, Culver IN

A Traditional Approach

Introduction

In this lab we will experimentally determine the value of R, the ideal gas constant, using the ideal gas law, PV = nRT. The gas we will use is butane (C_4H_{10}), commonly found in lighters. Under everyday conditions, butane acts as an ideal gas and thus can be used to calculate R. We will collect the gas by "water displacement" in a graduated cylinder and can then easily measure its volume, moles (from the loss of mass in the lighter), and temperature (we'll assume it's the same as the room). The pressure in the graduate will be equal to the atmospheric pressure but is not due solely to the butane; there will be a small amount of water vapor that will also contribute to the pressure. According to Dalton's law of partial pressures, $P_{total} = P_{butane} + P_{water}$. The partial pressure of the water depends on the temperature and can be looked up in a table. Thus, knowing P_{total} and P_{water}, one can calculate P_{butane} and then use this value to calculate R.

Procedure

Day 1

1. Obtain a lighter and note the number written on it. Determine its mass.
2. Fill a pneumatic trough up to the overflow hole with tap water.
3. Fill a 100 ml graduate to the brim with tap water. Put your hand on top of the graduate, invert it and lower it into the trough, being careful to prevent air from entering the graduate. Once the opening is completely under water, you may remove your hand. Clamp the graduate in place so that the opening is a couple of inches above the bottom of the trough, yet still under water. If there is an air bubble in the graduate with a diameter greater than a dime, empty the graduate and try again.
4. Carefully, put the lighter in the water and under the graduate. Open the trigger of the lighter to allow the butane to escape. Fill the graduate with about 95 ml of gas. Be very careful to get all the gas into the graduate.
5. Dry the lighter off with paper towel and set it aside to dry overnight.
6. Measure the room temperature.
7. Determine the atmospheric pressure using the barometer (be sure to report your value to the correct number of significant figures). Consult a table to figure out the partial pressure of the water and then calculate the partial pressure of the butane.

Day 2

8. Obtain the lighter you used on day 1 and determine its mass.
9. Using the ideal gas law, calculate the value of R in $mmHg \cdot L \cdot mol^{-1} \cdot K^{-1}$, $kPa \cdot L \cdot mol^{-1} \cdot K^{-1}$, and $atm \cdot L \cdot mol^{-1} \cdot K^{-1}$. Please show your work.

Results

Initial Mass	______________________	
Final Mass	______________________	
Mass of Gas	______________________	
Moles of Gas	______________________	
Volume of Gas	______________________	
Temperature	______________________	
Partial Pressure of Butane	______________________	
Partial Pressure of Water	______________________	
Total Pressure	______________________	
R	______________________	$L \cdot atm \cdot mol^{-1} \cdot K^{-1}$
R	______________________	$L \cdot mmHg \cdot mol^{-1} \cdot K^{-1}$
R	______________________	$L \cdot kPa \cdot mol^{-1} \cdot K^{-1}$
Percent Error	______________________	

Questions

1. How would your value for R have changed if you collected only 50 ml of gas?
2. Why did we wait 24 hours to take the final mass of the lighter?
3. If we had taken the final mass of the lighter on day 1, would our calculated value of R be too high or too low? Explain.
4. How does the partial pressure of water change as the temperature increases? Why?