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**Ideal Gas Lab – the Molar Mass of Butane Gas**

**Purpose:**

1. Students will collect a sample of gas by water displacement
2. Students will measure the volume, temperature, and pressure of the collected gas
3. Students will calculate the molar mass of the gas using the ideal gas law equation

**Background Knowledge:**

1. Write the equation that represents Dalton’s Law of Partial Pressures for gases collected over water.
2. What must be true about the water levels inside and outside the gas collection container in order for Dalton’s Law to apply?
3. Write the equation for the Ideal Gas Law and indicate the meaning of each variable with units.
4. Which of the variables in the Ideal Gas Law equation will allow you to calculate the molar mass of a known sample of gas?

**Materials:**

* Balance
* Butane lighter
* funnel
* Sink filled with water
* Thermometer
* 100 mL graduated cylinder

**Procedure:**

1. Fill the sink with water. Allow the water to reach room temperature.
2. Submerge the lighter in the water for at least 10 seconds. Remove the lighter and thoroughly dry off the water. Find the initial mass of the lighter to the nearest 0.01 g. Record this measurement in the data table.
3. Submerge the 100 mL graduated cylinder and fill it completely with water. Invert it under the water carefully so that no air bubbles are trapped inside. Place the end of the funnel into the graduated cylinder underwater, and hold the lighter within the funnel.
4. Release the butane gas from the lighter by pressing the small lever near the flint wheel. Release the gas into the funnel until you displace approximately 70 mL of water. Be careful not to allow the butane gas to escape outside of the funnel.
5. Wait approximately 5 minutes to allow the butane to reach room temperature. While you’re waiting, record the barometric pressure, air temperature, and water temperature in your data table.
6. Adjust the height of the graduated cylinder until the water levels inside and outside are the same. Record the volume of the gas collected to the nearest 0.1 mL.
7. Remove the lighter from the water and thoroughly dry off any excess water. Find the final mass of the lighter and record this measurement in your data table.
8. Clean up your lab station

**Data:**

|  |  |
| --- | --- |
| Initial mass of lighter (BEFORE experiment) | grams |
| Final mass of lighter (AFTER experiment) | grams |
| Barometric Pressure (convert to atm) | atm |
| Air Temperature (convert to Kelvin) | K |
| Water Temperature (convert to Kelvin) | K |
| Record the Water Vapor Pressure (PH2O) at this water temperature (convert to atm)  Use the chart on the back page | atm |
| Volume of gas collected (convert to L) | L |

**Data Analysis: SHOW ALL WORK AND ROUND TO THE PROPER NUMBER OF SIGNIFICANT FIGURES**

1. Calculate the *experimental* mass of butane gas collected in this experiment (initial mass – final mass)
2. Use Dalton’s Law of Partial Pressures to find the partial pressure of dry butane gas (Pbutane = Patm – PH2O)
3. Use the Ideal Gas Law to calculate the *experimental* moles of butane gas (Hint: use the air temperature, dry butane pressure and volume of collected gas)
4. Divide the *experimental* mass of butane (#1) by the *experimental* moles of butane gas (#3) to calculate the *experimental* MOLAR MASS of butane. (Hint: the units for molar mass are grams/mol – make the units work out, and the math is easy!)

**Discussion Questions:**

1. Identify the TWO gases collected in the graduated cylinder.
2. Differentiate between “wet” and “dry” butane gas.
3. Butane has the molecular formula C4H10. Calculate the *theoretical* molar mass of butane (Hint: Use the periodic table).
4. Calculate your percent error for this lab.

% error = Ι(experimental – theoretical)Ι/ theoretical X 100

1. Discuss at least 2 possible sources of error for this lab and explain how they may affect your results.
2. Can this experimental technique be used to determine the molar mass of other gases? Explain your answer.

