Lab #5: The Ideal Gas Law

Objectives:

1. To experimentally determine the molar mass and density of butane by using the ideal gas law.

Materials:

Disposable Butane Lighter	Barometer
Basin of Water	100 mL graduated cylinder
Electronic Balance	Thermometer

Procedure:

1. Submerge butane lighter in basin of room temperature water and press lever to release gas for about 5 seconds. Remove lighter from water, shake excess water off and dry off outside very well.
2. Take the mass of the dry butane lighter and record in the observation table.
3. Fill a 100 mL graduated cylinder completely with water from the basin or the tap. Place thumb over opening and invert cylinder into water in basin. Be sure no air bubbles are trapped in the cylinder.
4. Position the butane lighter under water and below the opening of the graduated cylinder. Press the lever and release butane gas into the graduated cylinder. The gas will displace the water in the cylinder. Do not allow any of the butane gas to escape through the outside of the cylinder. Collect about 80 mL of butane gas, and hold in the basin while completing next step.
5. Remove the butane lighter, shake and dry well as in step 1. Take the mass of butane lighter and record in the observation table. (If the final mass of the lighter is bigger than its initial mass, repeat steps 1 through 5.)
6. By raising and lowering the graduated cylinder in the basin, adjust the level of water inside and outside the cylinder until they are the same. Read the volume of gas collected and record in observation table.
7. Repeat steps 2-8 for four total trials.
8. Record the temperature of the water and air in the room; they should be the same.
9. Record the atmospheric pressure (from your teacher).
10. Look up the vapour pressure of water at the temperature recorded from the Internet at (http://en.wikipedia.org/wiki/Vapor_Pressure_of_Water_at_Various_Temperatures) and record in the observation.

Observations:

	Trial 1	Trial 2	Trial 3	Trial 4
Initial mass of butane lighter				
Final mass of butane lighter				
Volume of butane collected				

Temperature of Water and Room: _____

Atmospheric Pressure: _____

Water Vapour Pressure at Measured Temperature: _____

Analysis:

1. Calculate the mass of the butane collected for each trial and record in your data table. Show work.
2. Calculate the partial pressure of butane. Show work.
3. Use the rearranged ideal gas law given in the background to determine the molar mass (*M*) in g/mol of butane for **each** trial.
4. Calculate the average molar mass of butane from your best and consistent trials.
5. Calculate the average density in g/L of butane using the rearranged ideal gas law given in the background and the average molar mass obtained in the previous question.

Evaluation:

1. Butane has the formula C_4H_{10}. What is its theoretical molar mass?
2. Calculate the molar mass percent error using the average experimental value determined for butane.
3. Describe two sources of error and how they affected your experimental molar mass.
4. Do you think the same experimental technique could be used to determine the molar mass of any gas? Explain your answer.

Conclusion:

1. Summarize what you have learned from this lab.
2. Why do we have to account for the vapor pressure from the temperature in the calculation? Write a statement of understanding (phenomena, evidences, reasoning from a particle perspective, and claim) explaining what had happened. You might want to include diagrams to aide your explanations.