Lab: The Ideal Gas Law, Molar Mass, and Density

Objective:

To experimentally determine the molar mass and density of butane gas.

Materials:

Disposable butane lighter
Basin of water
Electronic balance
Barometer
100 mL graduated cylinder
Thermometer

Procedure:

1. Submerge the butane lighter in a basin of room temperature water. Press the lever to release gas for 45-60 seconds. Remove lighter from water, shake off excess water, and dry outside of lighter.
2. Determine the mass of the dry lighter.
3. Fill a 100 mL graduated cylinder completely with room temperature water from the basin. Place thumb over opening and invert cylinder into the water in the basin. Be sure no air bubbles are trapped in the cylinder.
4. Position the butane lighter under the 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 butane to escape outside of the cylinder. Collect about 80 mL of gas. Continue to hold the cylinder in the basin.
5. Remove the butane lighter and shake and dry as in step 1. Record the mass of the lighter. If the final mass of the lighter is greater than the initial mass, repeat steps 1-5.
6. By raising and lowering the graduated cylinder in the basin, adjust the height so that the water levels inside and outside the cylinder are the same. Record the volume of gas collected.
7. Repeat steps 2-6 for a total of four trials.
8. Record the temperature of the water and air in the room (they should be the same).
9. Record the atmospheric pressure.
10. Look up the vapor pressure of water at the temperature and record.

Data and Observations:

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

Water temperature_____

Room temperature_____

Atmospheric pressure (barometer)_____

Water vapor pressure at measured temperature_____

Analysis:

When calculations are required, ALL work must be shown. If multiple trials or data is being calculated in the exact same manner, show all work for one trial, then create a table with the information for the other calculations.

1. Calculate the mass of butane collected for each trial and record in your data table.
2. Calculate the partial pressure of butane.
3. Rearrange the ideal gas law to determine the molar mass (M) in g mol^{-1} of butane for each trial.
4. Calculate the average molar mass of butane from your best and most consistent trials.
5. Rearrange the ideal gas law to calculate the average density in g L^{-1} using the average molar mass.

Evaluation:

1. Butane has the formula C_4H_{10}. What is the theoretical molar mass?
2. Use your experimental average molar mass of butane to calculate your percent error.
3. Describe two sources of error and how they could have 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.