The Molecular Mass of Butane
AP Chemistry

Background: In this experiment you will determine the molecular mass of the gas butane, commonly found in pocket lighters. You will release butane from a lighter and allow it to displace a measured volume of water. From the displaced volume, the weight of the butane, the measured temperature, and the pressure, you can easily calculate the molecular mass of butane gas.

Materials:

250 mL Erlenmeyer flask	glass plate
Trough or water bath	butane lighter
Thermometer	graduated cylinder

Procedure:

1. Fill a 250 mL Erlenmeyer flask completely full of water. Cover the top with a small glass plate without trapping any air in the top of the flask.
2. Fill a trough or water bath with water. Hold the glass plate in place with your finger and carefully turn the flask upside down and place it in the trough. Be sure that no air bubbles enter the flask. Remove the glass plate.
3. Obtain a butane lighter and mark it for future identification. Weigh the lighter and record the weight to the nearest milligram.
4. Carefully hold the lighter under the water. Make sure that the gas opening is beneath the mouth of the inverted flask. Make sure the mouth of the flask is submerged at all times. Press the release lever of the lighter, making sure that all of the gas bubbles enter the flask.
5. Continue to hold the lever down until you have collected at least 200 mL of gas.
6. Remove the lighter and set it aside.
7. Without removing the flask from the water, carefully raise or lower the flask until the water level inside the flask is the same as the level of the water outside of the flask (which equalizes the pressure). Hold the flask at this level and carefully slip the glass plate under the flask. Hold the plate in place and carefully remove the flask from the water, and set it upright.
8. Remove the glass pate and, with a graduated cylinder, carefully fill the flask with water. Keep careful account of the volume of water needed to fill the flask completely to the top. The total volume of water added represents the volume of the butane gas collected. Record this volume as the volume of gas collected.
9. Measure and record the temperature of the water in the trough. Record the barometric pressure (you may use the school web site to obtain the current barometric pressure.)
10. On the following day the water on the lighter should have evaporated and you may now weigh the lighter in order to determine (by difference) the mass of butane used to “fill” the flask.
11. Determine the partial pressure of the butane gas by using Dalton’s Law of Partial Pressures. (i.e. subtract the vapor pressure of water at the experimental water temperature from the total pressure.)
12. Use the ideal gas equation to determine the molecular weight. Remember that PV=nRT but n (the number of moles of gas) is the mass (m) divided by the molecular mass. And so the equation can be rewritten PV=mRT/MW or MW=mRT/PV. Use R = 0.0821 L-atm/mole-K.
13. Determine the formula for butane and calculate the theoretical molecular weight; use this value to calculate your percentage error.

Remember to show all calculations performed in the lab.