Name: **Period:**   **Seat#:**

Required Sections: (Refer to R-5 for guidelines and requirements. Make note of any specific changes given by your teacher in class)
   Prelab: Answer Pre-Lab Questions, Materials, Reagent Table, Procedures, and set up Data Table before you get to class.
   During Lab: Data section – Fill out your data table that is already set up from the prelab.
   Post-lab: Calculation section, Post Lab Discussion Questions section, Post-Lab Two Pager done on separate worksheet.

Introduction:
In this particular lab, we are going to try to determine the molar mass of butane, C_4H_{10}, experimentally. A simple calculation using a periodic table would give us the correct answer for the molar mass of butane, but you are going to see how close you can come to this accepted value in the lab. To accomplish this, we will use the ideal gas law, $PV = nRT$ which can be rearranged to solve for n, the number of moles: $n = PV/RT$ We are trying to find the molar mass, which has units of grams/mole. We will measure the mass of the butane released from the pressurized container, and we will measure the volume of the gas that we collect at room conditions by water displacement. We merely need to plug our conditions of volume, temperature, and pressure into the ideal gas law in order to find n, the number of moles of butane collected. Once we know the mass, and the number of moles, we will divide the mass, g, by the number of moles, n

Concepts: Molar Mass   Ideal Gas Law   Collecting Gas Over Water Vapor

Pre-Lab Questions
1. Calculate the theoretical molar mass of butane using the formula and the periodic table.
2. We can rearrange the Ideal Gas Law to be able to solve for molar mass of a gas. What is the rearranged equation that we can we use to find molar mass?
3. What do we mean by "dry gas" versus "wet gas" when collecting gas over water?
4. What is the equation we would use to find the partial pressure of the dry gas when collecting gas over water?

Materials
Thermometer   Plastic tub   Butane Lighter   50mL Graduated Cylinder   Balance

Safety Precautions
Butane is a flammable gas, and at NO TIME during lab should there be any use of an open flame or other source of heat!

Procedure
1) Fill tub with tap water very close to the top of tub.
2) Find the mass of the dry lighter. Record.
3) Place thermometer in the water in the tub. Allow temperature to equalize and record.
4) Fill the graduated cylinder to the very top. MAKE SURE THERE IS NO AIR IN THE CYLINDER!
5) Place hand over the top of the cylinder and invert into the bucket of water without letting air into the cylinder. If air gets in redo until cylinder is completely filled with water.
6) One person must hold onto the graduated cylinder the entire time to keep it from falling.
7) Another student then places the butane lighter under the water, with the top of the lighter directly in the opening of the graduated cylinder. You want to make sure the butane bubbles go right into the cylinder and don't escape into the water tub.
8) Hold the thumb lever down to allow butane to escape into the funnel. Continue to allow butane to escape from the lighter until you have displaced 40 – 45 mL. You should clearly see bubbles filled with butane leave the lighter into the cylinder.
9) Lift the graduated cylinder until the water level inside the graduated cylinder matches with the water level in the tub. Record the volume of butane in the graduated cylinder. See *Figure 1*.
10) Read the barometer for the atmospheric pressure in the room.
11) Determine the partial pressure of water using the temperature of the water and the water vapor pressure chart.
12) Dry the outside of the lighter. DO NOT depress the lever or your results will be very flawed.
13) Bring the lighter back to your teacher. Your teacher will allow the lighters to dry overnight in the fume hood.
14) Do not empty the tub of water, but leave for next class. Dry all equipment except tub. Dry table. Leave materials on tray.
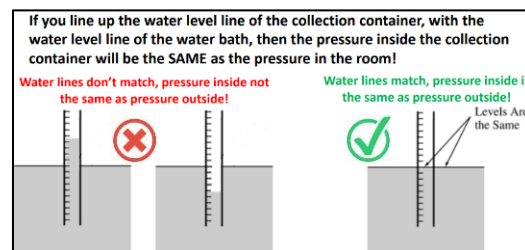**15)** The next day - Weigh the now dry lighter and record.

If you line up the water level line of the collection container, with the water level line of the water bath, then the pressure inside the collection container will be the SAME as the pressure in the room!

Water lines don't match, pressure inside is not the same as pressure outside!

Water lines match, pressure inside is the same as pressure outside!

Levels Are the Same

Figure 1

Dougherty Valley HS Chemistry
Gas Laws – Calculating the Molar Mass of a Gas

Data Table   *Remember, you need to make sure your data table has all required elements!*
                  This is just to get you started on the right track.

Descriptive Title for Data Table

Initial mass of the soaked and then dried butane lighter	
Temperature of the water	
Volume of butane in the graduated cylinder	
Atmospheric pressure	
Final mass of the dried butane lighter	

SAMPLE

Calculations
1. Determine the mass of the butane collected in the graduated cylinder
2. Determine the atmospheric pressure in mmHg
3. Determine the pressure of the DRY butane in the cylinder.
4. Determine the volume of the butane in the cylinder in liters.
5. Determine the molar mass of butane using the equation you identified in your Prelab Question #2
6. Determine the percent error of the calculated molar mass

$$\% \ error = \frac{|Accepted \ value - Experimental \ Value|}{Accepted \ value} \times 100\%$$

Post Lab Discussion Questions

1. A student performed a similar lab with an unknown gas. Using their lab data, and a list of possible gases, identify what their unknown gas might be. Make sure you show all your work!

Initial mass of the soaked and then dried gas cartridge	25.400 g
Temperature of the water	23°C
Volume of gas in the graduated cylinder	677 mL
Atmospheric pressure	0.987 atm
Final mass of the dried gas cartridge	24.189 g

Possible Unknown Gases
H_2
O_2
N_2
CO
CO_2
N_2O
NO_2
NH_3
SO_2