**Molar Mass of Butane**

**Lab Question: How are volume, pressure, temperature and moles calculated using the ideal gas law?**

Background Information:

Every pure substance is composed of a distinct combination of atoms and is identified by its own molecular formula. The sum of the atomic masses of the atoms in this molecular formula is the substance’s formula mass. The same number, measured in grams, is the substance’s molar mass.

Butane, with the molecular formula C4H10, is a gas at normal room conditions. It can be liquefied by placing it under pressure, as in a disposable butane lighter. When the valve is opened, the liquid butane quickly escapes and changes into a gas. Butane also is extremely insoluble in water, so it can be bubbled through water with very little of it going into solution. Because of these properties, a disposable lighter is a good source of butane gas, and water displacement is a good method of collecting a measurable sample of it.

In this investigation you will collect some butane gas in a container by means of water displacement. You will determine the volume of the gas collected and, from that volume, the number of moles of butane. The mass of the gas collected will be obtained by taking the difference between the mass of the disposable lighter before and after butane is released from it. From the mass, volume, pressure and temperature you can calculate the number of moles of the gas you collected using the ideal gas law: n = PV/ RT. Knowing the number of moles of the gas collected you can then calculate the mass of one mole, or the molar mass, of butane.

Safety:

* Butane is flammable! No open flames (Do not light the lighter)
* Spilt water on the floor will make it slippery. Notify your teacher at once of any water on the floor.

Data Table

|  |  |
| --- | --- |
|  |  |
| Initial Mass of Lighter |  |
| Final Mass of Lighter |  |
| Volume of Butane | 125mL |
| Temperature |  |
| Pressure |  |

Procedure:

* 1. Using an electronic balance, measure the mass of the disposable lighter and record.
* 2. Fill your pneumatic trough with tap water about halfway.
* 3. Completely fill your Erlenmeyer flask with tap water – no air bubbles whatsoever.
* 4. Put your ring over the neck of your flask while still under water. Carefully attach your ring to your stand. No air bubbles whatsoever should be in the flask.
* 5. Hold your lighter under your flask and depress the release lever. (Not the roller striker.) Keep releasing butane gas until exactly at the 125mL mark. Do not let bubbles out that are not collected in the flask. All gas from your lighter should go into your flask.
* 7. Thoroughly dry your lighter with paper towel and by gently tapping until no more moisture can be seen. Do not release any more gas. Measure and record the disposable lighter’s new mass.
* 8. Using a thermometer, measure the temperature of the water in your pneumatic trough and record.
* 9. Using a barometer, measure the air pressure.

**Calculations:**

**Pressure (P)**

1. Convert pressure into atm

2. Find vapor pressure of water (at above temperature on data) from chart given and subtract this from the above. (This answer is **P**)

**Volume (V)**

3. Convert volume of butane in mL into L.

**Temperature of (T)**

4. Convert °C into K

**Number of moles (n)**

5. n = PV R = 0.0821 atm·L

RV mol·K

**Mass of Butane (M)**

6. Subtract the final mass of the lighter from the initial mass of the lighter.

**Mass per mole of butane: Molar Mass of Butane (experimental)**

7. Calculate the experimental molar mass of butane by dividing the mass **(M)** by the number of moles **(n).**

**Extra Credit**

**Accepted value for the molar mass of butane**

Calculate the accepted value for the molar mass of butane, C4H10, using a periodic table.

**Percentage Error**

Using your experimental value of the molar mass of butane and the accepted value for the molar mass of butane, calculate your percentage error.