

# CHEMISTRY CLICKS

## YOUR BIC

### PRE-LAB DISCUSSION

A mole of any pure gas at STP has a volume of 22.4 liters. The weight of that gas in grams is equal to the molecular mass of the gas in atomic mass units.

If the volume, mass, temperature and pressure of a gas is known, then using the combined gas law, its volume can be mathematically converted to a volume at STP. Then, the mass of 22.4 liters can be determined. Thus its molecular mass can be determined experimentally.

When gas is collected by water displacement, Dalton's law of partial pressures can be used to factor out the water vapor.

**OBJECTIVE:** To experimentally determine the molecular mass of butane.

**CHEMICALS/EQUIPMENT:** butane lighter, balance, 250-300 ml flask, china marker or water proof marker, graduated cylinder, trough [bucket, dishpan etc], thermometer glass plate.

### PROCEDURE:

1. Place exactly 200 ml of water in the flask. Using the marker, draw a highly visible line at the 200 ml water line.
2. Determine and record the exact mass of the butane lighter [estimate to the 100th of a gram].
3. Fill the trough or other large container with water.
4. Fill the flask completely with water and using your hand or a glass plate, invert it into the trough without permitting any air bubbles in it.

5. Make sure that the lighter is turned to its highest gas flow. Hold the butane lighter under the mouth of the flask, press the release lever, being careful that all of the gas flows into the flask. Hold the flask so that the 200 ml mark is exactly even with the water level in the trough. Fill the flask to the 200 ml mark that you made on the flask.
6. Determine and record the temperature of the water in the trough and the barometric pressure of the lab.
7. Thoroughly dry the butane lighter and determine and record its exact mass.

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***DATA***

Initial mass of lighter.....

Final mass of lighter.....

Mass of butane collected.....

volume of butane collected..... 200 ml

Temperature ..... C  
 ..... K

lab pressure .....

water vapor pressure at this temperature.....

partial pressure of butane.....

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**Table of water vapor pressures at normal lab temperatures**

temperature (C)	pressure [torrs]	temperature (C)	pressure [torrs]
17	14.5	23	21.0
18	15.5	24	22.4
19	16.5	25	23.7
20	17.5	26	25.2
21	18.6	27	26.7
22	19.8	28	28.3

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**CALCULATIONS:**

1. Using Dalton's law of partial pressures, enter the pressure of water vapor that corresponds to the lab temperature in the data table. Then subtract this from the lab pressure to find the partial pressure of butane gas.
2. Convert the lab temperature from Celsius to Kelvin.
3. Using the combined gas law formula, calculate the volume of butane at STP. Record your answer.

$$\frac{[\text{volume of butane}] [\text{lab pressure}]}{\text{lab temp (K)}} = \frac{[\text{volume at STP}] [760 \text{ torrs}]}{273^{\circ} \text{ K}}$$

4. Determine what mass of this gas would produce 22,400 ml at STP. Record your answer.

$$\frac{[\text{mass of butane}] [22,400 \text{ ml}]}{\text{volume of butane @ STP}}$$

5. Butane has the formula  $\text{C}_4\text{H}_{10}$ . Calculate its molecular mass from this formula. Record your answer.
6. Calculate your percentage of error.

### THINKING SCIENTIFICALLY

1. What could you have done to have more accurate results?
2. Write a balanced equation for the reaction of butane with oxygen.

