

Molar Mass of Butane

Applying the Gas Laws

Introduction

Avogadro's law, Dalton's law, and the ideal gas law—show how these gas laws can be applied to determine the molar mass of butane.

Concepts

• Dalton's law

• Ideal gas law

• Molar mass

Materials

Balance, centigram precision (0.01 g)

Graduated cylinder, 100-mL

Barometer

Rubber stopper, size 5

Pneumatic trough or large beaker, 600-mL

Thermometer

Disposable butane lighter

Safety Precautions

Butane is a flammable gas; keep away from all sparks, flames, and heat. Perform the demonstration in a well-ventilated lab and dispose of the gas in a fume hood or outdoors. Wear chemical splash goggles and chemical-resistant gloves.

Procedure

1. Interface a temperature probe with your laptop and open the Capstone program dragging a digits box onto the page.
2. Fill a metal pan up to the overflow spout with lukewarm water. Place a beaker under the overflow spout.
3. From the side bench obtain a 100 mL graduated cylinder. Remove the plastic ring and the plastic base. Lie the graduated cylinder at the bottom of the metal pan. The cylinder is now completely filled with water.
4. Obtain a butane lighter from the side bench and record the initial mass of the lighter on the data sheet using the milligram balance (± 0.003 g.) **IMPORTANT:** above the Trial # on the data sheet record the id # of the lighter.
5. Use the temperature probe to record the temperature of the water in the pan.
6. Use the step stool to read the barometer and record the measurement on the data table.
7. Using your laptop, google a table of water vapor pressures and record the vapor pressure for the recorded temperature in Procedure #5. You may have to interpolate!
8. Upright the graduated cylinder and lift it high enough, but not out of the water, so that your fist can fit under the cylinder. Hold the butane lighter so that the gas jet of the lighter is just below the opening of the cylinder. Depress the trigger and begin displacing gas from the cylinder. Be sure no bubbles are escaping out the side! Displace around 90 mL of water which may take some time so your partner may want to relieve you if you tire from holding the trigger.
9. To collect the last 10 mL, adjust the level of the graduated cylinder so that the 100 mL mark is even with the level of water in the pan. Continue to collect butane until you have exactly 100 mL of butane and the 100 mL mark is even with the water level. When this happens stop collecting and lie the cylinder on the bottom of the pan.
10. Shake dry the butane lighter and leave it on the shelf to dry until the next day when you will determine the final mass.
11. Repeat steps 4-10 for Trials 2-3.

Molar Mass Data Chart

Measurement	Trial 1	Trial 2	Trial 3
1. Initial mass of butane lighter (g)	27.125	26.883	
2. Final mass of butane lighter (g)	26.883	26.665	
3. Mass of butane collected (g)			
4. Volume of butane collected <i>ML</i>	99.9	96.5	
5. Temperature of water bath and butane C°	22.1	22.9	
6. Vapor pressure of water (mmHg)			
7. Barometer reading (mmHg)	770.	770.	
8. Pressure of dry butane (mmHg)			
9. Molar mass of butane			

10. Calculate the average molar mass of butane from the 3 trials: _____

11. What is the actual molar mass of butane, C_4H_{10} ? _____

12. Calculate below your % error using the average molar mass: _____

13. List some possible errors as reasons for your % error: _____
