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Finding the Molar Mass of Lighter Fluid

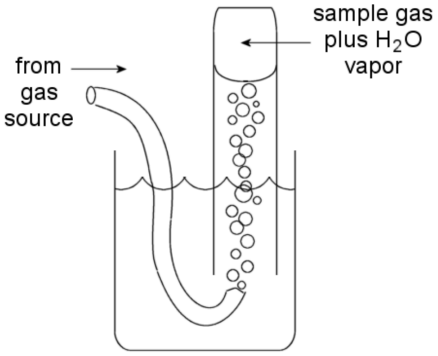
Objective:

- To successfully collect and store gas from a cigarette lighter.
- To use the Ideal Gas Law in calculating the number of moles of gas being stored.
- To use the mass and the number of moles of the gas being stored in calculating the molar mass of the gas.
- To compare the experimental molar mass of the gas with the theoretical mass (based on its molecular formula) and calculate a percent error.

Introduction

In many laboratory settings, a gas must be collected for study. There are several ways of collecting and storing gases and the preferred method will vary according to the gas being collected and the purpose for which it is needed.

The following diagram illustrates collecting a gas over water:



In the diagram, a gas is brought in from an outside source through a rubber tube. (In our lab , we will not use the tube.) The tube is passed under water until it opens into an inverted cylinder. At the start of the experiment the cylinder was completely filled with water, but as gas was collected the water level fell.

In today's experiment you will be collecting the gas from a regular cigarette lighter. After collecting it, you will make careful measurements of its mass, volume, temperature, and pressure. This will allow you to calculate the number of moles of gas trapped in the cylinder, which, along with the mass, will provide you with an experimental molar mass for the gas.

Pre-Lab Questions

1. Why should no flames be used in this laboratory?

2. Why is the insolubility of the gas in water critical to performing this experiment?

3. What are the conditions of STP?

4. Propane and methane are hydrocarbon fuels. If a 1000 g sample of each of these compressed gases was taken on a camping trip which one would contain the largest number of moles? Show a calculation to support your answer.

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Materials

Disposable lighter
100 mL graduated cylinder
Plastic bin for water collection
Thermometer
Analytical balance
Splash goggles

Safety Precautions

The gas is EXTREMELY flammable gas. At NO TIME may you ignite your lighter or have any other source of heat or flame present in lab.

Procedure *(Read this in its entirety prior to starting the experiment.)*

1. Create a data table suitable for recording quantitative data in your notebook.
2. Measure the mass of a dry disposable lighter using the correct uncertainty.
3. Fill a 100 mL graduated cylinder completely with water. Place the filled cylinder in a water-filled plastic lab bin such that there are no air bubbles in the cylinder. If you notice any air bubbles, refill the cylinder with water to remove them.
4. Lift the bottle up slightly (but keep its mouth below the surface of the water) and hold the lighter beneath the mouth. Depress the button/lever on the lighter so that bubbles of gas rise into the inverted graduated cylinder. Be careful that no bubbles of the gas miss the mouth of the cylinder.
5. As the cylinder fills with the gas, the level of the water will fall. Continue to collect approximately 75 mL of gas.
6. When you have collected a measurable amount of gas, release the button on the lighter and remove it from the water. Dry the lighter with paper towel and record its mass again. *The second mass should be LESS than the first mass you recorded earlier.* If the second mass is higher than or the same as the first mass, be sure that it is thoroughly dry (including inside the metal casing around the gas outlet) and mass it again. Be sure to NOT depress the button, which would release additional gas.
7. Read the volume of the gas you collected from the graduated cylinder. Make sure you are reading the correct set of measurements. Record this value in your data table.
8. Use a thermometer to measure the temperature of the gas inside the cylinder.
9. Perform the necessary calculations to determine the amount (in moles) of gas delivered into the graduated cylinder and the gram formula mass of the mystery gas.

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Calculations (Show all work!)

1. Calculate the mass of the gas in the graduated cylinder.

2. Convert the volume of gas collected to dm^3.

3. Convert the temperature recorded to Kelvin.

4. Calculate the number of moles of mystery gas collected.

5. Determine the gram formula mass of the alkane gas and identify it.

6. Calculate a percent error for the gram formula mass for your mystery gas.

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Post-Lab Questions

1. Identify both random (errors in precision) and systematic (errors in accuracy) errors that could help explain your percent error.

2. Discuss realistic and relevant suggestions for the improvement and extension of the investigation.