

CHAPTER 4	Investigation 4.A: Finding the Molar Mass of a Gas	BLM 4.2.7
HANDOUT		

In this investigation, you will measure the volume and mass of a sample of a hydrocarbon gas to find its molar mass. The purpose of the investigation is to test water displacement as a method for collecting gas in the laboratory. Butane, $C_4H_{10}(g)$, is suggested for use because it is readily available in butane lighters. However, any other available hydrocarbon gas may be substituted.

Question

How can you find the molar volume of a gas when it is combined with water vapour?

Prediction

Predict the molar mass of butane.

Safety Precautions



- Remember that hydrocarbon gases are flammable. Before beginning, check to ensure that there are no open flames in the laboratory.
- If water is spilled on the floor, wipe it up immediately so that no one steps in it.
- Release all the collected gas into an operating fume hood after the investigation. Return the lighter to your classroom teacher after you have completed collecting all your data.

Materials

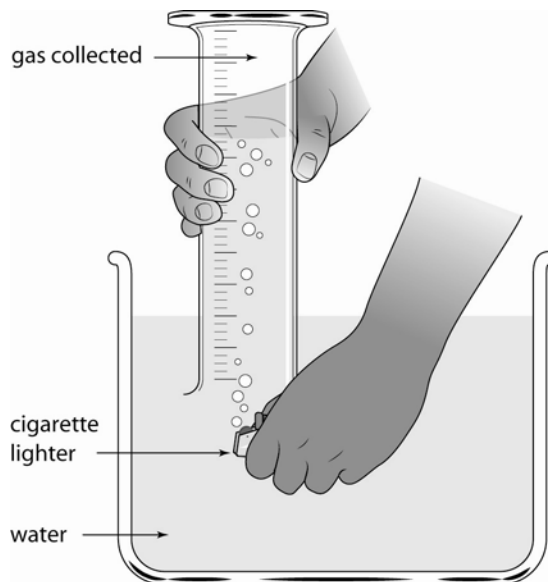
- tap water
- 4 L beaker or plastic pail
- balance
- disposable butane lighter
- 500 mL graduated cylinder
- blow drier
- parafilm or plastic wrap
- thermometer (alcohol or digital)
- barometer
- small beaker
- masking tape
- paper towel

Procedure

1. Fill the 4 L beaker (or pail) about two-thirds full of tap water at a comfortable temperature to keep your hand immersed in for about 15 minutes.
2. Determine and record the initial mass of the lighter.
3. Fill the graduated cylinder with water. Cover the cylinder tightly with a piece of parafilm. With your hand over the parafilm, place the cylinder upside down into the beaker. Make sure that no air bubbles are trapped in the cylinder. Slide the parafilm away from the mouth of the cylinder.

Investigation 4.A: Finding the Molar Mass of a Gas (continued)

- As shown in the diagram, hold the lighter underwater, below the graduated cylinder in the beaker. Depress the button on the lighter to release gas into the cylinder. Collect approximately 400 mL of the gas. You may find that you need to have one of the other group members take a turn after you have collected about 150 mL of gas.
- Adjust the position of the cylinder so that the water inside is at exactly the same level as the water in the beaker. You might have to add water to the beaker. Record the volume of the gas that you collected when the water levels are equal inside and outside the cylinder.
- Record the temperature of the water and the atmospheric pressure in the room.
- Place the lighter on a paper towel and dry it with the blow drier.
- Take your cylinder to the fume hood to release all the gas you have collected.
- After the lighter has dried, determine and record its final mass. Place the lighter in the small beaker and allow it to continue drying overnight. Determine the mass of the lighter the next day. If the mass indicates that no water has evaporated overnight, return the lighter to your teacher. If the lighter has lost mass indicating that more water has evaporated, correct your calculations.
Final mass of lighter after drying:
Mass of lighter on the next day:



Analysis

- Find the mass of the gas in your sample by subtracting the initial mass of the lighter from its initial mass.
- Find the partial pressure of the water vapour from Table 4.1 in the text. Use that value to find the partial pressure of the butane gas.

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- Use the ideal gas equation to calculate the molar mass of the gas.
- Determine the theoretical molar mass of butane. (You might have done this calculation for your prediction.)

Conclusion

- Calculate your percentage experimental error.
- Discuss the accuracy of your determination of the molar mass of butane. List all possible sources of experimental error.
- Critically assess the experimental design. What changes in the design do you think might enable you to obtain more accurate results?