

Determining a Molar Volume

A Safer Experiment



Introduction

The traditional method for calculating molar volumes involves generating oxygen gas—potassium chlorate is heated with manganese dioxide, a catalyst, to produce oxygen gas. This method is quite hazardous because large amounts of oxygen gas are produced and potassium chlorate is a powerful oxidizer of organic materials including the rubber stopper used in the set-up. In fact, potassium chlorate is a frequent source of accidents on school premises. An easier and safer method presented in this laboratory activity for the calculation of molar volumes involves the use of carbon dioxide instead of oxygen gas.

Concepts

- Mole
- Molar volume
- Ideal gas law

Materials

Dry ice, solid carbon dioxide, CO_2 , small piece about 3" square
Balance
Barometer
Erlenmeyer flask, Pyrex®, 125-mL

Graduated cylinder, 500-mL
Rubber stopper, to fit Erlenmeyer flask
Thermometer
Tongs or insulated gloves (Zetex®)



Safety Precautions

This activity requires the use of hazardous components and/or has the potential for hazardous reactions. Dry ice can cause frostbite; never touch dry ice directly with the skin; wear appropriate insulated gloves or use tongs whenever handling dry ice. Do not stopper the flask until all of the dry ice has sublimed. Failure to wait until all solid pieces are gone may cause the flask to shatter due to increased pressure. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Place the stopper in the Pyrex Erlenmeyer flask and mass to the nearest 0.01 g. Record this mass in the data table as the mass of the stoppered flask plus air. Recall that the flask is not actually empty—it contains air.
2. Remove the stopper. Using tongs, or while wearing insulated gloves, place a small piece of dry ice in the Erlenmeyer flask. Do not stopper the flask at this point.
3. Gently swirl the flask to aid in the sublimation of the dry ice.
4. Immediately after the last bit of dry ice has just sublimated and disappeared, tightly stopper the flask. Mass the flask and record this mass in the data table as the mass of the stoppered flask plus CO_2 .
5. Remove the stopper and fill the Erlenmeyer flask to the top lip with water. Stopper the flask again. Wipe any water off of the outside of the flask.
6. Remove the stopper from the flask. Pour the water into a large graduated cylinder and measure the volume of water. The volume of water is equal to the volume of air (Step 1) or CO_2 (Step 4) in the flask. Record this volume in liters in the data table.
7. Record the room temperature in degrees Kelvin and the atmospheric pressure in atm in the data table.
8. Record the density of air in the data table. The density of air is both temperature and pressure dependent. This value can be found in a chemistry textbook or reference manual if the temperature and pressure are known.
9. Calculate the mass of air in the flask by using the relationship that the density of air (Step 8) is equal to the mass of air

Flinn Sci Molar Volume Lab

Arturo Cuomo

A red circular graphic with a gradient, appearing as a stylized arrow or a partial circle, located to the right of the author's name.

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