# Construction of Gas Volume Cubes

Assessment Activity

## Introduction

According to Avogadro's law, the volume of an ideal gas is directly proportional to the number of moles of gas. Use this "constructivist" activity to help students visualize Avogadro's law and to integrate their understanding of the gas laws.

## Concepts

- Avogadro's law
- Ideal gas
- Molar volume
- Standard temperature and pressure (STP)

## Materials (for a class of 28 students working in groups of four)

Colored construction paper, at least 45 × 60 cm, 7 sheets

Markers, 7

Metric rulers, 7

Scissors, 7

Tape, glue or glue sticks, 7

## *Safety Precautions*

*Although this activity is considered nonhazardous, please follow all normal laboratory safety guidelines.*

## Overview of the Activity

1. Divide the class into groups of 3–4 students and assign each group a different number of moles of gas from the Assignment Table (see below). Do not give students the volume or length of side.
2. Distribute the Gas Volume Cubes Worksheet. Ask each group to determine the volume that the assigned number of moles of an *ideal gas* would occupy at STP. Determine the length of a side of a cube corresponding to the calculated volume.
3. Have each group construct a cube to represent the gas volume.
4. Answer the remaining questions on the worksheet.
5. Display the "gas volume cubes" for the entire class. The result is an Avogadro's law exhibit!

## Assignment Table

| Moles of Gas | Volume at STP | Side of Cube |
|---|---|---|
| 0.00964 | 0.216 L | 6.00 cm |
| 0.0153 | 0.343 L | 7.00 cm |
| 0.0228 | 0.512 L | 8.00 cm |
| 0.0325 | 0.729 L | 9.00 cm |
| 0.0446 | 1.00 L | 10.0 cm |
| 0.0593 | 1.33 L | 11.0 cm |
| 0.0772 | 1.73 L | 12.0 cm |
| 0.0982 | 2.20 L | 13.0 cm |
| 0.122 | 2.74 L | 14.0 cm |
| 0.151 | 3.38 L | 15.0 cm |



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## Tip

- The moles of gas have been purposely chosen to yield cubes with dimensions to the nearest centimeter. In each case, the number of moles of an ideal gas was calculated by dividing the desired volume by 22.41 L (the molar volume at STP). The results were rounded to three significant figures. *Example:* A cube with a volume of 343 $cm^3$ (7.0-cm sides) will contain 0.0153 moles of an ideal gas at STP.

## Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

***Unifying Concepts and Processes: Grades K–12***
Evidence, models, and explanation
Constancy, change, and measurement
***Content Standards: Grades 9–12***
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter

## Acknowledgement

Thank you to Kathleen Dombrink, McCluer North High School, Florissant, MO, for providing Flinn Scientific with the idea and instructions for this activity.

## Reference

This activity was adaped from *The Gas Laws*, Volume 9 in the *Flinn ChemTopic™ Labs* series; Cesa, I., Editor; Flinn Scientific, Inc., Batavia, IL (2003).

## Materials for *Construction of Gas Volume Cubes* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|---|---|
| AP4587 | Mole Balloon™ Activity Kit |
| AP6437 | Mole Box |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Name: _____

# Gas Volume Cubes Worksheet

1. Determine the volume in liters (to three significant figures) of _____ moles of an ideal gas at STP.
2. Convert the volume from liters to cubic centimeters ($cm^3$). *Hint:* 1 mL = 1 $cm^3$.
3. Write the formula for calculating the volume of a cube.
4. Determine the length in centimeters of one side of a cube that has the volume calculated in step 2.
5. Choose three gases and calculate their molar masses.
6. Determine the number of grams of each gas that would be needed to occupy the volume of your gas cube. *Note:* Check with the teacher before continuing with the construction project.
7. Using the materials supplied by the teacher, construct a cube having the dimensions calculated in step 4. The cube can be constructed using the pattern shown below or by assembling six identical sides.
8. Record the following information on the six sides (a–f) of the cube. *Note:* This is easier to do before assembling or gluing the final cube.
   a. Names of group members and class period.
   b. Assigned number of moles (step 1).
   c. Volume of the cube in liters and $cm^3$ (step 2).
   d. The number of grams of the first gas that would occupy this volume. Include the formula of the gas, the molar mass, and the grams (steps 5 and 6).
   e. The number of grams of a second gas that would occupy this volume. Include the formula of the gas, the molar mass, and the grams.
   f. The number of grams of a third gas that would occupy this volume. Include the formula of the gas, the molar mass, and the grams.