**MOLAR VOLUME OF A GAS**

## LAB PS 4

From Juniata College Science in Motion.

### INTRODUCTION

In chemistry many of the materials worked with are gases. It is often easier to measure the volume of a sample of a gas than to determine its mass. A conversion factor is needed to convert the volume of a gas to moles of gas. In this experiment, known amounts of magnesium will be reacted with hydrochloric acid to generate hydrogen gas.

The moles of hydrogen generated and the volumes (at STP) will be plotted. From the graph, a value for molar volume will be determined.

### Purpose

The purpose of this experiment is to determine the volume of one mole of a gas at STP (molar volume).

**EQUIPMENT/Materials**

|  |  |
| --- | --- |
| 60 mL syringe | 250 mL beaker |
| LeurLOK syringe cap | ruler (if magnesium ribbon is used) |
| vial cap that fits into the syringe barrel | 1 M HCl |
| magnesium ribbon or powdered magnesium | barometer  thermometer |

### Safety

* Always wear an apron and goggles in the lab.
* When removing the syringe cap, make sure that the syringe is not pointed at another individual.

**Procedure**

1. **If you are using magnesium ribbon**, record the mass of one meter of the ribbon on the Data Sheet. This value is needed to convert the length of magnesium ribbon to mass of magnesium. Cut five pieces of magnesium in 1.0, 2.0, 3.0, 4.0 and 5.0 cm lengths. If your values differ from these, record the actual values in your data table. Place the smallest piece of magnesium in the vial cap.
2. **If you are using magnesium powder,** weigh approximately 0.01 grams of Mg into the vial cap. Record the mass of Mg on the Data Sheet. For the next trial, increase the sample mass to approximately 0.02 grams, then 0.03 grams, then 0.04 grams.
3. Make sure the plunger moves smoothly in the barrel of the syringe. Remove the plunger, place your finger over the tip of the syringe and fill it with tap water. Float the vial cap on the water in the syringe, and let the water drain into a waste beaker. When all the water has drained from the syringe, replace the plunger and push it into the syringe as far as it will go.

Note the reading on the syringe here: \_\_\_\_\_\_\_\_ mL.

1. Draw 5 mL of the hydrochloric acid into the syringe. Place the LeurLOK syringe cap over the end of the syringe. Record the volume after drawing up the acid as the Initial Volume in the Data Table.
2. **With the syringe horizontal and not pointed at anyone**, shake it so that the acid and magnesium react. Note: As the reaction takes place, the hydrogen gas produced will push the plunger up the barrel of the syringe.
3. When the reaction is done, record the Final Volume in the Data Table. Subtract the Initial Volume to find the “Actual H2 Volume”.
4. Invert the syringe. **Making sure that the syringe is not pointed at anyone,** carefully remove the LeurLOK cap.Drain the liquid into a waste beaker.
5. Repeat steps 1-7 with the next sample of magnesium ribbon or powder.
6. Write and balance equation for this reaction.

**DATA SHEET** Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Period \_\_\_\_\_\_\_ Class \_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_

### MOLAR VOLUME OF A GAS

## DATA

# Mass of 1.00 meter of magnesium ribbon \_\_\_\_\_\_\_\_ g

# Mass per cm of magnesium \_\_\_\_\_\_\_\_ g/cm

# Room Temperature \_\_\_\_\_\_\_\_ °C = \_\_\_\_\_\_\_\_ K

# Barometric Pressure \_\_\_\_\_\_\_\_

## DATA TABLE

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Trial | Length  Mg  (cm) | Mass  Mg  (g) | Moles  Mg | Moles  H2 | Final  Volume  (mL) | Initial  Volume  (mL) | Actual H2 Volume (mL) | Volume  H2, STP  (L) | Molar Volume of H2 (L/mole) |
| 1 |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |

## CALCULATIONS

## Complete for one of your trials: (assume that the HCl is in excess)

1. Show the calculation of:
2. The mass of magnesium used
3. The moles of magnesium used
4. The moles of hydrogen formed
5. The actual H2 volume
6. Complete the following table:

#### Your experiment STP

P1 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ P2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

V1 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

T1 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ T2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Use the combined gas law to calculate the volume of hydrogen (liters) collected at STP.

##### 

1. Calculate the molar volume of hydrogen

**QUESTIONS**

1. What is the limiting reactant in this reaction?
2. What are some possible sources of error in this experiment?

3. What is your % error?