

12 • Gases and Their Properties

M O L A R V O L U M E O F H Y D R O G E N

Purpose: The purpose of this lab is to experimentally determine the molar volume of a gas at STP.

Apparatus:

ring stand	ring	400-mL beaker
eudiometer tube	3M HCl	4-5 cm of Mg ribbon
15 cm of copper wire	graduated cylinder	ruler
centigram balance	distilled water	tap water

Procedure:

- As a class, determine the mass of 1 meter of Mg ribbon. Put on goggles.
- Obtain a piece of ribbon between 4.5 and 5.0 cm long. Record its length (± 0.01 cm).
- Fold Mg ribbon in half and wrap with copper wire as shown in class. Leave a 15 cm wire “handle.”
- Place about 15 mL of 3M HCl in eudiometer tube. Gently fill the tube to the top with water.
- Insert Mg ribbon/copper wire into tube so metal will be below the numbers when inverted. Insert stopper to hold the wire in place.
- Fill 400-mL beaker about $\frac{2}{3}$ full of tap water.
- Place finger over stopper and invert eudiometer tube in the beaker. Observe.
- When reaction has stopped, tap tube to release any bubbles clinging to the side of the tube. Without losing any liquid, transfer eudiometer tube to a battery jar and equalize inside and outside pressure. Record volume of gas inside tube.
- Obtain matches and wood splint. Test gas to verify that it acts like hydrogen. Keep wood splint for others.
- Clean apparatus and station.

Data:

mass of 1 meter Mg = _____ g
 length of Mg ribbon = _____ cm (read to 2 decimal places)
 room pressure = _____ mmHg
 room temperature = _____ °C
 volume of H₂ = _____ mL (*read this in the grad. cylinder with liquid levels equalized*)
 equilibrium vapor pressure of water at today's temperature = _____ mmHg (from “CRC”)

Questions and Calculations:

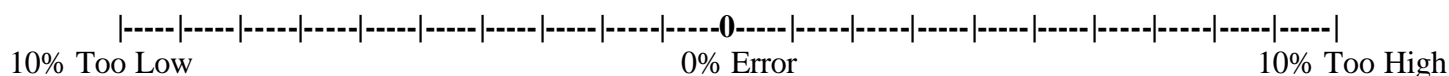
- Write a balanced chemical equation for the reaction between Mg ribbon and hydrochloric acid.
- Calculate the number moles of H₂(g) formed beginning with the length of magnesium ribbon used.
- Show your calculation of the partial pressure of hydrogen gas inside the tube. This is the pressure you should use for the room pressure of the hydrogen gas. [Note that another definition of partial pressure is the pressure the hydrogen gas would exert if it were alone in the tube. This is also called the pressure of dry hydrogen.]

4. Calculate the volume of hydrogen (at room temperature and pressure) you would have obtained if you had reacted 1.00 mole Mg ribbon (the “molar volume”). Report your answer in Liters.
5. Calculate the volume of your mole of dry H₂ gas if it were measured at STP. Show the calculation.
Variables:

Room Conditions	STP
molar volume (answer 4) =	molar volume at STP = x =
room temperature (data) =	temperature at STP = 273 K
room pressure (answer 3) =	pressure at STP = 760 mmHg

6. Knowing that the molar volume of a gas at STP *should be* 22.4 L, calculate the % error for **your** value.
7. Record the class values for the molar volume of H₂ gas in the chart below. Graphically show the class data by placing a ★ on the scale below for each team’s data.

Volume	% Error	Volume	% Error	Volume	% Error



What does this tell you about the accuracy and precision of the data?

8. If some of the gas bubbles from the reaction had escaped out the bottom of the tube, how would this have affected your molar volume at STP? Explain.
9. If some of the Mg ribbon had not reacted because it stuck to the side of the tube and did not contact the acid, how would this have affected your molar volume at STP? Explain.