

Gas laws and particle motion

AP Chemistry · Lab

Name: _____ Date: _____ Class: _____

Magnesium dissolves in acid and releases hydrogen. If you collect the gas over water, measure its volume, temperature and pressure, and know the mass of metal, you can calculate the gas constant R from $PV = nRT$. This lab tests whether your measurements agree with the accepted value of R .

Level: AP Chemistry · **Curriculum:** AP Chem Unit 3

Aim

To measure the volume of hydrogen released by magnesium and acid, and to use it to find the gas constant R .

Equipment

- magnesium ribbon (about 0.025 g, 0.050 g and 0.075 g pieces)
- balance reading to 0.001 g
- 1.0 mol/L hydrochloric acid, 20 mL for each run
- 50 mL measuring cylinder, trough, delivery tube and bung
- thermometer and barometer reading (or weather-station pressure)

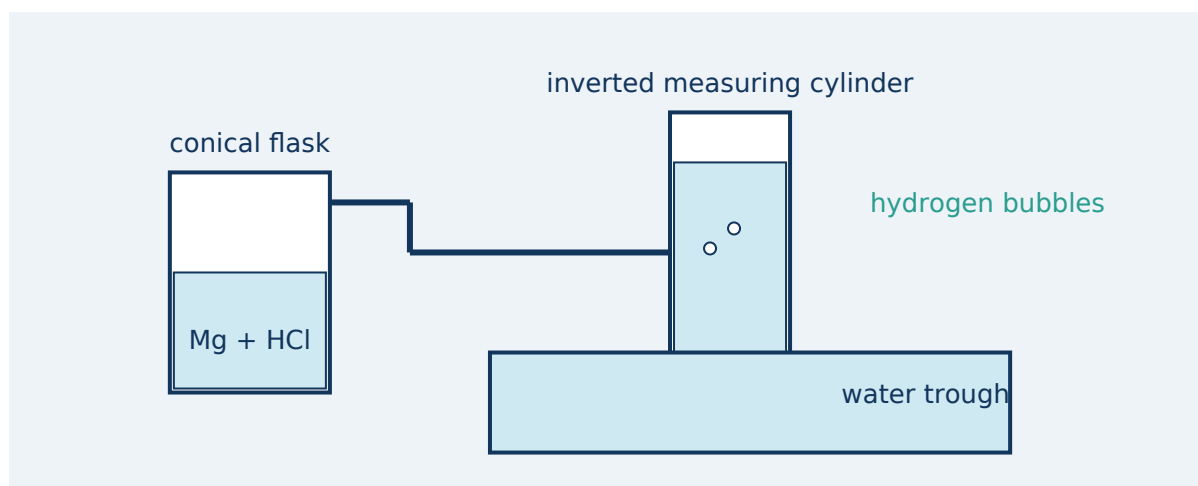
Safety

Safety

Wear goggles. Hydrochloric acid at 1.0 mol/L is an irritant: wash splashes with water. Hydrogen is flammable, so no flames. Magnesium ribbon should be dry and clean.

Method

1. Weigh a piece of magnesium ribbon and record its mass.
2. Fill the measuring cylinder with water, invert it into the trough without letting air in.
3. Put 20 mL of acid into the flask, add the magnesium and quickly fit the bung.
4. Wait until the metal disappears and bubbles stop, then read the gas volume with the water level inside and outside equal.
5. Record the water temperature and the air pressure.
6. Repeat with the other two masses.



Collecting hydrogen over water.

Results

Sample data. Air pressure 100.80 kPa, water temperature 21.0 °C (294.15 K), vapour pressure of water at 21.0 °C = 2.49 kPa.

Trial	Mass of Mg (g)	Volume of H ₂ (mL)
1	0.0250	25.6
2	0.0502	51.6
3	0.0751	76.2

Analysis questions

Question 1 Write the equation

Write a balanced equation for the reaction and state the mole ratio Mg : H₂.

Question 2 Amount of hydrogen

Calculate $n(\text{H}_2)$ for trial 1 ($M(\text{Mg}) = 24.305 \text{ g/mol}$).

Question 3 Pressure of hydrogen

Calculate the partial pressure of dry hydrogen.

Question 4 Calculate R

For trial 1, calculate $R = PV/(nT)$ in L·kPa/(mol·K).

Question 5 Mean value

Trials 2 and 3 give $R = 8.35$ and 8.24 . Calculate the mean R and the percentage difference

from 8.314.

Question 6 Graph

Describe the graph of volume against mass and what its gradient gives.

Question 7 Sources of error

State two errors and the direction in which each affects R.

Question 8 Improvement

Suggest an improvement that reduces the uncertainty.