



EXPERIMENT 9

THE UNIVERSAL GAS CONSTANT (R)

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The Ideal Gas Law

$$PV = nRT \rightarrow R = \frac{PV}{nT}$$

P is the pressure of the gas (usually in atm)

V is the volume of the gas (usually in L)

n is the number of moles of gas

T is the temperature of the gas (in K)

To determine the value of R...

We need to measure the pressure (P) and volume (V) of a known amount (n, moles) of a gas at a known temperature (T).



If Mg is the limiting reactant, then

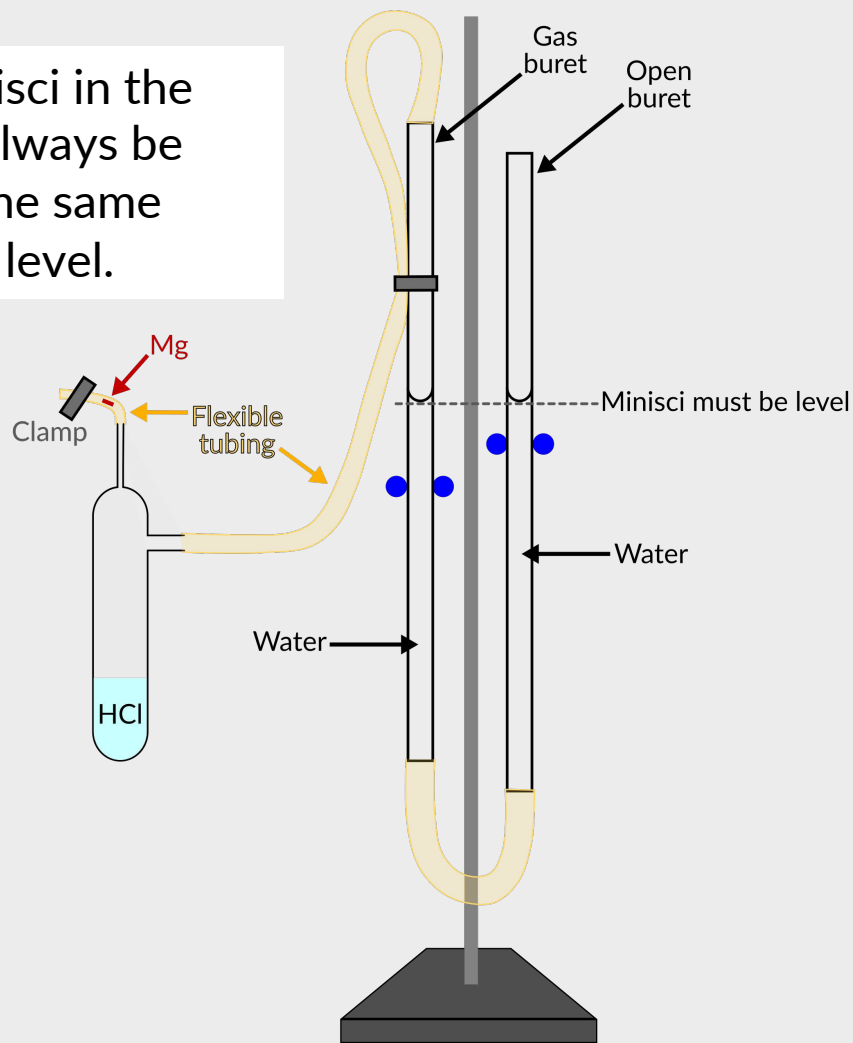
$$n_{\text{H}_2} = n_{\text{Mg}}$$

The Setup

The two menisci in the burets must always be brought to the same horizontal level.

Once, before the reaction, but after placing Mg inside sidearm tubing.

And, after all the Mg has reacted with the HCl (aq).



Collecting the data

Volume of H₂ (g) from the gas buret = (final buret reading) – (initial buret reading)



Pressure of H₂ (g) = $P_{\text{atmosphere}} - P_{\text{water vapor}}$

Dalton's Law of Partial Pressures

For a mixture of gases, the total pressure is equal to the sum of the partial pressures.

$$P_{\text{total}} = P_{\text{A}} + P_{\text{B}} + \dots$$

Partial pressure of a gas in a mixture of gases is the pressure that the gas of interest will exert if it were to occupy the container by itself.

$$P_{\text{total}} = \frac{n_{\text{A}}RT}{V} + \frac{n_{\text{B}}RT}{V} + \dots$$

Notes

1. Calibrate temperature probe using melting point of water.
2. Make sure your sidearm clamp is very tight.
3. Re-position the open buret before each run.
4. Barometer for $P_{\text{atmosphere}}$: 1 atm = 760 mm Hg = 1013.25 mbar
5. After adding HCl, use a very small amount of water to rinse the sidearm tube.
6. Rinse sidearm tubing before each run.
7. Use room temperature water for temperature equilibration.
8. Need four good runs: R value within 3% of accepted value.

$$R = 0.082057 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$\% \text{ error} = \frac{|\text{measured} - \text{accepted}|}{\text{accepted}} \times 100\%$$