Section 13.2

Using Gas Laws to Solve Problems

Objectives

1. To understand the ideal gas law and use it in calculations
2. To understand the relationship between the partial and total pressure of a gas mixture
3. To do calculations involving Dalton's law of partial pressures
4. To understand the molar volume of an ideal gas
5. To learn the definition of STP
6. To do stoichiometry calculations using the ideal gas law

Using Gas Laws to Solve Problems

A. The Ideal Gas Law

- Boyle's Law $V = \frac{k}{P}$ (at constant T and n)
- Charles's Law $V = bT$ (at constant P and n)
- Avogadro's Law $V = an$ (at constant T and P)

We can combine these equations to get

$$V = R\left(\frac{Tn}{P}\right)$$

Using Gas Laws to Solve Problems

A. The Ideal Gas Law

Rearranging the equation gives the ideal gas law

$$PV = nRT$$

$$R = 0.08206 \frac{L\ atm}{mol\ K}$$

Using Gas Laws to Solve Problems

B. Dalton's Law of Partial Pressures

- What happens to the pressure of a gas as we mix different gases in the container?

Using Gas Laws to Solve Problems

B. Dalton's Law of Partial Pressures

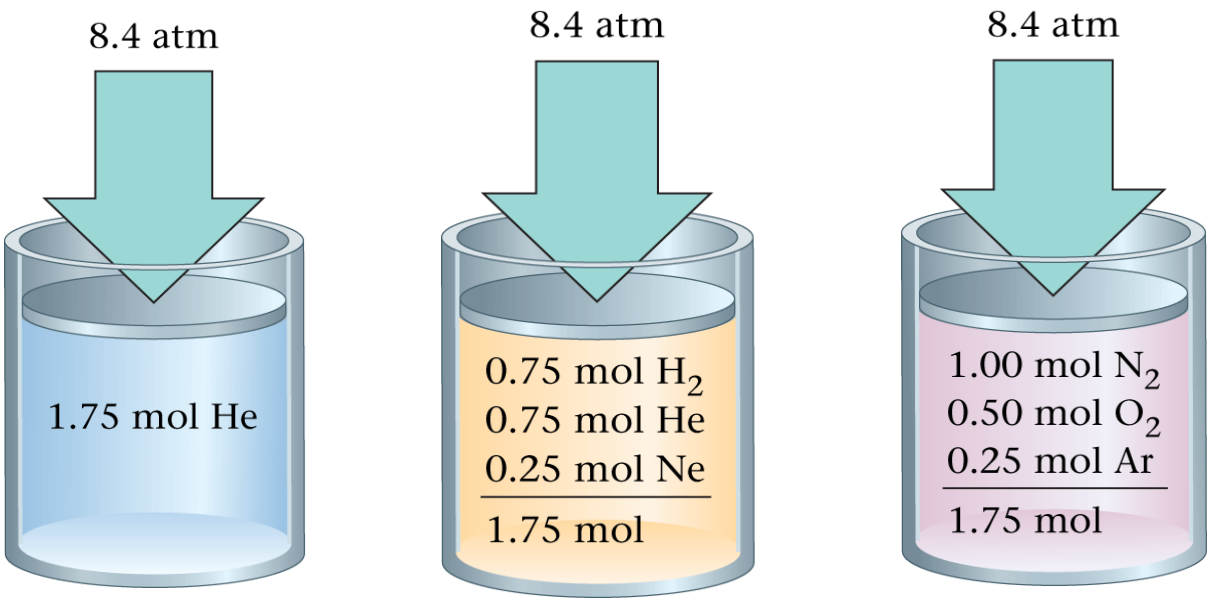
Dalton's law of partial pressures

- For a mixtures of gases in a container, the total pressure exerted is the sum of the partial pressures of the gases present.
- $P_{total} = P_1 + P_2 + P_3$

Using Gas Laws to Solve Problems

B. Dalton's Law of Partial Pressures

- The pressure of the gas is affected by the number of particles.
- The pressure is independent of the nature of the particles.



Using Gas Laws to Solve Problems

B. Dalton's Law of Partial Pressures

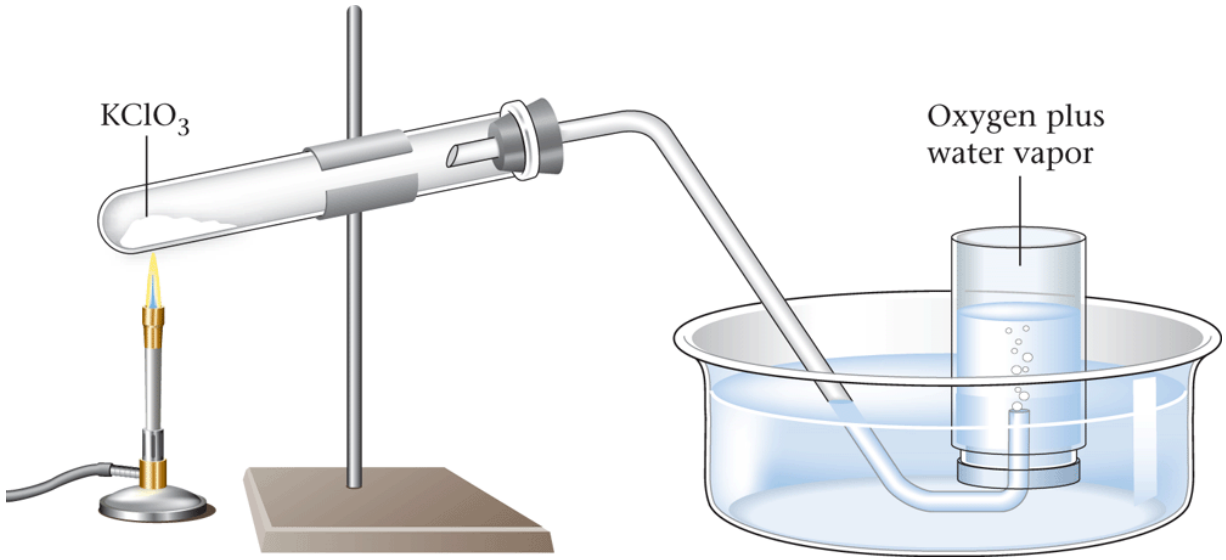
Two crucial things we learn from this are:

- The volume of the individual particles is not very important.
- The forces among the particles must not be very important.

Using Gas Laws to Solve Problems

B. Dalton's Law of Partial Pressures

Collecting a gas over water



- Total pressure is the pressure of the gas + the vapor pressure of the water.

Using Gas Laws to Solve Problems

B. Dalton's Law of Partial Pressures

Collecting a gas over water

- How can we find the pressure of the gas collected alone?

The Vapor Pressure of Water as a Function of Temperature

T (°C)	*P* (torr)
0.0	4.579
10.0	9.209
20.0	17.535
25.0	23.756
30.0	31.824
40.0	55.324
60.0	149.4
70.0	233.7
90.0	525.8

Using Gas Laws to Solve Problems

C. Gas Stoichiometry

Molar Volume

- Standard temperature and pressure (STP)
  - 0°C and 1 atm
- For one mole of a gas at STP

$$V = \frac{nRT}{P} = \frac{(1.00\ \cancel{\text{mol}})(0.08206\ \text{L}\ \cancel{\text{atm}}/\cancel{\text{K}}\cdot\cancel{\text{mol}})(273\ \cancel{\text{K}})}{1.00\ \cancel{\text{atm}}} = 22.4\ \text{L}$$

- Molar volume of an ideal gas at STP

  22.4 L