Gases: Outline

Pressure and Units of Pressure

atmospheres
pounds per inch (psi)
mm Hg or torr
Pascals (1.00 atm = 101.3 kPa)

Gas Laws

Boyle's Law ($P_1V_1=P_2V_2$ at constant T and constant n)
Charles' Law ($V_1/T_1=V_2/T_2$ at constant P and constant n – T must be in Kelvin)
Gay-Lussac's Law ($P_1/T_1=P_2/T_2$ at constant V and constant n – T must be in Kelvin)
Combined Gas Law ($P_1V_1/T_1 = P_2V_2/T_2$ at constant n – T must be in Kelvin)
Avogadro's Law
Equal volumes of any two gases at the same temperature and pressure contain the same number of molecules.
Standard Temperature and Pressure (273.15 K and 1.00 atm)
STP (22.4 L/mol)
The Ideal Gas Law (PV=nRT)
R=0.0821 L-atm/mol-K)
Density of a Gas
$D=PM_m/RT$

Stoichiometry

Gas Mixtures

Dalton's Law of Partial Pressures ($P_{tot} = P_a + P_b + P_c + \ldots$)
Mole fraction

$$\chi_A = \text{Mole fraction of A} = \frac{n_A}{n_{tot}} = \frac{P_A}{P_{tot}}$$

Collecting Gases Over Water

Table 5.6
Vapor Pressure of Water at Various Temperatures

Temperature (°C)	Pressure (mmHg)	Temperature (°C)	Pressure (mmHg)
0	4.6	27	26.7
5	6.5	28	28.3
10	9.2	29	30.0
11	9.8	30	31.8
12	10.5	35	42.2
13	11.2	40	55.3
14	12.0	45	71.9
15	12.8	50	92.5
16	13.6	55	118.0
17	14.5	60	149.4
18	15.5	65	187.5
19	16.5	70	233.7
20	17.5	75	289.1
21	18.7	80	355.1
22	19.8	85	433.6
23	21.1	90	525.8
24	22.4	95	633.9
25	23.8	100	760.0
26	25.2	105	906.1

Molecular Speeds: Diffusion and Effusion

Graham's Law

$$u = \sqrt{\frac{3RT}{M_m}}$$

$$\frac{\text{Rate of effusion of gas "A"}}{\text{Rate of effusion of gas "B"}} = \sqrt{\frac{M_m \text{ of Gas B}}{M_m \text{ of gas A}}}$$

The Kinetic-Molecular Theory of Gases

Volume of particles is negligible
Particles are in constant motion
No inherent attractive or repulsive forces
The average kinetic energy of a collection of particles is proportional to the temperature (K)

Real Gases: van der Waals equation

$$(P + \tfrac{n^2a}{V^2})(V - nb) = nRT$$

a corrects for interaction between atoms
b corrects for volume occupied by the gas molecules

You will need to have the following operational skills:

- ☐ Converting units of pressure.
- ☐ Using the empirical gas laws.
- ☐ Deriving empirical gas laws from the ideal gas law.
- ☐ Using the ideal gas law.
- ☐ Relating gas density and molecular weight.
- ☐ Solving stoichiometry problems involving gases.
- ☐ Calculating partial pressures and mole fractions.
- ☐ Calculating the amount of gas collected over water.
- ☐ Calculating the rms speed of gas molecules.
- ☐ Calculating the ratio of effusion rates of gases.
- ☐ Using the van der Waals equation.