Ch. 1 Gases:

Molecule velocities from $\frac{1}{2}RT = \frac{1}{2}MV_{rms}^2$

Pressure: $p = F/A$

$p = nRT/V$ (perfect)

$p = p_r + p_s + p_c$ (Dalton)

$p = RT\left(\frac{1}{V_m} - \frac{B}{V_m^2} + \ldots\right)$ (Virial eqn)

$p = RT\frac{a}{V_m - b} - \frac{c}{V_m^2}$ (van der Waals)

Units and values:

$N_{AVO} = 6.0221 \times 10^{23}$ objects/mol

$g = 9.807$ m s$^{-2}$

$R = 8.3145$ J K$^{-1}$ mol$^{-1}$

$R = 0.08205$ L atm K$^{-1}$ mol$^{-1}$

$R = 62.364$ L torr K$^{-1}$ mol$^{-1}$

SATP: $p^s = 1$ bar, $T^s = 298.15$ K

STP: $p^s = 1$ atm, $T^s = 273.15$ K

1 bar = 100000 Pa

1 atm = 101325 Pa = 1.01325 bar

1 J = 1 kg m$^2$ s$^{-2}$

1 L = 1 dm$^3$ = 10$^{-3}$ m$^3$ = 10$^3$ cm$^3$

Other:

$V_m = V/n$, $\rho = m/V$, ($p_c$, $V_c$, $T_c$)

Ch. 2 The 1st Law ($w$, $q$, $U$, $H$):

Systems can be: isolated, open, closed, adiabatic ($q = 0$), isothermal, isobaric

Expansions/compressions can be: reversible ($p = p_{ex}$) or else irreversible

Law of Cons. Of En.: $\Delta U_{isol} = 0$

1st Law: $\Delta U = q + w$

State function: $f(n,p,V,T)$

$pV$ work: $w = -\int p_{ex} dV$

Constant $p_{ex}$:

$w = -p_{ex} \Delta V$

Isothermal rev: $w = -nRT \ln \frac{V_f}{V_i}$, $q = -w$

Adiabatic rev: $w = c_v \Delta T$, $q = 0$,

and $T_f = T_i (V_i/V_f)^{k/v}$

Heat and enthalpy:

$q = c \Delta T$, $q_p = \Delta H$, $q_v = \Delta U$, $H = U + pV$

Know $\{c_p, c_v, c_{p,m}, c_{v,m}, c_p, c_v\}$

$c_p = c_v + nR$ (perfect gases)

Know $\Delta_{fus} H$, $\Delta_{vap} H$, $\Delta_{sub} H$, $\Delta_{sol} H$, $\Delta_f H$, $\Delta_c H$, $\Delta_r H$

Kirchhoff’s Law:

$\Delta H(T_2) = \Delta H(T_1) + (\Delta c_p)(\Delta T)$ (small $\Delta T$)

Ch. 3 The 2nd & 3rd Laws ($S$, $G$, $A$):

2nd Law: $\Delta S > 0$ (for spontaneous processes in isolated systems)

3rd Law: $S(T=0K) = 0$

Entropy (Boltzmann): $S = k_b \ln W$, $k_b = 1.381 \times 10^{-23}$ J K$^{-1}$

Entropy (Clausius): $\Delta S = \int \frac{dq_{rev}}{T}$

Isoth.

$\Delta S = q_{rev}/T$

Isoth. gas exp.

$\Delta S = nR \ln (V_f/V_i)$

Phase transitions $\Delta_{tr} S = \Delta_{tr} H/T_{tr}$

Trouton’s Rules $\Delta_{vap} S^0 \approx 85$ J mol$^{-1}$ K$^{-1}$

$\Delta_{vap} H^0 \approx (85$ J mol$^{-1}$ K$^{-1})T_b$

(for liquids with no H bonds)

Adiabatic exp.

$\Delta S = 0$

Heating

$\Delta S = c \ln (T_f/T_i)$

Gibbs & Helmholtz energies:

$G = H - TS$, $A = U - TS$

$\Delta G_{f,r} \leq 0$ (spontaneous process)

$\Delta A_{f,r} \leq 0$ (spontaneous process)

Maximum amount of work possible: $|\Delta A|$ of non-expansion work possible: $|\Delta G|$
Ch. 5 Simple Mixtures:

- Partial molar volume of A: \( \bar{V}_A \)
- Partial molar Gibbs energy of A: \( \mu_A = \sum V_A \mu_A \)

Equations:

1. \( \Delta G_{mix}^\ominus = n_RT \ln (x_A + x_B + \ldots) \) (due to eq. 1)
2. \( \Delta S_{mix}^\ominus = -R \ln (x_A + x_B + \ldots) \)

Henry’s Law:
- \( p_a = x_A p_b \) (pure A)

Colligative Properties:

- Extra pressure due to osmosis
- \( \Delta T_{bp} = K_b x_b \frac{RT^2 i}{\Delta v_{iH}} \)
- \( \Pi = BRT \)

Ch. 6 Equilibrium, and Electrochemistry:

- Equilibrium constant:
- \( Q = \prod_{i} a_i^{\text{prod}} / \prod_{i} a_i^{\text{react}} \)
- Activity coefficients:
- \( \mu_{a}^{\text{prod}} = \gamma_a^{\text{prod}} p_a^{\text{prod}} \)
- \( \mu_{a}^{\text{react}} = \gamma_a^{\text{react}} p_a^{\text{react}} \)

Le Chatelier Math:
- \( K \) dependent on \( T \) (van’t Hoff eqns)
- Corrosion:
- \( E_{cell}^{\text{cell}}(\xi) = E_0^{\text{cell}} - \frac{RT}{F} \ln Q(\xi) \)

Ch. 17A-C Macromolecules and Aggregation:

- Knowledge macromolecule vs. polymer
- Examples of natural vs. synthetic
- Examples of primary structures

- Secondary structures: random coil, \( \alpha \) helix, \( \beta \) sheet, double helix

- Polymers: crystalline vs. amorphous
- Type of material: smectic, nematic, cholesteric
- Colloids: aerosol, foam, sol, emulsion

- Surfactants: know examples & uses