R = 0.08206 liter atm K^{-1} $mole^{-1}$ = 8.314 J K^{-1} $mole^{-1}$ N_o = 6.02 x 10^{23} $mole^{-1}$

F = 96,485 coulombs (mol electrons)$^{-1}$ = 96,485 J eV^{-1}

General

$$E_2 - E_1 = q + w$$

$$H = E + PV = E + nRT$$

$$G = H - TS$$

$$dE = -PdV + TdS$$

$$dH = VdP + TdS$$

$$dG = VdP - SdT$$

$$C = \frac{\partial q}{\partial T} \qquad dS = \frac{dq_{rev}}{T} \qquad S = k \ln N$$

Ideal Gas

PV = nRT

$$\bar{C}_v = \frac{3}{2}R \qquad \bar{C}_P = \frac{5}{2}R \quad \text{(monoatomic)}$$

Phase Transition at Equilibrium

$$\Delta S = \frac{\Delta H}{T} \text{ (why?)}$$

Osmotic / Vapor Pressure / etc

$$\Pi = \frac{nRT}{V} = cRT \qquad \ln a_A = \frac{-\Pi \overline{V_A}}{RT}$$

$$\ln a_A = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_{boil}} - \frac{1}{T_o}\right) = \frac{\Delta H_{fus}}{R}\left(\frac{1}{T_o} - \frac{1}{T_{freeze}}\right)$$

Work

$$w = -\int_{V_1}^{V_2} P_{ex}\,dV \text{ (gases, } PdV \text{ work)}$$

$$w = -EIt \text{ (Electrical)} \qquad w = F\,d \text{ (linear)}$$

PV Work only

$$E_2 - E_1 = q_v = n\int_{T_1}^{T_2} \bar{C}_v dT$$

$$H_2 - H_1 = q_P = n\int_{T_1}^{T_2} \bar{C}_P dT$$

Gibbs Free Energy

$$\frac{\Delta G(T_2)}{T_2} - \frac{\Delta G(T_1)}{T_1} = -\int_{T_1}^{T_2} \frac{\Delta H(T)}{T^2} dT$$

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$\Delta G_{\text{xfer phase 1 to phase 2}} = n\left[RT \ln \frac{a_A^{phase\,2}}{a_A^{phase1}} + FZV\right]$$

van't Hoff

$$\left[\frac{d(\ln K)}{d(1/T)}\right]_P = -\frac{\Delta H^\circ}{R}$$

$$\ln \frac{K_2}{K_1} = -\frac{\Delta H^\circ}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Ligand Binding

$$\frac{\nu}{[A]} = K(n - \nu) \qquad \frac{f}{(1-f)} = K[A]^n$$

Solid H_2O at 0°C	**Liquid H_2O**	**Gaseous H_2O at 100°C**
Density = 0.915 g cm-3 Vapor Pressure = 4.579 Torr Absolute Molar Entropy = 41.0 J K^{-1} mol^{-1} Heat of melting = 333.4 kJ kg^{-1} = 6.007 kJ mol^{-1} Spec heat capacity = 2.113 kJ K^{-1} kg^{-1} Molar heat capacity = 38.07 J K^{-1} mol^{-1}	Density = 0.99 g cm^{-3} Absolute Molar Entropy ≈70 J K^{-1} mol^{-1} Spec heat capacity = 4.18 kJ K^{-1} kg^{-1} Molar heat capacity = 75.4 J K^{-1} mol^{-1}	Density = 5.88 x 10^{-4} g cm^{-3} Heat of condensation = -2257 kJ kg^{-1} = -40.66 kJ mol^{-1} Spec heat capacity = 1.874 kJ K^{-1} kg^{-1} Molar heat capacity = 33.76 J K^{-1} mol^{-1}