Equations and constants for Final Exam, CHM 3400, Fall 2015
You are responsible for knowing the conditions under which the equations apply.

1 atm = 760 Torr = 1.01325 bar

R = 8.31451 J K^{-1} mol^{-1} = 0.0831451 L bar K^{-1} mol^{-1} = 0.08206 L atm K^{-1} mol^{-1}

1 L bar = 100 J, 1 L bar = 100 J, 1 J = 1 kg m^2 s^{-1}, $N_A = 6.022 \times 10^{23}$ mol^{-1}

g = 9.81 m s^{-2}, c = 3.00 x 10^8 m s^{-1}, $m_e = 9.10938 \times 10^{-31}$ kg

F = 96,485 C mol^{-1}, $\frac{RT}{F} = 0.0257\, V\ at\ 298\, K$, 1 V = 1 J C^{-1}

Gases and molecular speeds

$$P = \frac{RT}{\bar{V} - b} - \frac{a}{\bar{V}^2}$$

$$Z = \frac{P\bar{V}}{RT} = 1 + \frac{B}{\bar{V}} + \frac{C}{\bar{V}^2} + \cdots$$

$$f(c) = 4\pi c^2 \left(\frac{m}{2\pi k_B T}\right)^{3/2} e^{-mc^2/2k_BT}$$

$$Z_{11} = \sqrt{2} d^2 \bar{c} \left(\frac{N}{V}\right)^2$$

$$\lambda = \frac{RT}{\sqrt{2} d^2 P N_A}$$

$$c_{mp} = \sqrt{\frac{2RT}{M}} \quad \bar{c} = \sqrt{\frac{8RT}{\pi M}} \quad c_{rms} = \sqrt{\frac{3RT}{M}}$$

Thermodynamic relationships

$$\Delta U = q + w \qquad dU = dq + dw$$

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

$$w = -nRT \ln (V_f/V_i)$$

$$dU = TdS - pdV$$

$$C = \frac{q}{\Delta T}$$

$$\Delta H = \int_{T1}^{T2} C_p\, dT \approx C_p\Delta T$$

$$\Delta C_p = \Sigma\nu C_p(\text{Prod.}) - \Sigma\nu C_{p,}(\text{React.})$$

$$\Delta_r H(T') = \Delta_r H(T) + \Delta C_p \Delta T$$

$$S = k_B lnW$$

$$dS = \frac{dq_{rev}}{T}$$

$$dS_{surr} = \frac{-dq}{T}$$

$$\Delta S = nRln\left(\frac{V_f}{V_i}\right)$$

$$\Delta S = \int \frac{n\bar{C}_P}{T} dT$$

$$\Delta S = n\bar{C}_p ln\left(\frac{T_f}{T_i}\right)$$

$$\Delta S = \frac{\Delta_{trans}H}{T}$$

$$\Delta S = -nR(x_A \ln x_A + x_B \ln x_B)$$

$$dG = -SdT + Vdp$$

$$\left(\frac{\partial G}{\partial T}\right)_P = -S$$

$$\left(\frac{\partial G}{\partial P}\right)_T = V$$

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = V\Delta p$$

Mixtures

$$\Delta G = nRT(x_A \ln x_A + x_B \ln x_B)$$

$$\frac{dP}{dT} = \frac{\Delta_{trans}H}{T\Delta_{trans}V}$$

$$ln\frac{P^2}{P^1} = \frac{\Delta_{vap}H^o}{R}\left(\frac{1}{T^1} - \frac{1}{T^2}\right)$$

f = c – p + 2

$p_A = x_A p_A$*

$p_B = x_B K$, $p_B = m_B K'$

$$G = n_A\mu_A + n_B\mu_B$$

$$\mu_A = \mu_A^* + \ln a_A$$

$$\mu_B = \mu_B^* + \ln a_B$$

$a_j = \gamma_j x_j$

$\Pi = [B]RT$

$\Delta T_f = K_f m_B$

$\Delta T_b = K_b m_B$

$$\gamma_\pm = \left(\gamma_+^{\nu_+}\gamma_-^{\nu_-}\right)^{\frac{1}{\nu}}$$

$$(where\ \ \nu = \nu_+ + \nu_-)$$

$$log_{10}\gamma_\pm = -A|z_+z_-|I^{1/2}$$

$$I = \frac{1}{2}\sum m_i z_i^2$$

Equilibrium

$$\Delta_r G = \Delta_r G^o + RTln\ Q$$

$$\Delta_r G^o = -RTln\ K$$

$$Q = \frac{a_C^{\nu_C}a_D^{\nu_D}}{a_A^{\nu_A}a_B^{\nu_B}}$$

for $\nu_A A + \nu_B B \rightarrow\ \nu_C C + \nu_D D$

$$K = Q_{eq}$$

$$\gamma = \frac{f}{P}$$

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

Electrochemistry

$$\Delta_r G = -\nu FE$$

$$K = e^{\nu FE^o/RT}$$

$$E = E^o - \frac{RT}{\nu F}\ln Q$$

Kinetics

$$[A] = [A]_o - kt$$

$$[A] = [A]_o e^{-kt}$$

$$\frac{1}{[A]} = \frac{1}{[A]_o} + kT$$

$$t_{1/2} = \frac{\ln 2}{k}$$

$$t_{1/2} = \frac{1}{k[A]_o}$$

$$k = Ae^{-E_a/RT}$$

Integrals

$$\int \frac{1}{x-a}dx = \ln(x-a) + C$$

$$\int x^n = \tfrac{1}{n+1}x^{n+1} + C \quad (n \neq -1)$$