3610 Final Exam Equations and Constants

Gas Constant Values

8.314	$\frac{J}{mole\ K}$	0.08314	$\frac{L\ bar}{mole\ K}$
0.08206	$\frac{L\ atm}{mole\ K}$	8.314	$\frac{m^3\ Pa}{mole\ K}$

Boltzmann Constant Values

1.381×10^{-23}	$\frac{J}{K}$	0.6950	$\frac{cm^{-1}}{K}$

Conversions

$1\ L\ atm$	$=$	$101.325\ J$
$1\ atm$	$=$	$1.01325\ bar$
$1\ atm$	$=$	$760\ torr$
$1\ atm$	$=$	$101,325\ Pa$

$$F = 96,485 \frac{C}{mol}$$

$$e = 1.60217662 \times 10^{-19} C$$

$$H = U + pV$$

$$Z = \frac{pV}{nRT} = \left(1 + \frac{B}{V_m} + \frac{C}{V_m^2} + \ldots\right)$$

$$\mathrm{d}U = đq + đw$$

$$C_{V,m} = \frac{1}{2} R \cdot n_{D.o.F}$$

$$đw = -p_{external} \mathrm{d}V$$

$$C_{p,m} = C_{V,m} + R$$

$$p = \frac{nRT}{V - nb} - a\frac{n^2}{V^2}$$

$$v_{mean} = \left(\frac{8RT}{\pi M}\right)^{1/2}$$

$$v_{rms} = \left(\frac{3RT}{M}\right)^{1/2}$$

$$\Delta H_p = C_p\, \Delta T$$

$$\Delta U_V = C_V\, \Delta T$$

$$pV = nRT$$

$$z = \sigma v_{rel} \mathcal{N}$$

$$v_{rel} = \sqrt{2} v_{mean}$$

$$\mathcal{N} = \frac{N}{V} = \frac{p}{k_B T}$$

$$\lambda = \frac{v_{rel}}{z} = \frac{k_B T}{\sigma p}$$

$$\Delta H_{rxn}(T_2) = \Delta H_{rxn}(T_1) + \int_{T_1}^{T_2} \Delta C_p \mathrm{d}T$$

$$\Delta H \approx \Delta U + \Delta n_{gas} RT$$

$$\Delta H^\circ_{rxn} = \sum_{products} \nu_i \Delta H^\circ_{f,i} - \sum_{reactants} \nu_j \Delta H^\circ_{f,j}$$

$$\pi_T = \left(\frac{\partial U}{\partial V}\right)_T$$

$$p_i V_i^\gamma = p_f V_f^\gamma$$

$$\gamma = \frac{C_{p,m}}{C_{V,m}}$$

$$\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p$$

$$V_i T_i^c = V_f T_f^c$$

$$c = \frac{C_{V,m}}{R}$$

$$\kappa_T = -\frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_T$$

$$\mathrm{d}U = \left(\frac{\partial U}{\partial V}\right)_T \mathrm{d}V + \left(\frac{\partial U}{\partial T}\right)_V \mathrm{d}T = \pi_T \mathrm{d}V + C_V \mathrm{d}T$$

$$\mathrm{d}H = \left(\frac{\partial H}{\partial p}\right)_T \mathrm{d}p + \left(\frac{\partial H}{\partial T}\right)_p \mathrm{d}T = -\mu C_p dp + C_p \mathrm{d}T$$

$$G = H - TS$$

$$A = U - TS$$

$$\mathrm{d}G = -S\mathrm{d}T + V\mathrm{d}p$$

$$\left(\frac{\partial \Delta G/T}{\partial T}\right)_p = -\frac{\Delta H}{T^2}$$

$$S = k_B \ln \mathcal{W}$$

$$C_V = \frac{1}{2} R \cdot n_{D.o.F}$$

$$\frac{q_H}{q_C} = -\frac{T_H}{T_C}$$

$$C_p = C_V + R$$

$$\eta = \frac{w}{q_H}$$

$$\mathrm{d}S_{system} = \frac{đq_{reversible}}{T}$$

$$S(T) = S(0) + \int_0^T \frac{C_p}{T} \mathrm{d}T + \sum_{transitions} \frac{\Delta H_{trs}}{T_{trs}}$$

$$\ln \frac{p_2}{p_1} = \frac{-\Delta H}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\eta = 1 - \frac{T_C}{T_H}$$

$$\mathrm{d}S_{surrounding} = -\frac{\text{đ}q_{sys}}{T}$$

$$\Delta S_T = nR \ln \frac{V_f}{V_i}$$

$$\Delta S_V = C_V \ln \frac{T_f}{T_i}$$

$$\Delta S_p = C_p \ln \frac{T_f}{T_i}$$

$$\Delta S_{trs} = \frac{\Delta H_{trs}}{T}$$

$$G(p_2) = G(p_1) + nRT \ln \frac{p_2}{p_1}$$

$$F = C - P + 2$$

$$\Delta S(T_2) = \Delta S(T_1) + \int_{T_1}^{T_2} \frac{\Delta C_p}{T} \mathrm{d}T$$

$$\left(\frac{\partial \mu}{\partial T} \right)_p = -S_m$$

$$\frac{\mathrm{d}p}{\mathrm{d}T} = \frac{\Delta H}{T \Delta V_m}$$

$$\left(\frac{\partial \mu}{\partial p} \right)_T = V_m$$

$$\Delta G_{mix} = nRT \left(\chi_A \ln \chi_A + \chi_B \ln \chi_B \right)$$

$$\Delta S_{mix} = -nR \left(\chi_A \ln \chi_A + \chi_B \ln \chi_B \right)$$

$$p_A = \chi_A p_A^\star$$

$$p_B = \chi_B K_B$$

$$\mu_A = \mu_A^\star + RT \ln \chi_A$$

$$K_b = \frac{RT_b^{\star 2}}{\Delta H_{vap}}$$

$$\Delta T_b = K_b \chi_B = K_b C_B$$

$$K_f = \frac{RT_f^{\star 2}}{\Delta H_{freeze}}$$

$$\Delta T_f = K_f \chi_B = K_f C_B$$

$$\frac{n_g}{n_{total}} = \left| \frac{x_B - z_B}{x_B - y_B} \right|$$

$$\frac{n_l}{n_{total}} = \left| \frac{z_B - y_B}{x_B - y_B} \right|$$

$$\ln \gamma_A = \xi \chi_B^2 \qquad \ln \gamma_B = \xi \chi_A^2$$

$$\mu_B = \mu_B^\ominus + RT \ln \gamma_B \chi_B$$

$$I = \frac{1}{2} \sum_{ions} z_i^2 \left(\frac{c_i}{c^\ominus} \right) \qquad c^\ominus = 1\, molal$$

$$\log \gamma_\pm = -\frac{A \left| z_+ z_- \right| \sqrt{I}}{1 + B\sqrt{I}} + CI$$

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

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

$$E_{cell} = E_{cathode} - E_{anode}$$

$$\Delta G^\ominus = -RT \ln K_{eq}$$

$$\frac{\mathrm{d}E_{cell}^\ominus}{\mathrm{d}T} = \frac{\Delta S^\ominus}{\nu F}$$

$$K_p = K_C \left(RT \right)^{\Delta n}$$

$$\nu_C E_C^\ominus = \nu_A E_A^\ominus + \nu_B E_B^\ominus$$

$$E_{cell} = E_{cell}^\ominus - \frac{RT}{\nu F} \ln Q$$

$$\Delta H^\ominus = -\nu F \left(E_{cell}^\ominus - T \frac{\mathrm{d}E_{cell}^\ominus}{\mathrm{d}T} \right)$$

$$J_{matter} = -D \frac{\mathrm{d}\mathcal{N}}{\mathrm{d}z} \qquad J_{energy} = -\kappa \frac{\mathrm{d}T}{\mathrm{d}z} \qquad J_{x-momentum} = -\eta \frac{\mathrm{d}v_x}{\mathrm{d}z}$$

$$D = \frac{1}{3} \lambda v_{mean} = \frac{1}{3} \left(\frac{k_B T}{\sigma p} \right) \left(\frac{8RT}{\pi M} \right)^{1/2}$$

$$\eta = \frac{1}{3} \lambda v_{mean} m \mathcal{N} = \frac{pMD}{RT}$$

$$\eta = \eta_0 e^{E_a/RT}$$

$$\kappa = \frac{1}{3}\lambda v_{mean}\nu\mathcal{N}k_B = \frac{\nu p D}{T} \qquad \nu = \frac{1}{2}N_{D.o.F.}$$

$$G = \frac{1}{R} = \kappa\frac{A}{l}$$

$$\Lambda_m = \frac{\kappa}{c} = \left(z_+u_+\nu_+ + z_-u_-\nu_-\right)F$$

$$f = 6\pi\eta a$$

$$u = \frac{ze}{f}$$

$$s = uE = u\frac{\Delta V}{m}$$

$$c(x,t) = \frac{n_0}{A\sqrt{\pi D t}}e^{-x^2/4Dt}$$

$$x_{rms} = \sqrt{2Dt}$$

$$v = \frac{\mathrm{d}\,[\mathrm{A}]}{\nu_A\mathrm{d}t} = \frac{1}{V}\frac{\mathrm{d}\xi}{\mathrm{d}t}$$

$$\ln\left(\frac{v_2}{v_1}\right) = m\ln\left(\frac{[\mathrm{A}]_2}{[\mathrm{A}]_1}\right)$$

$$\chi = \chi_0 e^{-t/\tau}$$

$$\tau = \frac{1}{k_r + k_r'}$$

$$k = Ae^{-\frac{E_a}{RT}}$$

$$\ln\left(\frac{k_2}{k_1}\right) = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$v_{\mathrm{Lind.-Hinsh.}} = \frac{k_a k_b [A]^2}{k_b + k_a'[A]}$$

$$\tau_0 = \frac{1}{k_F + k_{IC} + k_{ISC}}$$

$$\phi_{F,0} = \frac{k_F}{k_F + k_{IC} + k_{ISC}} = k_F\tau$$

$$\frac{\phi_0}{\phi} = 1 + \tau_0 k_Q[Q]$$

$$\eta_T = 1 - \frac{\phi_F}{\phi_{F,0}} = \frac{R_0^6}{R_0^6 + R^6}$$

$$\frac{1}{v} = \frac{1}{v_{max}} + \left(\frac{K_M}{v_{max}}\right)\frac{1}{[\mathrm{S}]_0}$$

$$v = P\sigma v_{rel}N_A^2 e^{-\frac{E_a}{RT}}[A][B]$$

$$k_d = \frac{8RT}{3\eta}$$

$$k \propto e^{\Delta S^\ddagger/R}e^{\Delta H^\ddagger/RT}$$