Physical Chemistry of Colloids and Surfaces – Midterm II reference

Constants:

$k_B = 1.38 \times 10^{-23}$ J/K k_BT (298K) $= 4.11 \times 10^{-21}$ J $g = 9.80$ m/s^2

R = 8.314 J/mol K $N_{av} = 6.02 \times 10^{23}$ $\overline{V} = 22414$ cm^3/mol (STP)

e= 1.60×10^{-19} C $\varepsilon_o = 8.85 \times 10^{-12}$ C^2/Jm ε_r, water = 78

1 Debye = 3.34×10^{-30} Cm

Equations:

$$\frac{P}{P_o} = \exp\left(\frac{-Mgz}{RT}\right) \qquad \frac{c_i}{c_{io}} = \exp\left(\frac{\Phi_i}{k_BT}\right) \qquad \Phi_i = \frac{4pr^3}{3}\left(r_P - r_f\right)z = sfgz$$

$$D = \frac{kT}{6pmr} \qquad v_{sed} = sg\,; \qquad v_{sed} = sw^2r \qquad s_{sph} = \frac{4pr^3}{3f}\left(r_P - r_f\right)$$

$$s = \frac{V}{f}\left(r_P - r_f\right) \qquad j = -D\left(\frac{dc}{dx}\right) \qquad \frac{\partial c}{\partial t} = D\left(\frac{\partial^2 c}{\partial x^2}\right)$$

$$\ln\left(\frac{c_2}{c_1}\right) = \frac{sg}{D}\left(x_2 - x_1\right) \qquad \ln\left(\frac{c_2}{c_1}\right) = \frac{sw^2}{2D}\left(r_2^2 - r_1^2\right) \qquad \left\langle r^2 \right\rangle = 6Dt$$

$$P(n,x)dx = \frac{1}{\sqrt{4pDt}}\exp\left(\frac{-x^2}{4Dt}\right)dx$$

$$g = \left(\frac{\partial G}{\partial A}\right)_{T,P} \qquad P_{in} - P_{out} = \Delta P = g\left[\frac{1}{R_1} + \frac{1}{R_2}\right] \qquad \frac{2g}{R} = \Delta rgh$$

$$\ln\left(\frac{p_{vap}}{p_{vb}}\right) = \frac{2g\overline{V_L}}{rRT} \qquad \ln\left(\frac{p_{vap}}{p_{vb}}\right) = -\frac{2g\overline{V_g}}{rRT}$$

$$\ln\left(\frac{T}{T_o}\right) = \frac{-2\overline{V_L}g}{\Delta H_{vap}r} \qquad \Delta H_{vap}\left[\frac{1}{T_o} - \frac{1}{T}\right] = R\ln\left[\frac{\frac{2g}{r} - P_l}{P_l}\right]$$

$$\cos q = \frac{g_{sv} - g_{sl}}{g_{lv}} \qquad S = g_{sv} - g_{sl} - g_{lv} \qquad P_{in} - P_{out} = \Delta P = \frac{2g\cos q}{R}$$

$$\frac{2g\cos q}{R} = \Delta r g h$$

$$\frac{dV^*}{dR} = \left(\frac{-dV^*}{d\Delta P}\right)\frac{(\Delta P)^2}{2g\cos q}$$

$$F_{cap} \cong 2pRg_L$$

$$\ln\left(\frac{p_{vap}}{p_{vb}}\right) = \frac{-2\overline{V}_L g_{lv}\cos q}{rRT}$$

$$dg = -\sum_i \Gamma_i dm_i$$

$$\Gamma_{surf} = \frac{1}{RT}\left(\frac{-\partial g}{\partial \ln c_{surf}}\right)_T$$

$$\Gamma_{surf} = \frac{1}{2RT}\left(\frac{-\partial g}{\partial \ln c_{surf}}\right)_T$$

$$\Gamma = \frac{\Gamma_{\max} c}{K'+c}$$

$$\Pi_S = RT\Gamma_{\max}\ln\left(\frac{K'+c}{K'}\right)$$

$$\Gamma(t) = 2c_0\sqrt{\frac{Dt}{p}}$$

$$\Pi_s(t) = RT\Gamma_{\max}\ln\left(1+\frac{\Gamma(t)}{\Gamma_{\max}-\Gamma(t)}\right)$$

$$\frac{1}{V}\left(\frac{x}{1-x}\right) = \left(\frac{C-1}{CV_m}\right)x + \frac{1}{CV_m}$$

$$x = \frac{P}{P_{vap}}$$

$$C = \exp\left(\frac{e-e_v}{kT}\right)$$

$$V_m = \frac{A_{sp}\overline{V}}{N_{Av}s^0}$$

$$N_s = \frac{v}{a_o l}$$

$$l = 0.154 + 0.1265n \text{ [=] nm}$$

$$v = (27.4 + 26.9n)*10^{-3} \text{ [=] nm}^3$$

$$V_{ij,ion-ion}(R) = \frac{q_1 q_2}{4pe_o R}$$

$$V_{ij,ion-dipole}(R) = \frac{q_1 m_1 \cos q}{4pe_o R_{12}^2}$$

$$U_{Keesom}(R) = \frac{-2m_1^2 m_2^2}{3(4pe_o)kTR^6}; kT > \frac{m_1 m_2}{4pe_o R^3}$$

$$U_{Debye}(R) = \frac{-m^2 a}{(4pe_o)R_{12}^6}$$

$$V_{ij,London}(R) = -\left(\frac{3}{2}\right)\left(\frac{I_1 I_2}{I_1 + I_2}\right)\left(\frac{a_1 a_2}{(4pe_o)^2 R_{12}^6}\right)$$

$$m_i = z_i e f(x) + kT \ln c_i^*(x)$$

$$c_i^*(x) = c_{i\infty}^* \exp\left(\frac{-z_i e f(x)}{kT}\right)$$

$$\frac{d^2 f}{dx^2} = \frac{-\sum_i z_i e c_i^*(x)}{e_r e_o}$$

$$\frac{d^2 f}{dx^2} = \frac{-e}{e_r e_o} \sum_i z_i c^*_{i\infty} \, exp\left(\frac{-z_i e f(x)}{kT}\right) \qquad \left.\frac{df}{dx}\right|_{x \to \infty} = 0; \quad \left.\frac{df}{dx}\right|_{x=0} = -\frac{s}{e_r e_o}$$

$$f(x) = \frac{2kT}{ze} ln\left\{\frac{1 + G_o \, exp(-kx)}{1 - G_o \, exp(-kx)}\right\} \qquad G_o = tanh\left(\frac{zef_o}{4kT}\right) \qquad \frac{1}{k} = \sqrt{\frac{e_r e_o kT}{\sum_i (z_i e)^2 c^*_{i\infty}}}$$

$$\frac{1}{k} = \frac{0.304}{\sqrt{c}}(1:1) \qquad \frac{1}{k} = \frac{0.176}{\sqrt{c}}(2:1,1:2) \qquad \frac{1}{k} = \frac{0.152}{\sqrt{c}}(2:2)$$

$$s = \sqrt{8kTc^*_\infty e_r e_o} \, sinh\left(\frac{zef_o}{2kT}\right) = \frac{2e_r e_o kkT}{ze} sinh\left(\frac{zef_o}{2kT}\right)$$

$$f_0 = \frac{2kT}{ze} arcsin\,h\left(\frac{sze}{2e_r e_o kkT}\right) \qquad f(x) = \frac{4kT}{ze} tanh\left(\frac{zef_o}{4kT}\right) exp(-kx)$$

$$sinh(x) = \frac{exp(x) - exp(-x)}{2} \qquad cosh(x) = \frac{exp(x) + exp(-x)}{2} \qquad tanh(x) = \frac{sinh(x)}{cosh(x)}$$

$$P_{os} \cong kTc^* \qquad F_{ww}(h) = 64kTc^*_\infty \left(tanh\left(\frac{zef_o}{4kT}\right)\right)^2 exp(-kh)$$

$$U(h) = -\int_\infty^h F(h')dh' \qquad F(h) = -\frac{dU(h)}{dx}$$

$$F_{ss}(h) = 2p\left(\frac{R_1 R_2}{R_1 + R_2}\right) U_{ww}(h) \qquad F_{sw}(h) = 2pRU_{ww}(h)$$

$$U_{ww}(h) = -\frac{H_{12}}{12ph^2} \qquad U_{sw}(h) = -\frac{H_{12}R}{6h} \qquad U_{ss}(h) = -\frac{H_{12}}{6h}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$$

$$H_{12} \cong \sqrt{H_{11} H_{22}} \qquad H_{131} \cong H_{313} \cong H_{11} + H_{33} - 2H_{13}$$

$$H_{132} \cong \left(\sqrt{H_{11}} - \sqrt{H_{33}}\right)\left(\sqrt{H_{22}} - \sqrt{H_{33}}\right)$$