

(2)

$$g = (X_{Na}X_{ce} g_{NaCe}^{\circ} + X_KX_{ag} g_{Kce}^{\circ} + X_{Na}X_F g_{NaF}^{\circ} + X_KX_F g_{KF}^{\circ}) + RT(X_{Na} \ln X_{Na} + X_K \ln X_K) + RT(X_F \ln X_F + X_{ce} \ln X_{ce}) + g^E$$

$$n_{TOTAL} = (n_{Na} + n_K) = (n_F + n_{ce}) \quad [\text{one equivalent of solution}]$$

$$X_{Na} = \frac{n_{Na}}{n_{Na} + n_K} = (1 - X_K)$$

$$X_F = \frac{n_F}{n_F + n_{ce}} = (1 - X_{ce})$$

$$g_{NaCe} = \left(\frac{2G}{2n_{NaCe}} \right)_{\frac{n_K}{n_F}}$$

where: $G = n_{TOTAL} \cdot g$

$$2n_{NaCe} = 2n_{Na} = 2n_{ce}$$

$$g_{NaCe} = \frac{2}{2n_{NaCe}} \left[\left(\frac{n_{Na}n_{ce}}{n_{TOT}} \right) g_{NaCe}^{\circ} + \frac{n_K n_{ce}}{n_{TOT}} g_{Kce}^{\circ} + \frac{n_{Na} n_F}{n_{TOT}} g_{NaF}^{\circ} + \frac{n_K n_F}{n_{TOT}} g_{KF}^{\circ} \right] + RT \left(n_{Na} \ln \left(\frac{n_{Na}}{n_{TOT}} \right) + n_K \ln \left(\frac{n_K}{n_{TOT}} \right) + n_F \ln \left(\frac{n_F}{n_{TOT}} \right) + n_{ce} \ln \left(\frac{n_{ce}}{n_{TOT}} \right) \right) + g_{NaCe}^E$$

$$= \left(\frac{n_{Na}}{n_{TOT}} + \frac{n_{ce}}{n_{TOT}} - \frac{n_{Na}n_{ce}}{n_{TOT}^2} \right) g_{NaCe}^{\circ} + n_K \left(\frac{1}{n_{TOT}} - \frac{n_{ce}}{n_{TOT}^2} \right) g_{Kce}^{\circ} + n_F \left(\frac{1}{n_{TOT}} - \frac{n_{Na}}{n_{TOT}^2} \right) g_{NaF}^{\circ} - \frac{n_K n_F}{n_{TOT}^2} g_{KF}^{\circ}$$

$$+ RT \left(\ln X_{Na} + \ln X_{ce} + n_{Na} \left(\frac{n_{TOT}}{n_{Na}} \right) \left(\frac{1}{n_{TOT}} - \frac{n_{Na}}{n_{TOT}^2} \right) - \frac{n_K}{n_K} \left(\frac{n_{TOT}}{n_{TOT}} \right) \left(\frac{-n_K}{n_{TOT}} \right) + \dots \right) + g_{NaCe}^E$$

$$= \left((X_{Na} + X_{ce} - X_{Na}X_{ce}) g_{NaCe}^{\circ} + X_K X_F g_{Kce}^{\circ} + X_K X_F g_{NaF}^{\circ} - X_K X_F g_{KF}^{\circ} \right) + RT (\ln X_{Na} + \ln X_{ce}) + g_{NaCe}^E$$

$$= g_{NaCe}^{\circ} - X_K X_F (g_{KF}^{\circ} + g_{NaCe}^{\circ} - g_{Kce}^{\circ} - g_{NaF}^{\circ}) + RT \ln (X_{Na} X_{ce}) + g_{NaCe}^E$$

$$RT \ln a_{NaCe} = (g_{NaCe} - g_{NaCe}^{\circ})$$

$$RT \ln a_{NaCe} = RT \ln (X_{Na} X_{ce}) - X_K X_F \Delta G_{EXCHANGE} + g_{NaCe}^E$$