$$BX + AY = AX + BY \qquad \Delta g^{EX} = (g^{\circ}_{AX} + g^{\circ}_{BY} - g^{\circ}_{BX} - g^{\circ}_{AY})$$

Probability of an A-X pair is $(X_A X_X + y)$

B-Y ... $(X_B X_Y + y)$

B-X .. $(X_B X_X - y)$

A-Y .. .. $(X_A X_Y - y)$

$$g = \left((X_A X_X + y)\, g^{\circ}_{AX} + \cdots\cdots + (X_A X_Y - y)\, g^{\circ}_{AY}\right) - T\Delta S^{config} + g^{E}$$

$$\Delta S^{config} = -R\left(X_A \ln X_A + X_B \ln X_B + X_X \ln X_X + X_Y \ln X_Y\right)$$

$$-RZ\left[(X_A X_X + y)\ln\frac{X_A X_X + y}{X_A X_X} + (X_A X_Y - y)\ln\frac{X_A X_Y - y}{X_A X_Y} + \cdots\right]$$

Set: $dg/dy = 0 \Rightarrow$

$$\frac{(X_A X_X + y)(X_B X_Y + y)}{(X_B X_X - y)(X_A X_Y - y)} = e^{-\Delta g^{EX}/ZRT}$$

$$\ln(1 + y/X_A X_X) + \ln(1 + y/X_B X_Y) - \cdots = -\Delta g^{EX}/ZRT$$

$\ln(1 + y/X_A X_X) \approx y/X_A X_X$ if y is small

$$y \approx -X_A X_B X_X X_Y (\Delta g^{EX}/ZRT)$$

Similarly: $\Delta S^{config} \approx -R(X_A \ln X_A + \cdots) - RZ\, y^2/2X_A X_B X_X X_Y$

Substitution gives:

$$g \approx (X_A X_X g^{\circ}_{AX} + \cdots) + RT(X_A \ln X_A + X_B \ln X_B + X_X \ln X_X + X_Y \ln X_Y)$$
$$+ g^{E} - X_A X_B X_X X_Y (\Delta g^{EX})^2/2ZRT$$