Manipulating K and chemical reactions

$A + 2B \rightleftharpoons C$ $\quad \Delta G_{ORIG}$ $\quad K_{ORIG}$

$$K_{ORIG} = \frac{[C]}{[A][B]^2} \qquad K_{ORIG} = e^{-\Delta G_{ORIG}/RT}$$

DOUBLING

$2A + 4B \rightleftharpoons 2C$ $\quad \Delta G = 2\Delta G_{ORIG}$

$$K = \frac{[C]^2}{[A]^2[B]^4} = \left(\frac{[C]}{[A][B]^2}\right)^2 = K_{ORIG}^2$$

$$K = e^{-\Delta G_{ORIG}/RT} = e^{-2\Delta G_{ORIG}/RT} = \left(e^{-\Delta G_{ORIG}/RT}\right)^2 = K_{ORIG}^2$$

REVERSING

$A + 2B \rightleftharpoons C$ $\quad \Delta G_{ORIG} = -\Delta G_{ORIG}$

$$K = \frac{[A][B]^2}{[C]} = \left(\frac{[C]}{[A][B]^2}\right)^{-1} = \frac{1}{K_{ORIG}}$$

$$K = e^{-\Delta G/RT} = e^{+\Delta G_{ORIG}/RT} = \left(e^{-\Delta G_{ORIG}/RT}\right)^{-1} = \frac{1}{K_{ORIG}}$$

COMBINING REACTIONS

$A + B \rightleftharpoons C$ $\quad \Delta G_1^\circ$

$B + C \rightleftharpoons D$ $\quad \Delta G_2^\circ$

$A + 2B \rightleftharpoons D$ $\quad \Delta G^\circ = \Delta G_1^\circ + \Delta G_2^\circ$

K_1

K_2

$K = K_1 K_2$

$$K_1 = \frac{[C]}{[A][B]} \qquad K_2 = \frac{[D]}{[B][C]} \qquad K = \frac{[D]}{[A][B]^2}$$

$K_1 \quad K_2 = K$

$$\left(\frac{[C]}{[A][B]}\right)\left(\frac{[D]}{[B][C]}\right) = \left(\frac{[D]}{[A][B]^2}\right)$$

$$\left(e^{-\Delta G_1^\circ/RT}\right)\left(e^{-\Delta G_2^\circ/RT}\right) = \left(e^{-\Delta G^\circ/RT}\right)$$

$$e^{-(\Delta G_1^\circ + \Delta G_2^\circ)/RT} = e^{-(\Delta G^\circ)/RT}$$

$$\Delta G_1^\circ + \Delta G_2^\circ = \Delta G^\circ$$