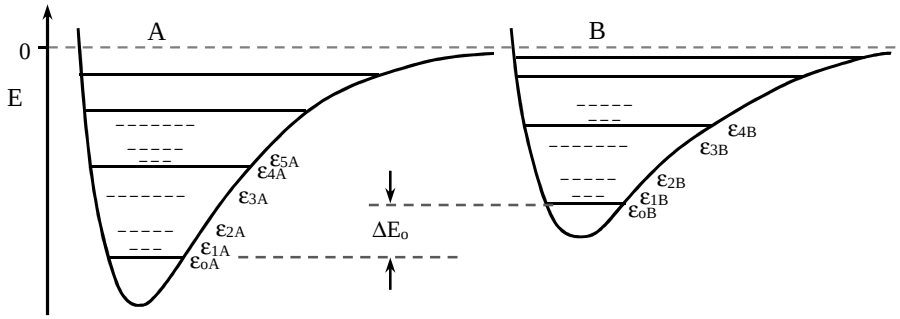
# Equilibrium Constants and Statistical Mechanics

$A \rightarrow B$

$\Delta_r G° = -RT \ln K_p$

$\Delta_r G°(0) = \Delta_r U°(0)$

$\Delta_r U°(0) = \Delta E_o$

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$$G - G(0) = -nRT \ln\left(\frac{q}{N}\right)$$

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$P = P° = 1 \text{ bar} \qquad V_m^\circ = RT/P° \qquad q_t = \frac{(2\pi mkT)^{3/2}}{h^3} V_m^\circ$

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$$G_{m,A}^\circ - G_{m,A}^\circ(0) = -RT \ln\left(q_{A/N_A}^\circ\right)$$

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$$\Delta_r G° = [G_{m,B}^\circ(0) - G_{m,A}^\circ(0)] - RT \ln\left(q_{B/N_A}^\circ\right) + RT \ln\left(q_{A/N_A}^\circ\right)$$

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$$\Delta_r G° = \Delta E_o - RT \ln\left(\frac{q_{B/N_A}^\circ}{q_{A/N_A}^\circ}\right)$$

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$$\ln K_p = \frac{-\Delta E_o}{RT} + \ln\left(\frac{q_{B/N_A}^\circ}{q_{A/N_A}^\circ}\right)$$

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$$K_p = \left(\frac{q_{B/N_A}^\circ}{q_{A/N_A}^\circ}\right) e^{-\Delta E_o/RT}$$

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in general: $aA + bB \rightleftarrows cC + dD \qquad \Delta E_o = c\,\varepsilon_{oC} + d\,\varepsilon_{oD} - a\,\varepsilon_{oA} - b\,\varepsilon_{oB}$

$$K_p = \frac{\left(q_{C/N_A}^\circ\right)^c \left(q_{D/N_A}^\circ\right)^d}{\left(q_{A/N_A}^\circ\right)^a \left(q_{B/N_A}^\circ\right)^b} e^{-\Delta E_o/RT}$$