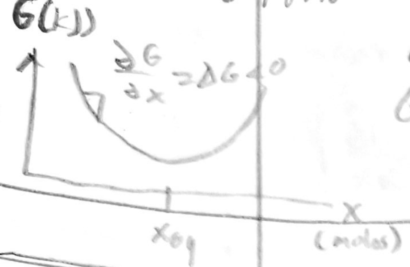
Lecture 28 review: $\Delta G = \Delta G^0 + RT \ln Q$



$aA + bB \rightleftarrows cC + dD$

$Q = \prod_i c_i^{\nu_i} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$

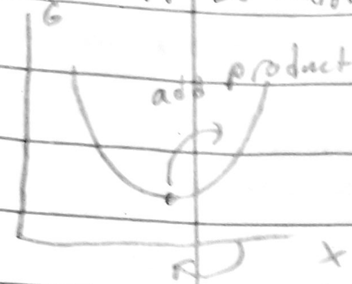
Equilibrium: $\Delta G = 0$
$\rightarrow Q = K_{eq} = e^{-\Delta G^0 / RT}$

Mass Action Law
Derivation: $G = \sum_i \mu_i n_i = \sum (h_i - Ts_i)(n_i^{(0)} + \nu_i x)$

$s_i = s_i^{(0)} - RT \ln c_i$

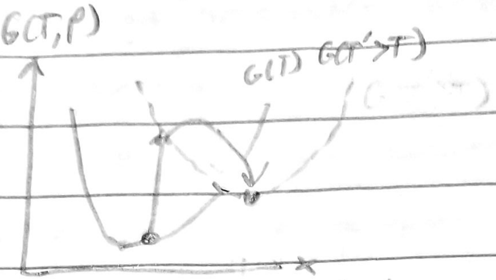
Lecture 29: Le Chatelier & computing K_{eq}

ex.



now rx. runs backward to restore equilibrium

ex.



rx. makes more product to absorb heat

K_{eq}: steps from postulates 1 & 2:

1. Use $H\Psi_j = E_j \Psi_j$ to calculate E_j and w_j

2. Calculate $z_j = \sum w_j e^{-\beta E_j}$ for each molecule in the reaction; $Z_j = \frac{z_j^{N_j}}{N_j!}$, $Z = \prod_j Z_j$

3. Calculate $\mu_j^{(0)} = -RT \frac{\partial \ln Z}{\partial n_j}$

$\Delta G^{(0)} = \sum_j \mu_j^{(0)} \nu_j$

$K_{eq} = e^{-\Delta G^{(0)}/RT}$

Origin:

$Z = e^{-\beta F} \rightarrow F = -RT \ln Z = E - TS$

$= -PV + \sum_j \mu_j n_j$

$\rightarrow \left.\frac{\partial F}{\partial n_j}\right|_{\text{standard conditions}} = \mu_j^{(0)}$

$\rightarrow -RT \ln \left.\frac{\partial \ln Z}{\partial n_j}\right|_{\text{standard conditions}} = \mu_j^{(0)}$