

17.2 Equilibrium Law

K_c (eqm constant) \rightarrow qualitative value for composition of eqm mixture

Calculations done w/ homogeneous equilibria

① calculating K_c when given [eqm] (pg 330)

1. write balanced rxn

2. write eqm expression

3. substitute given values \rightarrow solve

② Calculating K_c from initial conc (pg 332)

R 1. write balanced rxn

2. under rxn write values of rxn

I i) initial conc: originally placed, assume product = 0 (unless stated)

C ii) change in conc: amt of reacts to reach eqm
(-) for reactants } occur in same ratio
(+) for products as coefficients

E iii) eqm conc: conc present in eqm mixture
 $[eqm] = [I] \pm \Delta C$

3. write K_c expression, substitute, solve

③ Calculating $[eqm]$ from K_c (pg 333)

Simple

1. Know K_c
2. Know all but 1 conc
3. Substitute, solve

Complex

1. Know K_c and initial conc (use algebra)
2. Write rxn (if needed)
3. Set up RICE table
 - i) $[I]$ given (products = 0)
 - ii) $\Delta[I] = -x$ (reactants) / $+x$ (products)
in front = coefficient
 - iii) $[eqm] = [I] - x$, so on
4. Write K_c expression, substitute values
5. solve for x ($\Delta[I]$ value)
6. find $[eqm]$ for each compound

④ Calculating $[eqm]$ from small K_c (pg 334) ($K_c \ll 1$, reactants are favored)

$\Delta[R]$ very little (close to 0) $\therefore [R]_i \approx [R]_{eqm}$

1. Same as before
2. change is $[R]_{eqm} \approx [R]_i$

Free Energy (G^\ominus) + eqm

explains why some rxns barely start / others completion

★ $\Delta G (-) \rightarrow$ forward

$$\Delta G^\ominus = \Delta G_p^\ominus - \Delta G_r^\ominus$$

$\Delta G (+) \rightarrow$ reverse

$\Delta G = 0$ eqm

at eqm $\Delta G_p^\ominus = \Delta G_r^\ominus$

as rxn progresses \downarrow total free energy as work is being done by system, \uparrow in entropy

either direction rxn moves towards minimum free energy \rightarrow eqm (net rxn stops)

Composition of mix determined by difference in free energy of P + R

rxn has ΔG^\ominus large (-) $\# \rightarrow$ spontaneous (mostly P)

rxn has ΔG^\ominus large (+) $\# \rightarrow$ non-spontaneous (mostly R)

Relationship b/w K_c + ΔG

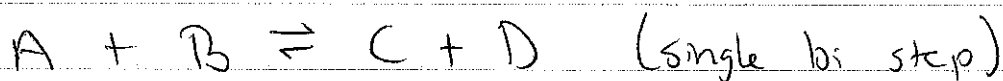
$$\Delta G^\ominus = -RT \ln K$$

Calc good for rxn: too slow to reach eqm

Some components too small to measure

Table (337) + ex

Kinetics + eqm



$$\text{rate forward rxn} = k[A][B]$$

$$\text{rate reverse rxn} = k'[C][D]$$

$$\text{eqm} = K_c = \frac{[C][D]}{[A][B]}$$

$$\text{at eqm} \quad k[A][B] = k'[C][D]$$

$$\frac{k}{k'} = \frac{[C][D]}{[A][B]} \rightarrow K_c = \frac{k}{k'}$$

eqm is ratio of rate constants

$$k \gg k' \rightarrow K_c \text{ large (completion)}$$

$$k \ll k' \rightarrow K_c \text{ small (barely starts)}$$

$\Delta[\]$: $\uparrow [R]$, $\uparrow k$ (fwd rxn), eqm \rightarrow
 $\uparrow [P]$, $\uparrow k'$ (reverse), eqm \leftarrow

k_c stays same (not affected by conc)

catalyst: adding $\uparrow k + k'$ same $\therefore k_c$ same

temp: $\frac{k}{k'}$ affected by temp since $k = Ae^{-E_a/RT}$

endo rxn $E_a(\text{fwd}) > E_a(\text{reverse})$



$\therefore \uparrow T$ greater affect on k than k' so
 $k_c \uparrow$ as temp \uparrow



$E_a(\text{fwd}) < E_a(\text{rev})$

$\therefore \uparrow T$ affect k' , $\downarrow k_c$