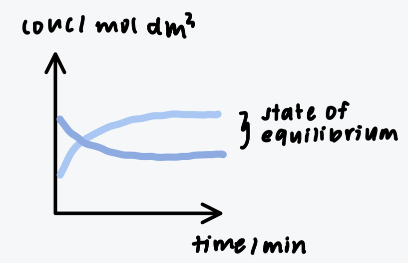
Dynamic Equilibrium

Chemical equilibrium

Types of reactions

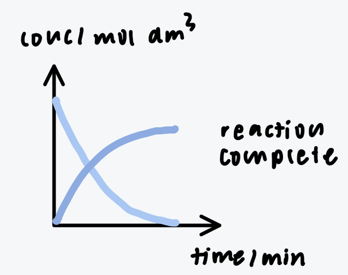
reversible reaction

proportion (mol)
reactants > products
ex: weak acid dissociation



irreversible reaction

proportion (mol)
products > reactants
ex: neutralisation



Equilibrium: change in composition of the mixture will come to an end

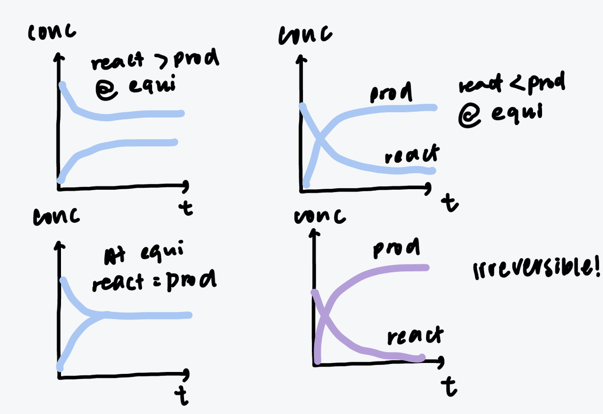
Dynamic Equilibrium

- rate of forward reaction = rate of backwards reaction
- no net change to overall mixture composition

conditions

1) reversible
2) closed system

types of graphs



Q_c Equilibrium constant

} reaction not in equi

$$Q_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

tells whether a system has reached equilibrium

} refers to the conc of each reactant and prod at a particular time of reaction

$Q_c = K_c$ reaction at equilibrium

$Q_c < K_c$ $\frac{P_t}{E_t} < \frac{P_E}{E_E}$

$Q_c > K_c$ $\frac{P_t}{E_t} > \frac{P_E}{E_E}$

▲ limiting reagant not applicable

when a change is made to a reversible reaction in dynamic equilibrium, Epos will shift to try to partially oppose the change

indicates if a reaction was completed

K_c Equilibrium constant

} reaction in equi

*DO NOT INCLUDE SOLIDS IN COMPUTATION

ratio of $\frac{\text{products}}{\text{reactants}}$

$aA + bB \rightleftharpoons cC$

At constant temperature,

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$3N_2(g) + H_2(g) \rightleftharpoons 2NH_3(g)$

$$K_c = \frac{[NH_3]^2}{[N_2]^3[H_2]}$$

} raise to coefficient

$K_c > 1$	products > reactants
$K_c < 1$	products < reactants

1) Does not provide rate of forward / reverse reactions
2) time req for equi to be established

1) All conc are equilibrium constants
2) K_c is constant at a fixed temp
3) units vary
4) Pure solids not included → conc of solid is constant
5) Solvents are not included → (l)

reaction	
Initial amt / mol	
change in amt / mol	based on stoi coefficients
Equilibrium amt / mol	initial amt + change in amt

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$
0.60mol 0.75mol

reaction	$2NO(g)$	$O_2(g)$	$2NO_2(g)$	
initial amt / mol	0.60	0.75	0	
change in amt / mol	-0.30	-0.15	+0.30	→ follows mol ratio
Equilibrium amt / mol	0.30	0.60	0.30	→ might not follow mol ratio (excess)

↳ use vals here for K_c

Le Chatelier's principle

constant at a fixed temperature

when a system at equilibrium is disturbed, system will react in a manner to partially rumove the disturbance

how system responds to K_c

constant K_c

position of equilibrium shifts to maintain ratio of products to reactants (K_c)

1) changing amts

$H_2O(g) + CO_2(g) \rightleftharpoons H_2(g) + CO_2(g)$
(if more added)

2) changing pressure

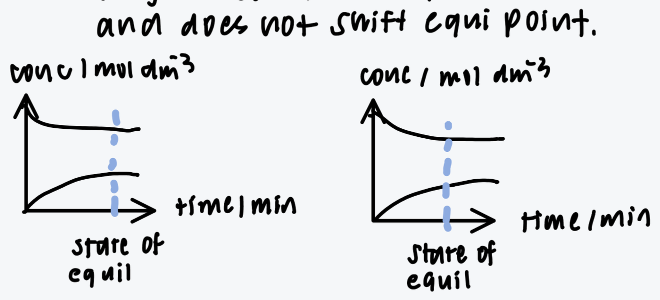
POE shifts left / right to partially towards a reduction of gaseous particles to partially offset the increase in pressure

reactants > products	P↑ K_c→	P↓ K_c←
products > reactants	P↑ K_c←	P↓ K_c→
reactants = products	no change	no change

no change in K_c, no change in POE

4) Catalyst

only increases rate of reaction and does not shift equi point.



changing K_c

both K_c and position of equilibrium shifts

3) changing temperature

position of equilibrium shifts left / right to ausorb some heat to partially offset the increase in temperature.

	If forward reaction is exothermic ($\Delta H < 0$)		If forward reaction is endothermic ($\Delta H > 0$)	
↑	←	K_c ↓	→	K_c ↑
↓	→	K_c ↑	←	K_c ↓