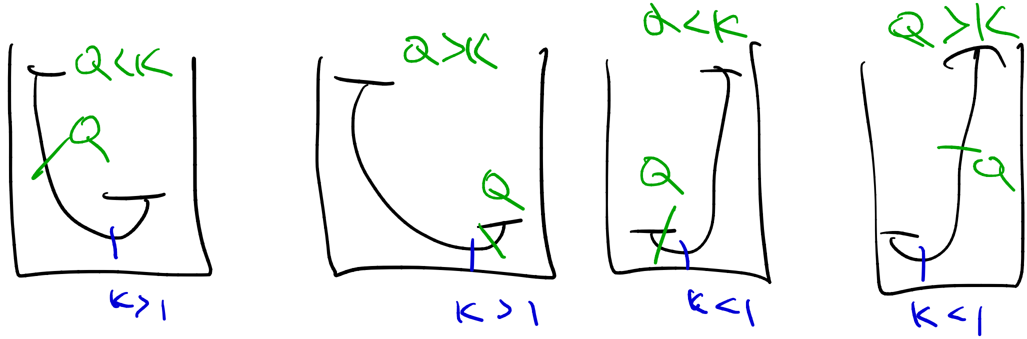
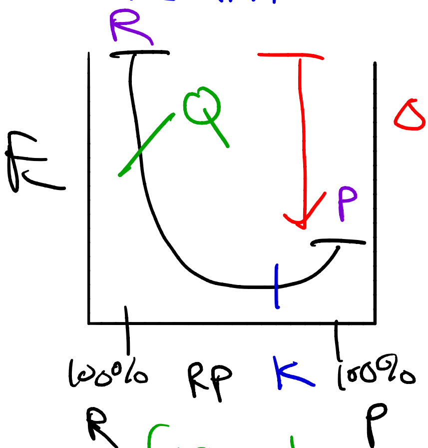

Q<K
Q
K>1
Q>K
Q
K>1
Q<K
Q
K<1
Q>K
Q
K<1

Le Châtelier's Principle

If a system at equilibrium is disturbed, it will respond to that stress to return to equilibrium.



In this example, a rxn in which products are lower in energy starts at equilibrium, but then more reactants are suddenly added.

$$R \underset{\text{reverse}}{\overset{\text{forward}}{\rightleftharpoons}} P$$

- If reactants are suddenly added, the rate of the forward rxn will suddenly increase, but not the rate of the reverse rxn. More products must be made in order for the rates to equal each other again.

The rxn moves forward.

- If reactants are suddenly added, this changes the balance of products and reactants in solution ($Q \neq K \longrightarrow Q < K$), specifically, Q is now less than K, More products must be made for Q to increase and again equal K.

The rxn moves forward,

- If reactants are suddenly added, the reaction is no longer at its lowest energy point (reactants are higher in energy than products). More products must be produced in order to lower the energy of the system back to its lowest point.

The rxn moves forward,

when reactants are added to a solution at equilibrium, they are consumed to make products when products are removed from a rxn at equilibrium, more products will be formed as a result. L3

The only factor that can change an equilibrium constant is temperature.

Changes in concentration will **not** affect K, only Q.

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

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

What would happen if the volume suddenly doubled?

— A sudden increase in volume would cause a sudden drop in pressure. This would favor the side of the rxn with more moles since this would help increase the pressure again.

$$Q_c = \frac{[\tfrac{1}{2} N_2][\tfrac{1}{2} H_2]^3}{[\tfrac{1}{2} NH_3]^2}$$

$$= \frac{(\tfrac{1}{2})(\tfrac{1}{2})^3}{(\tfrac{1}{2})^2} \cdot \left(\frac{[N_2][H_2]^3}{[NH_2]^2}\right)$$

$$= (\tfrac{1}{2})^{4-2} \cdot \left(K_c\right)$$

$$= (\tfrac{1}{2})^2 \cdot K_c$$

$$= \tfrac{1}{4} K_c$$

Q is now less than K, so the rxn moves forward.

If there is no change in the # of moles during the rxn, a volume change will not affect equilibrium (Q = K).

$\Delta H \rightarrow$ enthalpy (kinda like heat) 5

$\Delta H < 0$ exothermic

$\Delta H > 0$ endothermic

$$\Delta G = \Delta H - T\Delta S$$

ΔS: entropy

If $MgSO_{4}(s)$ is added to water, it will dissolve and get cold.

$\longrightarrow$ endothermic

Why is it able dissolve if the process is endothermic? Entropy.