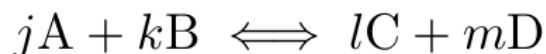


Equilibrium & Pressure

With gases it is usually more useful to express the equilibrium expression in terms of pressure instead of concentration.

$$P = \left(\frac{n}{V}\right) RT \quad PV = nRT \quad P = CRT$$

If we look at the equilibrium expression from a generic equation we can see how the K_p is related to K .

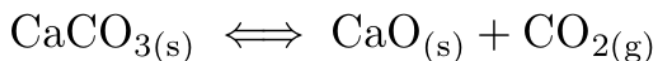


$$K_p = \frac{P_C^l P_D^m}{P_A^j P_B^k} = \frac{(C_C \cdot RT)^l (C_D \cdot RT)^m}{(C_A \cdot RT)^j (C_B \cdot RT)^k} = \frac{C_C^l C_D^m}{C_A^j C_B^k} \cdot \frac{(RT)^{l+m}}{(RT)^{j+k}} = K(RT)^{(l+m)-(j+k)}$$

$$K_p = K(RT)^{\Delta n}$$

Heterogeneous Equilibria

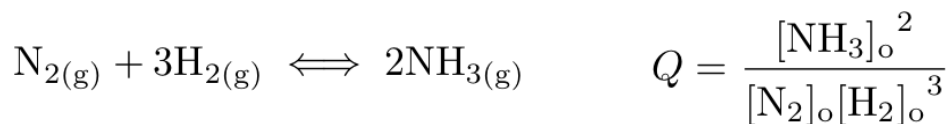
We need to consider how solids and liquid concentrations can be dealt with in the equilibrium expression. When pure solids or liquids are part of a chemical reaction their concentrations are not included in the equilibrium expression.



$$K' = \frac{[\text{CO}_2][\text{CaO}]}{[\text{CaCO}_3]} \quad K' = \frac{[\text{CO}_2]C_1}{C_2} \quad \frac{C_2 K'}{C_1} = K = [\text{CO}_2]$$

Reaction Quotient

The first thing we need to be able to calculate is which direction does a system need to move to establish equilibrium. To do this we calculate the reaction quotient (Q) and compare it to the equilibrium constant.



There are three possibilities for the relationship of Q and K:

1- $Q=K$, the system is at equilibrium and no change in concentrations will take place.

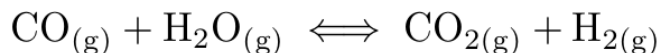
2- $Q>K$, the ratio is too large. The concentration of products is too large. The system will shift to the left. The concentration of reactants will increase.

3- $Q<K$, the ratio is too small. The concentration of reactants is too large. The system will shift to the right. The concentration of products will increase.

Equilibrium Calculations

A common procedure for organizing equilibrium calculations uses the acronym ICE(Initial, Change, Equilibrium) to set up a chart to track the values.

A 1.0L tank has 1.00 mol each of CO, H₂O, CO₂, and H₂. What will be the equilibrium concentration of each species?



I	1.0	1.0		1.0	1.0
C	-x	-x		+x	+x
E	1.0-x	1.0-x		1.0+x	1.0+x

$$K = \frac{[1.0 + X][1.0 + X]}{[1.0 - X][1.0 - X]} = 5.10$$

$$5.10 = \frac{[1.0 + X]^2}{[1.0 - X]^2}$$

$$\sqrt{5.10} = \frac{[1.0 + X]}{[1.0 - X]}$$

$$2.26 = \frac{[1.0 + X]}{[1.0 - X]}$$

$$2.26[1.0 - X] = [1.0 + X]$$

$$2.26 - 2.26X = 1.0 + X$$

$$\frac{1.26}{3.26} = X = 0.39$$