Equilibrium Law

Equilibrium Constant (K) - analysis of the experiments reveals a mathematical relationship that provides a constant value for an chemical system over a range of concentrations.

This constant value is called the equilibrium constant (K) for the reaction system.

EQUILIBRIUM LAW

The Equilibrium Law is applied to calculate K:

For the reaction: aA + bB <==> cC + dD

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

mol/L (M)

A,B,C,D are chemical entities and a,b,c,d are their coefficients in the balanced equation.

The greater the value of the equilibrium constant, the more the system will favor the forward reaction.

The greater the value of K, the greater the percent reaction.
K > 1 is a product-favoured reaction
K < 1 is a reactant-favoured reaction

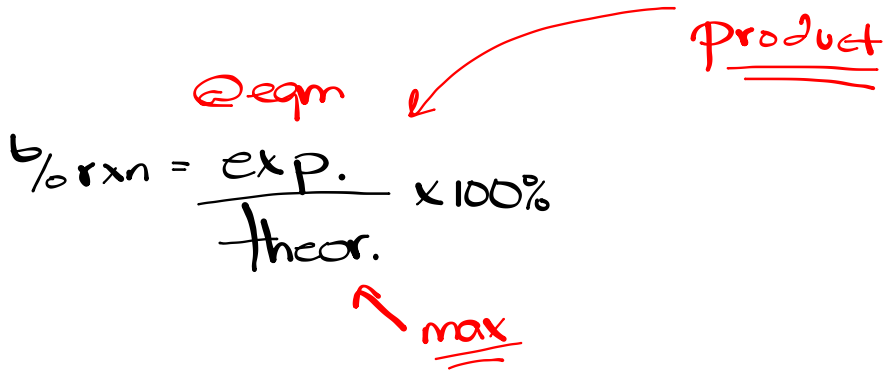
Sample Problem
Write the equilibrium law for the reaction of nitrogen monoxide gas with oxygen gas to form nitrogen dioxide gas.

(1) equation:

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$$

(2) write equilibrium expression:

$$K = \frac{[NO_{2(g)}]^2}{[NO_{(g)}]^2[O_{2(g)}]}$$


Product
@ eqm
% rxn = exp. / theor. x 100%
max

Sample Problem

A mixture of H_2 and I_2 is allowed to react at 448°C. When the equilibrium is established the concentrations of the participates are found to be $[H_2] = 0.46$ mol/L, $[I_2]=0.39$ mol/L, and $[HI] = 3.0$ mol/L. Calculate the value of K_{eq} at 448°C from these data.

$C = \frac{n}{V}$

$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

eqm. 0.46M 0.39M 3.0M

$K = \frac{[HI_{(g)}]^2}{[H_{2(g)}][I_{2(g)}]}$

Q

$K = \frac{[3.0]^2}{[0.46][0.39]}$

$\frac{mol^2/L^2}{mol^2/L^2}$

$K = 50.$

Product-favoured

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3} \qquad \frac{mol^2/L^2}{mol^4/L^4}$$

Worksheet

EXERCISE #7, 8 p. 557
#9, 10 p. 558