

Equilibrium I

NOTES #47

Ap Chemistry

1. What is Equilibrium????

A. Most reactions are REVERSIBLE!!!!

B. There are two different types of equilibrium.

PHYSICAL EQUILIBRIUM:
ex:

CHEMICAL EQUILIBRIUM:
ex:

C. Characteristics of Equilibrium....

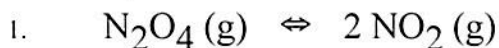
1.

2.

3.

**** Equilibrium simulation demonstration.....

D. Graphically, what does Eq look like?



Concentration vs Time



Rate vs Time



2. Take a look at some more data of this reaction starting out at varying $[\text{N}_2\text{O}_4]$ and $[\text{NO}_2]$ concentrations.....

TABLE 14.1 The NO_2 - N_2O_4 System at 25°C

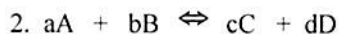
INITIAL CONCENTRATIONS (M)		EQUILIBRIUM CONCENTRATIONS (M)		RATIO OF CONCENTRATIONS AT EQUILIBRIUM	
$[\text{NO}_2]$	$[\text{N}_2\text{O}_4]$	$[\text{NO}_2]$	$[\text{N}_2\text{O}_4]$	$\frac{[\text{NO}_2]}{[\text{N}_2\text{O}_4]}$	$\frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$
0.000	0.670	0.0547	0.643	0.0851	4.65×10^{-3}
0.0500	0.446	0.0457	0.448	0.102	4.66×10^{-3}
0.0300	0.500	0.0475	0.491	0.0967	4.60×10^{-3}
0.0400	0.600	0.0523	0.594	0.0880	4.60×10^{-3}
0.200	0.000	0.0204	0.0898	0.227	4.63×10^{-3}

No matter what concentrations of N_2O_4 and NO_2 you start with, you will notice that the ratio of _____ is always a constant!

E. Writing Equilibrium Expressions

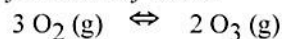
1. The Law of Mass Action:

the ratio of the [products] / [reactants] at equilibrium and at a constant _____ is constant for a particular reaction.



$K =$

ex: a) *formation of ozone:*



b) *dissociation of acetic acid:*

3. Never include SOLIDS or PURE LIQUIDS (like _____) in your eq expression.

ex: decomposition of chalk: _____ $K' =$

Why? _____

*** So, what *do* you include in your Eq expression??? _____

4. K_c vs K_p - The concentrations of the reactants/products in an Eq expression can either be express in terms Molarity (K_c) or in terms of partial pressures (K_p).

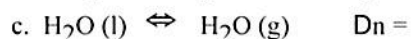
a. So, in the reaction, $N_2O_4 (g) \rightleftharpoons 2 NO_2 (g)$, the Eq expression can be written two ways.

b. Do you suspect K_c and K_p are equal? _____

c. What is the relationship between K_c and K_p ? $aA (g) \rightleftharpoons bB (g)$

d. When would $K_c = K_p$??? _____

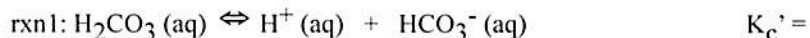
EX: For which reaction will $K_c = K_p$?



Equilibrium II NOTES #48

5. Writing Eq expressions for rxns with MULTIPLE EQUILIBRIA.

- a. This often happens with the ionization of acids with more than one acidic proton to donate (DIPROTIC ACIDS).



- * The Eq expression can be written from the products and reactants of the overall equation.
- * If a reaction can be expressed as the sum of two or more reactions, the eq constant is given by the product of the equilibrium constants of the individual reactions.

$K_c =$

6. K can vary depending on how the equation is written.

- a. What if the reaction is written in the opposite direction?



$K_c =$

$K_c' =$

* K_c' would be the _____ of K_c .

$K_c' =$

- b. What if the reaction is balanced with different coefficients?



$K_c =$

$K_c =$

PRACTICE:

ex: If K_c for the following reaction, $\text{N}_2 (\text{g}) + 3 \text{H}_2 (\text{g}) \rightleftharpoons 2 \text{NH}_3 (\text{g})$, is 2.6×10^{-5} at 25°C , what is K_c for the following:



II. What ever does K really tell us??

1. The magnitude of K tells us whether the forward reaction or the backward reaction is favored. $K = \frac{[\text{products}]}{[\text{reactants}]}$

- If $K > 1$ The _____ rxn is favored; or the _____ are favored.

** If K is *really* big, we can say that the reaction goes to _____.

- If $K < 1$ The _____ rxn is favored; or the _____ are favored.

** If K is *really* small, the reaction does not occur to any significant extent.

** It's important to realize that the size of K and the time required to reach equilibrium are not directly related. In other words, a large K does not necessarily mean that the reaction will reach equilibrium quickly.

- Time to achieve equilibrium is determined by the reaction rate which is determined by...

E _____
rxn progress

- K, on the other hand, is determined by _____, the relative stability of the products vs reactants. (Other similar driving forces will be discussed later....such as the tendency towards *disorder*.....)

III. Predicting the direction of a reaction.

1. For reactions that are NOT in equilibrium, we can still calculate the ratio of products to reactants. This ratio obtained, however, would not be K so instead, we would call such a value, Q or the _____. Q is a valuable piece of info that will allow us to make predictions about the reaction.

EX: The K_c for the following reaction is 6.5×10^4 at 35°C . $2 \text{ NO (g)} + \text{Cl}_2 \text{ (g)} \rightleftharpoons 2 \text{ NOCl (g)}$

In a certain experiment, 2.0×10^{-2} mole of NO, 8.3×10^{-3} mole of Cl_2 and 6.8 moles of NOCl are mixed in a 2.0 L flask.

In which direction will the system proceed to reach equilibrium?

** Since Q_c is _____ than K_c , the reaction will have to proceed to the _____ or towards the _____ in order to reach equilibrium.

2. $Q > K$ The ratio of [products] to [reactants] is too _____. Need to convert _____ back to _____.
Eq shifts to the _____ to reach eq.

$Q = K$ The system is at Eq. (yeah!)

$Q < K$ The ratio of [products] to [reactants] is too _____. Need to convert _____ back to _____.
Eq shifts to the _____ to reach eq.

*** Just like our favorite story, _____.