

Chem 1062

Note Title

7/17/2008

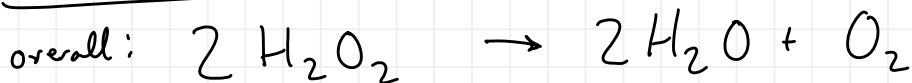
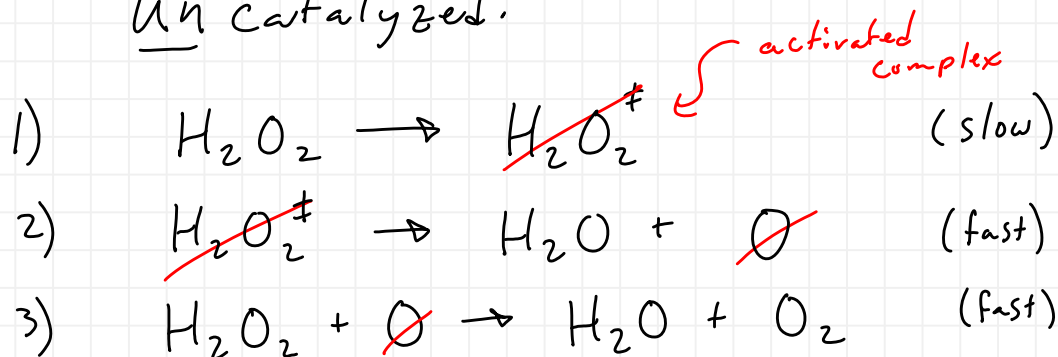
- * Lab Project Information Now Posted
- * Lab Partners & Lab Reports
- * D2L Homework Quizzes - Ch. 12, 14, 15

From end of lecture yesterday:

Reactions usually occur in a series of steps. Each step is limited to one, two, or three molecules reacting (colliding) at once. Each step in this process is called an elementary reaction. The series of steps is called the reaction mechanism.

* Example: The decomposition of H_2O_2

Uncatalyzed:

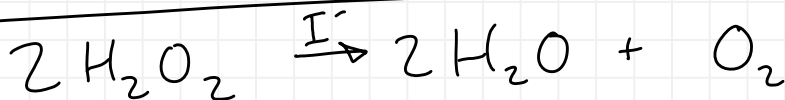
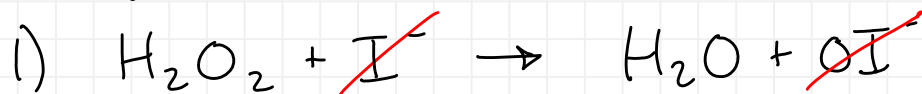


intermediate - produce in an earlier, consumed in a later step

unimolecular, bimolecular, termolecular

rate-determining step - slowest step in
in a multi step process

Catalyzed:



intermediate \Rightarrow OI^-

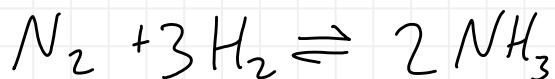
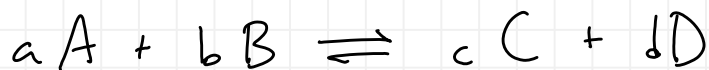
catalyst \Rightarrow I^-

Catalyst - consumed in an early step &
produced in a later step

A catalyst speeds up a reaction by
lowering the activation energy.

Ch. 15 - Chemical Equilibrium

What is it that is equal at equilibrium?



In a reaction, 0.600 mol N_2 and
1.200 mol H_2 were combined. If there
were 0.040 mol NH_3 present @ equilibrium,
how many moles of the other substances

would be present @ equilibrium?

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

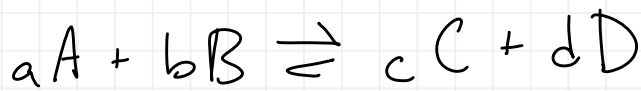
moles			
Initial	0.600	1.200	0
Change	-x	-3x	+2x
Equil	0.600-x = 0.580	1.200-3x = 1.140	2x = 0.040

(1)

$0.600 - x = 0.600 - 0.020 =$
 $1.200 - 3x = 1.200 - 3(0.020) = 1.140$

$\frac{2x}{2} = \frac{0.040}{2}$
 $x = 0.020$

@ Equil: 0.580 mol N_2 , 1.140 mol H_2 , 0.040 mol NH_3



a, b, c, d
✓ represent coefficients

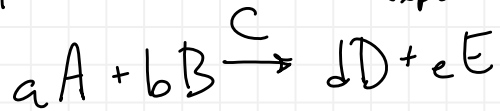
$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$

↑
equilibrium constant

Law of Mass Action

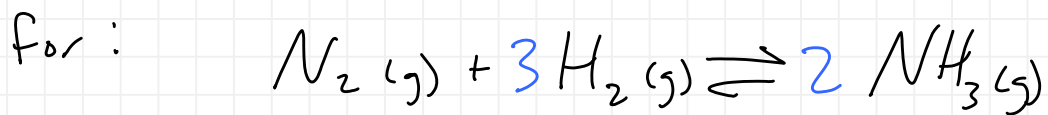
~~Important!~~

Kinetics: ^{x, y, z - determined experimentally}



Rate = $k[A]^x[B]^y[C]^z$

Write an equilibrium constant expression



Then calculate the equilibrium constant for problem (1), assuming the reaction took place in a container having a volume of 15.0 L.

@ Equil:
$$\frac{0.580 \text{ mol N}_2}{15.0 \text{ L}}, \frac{1.140 \text{ mol H}_2}{15.0 \text{ L}}, \frac{0.040 \text{ mol NH}_3}{15.0 \text{ L}}$$

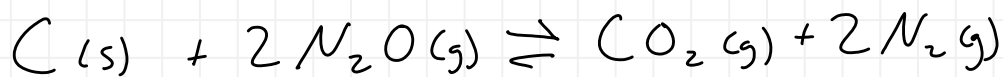
$$0.03867 \text{ M}; 0.0760 \text{ M}; 0.002667 \text{ M}$$

$$\text{N}_2 \qquad \qquad \text{H}_2 \qquad \qquad \text{NH}_3$$

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{(0.002667 \text{ M})^2}{(0.03867 \text{ M})(0.0760 \text{ M})^3}$$

$$(K_c = 0.419)$$

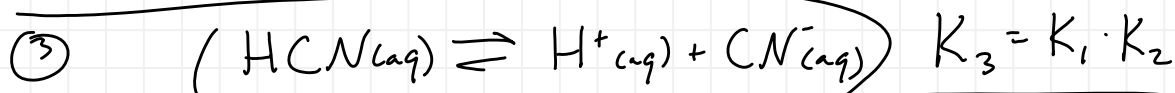
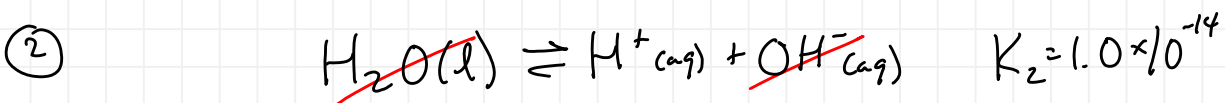
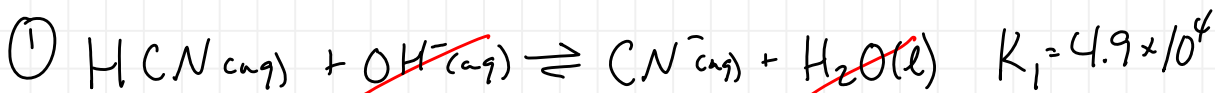
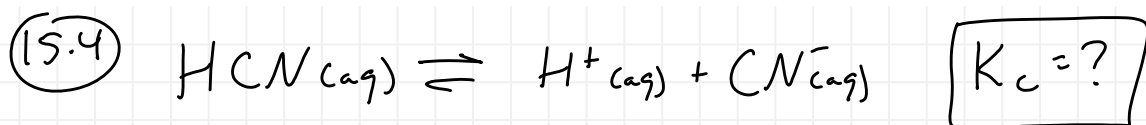
Heterogeneous Equilibria



Write K_c expression:

$$K_c = \frac{[\text{CO}_2][\text{N}_2]^2}{[\text{N}_2\text{O}]^2}$$

leave out
(s), (s) !!

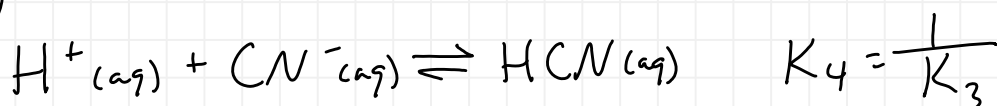


$$K_1 \times K_2 = K_3$$

$$K_3 = 4.9 \times 10^{-10}$$

$$\frac{[\text{CN}^-]}{[\text{HCN}][\text{OH}^-]} \times [\text{H}^+][\text{OH}^-] = \frac{[\text{H}^+][\text{CN}^-]}{[\text{HCN}]}$$

④



$$K_4 = \frac{[\text{HCN}]}{[\text{H}^+][\text{CN}^-]}$$

$$K_4 = \frac{1}{4.9 \times 10^{-10}}$$

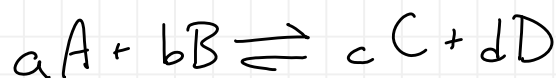
$$K_4 = 2.0 \times 10^9$$

Qualitative Interpretation of Equilibrium Constant

K_c is small, reactant-favored

K_c is large, product-favored

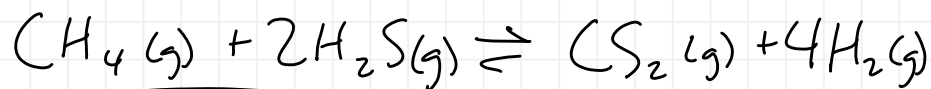
Predicting the Direction of a Reaction for a system that is not at equilibrium:



Find the Q_c (reaction quotient)

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

(15.56)



$$K_c = 3.59 @ 900^\circ\text{C}$$

a) $[\text{CH}_4] = 1.26 \text{ M}$ $[\text{H}_2\text{S}] = 1.32 \text{ M}$

$[\text{CS}_2] = 1.43 \text{ M}$ $[\text{H}_2] = 1.12 \text{ M}$

$$Q_c = \frac{[\text{CS}_2][\text{H}_2]^4}{[\text{CH}_4][\text{H}_2\text{S}]^2} = \frac{(1.43)(1.12)^4}{(1.26)(1.32)^2}$$
$$= 1.02$$

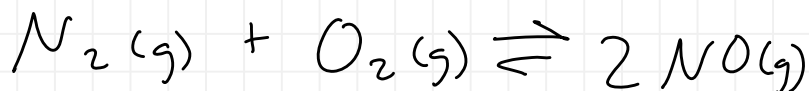
not at equilibrium, goes to the right

If $Q_c = K_c$, then at equilibrium.

$Q_c < K_c$, then reaction goes to right

$Q_c > K_c$, " " " " left

(15.60)



$$K_c = 0.0025 @ 2127^\circ\text{C}$$

$$[\text{N}_2] = 0.023 \text{ M}; [\text{O}_2] = 0.031 \text{ M}$$

$$[\text{NO}] = ?$$

$$[\text{N}_2][\text{O}_2]K_c = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]} = (0.023)(0.031)(0.0025)$$
$$= \sqrt{1.7825 \times 10^{-6}}$$

$$[NO] = 0.0013 M$$

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do this one for Monday