

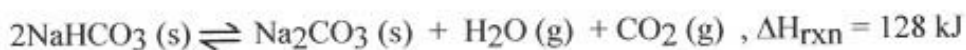
## PS#7 CHEM 113 -General Equilibria - (Revised 1/2004)

Text: Zumdahl-Chapter 13 (13.1-13.7)

Problems: 1,8,9,11,13,15,17,19,21,23,25,27,29,31,33,35,39,41,43,47,51,55,57,59,61,67,71

Additional Problems:

1. Answer questions concerning the following reaction:



How will this reaction shift if the following changes are made (on the system in equilibrium)?

a. removing  $\text{CO}_2(\text{g})$ b. adding  $\text{H}_2\text{O}(\text{g})$ 

c. increasing the temperature

d. adding  $\text{NaHCO}_3(\text{s})$ 

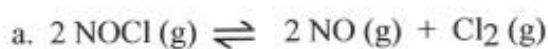
a. shift right

c. shift right

b. shift left

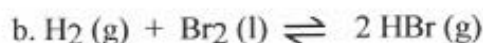
d. no effect.

2. Write an
- equilibrium constant expression
- for each of the following reactions:



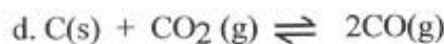
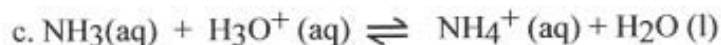
a.  $K = \frac{[\text{NO}]^2 [\text{Cl}_2]}{[\text{NOCl}]^2}$

c.  $K = \frac{[\text{NH}_4^+]}{[\text{NH}_3] [\text{H}_3\text{O}^+]}$



b.  $K = \frac{[\text{HBr}]^2}{[\text{H}_2]}$

d.  $K = \frac{[\text{CO}]^2}{[\text{CO}_2]}$

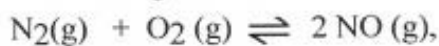


3. A 1.00 L vessel contains 0.777 mole of
- $\text{SO}_3(\text{g})$
- at 1100 K. What is the value of
- $K_c$
- for the following reaction if 0.520 mole of
- $\text{SO}_3$
- remains
- at equilibrium
- ?

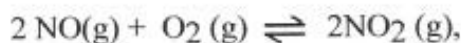


$$K_c = 3.14 \times 10^{-2}$$

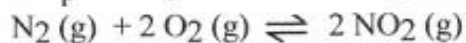
4. Given the following reactions:



$$K_p = 2.3 \times 10^{-4}$$



$$K_p = 1.3 \times 10^{-4}$$

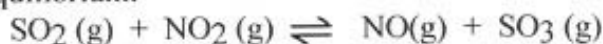
Calculate  $K_p$  and  $K_c$  for the following reaction:

$$K_p = 2.99 \times 10^{-8}$$

$$K_c = 7.32 \times 10^{-7}$$

→ assume at 298K

5. Consider the following equilibrium:

where  $K_c = 85.0$  at  $460^\circ\text{C}$ . The following mixture was prepared in a reactor at  $460^\circ\text{C}$ :
 $[\text{SO}_2] = 0.0200 \text{ M}, [\text{NO}_2] = 0.0200 \text{ M}, [\text{NO}] = 0.100 \text{ M}, [\text{SO}_3] = 0.100 \text{ M}$ 
What will the concentration of the four gases be when equilibrium is reached?

$$[\text{SO}_2] = 0.0200 - x = 1.17 \times 10^{-2} \text{ M}$$

$$[\text{NO}_2] = 1.17 \times 10^{-2} \text{ M}$$

$$[\text{NO}] = 0.100 + x = 1.083 \times 10^{-1} \text{ M}$$

$$[\text{SO}_3] = 1.083 \times 10^{-1} \text{ M}$$

$$x = 0.26 \times 10^{-3} \text{ M}$$

**PS#8 CHEM 113 - Acid/Base Equilibrium and pH - (Revised 1/2004)**

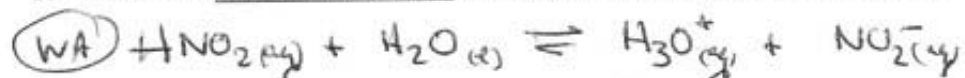
Text: Zumdahl-Chapter 14 (14.1-14.12)

Problems: 1,2,5,17,19,21,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,63\*,65,69,71,73,75,77,79,85,87,89,93,97\*,99,103,119,125,129\*,135\*

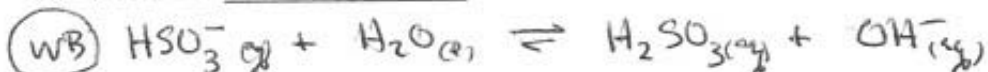
Additional Problems:

**Net Ionic Equations and Other Useful Stuff**

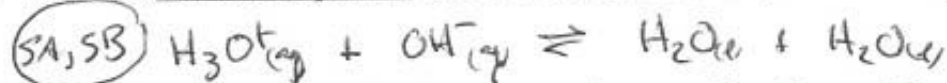
1. Write the acid dissociation reaction for nitrous acid in water.



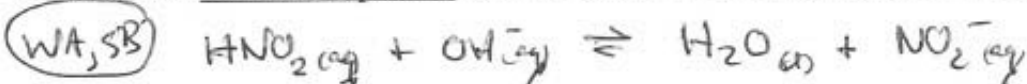
2. Write the base dissociation reaction for bisulfite ion in water.



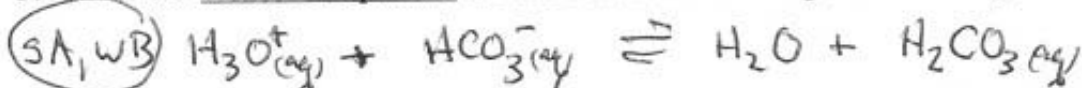
3. Write the net ionic equation for the reaction resulting from mixing 0.1M HCl and 0.1M KOH.



4. Write the net ionic equation for the reaction resulting from mixing 0.1M HNO<sub>2</sub> and 0.1M KOH.



5. Write the net ionic equation for the reaction resulting from mixing 0.1M HCl and 0.1M NaHCO<sub>3</sub>



6. Write the net ionic equation for the reaction resulting from mixing 0.1M HCN and 0.1M NaF.



7. Calculate the following :

Solution	pH	pOH	[H <sub>3</sub> O <sup>+</sup> ]	[OH <sup>-</sup> ]
(SA) 0.060 M HClO <sub>4</sub>	1.22	12.78	0.060 M	$1.67 \times 10^{-13} \text{ M}$
(SB) 0.060 M Mg(OH) <sub>2</sub>	13.08	0.92	$8.33 \times 10^{-14} \text{ M}$	0.120 M*
(WA) 0.060 M HF**	2.21	11.79	0.00622 M	$1.61 \times 10^{-12} \text{ M}$
(WB) 0.060 M NH <sub>3</sub>	11.02	2.98	$9.55 \times 10^{-12} \text{ M}$	0.00104 M

\*\* x not smell!

\* Double OH<sup>-</sup>

8. Calculate the % ionization of the following solutions:

a. 0.50 M HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> (aq),  $K_a = 1.8 \times 10^{-5}$

b. 0.50 M ethylamine (C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub>),  $K_b = 4.3 \times 10^{-4}$

0.60% ionized

2.9% ionized

**PS#9 CHEM 113 -Mixing Problems, Buffers, and Titrations - (Revised 1/2004)**

Text: Zumdahl-Chapter 15 (15.1-15.5)

Problems: 1,3,13,15,19,21,23,25,27,29,31,33,37,41,49,53,55,57,59,63,65,107\*,109\*,113,115,117\*

Additional Problems:

1. What is the pH of a solution prepared by mixing each of the following:

a. 45.0 mL of 0.45 M hydrobromic acid with 35.0 mL of 0.55 M potassium hydroxide.

(done in class)

b. 45.0 mL of 0.45 M hydrofluoric acid with 25.0 mL of 0.55 M potassium hydroxide

(done in class)

c. 45.0 mL of 0.45 M hydrobromic acid with 25.0 mL of 0.55 M potassium nitrite.

(done in class)

d. 25.0 mL of 0.45 M hydrobromic acid with 35.0 mL of 0.55 M potassium nitrite.

(done in class)

2. If 1.0 mmole of  $\text{HC}_2\text{H}_3\text{O}_2$  in 50.0 mL of solution is titrated with 0.080 M NaOH (aq):

a. What will be the pH when 20.0 mL of NaOH is added?

$\text{pH} = 10.93$  xs base

b. How many mL of NaOH (aq) will be required to reach the equivalence point?

12.5 mL

c. What will be the pH at the equivalence point?

$\text{pH} = 8.48$

3. If 2.5 mmole of  $\text{NH}_3$  in 75.0 mL of solution is titrated with 0.10 M HCl (aq):

a. What will be the pH when 30.0 mL of 0.10 M HCl is added?

$\text{pH} = 2.32$  xs acid

b. How many mL of 0.10 M HCl (aq) will be required to reach the equivalence point?

25.0 mL

c. What will be the pH at the equivalence point?

$\text{pH} = 5.43$