Announcements

1. Hour Exam III review posted on-line.
2. Check website for your exam location.
4. Complete solutions to Professor Hummel’s past hour exams in red book are on-line on his website.
Chapter 13

1. Reaction Quotient (Q).
2. Equilibrium Calculations.
3. Le Chatelier’s principle.
Equilibrium Calculations

If 0.80 mol of $\text{N}_2\text{O}_4$ gas is reacted in a 2.0 L container, what is the equilibrium concentration of $\text{NO}_2$ in the container?

$$\text{N}_2\text{O}_4 (g) \rightleftharpoons 2 \text{ NO}_2 (g) \quad K = 4.0 \times 10^{-7}$$

(a) $8.0 \times 10^{-4}$ M
(b) $1.0 \times 10^{-4}$ M
(c) $2.0 \times 10^{-4}$ M
(d) $8.0 \times 10^{-7}$ M
(e) $4.0 \times 10^{-4}$ M
Consider the following reaction at equilibrium:

\[ 2 \text{CO}_2 (g) \rightleftharpoons 2 \text{CO} (g) + \text{O}_2 (g) \quad \Delta H = 566 \text{ kJ} \]

How many of the following changes (I-IV) will cause an increase in the equilibrium concentration of \( \text{O}_2 (g) \)?

I. The volume of the reaction container is decreased.
II. The temperature is decreased.
III. \( \text{CO} (g) \) is added.
IV. \( \text{CO}_2 (g) \) is removed.

(a) 0  (b) 1  (c) 2  (d) 3  (e) 4
Chapter 14

2. Acid dissociation constant ($K_a$).
3. Significance of acid dissociation constant (weak versus strong acids).
4. Strong bases versus weak bases ($K_b$).
5. Conjugate acids and bases.
6. Autoionization of water.
7. pH scale.
8. Calculating pH of strong acid solutions.
13. Metal versus nonmetal oxides.
Basic solutions

Which of the following only contain compounds which would produce basic solutions when 0.10 mol of compound were dissolved in 100.0 mL of solution?

(a) NH₃, NaOH, NH₄NO₃
(b) NH₃, KCN, CaO
(c) NaCl, KCl, LiNO₃
(d) NH₄NO₃, NH₄Cl, SO₃
(e) NaF, KOH, KClO₄
Autoionization of Water

\( K_W \) is the equilibrium constant for the autoionization of water reaction. The value of \( K_W \) depends on the temperature. For example at 25\(^\circ\)C, \( K_W = 1.0 \times 10^{-14} \) and at 47\(^\circ\)C, \( K_W = 4.0 \times 10^{-14} \). With this in mind, which of the following statements (a-c) is true?

a) At 47\(^\circ\)C the pH of neutral water is 6.70.
b) At 47\(^\circ\)C, the OH\(^-\) concentration in neutral water is 4.0 \times 10^{-7}.
c) The autoionization of water reaction is an exothermic process.
d) None of the above.
The $K_a$ value for acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$) is $1.8 \times 10^{-5}$ and the $K_b$ value for ammonia ($\text{NH}_3$) is $1.8 \times 10^{-5}$. Which of the following statements is true?

a) A 1.0 M solution of $\text{NaC}_2\text{H}_3\text{O}_2$ would have a lower pH than a 1.0 M solution of $\text{NH}_4\text{Cl}$.

b) $\text{C}_2\text{H}_3\text{O}_2^-$ is a stronger base than $\text{NH}_3$.

c) A 1.0 M solution of acetic acid would have a higher pH than a 1.0 M solution of ammonium chloride.

d) $\text{NH}_4^+$ is a stronger acid than acetic acid.

e) A 1.0 M solution of ammonia, would have a higher pH than a 1.0 M solution sodium acetate.
Rank the following 1.0 M solutions in order of increasing pH (lowest to highest):

\[ \text{HONH}_2, \text{KNO}_3, \text{CH}_3\text{NH}_2 \]
What is the concentration of an HNO₃ solution which has pOH = 13.85?
Strong Base Calculation

Calculate the pH of a 0.01 M Sr(OH)₂ solution?
If a 2.0 M solution of a monoprotic acid is 5.0% dissociated, what is the pH of the solution?
Weak Base Calculation

Consider a 0.20 M \( \text{H}_2\text{NNH}_2 \) solution. Calculate the concentration of OH\(^-\) in this solution. \( K_b \) for \( \text{H}_2\text{NNH}_2 \) = \( 3.0 \times 10^{-6} \).
A 0.10 M solution of \( \text{KOC}_6\text{H}_5 \) has a \( \text{pH} = 11.50 \). Calculate the \( K_a \) value for \( \text{HOC}_6\text{H}_5 \).
A gardener wants to increase the pH of his soil. Which of the following compounds could the gardener add to the soil (along with water) in order to increase the pH?

a) $\text{NH}_4\text{Cl}$  
b) $\text{P}_2\text{O}_5$  
c) $\text{CaO}$  
d) $\text{SrBr}_2$  
e) $\text{HF}$
1. Definition of a buffer.
2. Characteristics of a good buffer system.
3. pH calculations of buffer systems on their own and when strong acid/base has been added.
4. Strong acid by strong base titration.
5. Strong base by strong acid titration.
6. Weak acid by strong base titration.
7. Weak base by strong acid titration.
8. Polyprotic acid by strong base titration.
Buffers

Which of the following statements is true concerning a \( \text{C}_2\text{H}_5\text{NH}_2/\text{C}_2\text{H}_5\text{NH}_3^+ \) buffer solution. \( K_b \) for \( \text{C}_2\text{H}_5\text{NH}_2 = 5.6 \times 10^{-4} \).

a) If initially in the buffer, \( [\text{C}_2\text{H}_5\text{NH}_2] = [\text{C}_2\text{H}_5\text{NH}_3^+] \), then \( pH = 3.25 \).
b) If initially in the buffer, \( [\text{C}_2\text{H}_5\text{NH}_2] > [\text{C}_2\text{H}_5\text{NH}_3^+] \), then \( pH > 10.75 \).
c) If initially in the buffer, \( [\text{C}_2\text{H}_5\text{NH}_3^+] = 2 [\text{C}_2\text{H}_5\text{NH}_2] \), then \( pH = 11.82 \).
d) If initially in the buffer, \( [\text{C}_2\text{H}_5\text{NH}_2] = 6 [\text{C}_2\text{H}_5\text{NH}_3^+] \), then \( pH = 6.72 \).
e) Added NaOH to the buffer solution will cause the \( \text{C}_2\text{H}_5\text{NH}_3^+ \) concentration to increase and the \( \text{C}_2\text{H}_5\text{NH}_2 \) concentration to decrease.
Buffers

Calculate the pH of a solution containing 0.35 M \( \text{HC}_3\text{H}_5\text{O}_2 \) and 0.65 M \( \text{KC}_3\text{H}_5\text{O}_2 \). \( K_a \) for \( \text{HC}_3\text{H}_5\text{O}_2 \) = \( 1.3 \times 10^{-5} \).
Buffers

Calculate the pH after 0.30 mol of HCl is added to 2.0 L of a solution containing 0.35 M $\text{HC}_3\text{H}_5\text{O}_2$ and 0.65 M $\text{KC}_3\text{H}_5\text{O}_2$. Assume no volume change when the HCl is added. $K_a$ for $\text{HC}_3\text{H}_5\text{O}_2 = 1.3 \times 10^{-5}$. 
Consider the following titrations (I-IV):

I. 50.0 mL of 0.60 M HI titrated by 0.30 M NaOH
II. 50.0 mL of 0.60 M RbOH titrated by 0.30 M HCl.
III. 50.0 mL of 0.60 M NH₃ (Kₛₐ = 1.8 x 10⁻⁵) titrated by 0.30 M HCl.
IV. 50.0 mL of 0.60 M HONH₂ (Kₛₐ = 1.1 x 10⁻⁸) titrated by 0.30 M HCl.

How many of the above titrations have a pH = 7.0 at the equivalence point?

a) 0   b)1   c) 2   d) 3   e) 4
Titrations

The next four questions refer to the titration of 25.0 mL of 0.400 M hypochlorous acid (HOCl) by 0.200 M KOH. The $K_a$ value for HOCl is $3.5 \times 10^{-8}$.

1. Calculate the pH when 0.0 mL of KOH has been added.
2. Calculate the pH after 25.0 mL of KOH has been added.
3. Calculate the pH after 40.0 mL of KOH has been added.
4. Calculate the pH at the equivalence point.