Quiz Three
CHM 205 (DR. MATTSON)
24 February 2004

Quiz: ______ / 50
A ≥ 46.5; B+ ≥ 43.5; B ≥ 41.0;
C+ ≥ 37.5; C ≥ 34.00; D ≥ 30.00

Name:

Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. This exam is worth 50 points. Scores greater than 50 will be recorded as 50. BOX YOUR ANSWERS!

1. (3 pts) What is the pH of each of the following.
   (a) pH = 3.8
   (b) $[\text{OH}^-] = 5.5 \times 10^{-3}$
   (c) $[\text{H}_3\text{O}^+] = 9.1 \times 10^{-5}$

2. (5 pts) Identify each of the following as a strong acid, strong base, weak acid or weak base.
   (a) hydrobromic acid
   (b) ammonium chloride
   (c) methylamine, $\text{NH}_2\text{CH}_3$
   (d) potassium fluoride
   (e) sodium hydroxide

3. (4 pts) Complete the following table matching the conjugate weak acid and weak base.

<table>
<thead>
<tr>
<th>Weak acid</th>
<th>Weak base</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF</td>
<td>CN$^-$</td>
</tr>
<tr>
<td>H$\text{CO}_3^-$</td>
<td></td>
</tr>
<tr>
<td>H$_2\text{SO}_3$</td>
<td></td>
</tr>
</tbody>
</table>

4. (3 pts) What is the pH of a 0.035 M HCl(aq) solution?

5. (3 pts) Calculate the pH of a 0.40 M solution of acetic acid.

6. (3 pts) Using your answer from the previous question, what is the percent dissociation of a 0.40 M solution of acetic acid?

7. (3 pts) Gallic acid (HG) is present in tea. A 0.100 M solution of HG has a pH of 2.70. Calculate the $\text{pK}_a$ of HG.

8. (3 pts) What is the pH of a 0.50 M NaF solution?

9. (3 pts) Suppose 1.0 mL of a pH=3.00 solution were added to a 1.00 L flask and diluted to the mark with water. What is the pH of the resulting solution?
10. (4 pts) What is the pH of a 0.050 M sulfurous acid solution?

12. (2 pts) Circle the strongest of the following weak acids and draw a box around the weakest.
(a) HA, $K_a = 5.0 \times 10^{-6}$
(b) HB, $K_a = 6.0 \times 10^{-7}$
(c) HC, $K_a = 4.0 \times 10^{-3}$
(d) HD, $K_a = 3.0 \times 10^{-9}$

13. (2 pts) Referring to Question 12, which of the following would be the strongest weak base?
NaA    NaB    NaC    or    NaD

14. (2 pts) Referring again to Question 12, what is the $pK_b$ for NaA?

15. (4 pts) Write the appropriate equilibrium expression, complete with arrows that show how each of the following substances behave in water.

16. (7 pts) The bisulfite ion, $\text{HSO}_3^-$ can function as an acid or a base. Writing the balanced net-ionic equation showing bisulfite functioning as (a) an acid and (b) as a base in water.

(a) an acid in water (Include long/short arrows)

(b) a base in water (Include long/short arrows)

(c) Is the bisulfite ion a better weak acid or weak base?

Determine the pH of a 0.10 M NaHSO$_3$ solution.

Dissociation Constants

**ACIDS**
- Acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$, $K_a = 1.8 \times 10^{-5}$
- Hydrofluoric acid, HF, $K_a = 3.5 \times 10^{-4}$
- Phosphoric acid, $\text{H}_3\text{PO}_4$, $K_{a1} = 7.5 \times 10^{-3}$
  - $K_{a2} = 6.2 \times 10^{-8}$
  - $K_{a3} = 4.8 \times 10^{-13}$
- Sulfurous acid, $\text{H}_2\text{SO}_3$, $K_{a1} = 1.5 \times 10^{-2}$
  - $K_{a2} = 6.3 \times 10^{-8}$

**BASES**
- Ammonia, $\text{NH}_3$, $K_b = 1.8 \times 10^{-5}$
Answers: (tentative as of 10 February 2005)
1. (a) 10.2; (b) 11.74; (c) 4.04
2. (a) SA; (b) WA; (c) WB; (d) WB; (e) SB
3. 
<table>
<thead>
<tr>
<th>Weak acid</th>
<th>Weak base</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF</td>
<td>F^-</td>
</tr>
<tr>
<td>HCN</td>
<td>CN^-</td>
</tr>
<tr>
<td>HCO$_3$^-</td>
<td>CO$_3^{2-}$</td>
</tr>
<tr>
<td>H$_2$SO$_3$</td>
<td>HSO$_3$^-</td>
</tr>
</tbody>
</table>
4. 1.46
5. 2.57
6. 0.67%
7. pK$_a$ = 4.4
8. 8.58
9. 6.00
10. 1.68 (Note: Quadratic equation required)
12. strongest weak acid: HC
    weakest weak acid: HD
13. strongest weak base NaD
    weakest weak base: NaC
14. 8.70
15.
   CN^- + H$_2$O $\rightleftharpoons$ OH^- + HCN
   H$_3$PO$_4$ + H$_2$O $\rightleftharpoons$ H$_3$O$^+$ + H$_2$PO$_4$-
   NH$_3$ + H$_2$O $\rightleftharpoons$ OH^- + NH$_4$+
   HF + H$_2$O $\rightleftharpoons$ H$_3$O$^+$ + F^-
16. (a) HSO$_3$^- + H$_2$O $\rightleftharpoons$ H$_3$O$^+$ + SO$_3^{2-}$
    \[K_a = 6.3 \times 10^{-8}\]
(b) HSO$_3$^- + H$_2$O $\rightleftharpoons$ OH^- + H$_2$SO$_3$
    \[K_b = 6.7 \times 10^{-13}\]
(c) by looking at Ka > Kb, therefore bisulfite is a better weak acid
(d) pH = 4.10