Name _________________________

CHEM 1474
Test #3
Fall 2010 (Buckley)

Multiple Choice. Each is worth 2 points.

1. Which of the following is the conjugate base of $\text{HPO}_4^{2-}$?
   a. $\text{PO}_4^{3-}$  
   b. $\text{H}_2\text{PO}_4^-$  
   c. $\text{H}_3\text{PO}_4$  
   d. $\text{OH}^-$

2. $K_a$ for phenol, $\text{HC}_6\text{H}_5\text{O}$, is $1.3 \times 10^{-10}$. What is the expression that will give the value of $K_b$ for the phenolate ion, $\text{C}_6\text{H}_5\text{O}^-$?
   a. $(1.3 \times 10^{-10}) \times (1.0 \times 10^{-14})$  
   b. $\frac{1.3 \times 10^{-10}}{1.0 \times 10^{-14}}$  
   c. $\frac{1.0 \times 10^{-14}}{1.3 \times 10^{-10}}$  
   d. $\frac{1.0 \times 10^{-14}}{(1.3 \times 10^{-10})^2}$

For questions 3-5 consider the following compounds and their associated Roman numerals.

I. $\text{Ba(C}_2\text{H}_3\text{O}_2)_2$  
II. $\text{NH}_4\text{NO}_3$  
III. $\text{SrCl}_2$  
IV. $\text{AlCl}_3$  
V. $\text{Ca(NO}_2)_2$

3. Solutions of which of the compounds above, I through V, would form acidic solutions?
   a. I only  
   b. III and IV only  
   c. I and V only  
   d. II and IV only  
   e. II only

4. Solutions of which of the compounds above, I through V, would form neutral solutions?
   a. I only  
   b. III and IV only  
   c. III only  
   d. II, III, and IV only  
   e. V only

5. Solutions of which of the compounds above, I through V, would form basic solutions?
   a. I only  
   b. III and IV only  
   c. I and V only  
   d. II and IV only  
   e. V only

$$p\text{H} = pK_a + \log \frac{[\text{base}]}{[\text{acid}]}$$
6. Which of the following compounds would you expect to be the most acidic?

a. \[
\begin{array}{c}
\text{C} \\
\text{Cl} \\
\text{O} \\
\text{H}
\end{array}
\quad \text{d.} \quad \begin{array}{c}
\text{C} \\
\text{C} \\
\text{O} \\
\text{H}
\end{array}
\]

b. \[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{O} \\
\text{O} \\
\text{H}
\end{array}
\quad \text{e.} \quad \begin{array}{c}
\text{C} \\
\text{C} \\
\text{O} \\
\text{Cl} \\
\text{O} \\
\text{H}
\end{array}
\]

c. \[
\begin{array}{c}
\text{F} \\
\text{C} \\
\text{O} \\
\text{H}
\end{array}
\]

7. Which of the following could act as a Lewis acid?

a. \( \text{AlCl}_4^- \)  
   b. \( \text{NH}_3 \)  
   c. \( \text{NH}_4^+ \)  
   d. \( \text{Cl}^- \)  
   e. \( \text{AlCl}_3 \)

8. The titration of which of the following will have a pH of 7 at the equivalence point?

a. a weak acid with a strong base
b. a weak base with a strong acid
c. a weak base with a weak acid
d. a strong acid with a strong base

9. Which of the following combinations could NOT be used to form a buffer solution?

a. \( \text{NH}_3 \) and \( \text{NH}_4\text{Cl} \)
b. \( \text{Ba(ClO}_4)_2 \) and \( \text{HClO}_4 \)
c. \( \text{KNO}_2 \) and \( \text{HNO}_2 \)
d. \( \text{HC}_2\text{H}_3\text{O}_2 \) and \( \text{Ca(C}_2\text{H}_3\text{O}_2)_2 \)
e. \( \text{CH}_3\text{NH}_2 \) and \( \text{CH}_3\text{NH}_3\text{Br} \)

10. At the equivalence point of a weak base-strong acid titration the pH will be:

a. equal to 7
b. greater than 7
c. less than 7
d. impossible to tell without further information

\[
pH = pK_a + \log \left( \frac{[\text{base}]}{[\text{acid}]} \right)
\]
Problems. Point totals are indicated in parentheses to the right of the problem number. Show your work to receive full credit.

11. (5 points) Find the pH, pOH, $[H^+]$, and $[OH^-]$ for a 0.15 M solution of NH$_4$NO$_3$. $K_b$ for NH$_3$ is $1.8 \times 10^{-5}$.

12. (5 points) Find the pH, pOH, $[H^+]$, and $[OH^-]$ for a 0.25 M solution of Ba(BrO)$_2$. $K_a$ for HBrO is $2.5 \times 10^{-9}$.

13. (5 points) Find the pH of a solution containing 0.00500 M NaClO and 0.0125 M HClO. $K_a$ for HClO is $2.3 \times 10^{-11}$.

\[
pH = pK_a + \log \frac{[base]}{[acid]}
\]
14. (8 points) A flask contains 35.00-mL of 0.125 M HCN. The flask is titrated with a 0.175 M solution of KOH. Find the pH in the flask at the following points in the titration. Show your work. $K_a$ for HCN is $4.9 \times 10^{-10}$.

a. Before the titration starts:

$$pH = pK_a + \log \frac{[base]}{[acid]}$$

b. After the addition of 15.00-mL of the KOH solution.
c. (Problem 14 continued)  At the equivalence point

d. After 10.00-mL of the KOH solution have been added past the equivalence point.

\[ pH = pK_a + \log \frac{[base]}{[acid]} \]
\[ pH = pK_a + \log \frac{[\text{base}]}{[\text{acid}]} \]