Problem Set 5 (**Due April 24th 8:00 AM**)

Answers to the problems in **RED** need to be submitted through the course website before class begins on the due date.

Acids and Bases

Follow this link for a table of pKa values

1. For each of the following salts, predict if a 100 mM solution would be acidic, basic, or neutral.

NaCl $NaNO_3$ KNO_2 KH_2PO_4 sodium acetate ammonium chloride

2. For each pair, identify which will be a more acidic solution:
   a. 10 mM HCl or 10 mM HF
   b. 10 mM HNO_2 or 10 mM HNO_3
   c. 10 mM H_2SO_4 or 10 mM HCl
   d. 10 mM H_3PO_4 or 10 mM HF
   e. 10 mM HNO_2 or 20 μM HNO_2
   f. 10 mM H_2SO_4 or 0.2 M H_2SO_4

3. For each of the following, calculate K_a
   a. HClO (pKa = 7.53)
   b. HF (pKa = 3.2)

4. For each acid in problem 3, determine the conjugate base.

5. For each base in problem 3, determine the K_b and pK_b.

6. Determine the pH of each of the following solutions:
   a. $[H_3O^+]$ = 1.5 μM
   b. $[OH^-]$ = 1.5 μM
   c. pOH = 5
   d. $[H_3O^+]$ = 4.89 mM
   e. $[OH^-]$ = 18.6 μM
   f. pOH = 11

7. Calculate the pH of each of the following solutions (note pKa values are available here):
   a. 650 μM HF
   b. 175 μM HClO
   c. 650 μM HCl
   d. 175 μM $HClO_4$
   e. 1 mM $Mg(OH)_2$
   f. 10 μM $Mg(OH)_2$
   g. 650 mM MgF_2
   h. 175 mM $Ca(ClO)_2$

8. Calculate the pOH of:
   a. 650 mM NaF
   b. 175 mM NaClO

9. For each of the following acids, determine what concentration is needed to have a pH of 5.5. Please answer in **micromolar**.
   a. Hydrochloric acid
   b. Nitric acid
   c. Ammonium chloride
   d. Chloroacetic acid

Buffers and Titrations

10. For each buffer, determine the buffering range.

Buffer	Maximum buffered pH	Minimum buffered pH
Hypochlorous Acid		
Boric Acid		
Formic Acid		

11. For each of the following, determine which form of the buffer (HA or A^-) will be present at higher concentration.
    a. pKa = 5.75 pH = 4.5
    b. pKa = 3.75 pH = 4.5
    c. pKa = 8.8 pH = 8.8
    d. pKa = 7.1 pH = 7.2

12. Calculate the pH of a 500 mL solution that is:
    a. 0.15 M CH_3CO_2H and 0.25 M $CH_3CO_2^-$.
    b. 1.25 M F^- and 1.38 M HF

13. Calculate the mass of the indicated ionic compound that is needed for each of the following solutions
    a. How much potassium hypochlorite is needed to create a 250 mL buffer at pH 7.0 with 100 mM hypochlorous acid?
    b. How much sodium nitrite is needed to create a 500 mL buffer at pH 3.8 with 75 mM nitrous acid?

14. Calculate the resulting pH when 10 mL of 0.5 M NaOH is added to:
    a. 1.8 L solution of 50 mM hypochlorite buffered at a pH of 7.0
    b. 3.6 L of 200 mM solution of nitrite buffered at pH 3.8.

15. What mass of sodium acetate needs to be added to each of the following solutions of acetic acid to create a buffer at pH 5.3?
    a. 500 mL of 1.00 M acetic acid
    b. 250 mL of 385 mM acetic acid.

1. NaCl = Neutral (HCl is a strong acid)
   KNO_2 = basic sodium acetate = basic
3. a. Ka = 2.95×10^{-8}
5. a. pKb = 6.47 Kb = 3.38×10^{-7}
7. a. pH = 3.4 c. pH = 3.19 e. pH = 11.3 g. pH = 8.66

9. a. 3.16 μM c. 17,800 μM
11. a. HA b. A^-
13. a. 0.901 g

2. a. HCl c. H_2SO_4 e. 10 mM HNO_2

4. ClO^-
6. a. pH = 5.82 b. pH = 8.18 c. pH = 9

8. a. pOH = 5.49
10. Minimum = 6.4 Maximum = 8.4
12. pH = 4.97
14. a. 6.873