Acid Base Equilibrium Questions

1. Write formulas for the conjugate bases for each of these acids

(a) HCl
(b) CH_4
(c) HSO_3^{1-}
(d) H_2SO_4
(e) NH_3
(f) $HClO_4$

2. Show how each of these acids react with water and forms a conjugate acid-base pair. Show the conjugate acid base pairs, identify the bases competing for protons, indicate which base is the better base, which side the equilibrium will lye on (left or right) and finally if the resulting equilibrium is acidic or basic.

(a) HCl
(b) HNO_3
(c) H_2SO_4
(d) $HClO_4$
(e) H_2S
(f) H_3PO_4

3. Draw the electron-dot structures for these species and show that each has an unshared pair of electrons.

(a) NH_3
(b) CH_3^{1-}
(c) H_2O
(d) CH_3OH
(e) Cl^{1-}
(f) SO_4^{2-}
(g) S^{2-}
(h) NH_2^{1-}
(i) HSO_3^{1-}

4. Write the reaction of water with each of the species listed in Question 3. Show the conjugate acid base pairs, identify the bases competing for protons, indicate which base is the better base, which side the equilibrium will lye on (left or right) and finally if the resulting equilibrium is acidic or basic.

5. Use Table 15-1 to predict whether a reaction between these pairs occurs to any appreciable extent. Answer each question fully using the instructions from question #2

(a) $HCl + H_2O$
(b) $H_2O + H_2SO_4$
(c) $HSO_4^{1-} + H_3O^{1+}$
(d) $HS^{1-} + H_3O^{1+}$
(e) $CH_3COOH + H_2SO_4$
(f) $HClO_4 + OH^{1-}$
(g) $HCO_3^{1-} + OH^{1-}$
(h) $NH_3 + HSO_3^{1-}$

6. The formation of products is strongly favored in this acid-base system:

$$HB + X^{1-} \rightleftharpoons HX + B^{1-}$$

(a) Identify the bases competing for protons.
(b) Which base is stronger?
(c) Which is the weaker acid, HX or HB?
(d) Does the K for this system have a large or small value?
(e) How is the equilibrium affected by the addition of the soluble salt NaB?

7. Write the equation for the reaction of each of these ions with water. Experiments show that (b), (c), and (d) form acid solutions. Answer each question fully using the instructions from question #2

(a) HCO_3^{1-}
(b) $H_2PO_4^{1-}$
(c) HSO_4^{1-}
(d) NH_4^{1+}
(e) HS^{1-}
(f) HPO_4^{2-}
(g) CO_3^{2-}

8. Which of these 1.0 kmol/m^3 solutions is acidic or basic? Explain. Fully as per instructions from question #2. If multiple equilibrium exist, treat accordingly

(a) Na_2CO_3
(b) Na_2S
(c) $FeCl_3$
(d) $(NH_4)_2SO_4$
(e) $Al_2(SO_4)_3$
(f) $MgSO_4$
(g) $KHCO_3$
(h) $AgNO_3$
(i) NH_4I
(j) $NaHSO_4$

Acid Base Equilibrium Problems

1. Calculate the $[H_3O^{1+}]$, $[OH^{1-}]$, pH, and pOH of these solutions:
(a) 1.0 kmol/m^3 HCl
(b) 0.50 kmol/m^3 HNO_3
(c) 0.0020 kmol/m^3 $HClO_4$
(d) 1.5 X 10^{-4} kmol/m^3 KOH
(e) a solution prepared by dissolving 0.040 g NaOH 2.0 L of solution
(f) a solution prepared by diluting 1.0 mL of 0.20 kmol/m^3 HCl to a total volume of 5.0 L
(g) a solution made by dissolving 0.10 mol Na_2O in 1.0 L of solution

2. Calculate the $[H_3O^{1+}]$, pH, and percentage dissociation of these solutions:
(a) 1.0 kmol/m^3 HCN
(b) 0.001 kmol/m^3 HCN
(c) 1.0 kmol/m^3 HF
(d) 0.50 kmol/m^3 HNO_2
(e) 0.5 kmol/m^3 $HCHO_2$
(f) 0.50 kmol/m^3 H_3BO_3

3. A solution of hydrofluoric acid contains 2.0 g of HF per litre and has a pH of 2.2 What is the dissociation constant for HF?

4. A weak acid, HX, is a weak monoprotic acid. A 0.100 kmol/m^3 solution is 6.0% dissociated. What is the dissociation constant for the acid?

5. A 1.0 X 10-3 kmol/m^3 solution of a weak acid, HX, is 20.0% dissociated.:
(a) What is the pH of the solution?
(b) What is the concentration of X^{1-}?
(c) What is the dissociation constant for the acid?

6. Hypobromous acid (HBrO) has a dissociation constant of 2.0×10^{-9}. A solution of HBrO has a pH of 4.8. What is the concentration of the solution?

7. Calculate the [OH-], pOH, and pH of these solutions:

(a) 1.0 kmol/m^3 NH_3

(b) 0.10 kmol/m^3 aniline ($C_6H_5NH_2$),

(c) 5.0×10^{-2} kmol/m^3 hydrazine (N_2H_4)

(d) 0.20 kmol/m^3 hydroxylamine (NH_20H)

(e) 1.5 kmol/m^3 trimethylamine ($(CH_3)_3N$)

8. Calculate the [OH^{1-}], pOH and pH of these solutions:

(a) 0.10 kmol/m^3 Na_2SO_3

(b) 0.50 kmol/m^3 KCN

(c) 1.0 kmol/m^3 Na_2CO_3

(d) 0.05 kmol/m^3 $NaC_7H_5O_2$

(e) 0.2 kmol/m^3 NaClO.

9. For this buffer solution:

(a) What is the pH of a solution made by combining 0.60 mol of acetic acid with 0.40 mol of sodium acetate in enough water to make one litre of solution?

(b) What is the pH of this solution if four additional litres of water is added to it?

10. What concentration of sodium acetate is required to prepare a solution in which the pH is 5.0 and the acetic acid is 0.10 kmol/m^3.

11. What mass of NH_4Cl must be added to 0.500 L of 1.0 kmol/m^3 NH_3 solution to yield a solution with a pH of 9.0? Assume no change in volume occurs.

12. A buffer solution is prepared by adding 1.0 mol of NH_4Cl to 1 litre of a solution containing 1.0 mol NH_3.

(a) What is the pH of the solution?

(b) What is the pH of the solution resulting from the addition of 1.0 mmol of HCl to 10.0 mL of the buffer? Assume no volume change occurs.

(c) What is the pH of the solution resulting from the addition of 1.0 mmol NaOH to 1000 mL of the buffer? Assume no volume change.

(d) How many mL of 6 M HCI would be required to change the pH of one litre of buffer by 1 pH unit?