Acid-Base Titrations
CHEM 212

1. Predict the pH at the equivalence point for each of the cases below:

Strong acid/ strong base weak acid/ strong base weak base/ strong acid

2. Explain why the pH $\neq 7.00$ in some cases.

3. Calculate the pH of a solution containing 0.05M weak acid with a $pk_a=5.4$. Write the equation for this solution and the equilibrium expression. Use the quadratic equation to solve for $[H^+]$ and calculate the pH

If $[H^+] << F$ (0.05M), then you can avoid using the quadratic equation to solve the problem. **A good rule of thumb is that you can ignore [H+] in the denominator when [H+] is less than 1% of F.** Use this assumption and rewrite the equilibrium expression. Solve for [H+], and calculate the pH. Do your answers match?

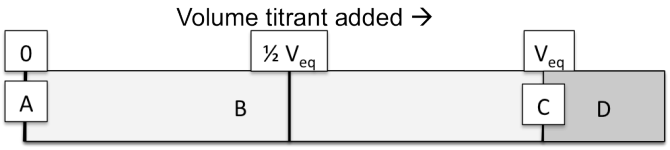
4. At the equivalence point, mols acid= mols base. Calculate the volume of 0.05 M strong base required to titrate 100 ml of 0.02 M weak acid.

5. When both species of the conjugate pair are present in solution, it is called a buffer. Buffers are governed by the Henderson- Hasslebach equation. Write the stoichiometry equation and the Henderson Hasslebach equation for both weak acid/strong base and weak base/ strong acid titrations.

6. Determine the pH and volume added at the ½ equivalence volume if the pka= 5.7 for the weak acid above.

7. At the ½ equivalence volume, pH= pka or pH= 14- pkb. Demonstrate why this is the case using the Henderson-Hasslebach equation? Then state, in your own words, why this is the case.

8. For each titration type, write the reactions governing the solution chemistry in each region. Then write the equilibrium expression you would use to calculate the pH.



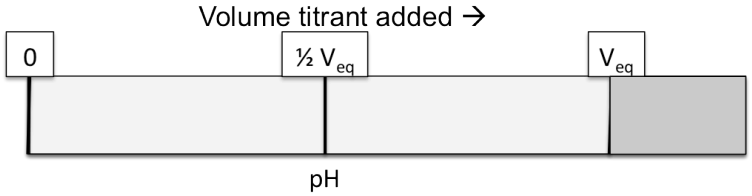
Region	Weak Acid, Strong Base	Weak Base, Strong Acid
A		
B		
½ Veq		
C		
D		

9. A weak acid HA (pKa=4.50) was titrated with 1.00 M KOH. The acid solution had a volume of 100.0 mL and a molarity of 0.100M.

Do you expect the pH at the end point to be greater or less than 7?

Determine the volume base added at the equivalence point.

L abel this drawing with the locations of the volumes base added and any pH values you know. Fill in the diagram below, then use the diagram to "check" your calculations in the rest of the problem.



	0 ml	0<V< ½V$_{eq}$	V= ½V$_{eq}$	½V$_{eq}$<V< V$_{eq}$	V= V$_{eq}$	V> V$_{eq}$
Volume (or range) titrant added						
Expected value or range of pH						
Calculated pH						

Determine the pH at each of the volumes below. For each case, **begin by writing the equation governing the solution chemistry.**

Before the titration begins.

after 3 ml base is added.

after 5 ml base is added.

after 7 ml base is added.

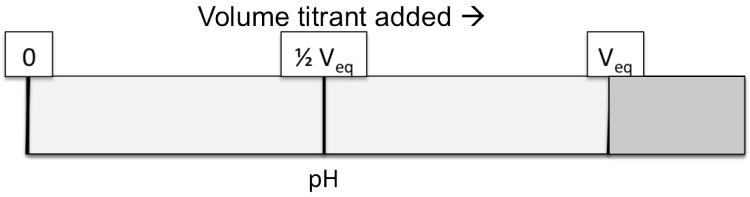
after 10 ml base is added.

after 12 ml base is added.

10. A 50 ml solution of 0.0319 M benzylamine was titrated with 0.050 M HCl. Given $pK_a = 9.35$
Do you expect the pH at the end point to be greater or less than 7?

Determine the volume acid added at the equivalence point.

Label this drawing with the locations of the volumes base added and any pH values you know. Fill in the diagram below, then use the diagram to "check" your calculations in the rest of the problem.



		$0<V<\frac{1}{2}V_{eq}$	$V=\frac{1}{2}V_{eq}$	$\frac{1}{2}V_{eq}<V<V_{eq}$	$V=V_{eq}$	$V>V_{eq}$
Volume (or range) titrant added	0 ml					
Expected value or range of pH						
Calculated pH						

Determine the pH at each of the volumes below. For each case, **begin by writing the equation governing the solution chemistry.**
Before the titration begins.

after 6 ml acid is added.

after 12 ml acid is added.

after 16 ml acid is added.

after 32 ml acid is added.

after 35 ml acid is added.

11. How many grams of NaOH (FM=40 g mol^{-1}) must be added to 1.50 L of a 0.400 M solution of oxoacetic acid ($HCOCO_2H$; pKa=3.46) to produce a buffer pH 4.00?

12. A dibasic compound (pK_{b1}= 4.00, pK_{b2}=8.00) was titrated with 1.00M HCl. The initial solution of B was 0.100M and had a volume of 100 mL. Find the concentration of each species in solution at pH= 6.75.