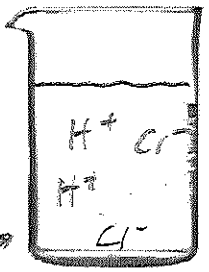
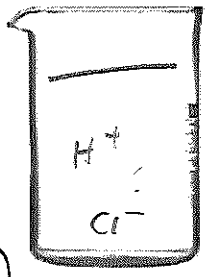
Acid Base Titration Analysis

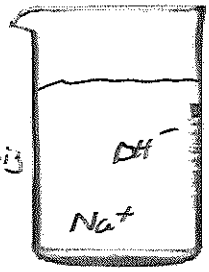
1. 0.10M hydrochloric acid solution.
   a. Determine the pH. $-\log(.1) = 1$
   b. How would you describe the value of the Ka of hydrochloric acid? Very large
   c. Draw a picture of this solution 0.10M in the beaker provided.
   d. Draw a picture of a 0.05M solution of HCl in the beaker provided.

Video

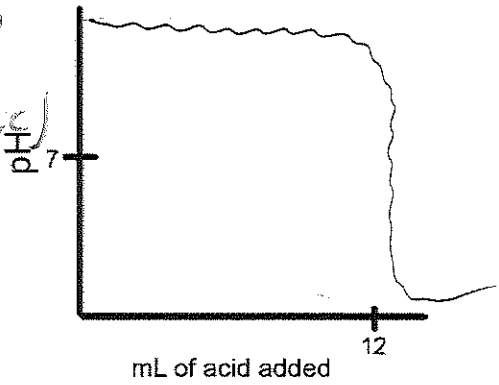


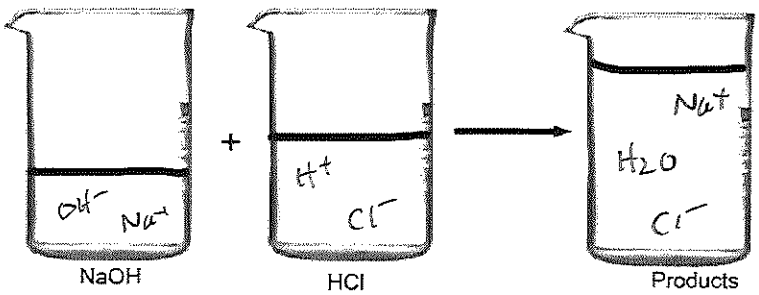


2. 0.5M NaOH
   a. Determine the pH of this solution. $-\log(.5) = 0.3$ $14 - .3 = 13.6$
   b. Justify or nullify the following statement: NaOH does not have a Kb value because it does not undergo hydrolysis. True, it has a Ksp but that is very Big too.
   c. Draw a picture of the basic solution in the beaker provided.

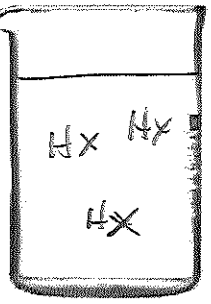


3. A pH meter and 10mL of 0.5M NaOH are placed in a beaker. 12mL of 0.5M HCl and 2 drops of phenolphthalein are added to a beaker. $HCl + NaOH \rightarrow NaCl + H_2O$
   a. Write the neutralization reaction. $H^+ + OH^- \rightarrow H_2O$
   b. Will the beaker be clear/pink/green? Start Pink (Basic) → go Clear (acid.)
   c. Sketch the relative pH graph for this reaction.
   d. In the three beakers below sketch the reactants and products.





4. 0.5M Acetic acid, commonly used as a preservative in the food industry.
   a. The pka of acetic acid = 4.76.
      i. What does this pKa mean? at ½ equivalence pH = 4.76
      - acid stronger than Base [acid] = [Base]
      - general Buffer area 4.76
      ii. What is the ka of this acid?
      $10^{-4.76} = 1.73E-5$
      iii. Determine the pH of this solution.
      $1.73E-5 = \frac{x^2}{.5}$ $x = 0.0029$ $-\log(\quad) = 2.53$
      iv. Draw a representative picture of the solution in the beaker provided.
      H+ and X- so small that likely Not Shown.



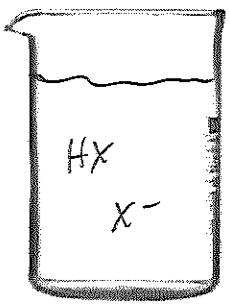
5. Sodium acetate is the conjugate of acetic acid.
   a. What is the pKb of acetate. $\frac{1.0E-14}{1.73E-5} = 5.7E-10$
   b. What is the Kb of acetate? $-\log(\quad) = 9.23$
   $pK_a + pK_b = 14$
   c. If you had a solution that had equal concentrations of acetic acid and sodium acetate, this solution would be (acidic, basic, neutral)?
   d. Calculate the actual pH of letter "c". 4.76 pKa

82 g/mol
$NaC_2H_3O_2$

6. A 50mL sample of 0.5M $HC_2H_3O_2$ has 1.025g of $NaC_2H_3O_2$ added to it.
   a. What is the concentration of the $C_2H_3O_2^{-1}$ ion? $1.025g \cdot \frac{1\ mol}{82\ g} = 0.0125mol$ / .05L = 0.25M
   b. What is the pH of this solution?
   $K_a = \frac{[X^-][H^+]}{[HX]}$ $1.73E-5 = \frac{.25\ x}{.5}$ $x = 3.4E-5$ $-\log(\quad) = 4.46$
7. A 50mL sample of .5M Acetic acid has 125mL of 0.1M NaOH added.
   a. Write the net ionic equation for this reaction.
   $HX + OH^- \rightarrow X^- + H_2O$
   b. Determine the number of moles of acetic acid and hydroxide before the reaction
   M · L = mol
   $.5 \cdot .05 = .025mol$ $0.1 \cdot .125 = .0125mol$
   c. Determine the new concentration of acetic acid and acetate ion after the reaction.
   .025 0
   −.0125 +.0125 → .0125 eq / .175 = 0.071
   d. Determine the pH of the solution after mixed.
   at ½ eq. 4.76
   $K_a = [\quad]$ $K_a = \frac{.071\ [\quad]}{.071}$ $-\log K_a = pK_a$ 4.76
8. A 25mL of acetic acid with an unknown concentration is mixed with 0.5M NaOH. 20mL of the base is required to reach equivalence.
   a. The unknown is (more/less) concentrated then the known base?
   Same mole / Larger vol = M

b. Determine the actual concentration of the acid.

$.5 \cdot 0.02L = .01 mol \frac{1}{} = .01/.025 = 0.4M$



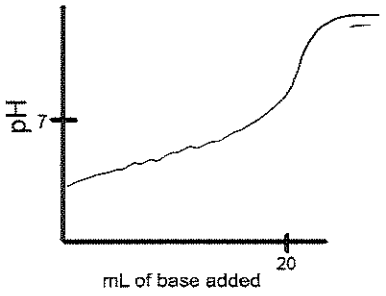
c. How many mL of the NaOH will be required to reach the half equivalence. 10 mL

d. Draw a picture of this half equivalence in the beaker provided.

e. The half equivalence will be (acidic/base/neutral) justify.

Ka > Kb So Acid stronger

f. Sketch the titration curve for this reaction. Conc = equal



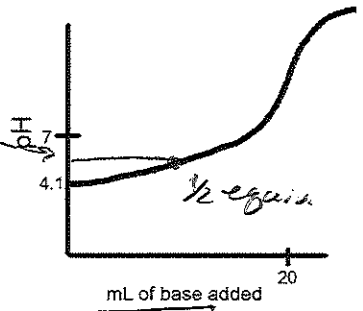
9. 0.5g of an unknown solid acid is dissolved in 50mL of distilled water and titrated with 0.1M of NaOH. The titration curve is given. Answer the following questions.

a. Estimate the pKa of this acid. Little bigger then 4.1

b. Using the curve, determine the molar mass of the acid.

$.1 \cdot .02L = .002 mol$ $\frac{.5g}{.002} = 250 g/mol$

$\frac{.002 mol}{.05L} = .04M$



c. Using the curve determine the ka of the acid.

$HV + H_2O \rightleftharpoons H_3O^+ + X^-$

I .04 0 0
C -x +x +x
E .04-x x x

→ fill out ICE table

$10^{-4.1} = 7.9E\text{-}5 M$

$1.58E\text{-}7 = Ka$

$\frac{(7.9E\text{-}5)^2}{.04}$

d. Using your concentration calculated, calculate the percent ionization.

$\frac{7.9E\text{-}4}{.04} \times 100 = 0.19\%$ ionized

10. 10mL of NH_3 is titrated with 0.1M HCl. The equivalence is reached after 8mL of acid.

a. Write the molecular reaction taking place. NH_3 = 1.8E-5

$NH_3 + HCl \rightarrow NH_4Cl$

b. Write the net ionic reaction taking place.

$NH_3 + H^+ \rightarrow NH_4^+$

c. At 4 mL will the solution be (basic, acidic, neutral)?

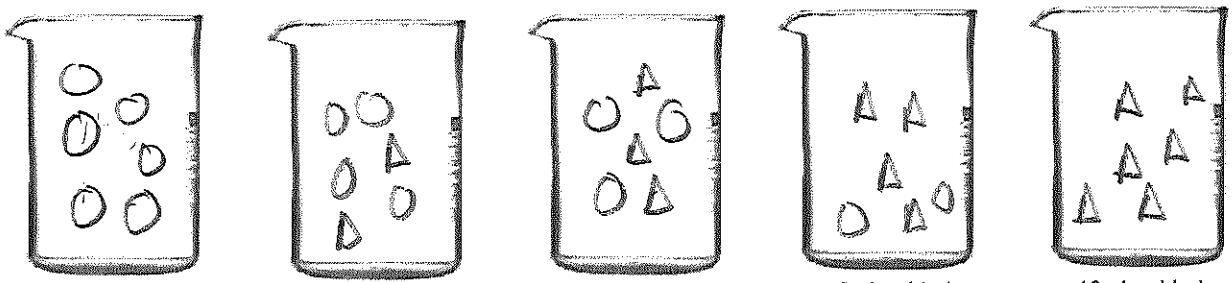
d. At 8mL will the solution be (basic, acidic, neutral)?

Only NH_4^+

↓

WEAK acid

e. To the best of your ability draw the following beaker at different times of the neutralization.



0 ml added | 2 ml added | 4 ml added | 8mL added | 10mL added

$O = NH_3$

$\Delta = NH_4^+$