## Neutralization & Titrations



## Neutralization Reactions

- _____ – acid + base → a salt + water
- Neutralization reactions are just a special type of double replacement reactions

## Neutralization Reactions

- Write the equations for the following neutralization reactions
- Acetic acid and ammonium hydroxide
- Nitric acid and cesium hydroxide

## Acid base Titrations

- _____– a method for determining the concentration of a solution by reacting a volume of a solution of known concentration with a volume of an unknown concentration
- Know that titrating means reacting. You must write a reaction
- Titrations are just limiting reactant problems. Use ICE table with mmol & HH equation

## Steps for a titration

1. A measured volume of the unknown concentration of the acid is placed in a beaker with a few drops of indicator or a pH meter
2. A buret is filled with the titrating solution of known concentration. This is called the _____ solution
3. A measured volume of the standard solution is slowly added to the beaker of unknown concentration
4. This continues until the _____ point is reached
   - **Equivalence point** – point where the # moles H+ = # moles of OH-

## Titrations

- You can use a pH meter or an indicator
- _____– chemical dye whose color changes according to the pH
- If using an indicator, the point at which the solution changes color is called the _____

## Titrations (SA & SB)

- What is the molarity of a nitric acid solution if 43.33 ml of 0.100M KOH is needed to neutralize 20.00 ml of an unknown concentration of $HNO_3$?

## Titrations (SA & SB)

- Calculate the concentration of $H_2SO_4$ if 50.0 ml of 0.1 M NaOH is added to 25.0 ml of an unknown concentration of $H_2SO_4$.

## Indicators

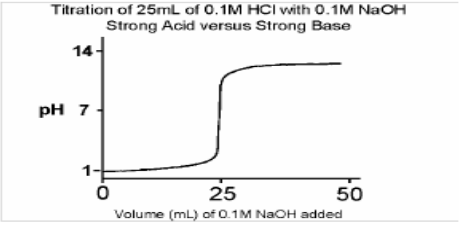
- An acid base indicator is a substance that changes color according to the pH of the solution.

| | pH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Methyl orange | R | R | R | R | * | * | Y | Y | Y | Y | Y | Y | Y | Y |
| Methyl red | R | R | R | R | R | * | * | Y | Y | Y | Y | Y | Y | Y |
| Litmus | R | R | R | R | R | R | * | * | B | B | B | B | B | B |
| Phenolphth alein | C | C | C | C | C | C | C | C | * | * | R | R | R | R |
| Thymolphth alein | C | C | C | C | C | C | C | C | C | C | * | * | B | B |

Where R = RED, B = BLUE, Y = YELLOW, C = COLOURLESS, * = the pH range where the color change takes place.

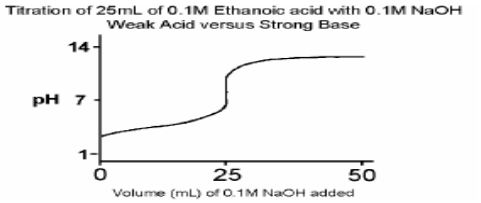
## Titration Curves

**Strong Acid titrated with Strong Base**



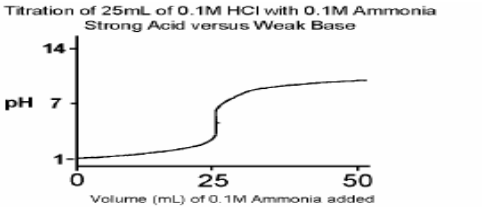

## Titration Curves

**Weak Acid titrated with Strong Base**



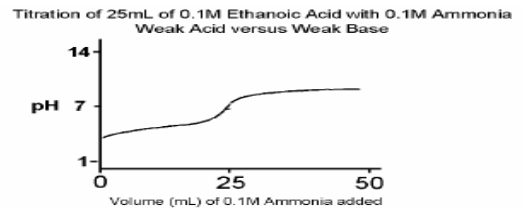

## Titration Curves

**Strong Acid titrated with Weak Base**



## Titration Curves

**Weak Acid titrated with Weak Base**




## Choice of Indicators

- The equivalence point represents the point at which equimolar amounts of acid and base have reacted and is located in the middle of the vertical portion of the titration curve.
- Since in an acid/base titration we need to find the equivalence point, we must choose an indicator that changes color (reaches the end point) over the pH range of the sharp vertical step on each graph.

## Buffers

- _____ - solution that resists changes in pH when small amounts of acid or base are added
- A buffer is a mixture of a weak acid and its conjugate base
- Or
- A weak base and its conjugate acid
- _____– the amount of acid or base that the buffer can neutralize before the pH begins to change

## pH of Buffers

- To calculate the pH of an acidic buffer use the Henderson Hasselbalch equation
- pH = pKa + log ([salt]/[acid])
- pH = pKa + log ([acid]/[base])
- pOH = pKb + log ([salt]/[base])
- pH = pKb + log ([base]/[acid])

## pH of Buffers

- A 0.100 M solution of ethanoic acid ($K_a$ = 1.80 x $10^{-5}$) is mixed with a solution of 0.100 M potassium ethanoate. Calculate the pH of the resulting solution.

## Titration (SA & WB)

- What is the pH when 20.0 ml of 0.25 M HCl is reacted with 20.0 ml of 0.35 M $NaNO_2$?

## Example

- What is the pH when 15 ml of 0.20 M $HNO_3$ is added to a buffer that contains 50.0 ml of 0.25 M $HCO_2H$ and 0.30 M $NaCO_2H$ (Ka $HCO_2H$ = 1.8 x $10^{-4}$)

## Example

- What is the pH when 15 ml of 0.20 M NaOH is added to a buffer that contains 50.0 ml of 0.25 M $HCO_2H$ and 0.30 M $NaCO_2H$ (Ka $HCO_2H$ = 1.8 x $10^{-4}$)

## Example

- What is the pH when 40.0 ml of 0.25 M NaOH is added to a buffer that contains 100.0 ml of 0.40 M ethylamine ($C_2H_5NH_2$) and 0.40 M ethyl ammonium chloride ($C_2H_5NH_3Cl$) (Kb $C_2H_5NH_2$ = 4.38 x $10^{-4}$).

## Example

- What is the pH when 40.0 ml of 0.25 M NaOH is added to 20.0 ml of 0.50 M $HC_2H_3O_2$ (Ka $HC_2H_3O_2$ = 1.5 x $10^{-5}$).

## Example

- What is the pH when 20.0 ml of 0.20 M $CH_3NH_2$ is mixed with 10.0 ml of 0.20 M $HNO_3$ (Kb = 4.38 x $10^{-24}$).

## Example

- What is the pH when 20.0 ml of 0.20 M $CH_3NH_2$ is mixed with 20.0 ml of 0.20 M $HNO_3$ (Kb $CH_3NH_2$ = 4.38 x $10^{-4}$).

## Example

- What is the pH when 20.0 ml of 0.20 M $CH_3NH_2$ is mixed with 24 ml of 0.20 M $HNO_3$ (Kb $CH_3NH_2$ = 4.38 x$10^{-4}$).

## Often on AP test…

- ½ the volume of the equivalence point the pH will = the pKa