Neutralization Reactions

Remember double replacement reactions?

+1 -1 +1 -1

HCl + NaOH → ???

HCl + NaOH → NaCl + HOH

acid base salt water

Acid + Base --> Salt + water

May 10-7:53 AM

Neutralization Reactions

HCl + NaOH → NaCl + HOH

- *Acids and bases are opposite each other*
  > *acids donate H^+, bases accept H^+*
- *When they combine they NEUTRALIZE each other -- neither acidic nor basic anymore*

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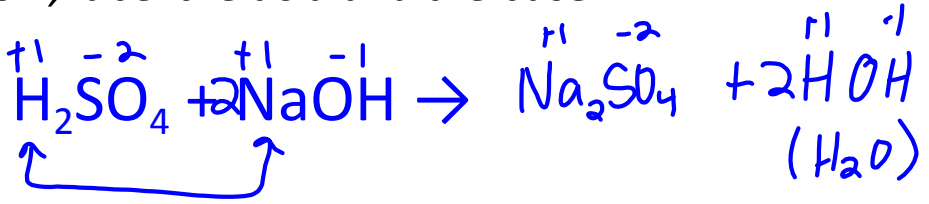
Neutralization Reactions

Practice #1

Complete and balance the neutralization reaction below, label the acid and the base:



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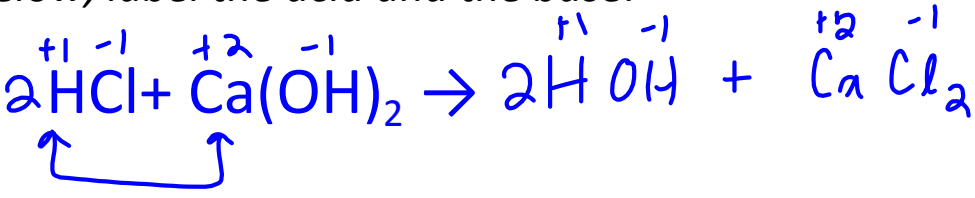
Neutralization Reactions

Practice #2

Complete and balance the neutralization reaction below, label the acid and the base:



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Neutralization Reactions

Practice #3

Complete and balance the neutralization reaction below, label the acid and the base:

$H_2SO_3 + NH_4OH \rightarrow (NH_4)_2SO_3 + 2HOH$

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Titrations

Titration: adding a *known amount of solution of known concentration* to a *solution with an unknown concentration*

****Goal: To determine the unknown concentration****

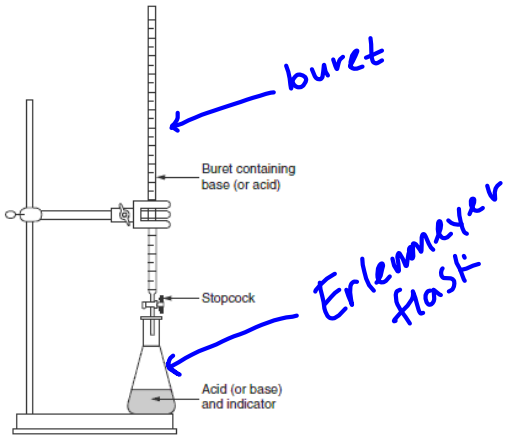

Figure 19.3 General acid–base titration set-up

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Equivalence Point

Endpoint: the point of neutralization in a titration

Equivalence point: the point where the moles of H^+ and OH^- are equal -- usually close to the endpoint (not always at pH = 7)

- > *strong acid and strong base, equivalence point pH around 7*
- > *strong acid and weak base, equivalence point pH less than 7*
- > *weak acid and strong base, equivalence point pH greater than 7*

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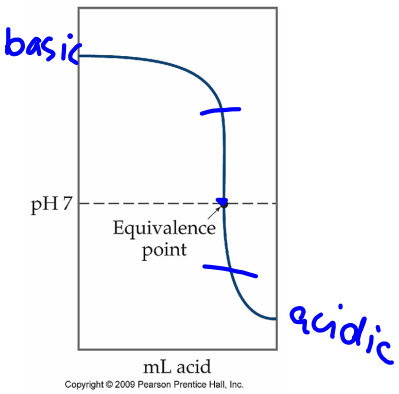
Equivalence Point

How do we know we reached the endpoint in a titration?

We can use an indicator and look for a color change!

OR

We use a graph.



Titration

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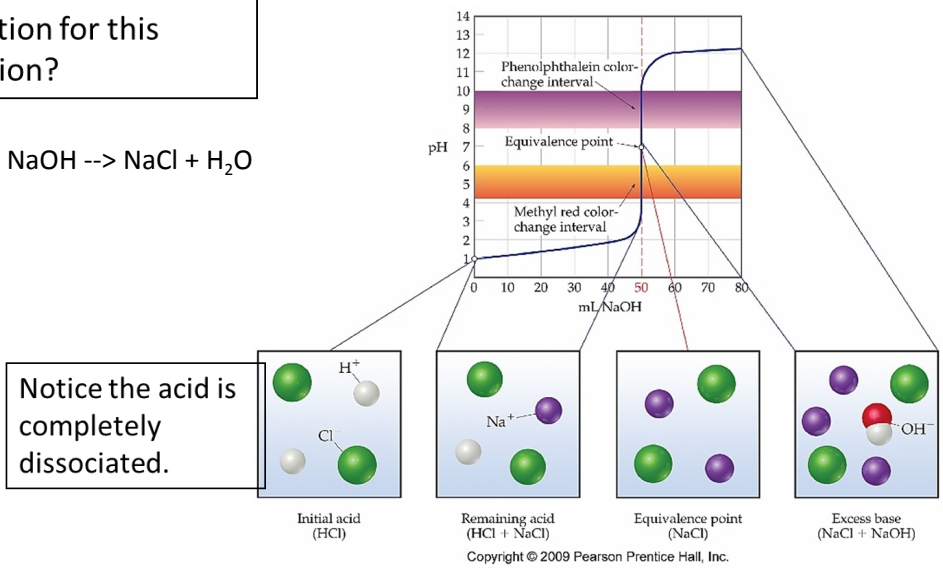
Equivalence Point and Ions

HCl and NaOH

What is the balanced equation for this reaction?

HCl + NaOH --> NaCl + H_2O



Notice the acid is completely dissociated.

Notice the equivalence point. What is the mole ratio?

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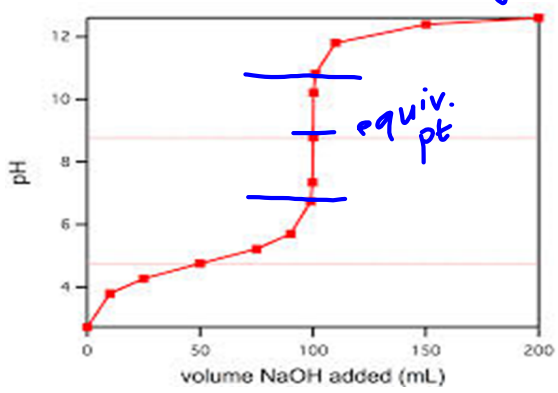
Equivalence Point and Ions

HCl and NaOH

- Look at the vertical part of the graph.
- Draw a line at the top of the vertical part.
- Draw a line at the bottom of the vertical part.
- Half-way between the two lines is your equivalence point.

Strong base weak acid



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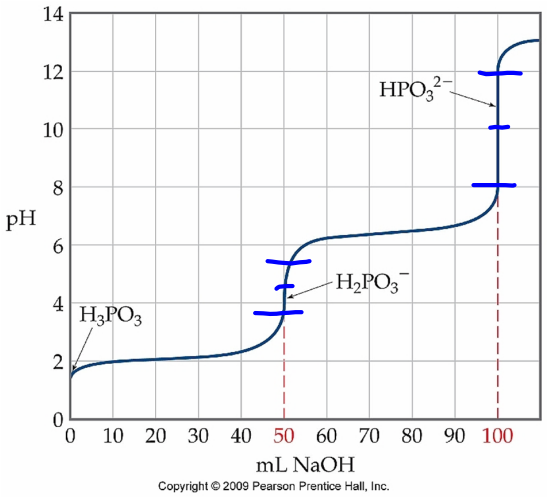
Equivalence Point and Ions

HCl and NaOH

- Look at the vertical part of the graph.
- Draw a line at the top of the vertical part.
- Draw a line at the bottom of the vertical part.
- Half-way between the two lines is your equivalence point.



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Titration Calculations

After we do the experiment, how do we determine the concentration of the known???

--- STOICH!!

Steps:

1. Write and balance the equation.
2. List what you know (vol of acid, vol of base, conc of standard, mole ratio)
3. Begin with the volume (L) of the standard solution
4. Set up dimensional analysis to determine the number of moles of the unknown (Use the known molarity and the mole to mole ratio as conversion factors)
5. Divide by the volume (L) of the unknown to find molarity of the unknown

May 10-7:53 AM

Titration Calculations

Practice #1

20.0 mL of 0.100 M HCl are titrated with 19.5 mL of an NaOH solution. What is the molarity of the NaOH solution?

1. Write and balance the equation. List what you know and don't know.

$HCl + NaOH \rightarrow NaCl + H_2O$

20.0 mL, 0.100 M ($\frac{mol}{L}$), 19.5 mL, x M – $\frac{mol}{L}$

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (NaOH)

$20.0\,mL\,HCl \times \frac{1\,L}{1000\,mL} \times \frac{0.100\,mol\,HCl}{1\,L} \times \frac{1\,mol\,NaOH}{1\,mol\,HCl} = .002\,mol\,NaOH$

3. Divide the number of moles of NaOH by the volume of NaOH to find molarity.

$\frac{.002\,mol}{.0195\,L} = 0.103\,M\,NaOH$

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Titration Calculations

Practice #2

In a titration, 33.21 mL of 0.3020 M strontium hydroxide ($Sr(OH)_2$) solution is required to exactly neutralize 20.00 mL of hydrofluoric acid solution (HF). What is the molarity of the hydrofluoric acid solution?

1. Write and balance the equation. List what you know and don't know.

$2HF + Sr(OH)_2 \rightarrow SrF_2 + 2H_2O$

20.0 mL, x M, 33.21 mL, 0.3020 M ($\frac{mol}{L}$)

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (HF)

$33.21\,mL \times \frac{1\,L}{1000\,mL} \times \frac{.3020\,mol\,Sr(OH)_2}{1\,L} \times \frac{2\,mol\,HF}{1\,mol\,Sr(OH)_2} = .0201\,mol\,HF$

3. Divide the number of moles of HF by the volume of HF to find molarity.

$\frac{.0201\,mol}{.020\,L} = 1\,M$

May 10-7:53 AM