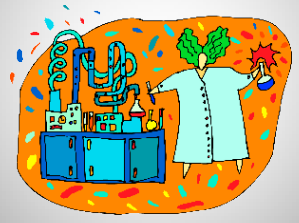
Neutralization Reactions
Mixing Acids & Bases



Acid/Base Neutralization

- A **salt** is any compound that can be derived from the neutralization of an acid and a base.
- The word "**neutralization**" is used because the acid and base properties of H+ and OH- are destroyed or neutralized.
- In the reaction, H+ and OH- combine to form HOH or H_2O (water molecules).
- A neutralization reaction is a type of ***double replacement*** reaction.

Writing neutralization equations

When acids and bases are mixed, a salt forms

$NaOH + HCl \rightarrow H_2O + NaCl$

base + acid → water + salt

The cation (metal) from the base and the anion from the acid join to form the salt. The OH from the base and the H from the acid join to form water .

Writing neutralization equations

Example: Write the chemical reaction when lithium hydroxide is mixed with carbonic acid.

Step 1: write out the reactants

$LiOH + H_2CO_3 \rightarrow$

Step 2: determine products…(make sure the salt is written with correct subscripts! Refer to Oxidation Chart.)

H_2O Li_2CO_3 (+1, −2)

Remember the "criss-cross" method from Chapter 20.

$LiOH + H_2CO_3 \rightarrow Li_2CO_3 + H_2O$

Writing neutralization equations

Step 3: balance the equation

Remember balancing equations… Ch. 21 (use coefficients only)

$2LiOH + H_2CO_3 \rightarrow Li_2CO_3 + 2H_2O$

lithium hydroxide + carbonic acid → lithium carbonate + water

Writing neutralization equations

Example: Complete the neutralization reaction…

$Ca(OH)_2 + H_2SO_4 \rightarrow$

Step 1: already completed for you

$Ca(OH)_2 + H_2SO_4 \rightarrow$

Step 2: determine products…(make sure the salt is written with correct subscripts! Refer to Oxidation Chart.)

H_2O + $CaSO_4$ (+2, −2)

Charge of cation equals the charge of the anion…no need to add subscripts.

Writing neutralization equations

Step 3: balance the equation

Remember balancing equations… Ch. 21 (use coefficients only)

$Ca(OH)_2 + H_2SO_4 \rightarrow 2H_2O + CaSO_4$

calcium hydroxide + sulfuric acid → calcium sulfate + water

Writing neutralization equations

Example: Complete the neutralization reaction…

iron(II) hydroxide + phosphoric acid

Step 1: write out the reactants …(make sure the acid and base are written with correct subscripts! Oxidation Chart.)

Think "criss-cross" Method.

$Fe(OH)_2 + H_3PO_4 \rightarrow$

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Writing neutralization equations

Step 2: determine products…(Is the salt written with correct subscripts? Oxidation Chart.)

$Fe(OH)_2 + H_3PO_4 \rightarrow$

$H_2O + Fe_3(PO_4)_2$

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Step 3: balance the equation

Remember balancing equations… Ch. 21 (use coefficients only)

$3Fe(OH)_2 + 2H_3PO_4 \rightarrow 6H_2O + Fe_3(PO_4)_2$

iron II hydroxide + phosphoric acid → iron II phosphate + water

Practice

Write balanced chemical equations for these neutralization reactions.

1) $Ba(OH)_2 + HCl$
2) calcium hydroxide + nitric acid
3) $Al(OH)_3 + H_2SO_4$
4) $KOH + HClO_2$

a) $Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$

barium hydroxide + hydrochloric acid → barium chloride

b) $Ca(OH)_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2H_2O$

calcium hydroxide + nitric acid → calcium nitrate

c) $2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$

aluminum hydroxide + sulfuric acid → aluminum sulfate

d) $KOH + HClO_2 \rightarrow KClO_2 + H_2O$

potassium hydroxide + chlorous acid → potassium chlorite

Titration

Titration-process of determining the concentration of an acid or a base

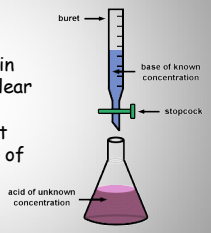
Phenolphthalein has two chemical forms. In acidic conditions it is colorless. In basic conditions it turns red.

An indicator is added to the solution being titrated. The indicator is a substance that changes color when the reaction is complete. Phenolphthalein, which is a commonly used acid-base indicator, is added to the acid solution in a flask.

Titration

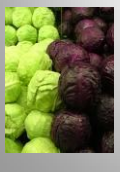
Titration Animation

Slowly and carefully, the base is added to the acid/phenolphthalein mix. When the mix turns from clear to red, the acid has been neutralized by the base. At that point you know exactly how much of the base solution it took to neutralize the acid.



Natural Indicator

Hydrangeas are natural indicators. When the pH of the soil is acidic, they produce blue blossoms. When the pH of the soil is basic, pink blossoms.



Cabbage is another natural indicator. When acidic, deep red color; when neutral, lavender; when basic, yellow-green.

Applying Science

You have learned that neutralization reactions change acids and bases into salts. Antacids typically contain small amounts of $Ca(OH)_2$, $Al(OH)_3$, or $NaHCO_3$, which are bases. The base in the antacid is meant to neutralize the excess acid in your stomach causing your tummy ache.

1) What compounds are produced from a reactions of HCl and $Mg(OH)_2$?

2) Why is it important to have some acid in your stomach?

3) How could you compare how well antacid products neutralize acid? (Hint: Titrations?!) What procedure could you use?

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