More reaction types... combustions and acid/base neutralizations

Combustion reactions

$$C_xH_y + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(I)} + E$$

If the hydrocarbon contains nitrogen as well...

$$C_x H_y N_z + O_{2(g)} \rightarrow CO_{2(g)} + H_2 O_{(I)} + N_{2(g)}$$

Acid/Base Neutralization

- Hydroxide base general form Acid + Base \rightarrow Salt + H₂O
- what's actually happening?

$H^+ + OH^- \rightarrow H_2O$

Salt = the anion from the acid
 + the cation from the base

Acid + hydroxide base...

Example: NaOH + HCl \rightarrow

1. Write H₂O as a product

 $NaOH + HCI \rightarrow H_2O$

Acid + hydroxide base...

<u>Example:</u> NaOH + HCl \rightarrow

2. Form the salt from the remainders of the acid and base

$NaOH + HCI \rightarrow H_2O + Na^+CI^-$

Acid + hydroxide base...

<u>Example:</u> NaOH + HCl \rightarrow

3. Balance the charges in the salt NaOH + HCl \rightarrow H₂O + NaCl

4. Balance the equation NaOH + HCl \rightarrow H₂O + NaCl

<u>Acid + hydroxide base...</u> <u>Example:</u> $H_2SO_4 + AI(OH)_3 \rightarrow$

1. Write H₂O as a product

$H_2SO_4 + AI(OH)_3 \rightarrow H_2O$

Acid + hydroxide base...

Example: $H_2SO_4 + Al(OH)_3 \rightarrow$

2. Form the salt from the remainders of the acid and base

 $H_2SO_4 + AI(OH)_3 \rightarrow H_2O + AI^{3+}SO_4^{2-}$

Acid + hydroxide base...

Example: $H_2SO_4 + Al(OH)_3 \rightarrow$

- 3. Balance the charges in the salt $H_2SO_4 + Al(OH)_3 \rightarrow H_2O + Al_2(SO_4)_3$
- 4. Balance the equation $3H_2SO_4 + 2Al(OH)_3 \rightarrow Al_2(SO_4)_3 + 6H_2O$

Acid/Base Neutralization

- carbonate base general form
- Acid + Base $(CO_3^2 \text{ or } HCO_3^-) \rightarrow Salt + H_2O + CO_2$
- what's actually happening? $2H^+ + CO_3^{2-} \rightarrow H_2CO_3$ $H_2CO_3 \rightarrow H_2O + CO_2$
- Salt = the anion from the acid
 + the cation from the base

Acid + carbonate base... Example: $CaCO_3 + HCI \rightarrow$

1. Write $H_2O + CO_2$ as products

$CaCO_3 + HCI \rightarrow H_2O + CO_2$

Acid + carbonate base... Example: $CaCO_3 + HCI \rightarrow$

2. Form the salt from the remainders of the acid and base

 $CaCO_3 + HCI \rightarrow H_2O + CO_2 + Ca^{2+}CI^{-}$

Acid + carbonate base...

<u>Example:</u> $CaCO_3 + HCl \rightarrow$

3. Balance the charges in the salt $CaCO_3 + HCI \rightarrow H_2O + CO_2 + CaCl_2$

4. Balance the equation $CaCO_3 + \underline{2}HCI \rightarrow H_2O + CO_2 + CaCl_2$

<u>Acid + carbonate base...</u> <u>Example:</u> H_2SO_4 + NaHCO₃ →

1. Write $H_2O + CO_2$ as products $H_2SO_4 + NaHCO_3 \rightarrow H_2O + CO_2$

Acid + carbonate base...

Example: $H_2SO_4 + NaHCO_3 \rightarrow$

2. Form the salt from the remainders of the acid and base

 $H_2SO_4 + NaHCO_3 \rightarrow H_2O + CO_2 + Na^+SO_4^{2-}$

Acid + carbonate base...

Example: $H_2SO_4 + NaHCO_3 \rightarrow$

- 3. Balance the charges in the salt
 - $H_2SO_4 + NaHCO_3 \rightarrow H_2O + CO_2 + Na_2SO_4$

4. Balance the equation

 $H_2SO_4 + 2 \text{ NaHCO}_3 \rightarrow 2 H_2O + 2 CO_2 + Na_2SO_4$

What reaction would be the best choice to make...

An insoluble ionic compound?

- Double replacement
- But remember...
 - -Both reactants must be aqueous solutions
 - You CANNOT use an insoluble compound as a reactant
 - -The other product MUST be soluble

A soluble ionic compound?

• Double Replacement

-IF...The other product is insoluble

Acid/Base Neutralization

- -But remember...
 - the reactants must be an acid and a base
 - The other product must be water or water and CO₂

A free element?

- Single Replacement
 - -But remember...
 - —the element must start as part of the compound in the reactants
 - -the reactant free element must be able to replace the desired element out of the compound
 - -Watch out for metals that react with water

H₂ gas?

Single replacement

-IF... the free element metal reacts with water or an acid

$M + HX \rightarrow H_2 + MX$ $M + H_2O \rightarrow H_2 + MOH$

Water?

Combustion

– IF...You have a hydrocarbon to burn

- Acid/Base Neutralization
 - -But remember...
 - the reactants must be an acid and a base
 - The other product must be a salt (and maybe CO₂ if the base is a carbonate)

CO₂ gas?

Combustion

-IF...You have a hydrocarbon to burn

Acid/Base Neutralization

- -But remember...
 - the reactant base must be a carbonate or bicarbonate