CLASSIFYING REACTIONS

3 COMBUSTION REACTIONS

- Reactions of substances with MOLECULAR OXYGEN (O_2) to form OXIDES.
- Combustion forms an OXIDE of EACH ELEMENT in the burned substance!

- Form: $\boxed{AB + O_2 \longrightarrow AO + BO}$

Oxide: a compound containing OXYGEN and one other element!

* Combustion of hydrocarbons makes carbon dioxide and water, if enough oxygen is present. In low-oxygen environments, carbon monoxide is made instead!

Examples:

Oxides!

* $C_3H_8(g) + 5O_2(g) \longrightarrow 4H_2O(g) + 3CO_2(g)$

$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

This reaction can also be called a combination!
Two reactants form a single product.

CLASSIFYING REACTIONS

4 SINGLE REPLACEMENT REACTIONS

- Reactions where one element REPLACES another element in a compound.
- Can be predicted via an ACTIVITY SERIES (more on that later!)
- Form: $\boxed{A + BC \longrightarrow AC + B}$ "A" and "B" are elements., often metals.
- Easy to spot, since there is an element "by itself" on each side of the equation.

Examples:

$$\overset{0}{Cu}(s) + 2\,\overset{+1}{Ag}NO_3(aq) \longrightarrow \overset{+2}{Cu}(NO_3)_2(aq) + 2\,\overset{0}{Ag}(s)$$

$$\overset{0}{Zn}(s) + \overset{+1}{H}_2SO_4(aq) \longrightarrow \overset{+2}{Zn}SO_4(aq) + \overset{0}{H}_2(g)$$

* Single replacement reactions are all examples of ELECTRON TRANSFER or OXIDATION-REDUCTION chemistry!

CLASSIFYING REACTIONS

5 DOUBLE REPLACEMENT REACTIONS

- Also called "exchange" reactions
- The ions in two ionic compounds (one compound may also be an acid) EXCHANGE PARTNERS, forming two new compounds.
- Form: $\boxed{AB + CD \longrightarrow AD + CB}$

"A" and "C" are CATIONS
"B" and "D" are ANIONS

- Can be predicted based on the characteristics of the potential products (More on that later!)
- Occur in AQUEOUS SOLUTION
- Do not involve electron transfer.

Examples:

Precipitation!

$$3MgCl_2(aq) + 2Na_3PO_4(aq) \longrightarrow Mg_3(PO_4)_2(s) + 6NaCl(aq)$$

$$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$$

DOUBLE REPLACEMENT (EXCHANGE) REACTIONS

$$AB + CD \longrightarrow AD + CB$$

In exchange reactions, ions switch partners to make new compounds!

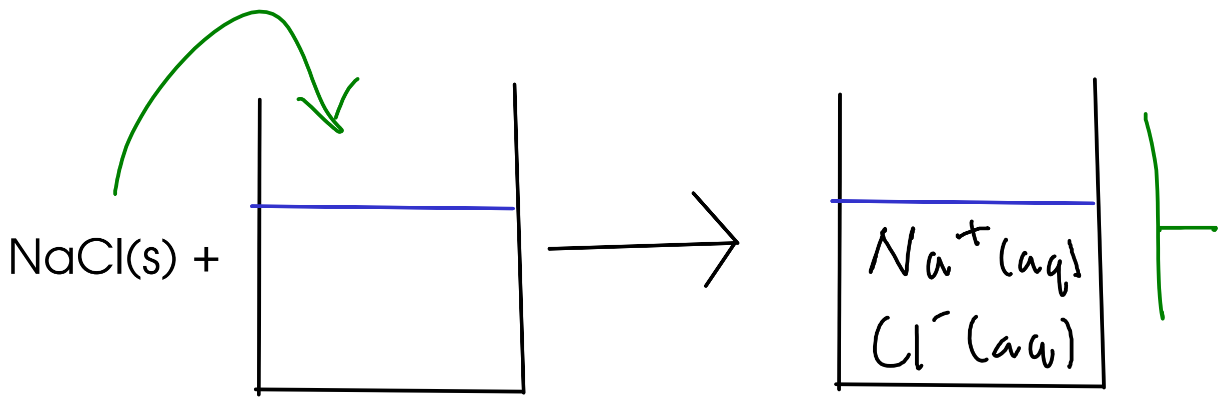
... but HOW do they switch partners?

1. Exchange reactions almost always take place in AQUEOUS SOLUTION

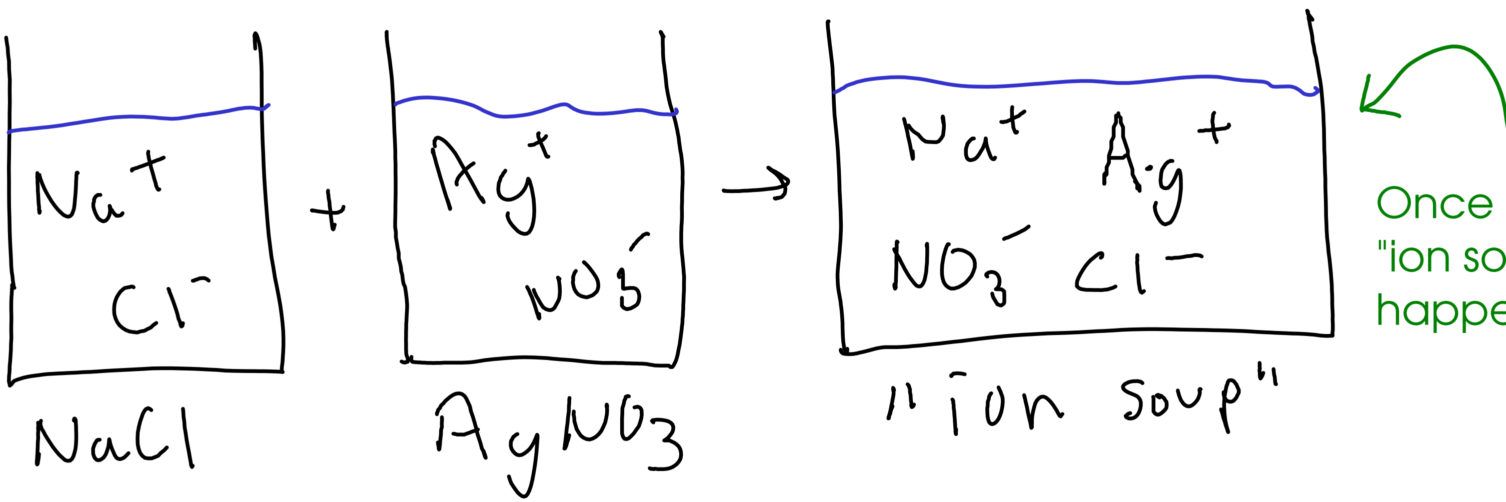
2. In aqueous solution, IONIC THEORY applies!

IONIC THEORY OF SOLUTIONS

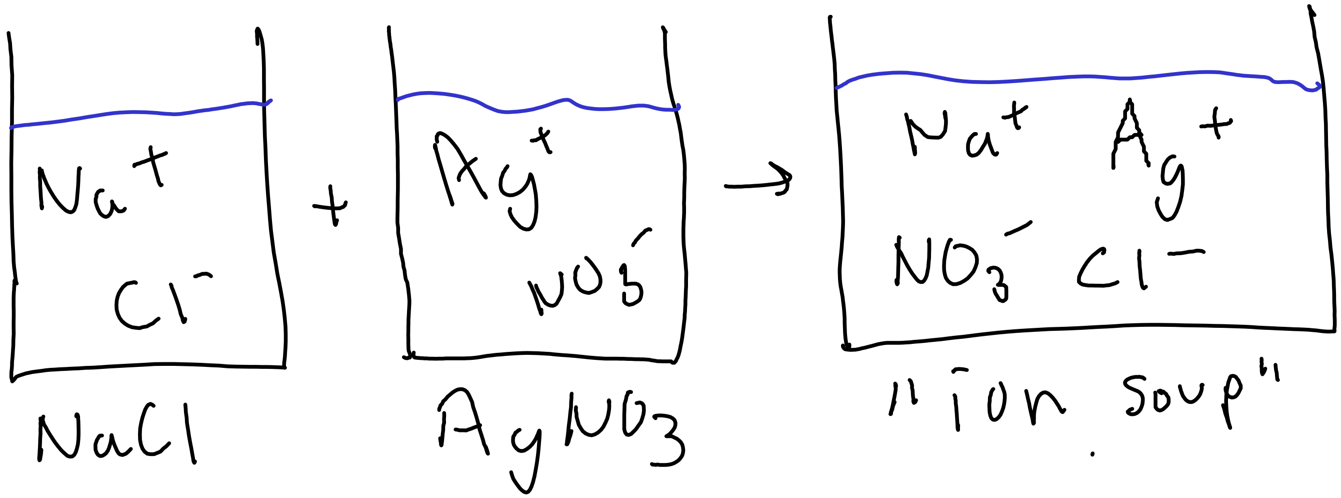
- Briefly, ionic theory states that certain substances (like soluble ionic componds) break apart into their component ions when dissolved in water!



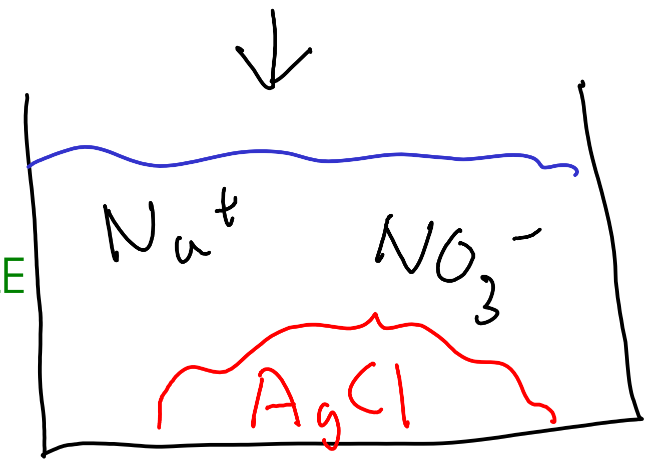
NaCl breaks apart into independent sodium and chloride ions!



Once you have "ion soup", what happens next?



When silver and chloride ions meet, they form an INSOLUBLE compound, silver(I) chloride. This falls out of the solution



"precipitate"

$$NaCl(aq) + AgNO_3(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$$

Formation of AgCl drives this reaction!

For an exchange reaction to proceed, there must be something (a new product) DRIVING the reaction.

3 kinds of exchange chemistry:

1 Reactions that form PRECIPITATES (insoluble ionic compounds)

2 Reaction that form STABLE MOLECULES like water

- if water forms, reaction is called "neutralization"

3 Reactions that form UNSTABLE MOLECULES that break down into other small molecules, often gases.

If any of these three possibilities form from the "ion soup", a reaction will occur.

If not, NO reaction occurs.

PRECIPITATION

Experiment 11 in your laboratory involves EXCHANGE REACTIONS!

- Form an insoluble ionic compound

$MgCl_2(aq) + Na_3PO_4(aq) \rightarrow$???

Ions: Mg^{2+} Cl^- Na^+ PO_4^{3-}

Potential products:

$$\frac{Na^+ \quad Cl^-}{NaCl}$$

$$\frac{\begin{matrix} Mg^{2+} & PO_4^{3-} \\ Mg^{2+} & PO_4^{3-} \\ Mg^{2+} & \end{matrix}}{Mg_3(PO_4)_2}$$

Remember, IONS exchange partners. That means that you need to write out the IONS, including their charges, and pair them up. The formulas of the products are controlled by the CHARGES of the IONS in the new compounds!

$$3MgCl_2(aq) + 2Na_3PO_4(aq) \rightarrow \underline{\underline{Mg_3(PO_4)_2}}(s) + 6NaCl(aq)$$

(Table 7.1)

- Does a solid (insoluble) ionic compound form? Check DATA (p 172 in book)

* When writing exchange reactions, figure out the formulas of the products FIRST, and THEN balance the equation.