CLASSIFYING REACTIONS

- It's simpler to talk about different reactions if we can classify them into a small number of classes.

- We will discuss five classes of chemical reaction. (You mey learn additional ways to classsify reactions in more advanced chemistry courses!)

1 COMBINATION REACTIONS

- Reactions that involve two or more simple substances COMBINING to form a SINGLE product

- Often involve large energy changes. Sometimes violent!

- Form: $A + B + \ldots \longrightarrow C$

Example:

$$2\,Al(s) + 3\,Br_2(l) \longrightarrow 2\,AlBr_3(s)$$

CLASSIFYING REACTIONS

2 DECOMPOSITION REACTIONS

- Reactions where a SINGLE REACTANT breaks apart into several products

- Form: $A \longrightarrow B + C + \ldots$

Example:

$$2\,H_2O_2(\ell) \longrightarrow 2\,H_2O(\ell) + O_2(g)$$

* This reaction is NOT a combustion reaction, even though O_2 is involved!

* Combustion reactions CONSUME O_2, while this reaction PRODUCES O_2

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: $AB + O_2 \longrightarrow AO + BO$

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: $A + BC \longrightarrow AC + B$

"A" and "B" are elements., often metals.

- Easy to spot, since there is an element "by itself" on each side of the equation.

Examples:

$$Cu(s) + 2AgNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

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: $AB + CD \longrightarrow AD + CB$

"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

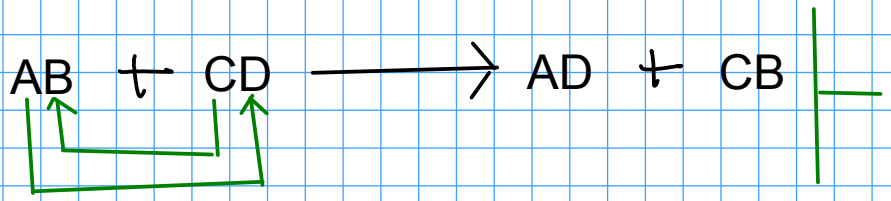
Examples:

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



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

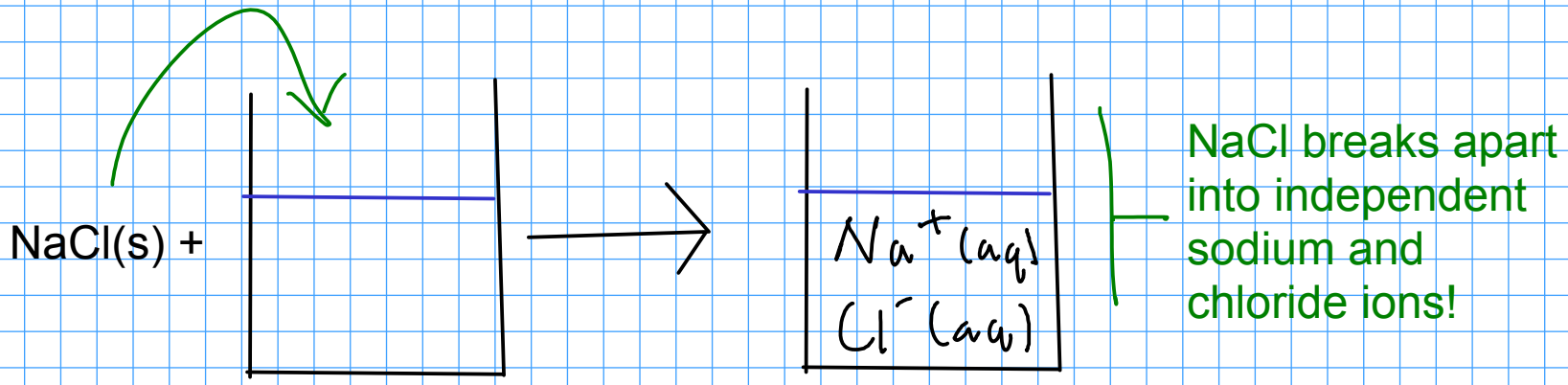
... but HOW do they switch partners?

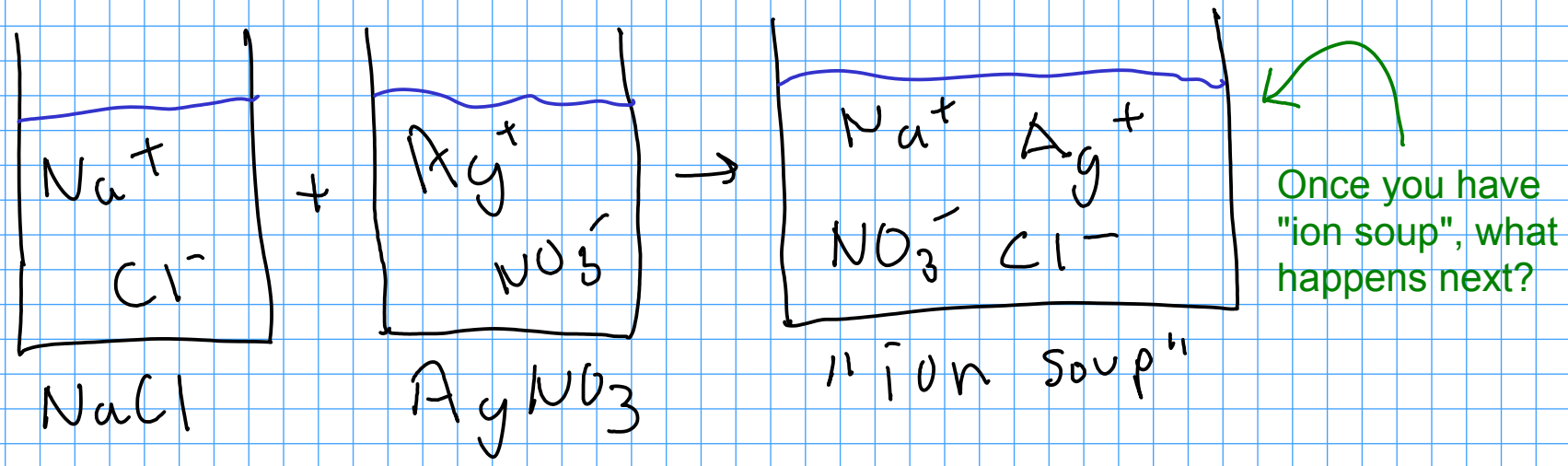
1. Exchange reactions almost always take place in AQUEOUS SOLUTION

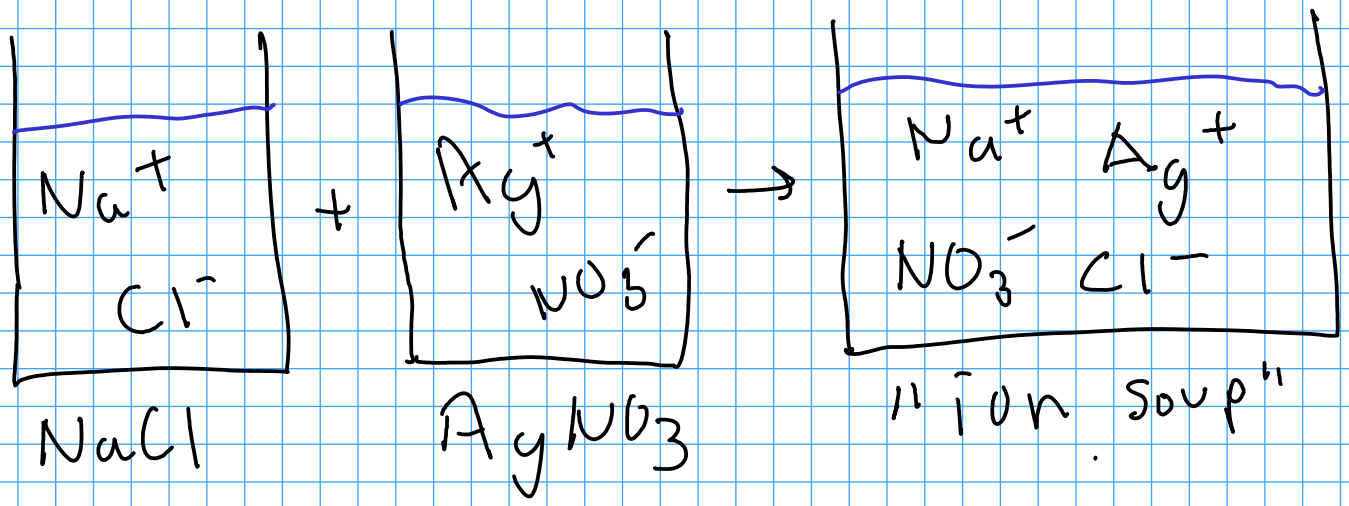
2. In aqueous solution, IONIC THEORY applies!

IONIC THEORY OF SOLUTIONS

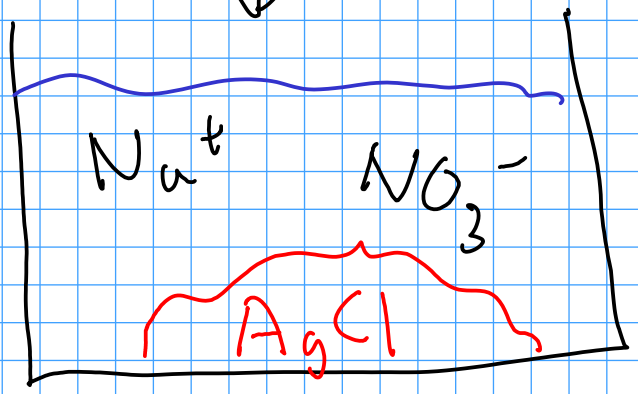
- Briefly, ionic theory states that certain substances (like soluble ionic componds) break apart into their component ions when dissolved in water!







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



"precipitate"

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

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.