# BALANCING

$$3\,MgCl_2 + 2\,Na_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6\,NaCl$$

$$C_2H_2 + \frac{5}{2}O_2 \rightarrow 2\,CO_2 + H_2O$$

4      1

5

... to get a SINGLE oxygen atom from molecular oxygen, we need half of a molecule. So, to get 5 oxygen atoms, we need 5/2 molecules!

To get rid of the fraction, multiply ALL coefficients by the denominator (2)

$$2\,C_2H_2 + 5\,O_2 \rightarrow 4\,CO_2 + 2\,H_2O$$

$$H_2SO_4 + 2\,NaOH \rightarrow Na_2SO_4 + 2\,H_2O$$

H: 2+2=4      H: ~~2~~ 4

O: 4+2=6      O: 4+2=6

... initially, we will skip hydrogen and oxygen because they appear in more than one compound on each side of the equation!

# IDENTIFYING REACTIONS

You may see one or more of these signs when a chemical reaction occurs

1. - A change in temperature that can't be explained in another way.
2. - Emission of light that can't be explained in another way
3. - The formation of a solid - or PRECIPITATION - in a previously liquid solution. (Not a simple phase change!) or gas formation.
4. - Color change (not simply lightening of color caused by diluting a solution!)

# CLASSIFYING REACTIONS

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

- Most of these reaction classes are reactions that involve TRANSFER OF ELECTRONS from one atom to another. The LAST class or reactions we will discuss does NOT involve electron transfer!

## (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: $A \longrightarrow B + C + ...$

Example:

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

* 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.

## 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 ⟶ 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:

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

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

## (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

- Do not involve electron transfer.

Examples:

Precipitation!

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

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

# DOUBLE REPLACEMENT (EXCHANGE) REACTIONS

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

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

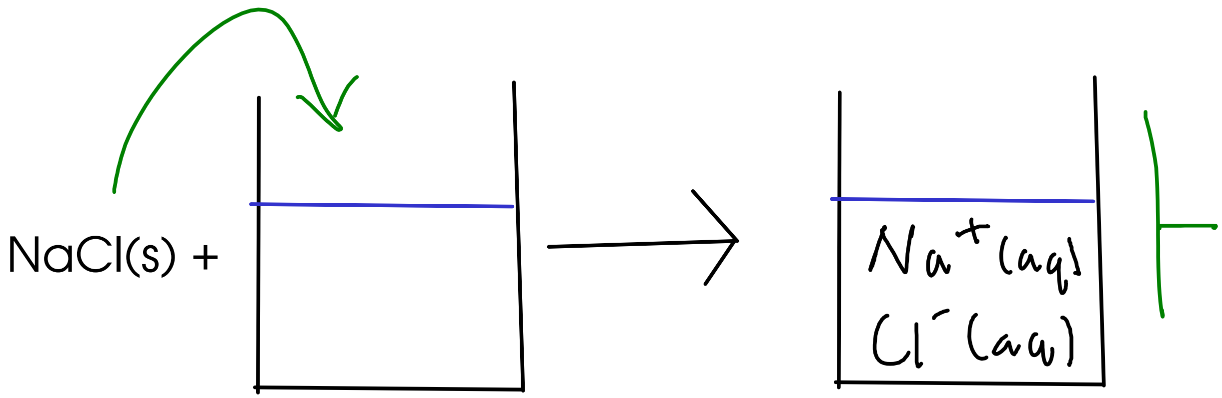
... but HOW do they switch partners?

1. Exchange reactions almost always take place in AQUEOUS SOLUTION

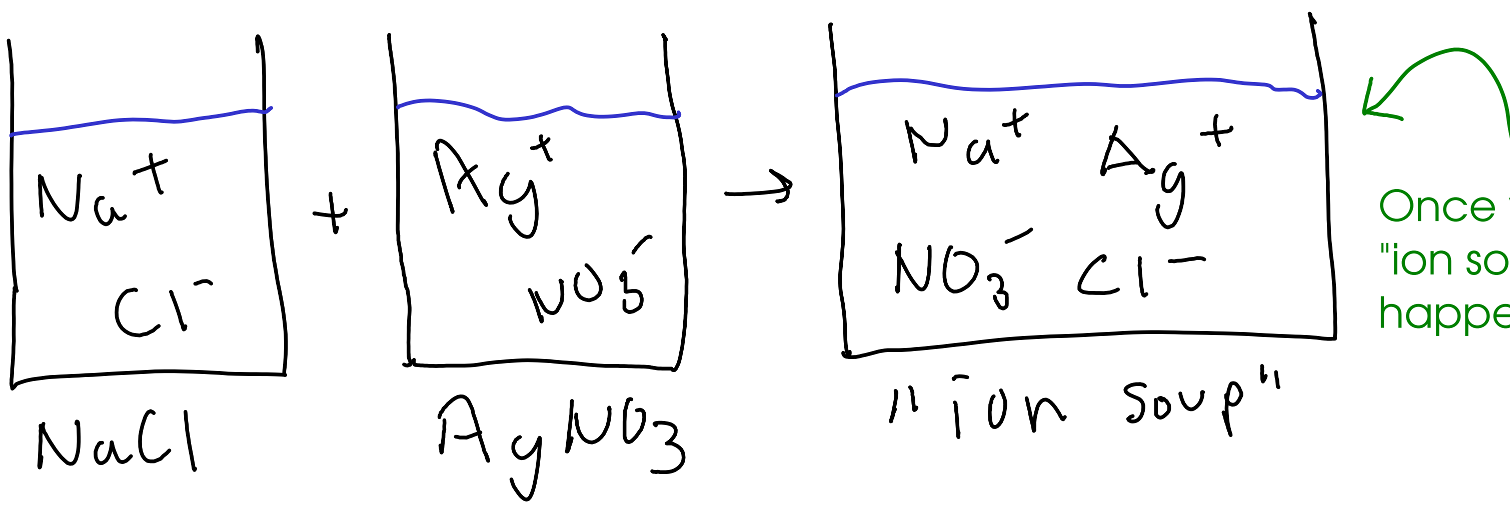
2. In aqueous solution, IONIC THEORY applies!

# IONIC THEORY OF SOLUTIONS

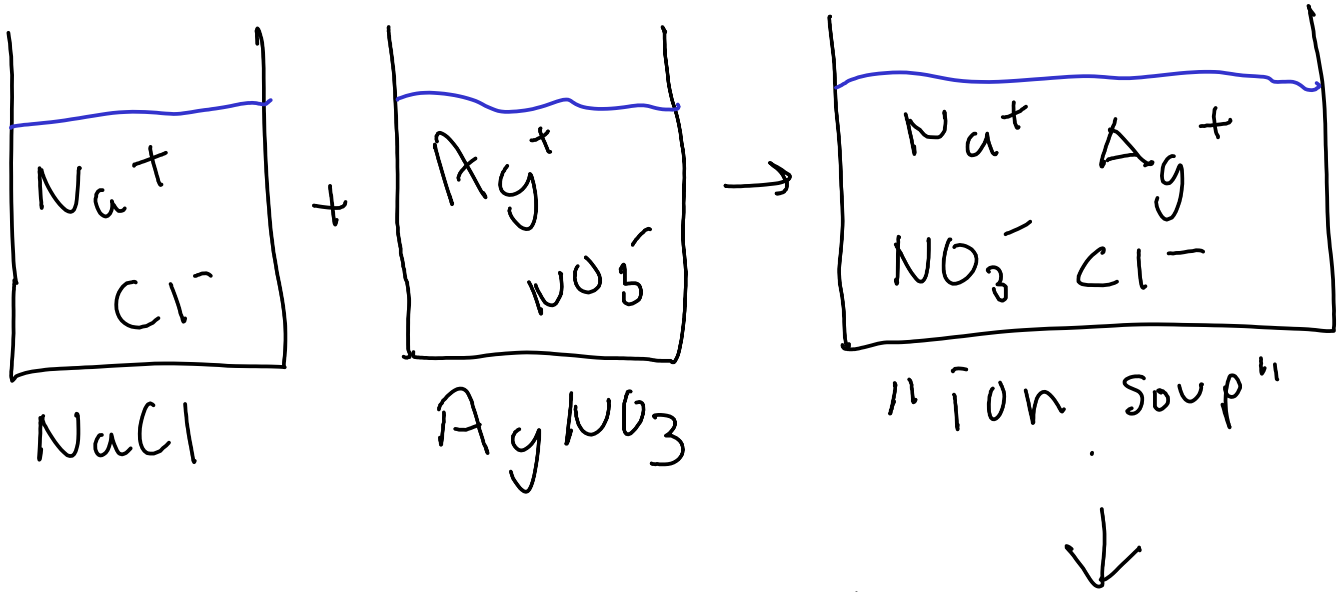
- Briefly, ionic theory states that certain substances (like soluble ionic componds) break apart into their component ions when dissolved in water!



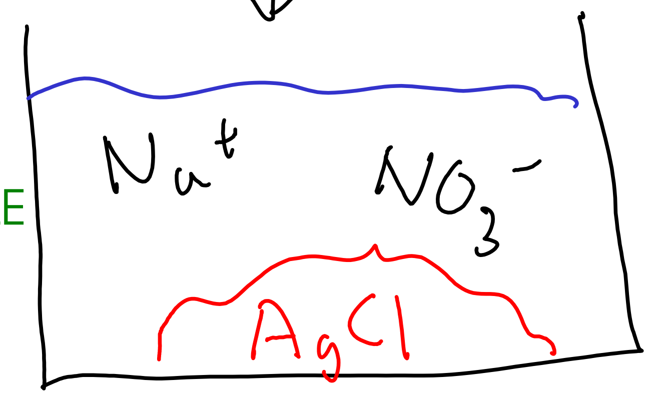

NaCl breaks apart into independent sodium and chloride ions!




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

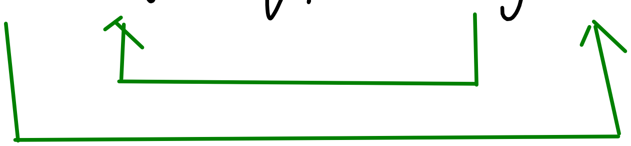



When silver and chloride ions meet, they form an INSOLUBLE compound, silver(I) chloride. This falls out of the solution




"precipitate"

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



Formation of AgCl drives this reaction!