

Exchange Chemistry

- Three kinds of exchange chemistry.

① PRECIPITATION

② ACID/BASE or NEUTRALIZATION

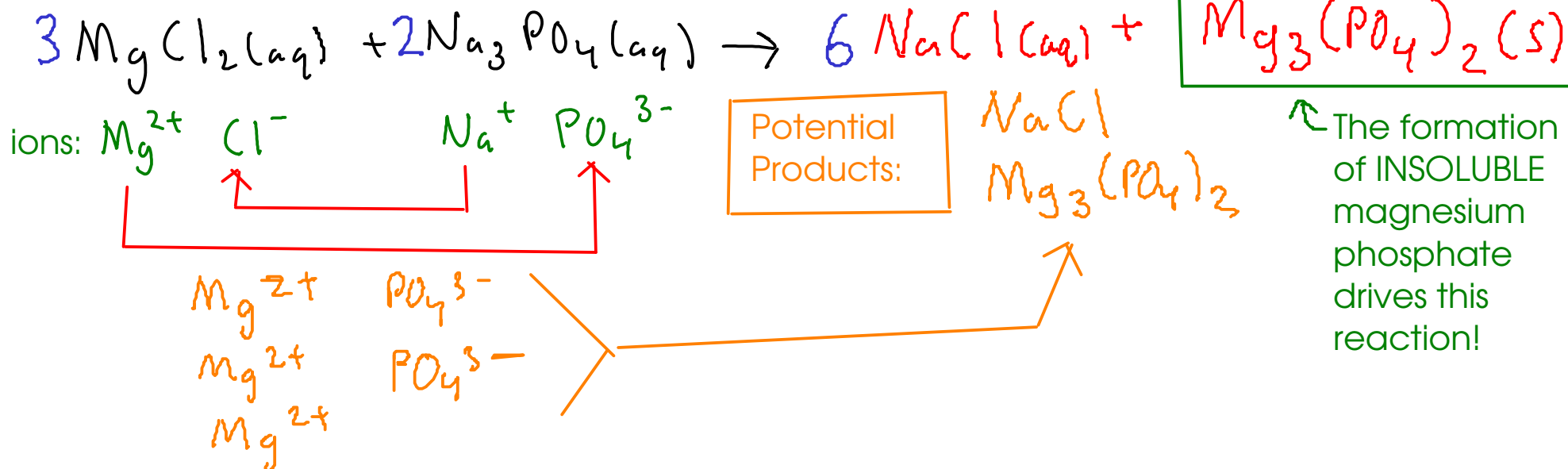
③ GAS FORMATION (formation of unstable molecules)

↳ SOME (but not all) reactions that form gases
are examples of exchange chemistry.

Just because you mix together two ionic compounds does NOT mean that a reaction will occur. You need a DRIVING FORCE for a reaction.

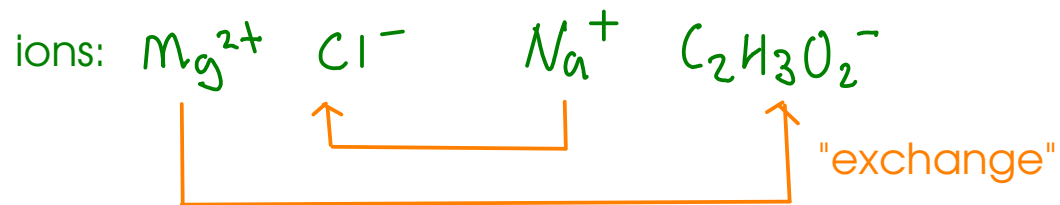
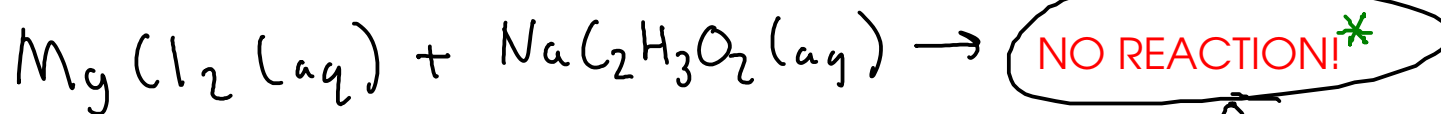
PRECIPITATION REACTIONS

- driving force is the formation of an insoluble ionic compound.



When you're trying to complete a precipitation reaction:

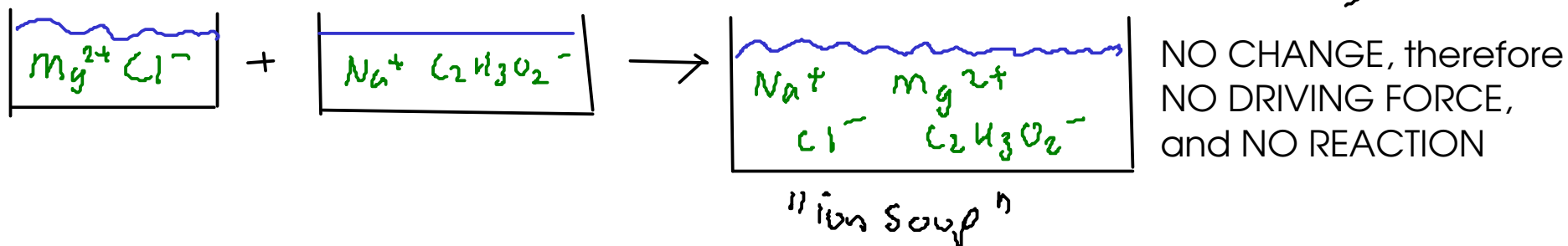
- ① Write the IONS that form when the reactants are dissolved.
- ② Make NEW compounds by pairing up cations with anions. Don't forget that the positive and negative charges must balance each other out!
- ③ Use the solubility rules to determine the PHASE of each new compound - solid or aqueous.
- ④ Balance the overall equation.



$\text{Mg}(\text{C}_2\text{H}_3\text{O}_2)_2$... dissolves in water

NaCl ... dissolves in water

So, no solid forms here. All possible combinations of these four ions result in compounds that dissolve readily in water.



* We will learn about other driving forces than the formation of solid, but these driving forces do not apply to this reaction

ACIDS

- compounds that release hydrogen ion (H^+), when dissolved in water.

Properties of acids:

- Corrosive: React with most metals to give off hydrogen gas
- Cause chemical burns on contact
- Taste sour (like citrus - citric acid!)
- Changes litmus indicator to RED

BASES

- Substances that release hydroxide ion (OH^-) when dissolved in water

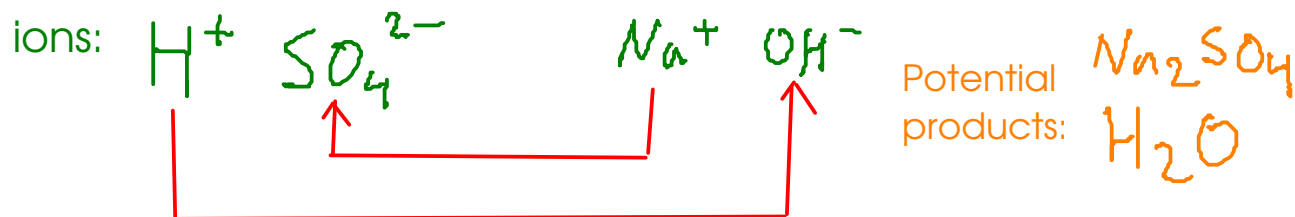
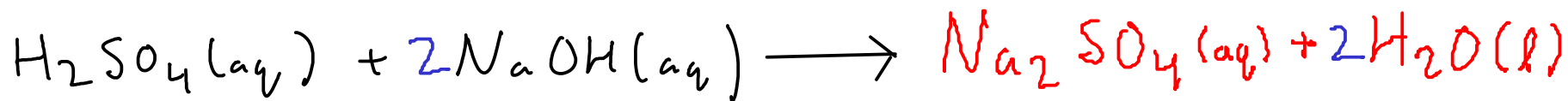
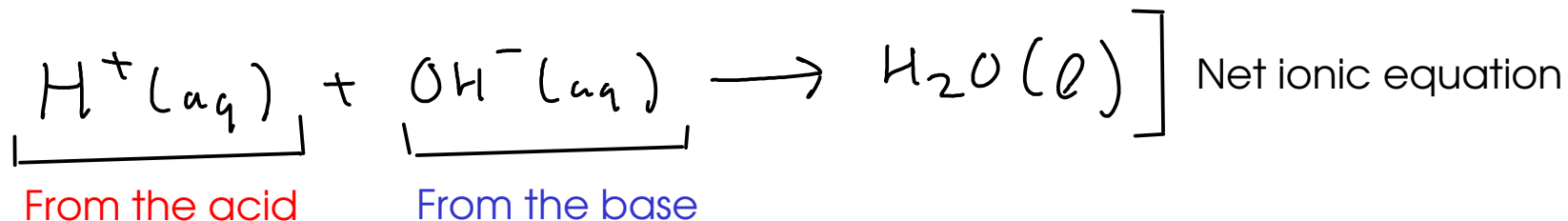
Properties of bases:

- Caustic: Attack and dissolve organic matter (think lye, which is NaOH)
- Cause skin/eye damage on contact
- Taste bitter
- changes litmus indicator to BLUE

Due to the dissolving action of base on your skin, bases will feel "slippery". The base ITSELF is not particularly slippery, but what's left of your skin IS!

ACID/BASE or NEUTRALIZATION reactions continued

- the driving force of these reactions is the formation of water molecules.



- How can this reaction be detected?

- pH detector (indicator paper, etc.)
- do the products have similar chemical properties to the reactants?
- release of heat!

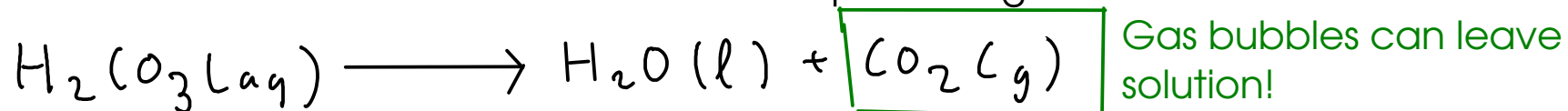
... formation of water is usually accompanied by a release of heat

GAS FORMATION / OTHER MOLECULES

- There are a few other molecules that can be made with exchange-type chemistry.
- Most of these molecules are unstable and can break apart to form gases.

- Formation of a weak acid:

- The formation of ANY weak acid in an exchange-type reaction can be a driving force.
- Some weak acids are unstable and can break apart into gas molecules.

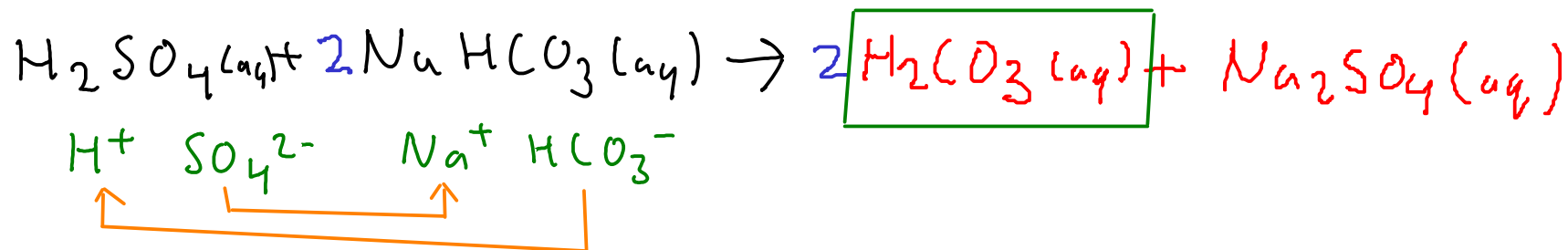


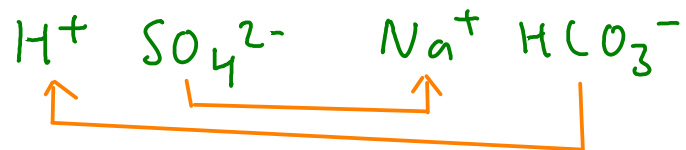
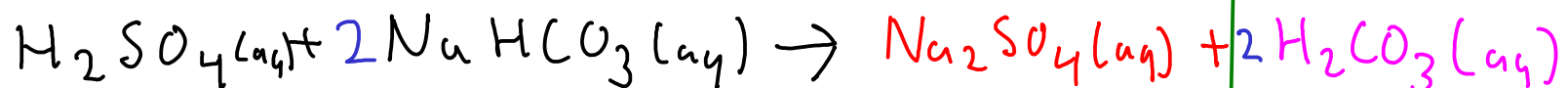
... but how would you form carbonic acid in an exchange-type reaction?

acid + carbonate CO_3^{2-}

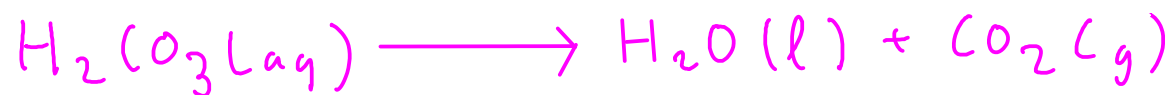
OR

acid + bicarbonate HCO_3^-



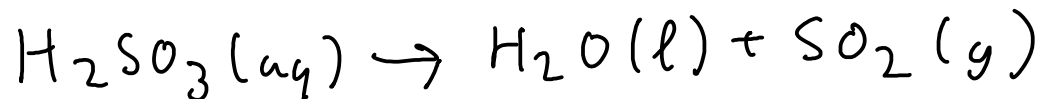


... but when we mix sulfuric acid and sodium bicarbonate, we observe BUBBLES. We need to write an equation that agrees with our observations. We know that carbonic acid decomposes, so we go ahead and put that into our equation.

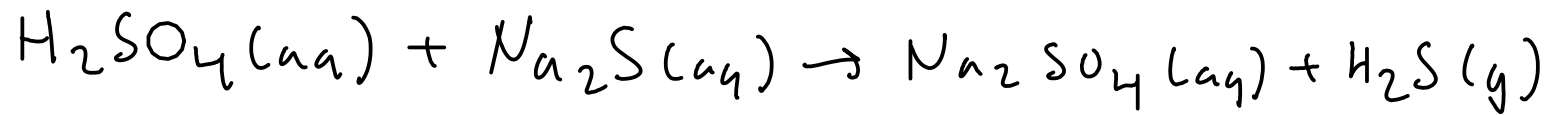


Other molecules of interest:

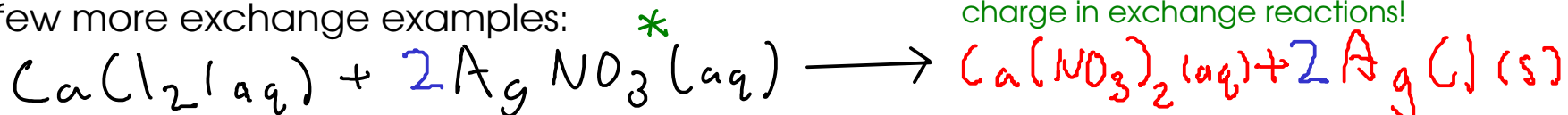
H_2SO_3 : sulfurous acid - React an ACID with a SULFITE



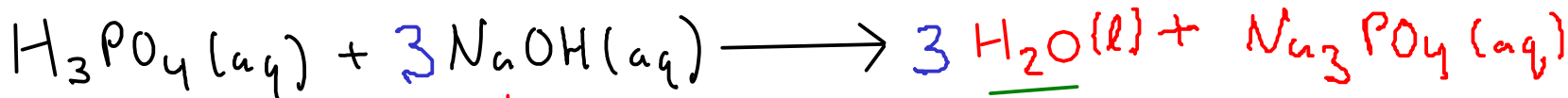
H_2S : hydrogen sulfide (gas) - React an ACID with a SULFIDE



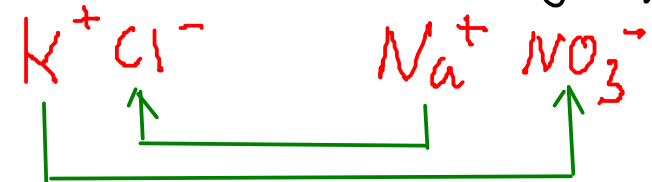
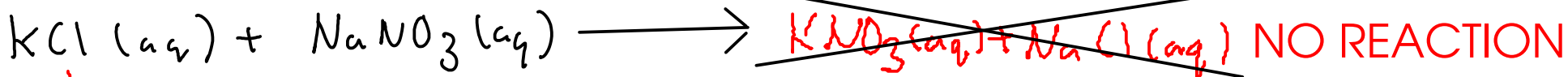
A few more exchange examples:



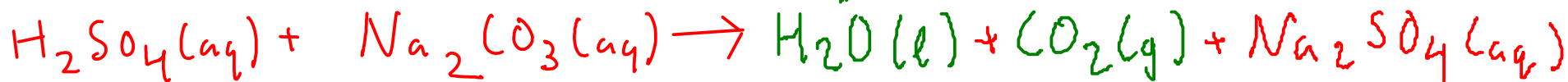
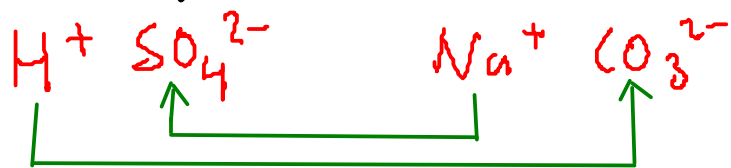
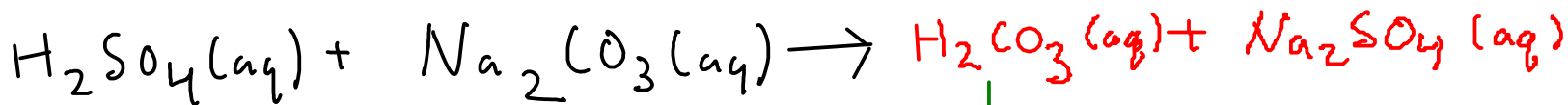
PRECIPITATION of AgCl drives this reaction!



Formation of liquid WATER drives this neutralization reaction. Detect by RELEASE OF HEAT.



Both "products" are water-soluble ionic compounds - present in water as FREE IONS. This is the same state they were in before they were mixed. We conclude that there is not a reaction going on - no driving force!



Formation of carbonic acid (which breaks apart to form water and carbon dioxide gas) is our driving force. We will observe FIZZING as the carbon dioxide escapes.

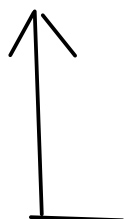
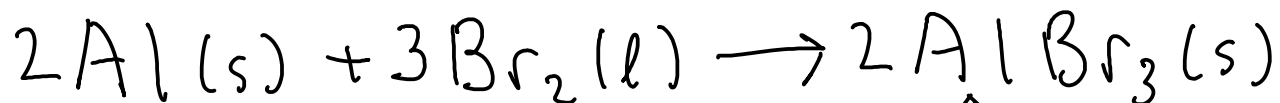
* Transition metals DO NOT change their charge in exchange reactions!

126 OXIDATION / REDUCTION CHEMISTRY

- Exchange reactions involve ions pairing up, but the ions themselves are not formed in exchange reactions. Exchanges start with pre-existing ions.

... but the ions have to be produced somehow - through a chemistry that involves the transfer of electrons.

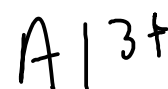
- oxidation / reduction chemistry ("redox" chemistry) involves transfer of electrons and can make ions.



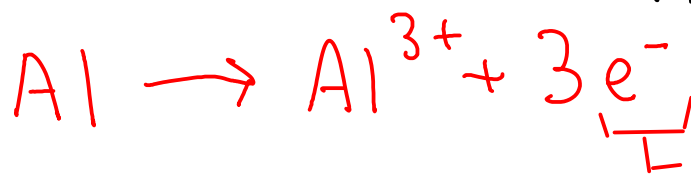
Elemental,
metallic
aluminum.
Uncharged!



Aluminum
cation



These are called
"half-reactions"



electron

oxidation: loss
of electrons



reduction: gain of
electrons

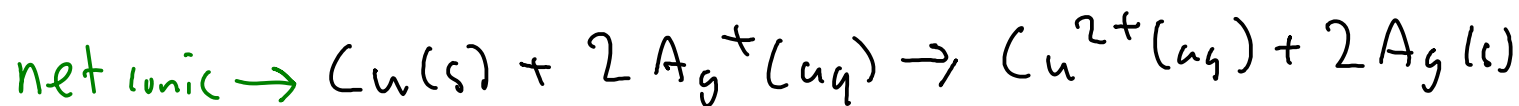
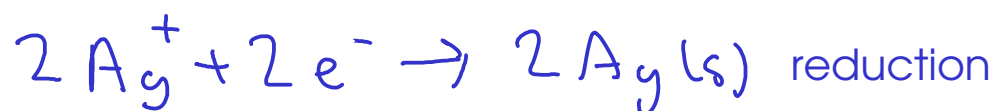
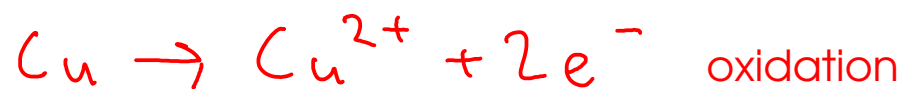
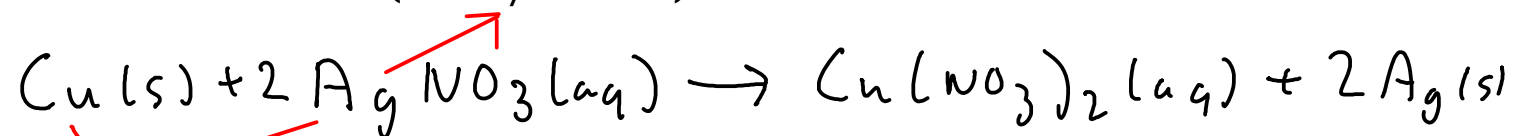
- oxidation and reduction always occur together. In other words, we can't just make free electrons using oxidation without giving them somewhere to go.

- Many of the types of reactions that we learned about in previous courses are redox reactions!

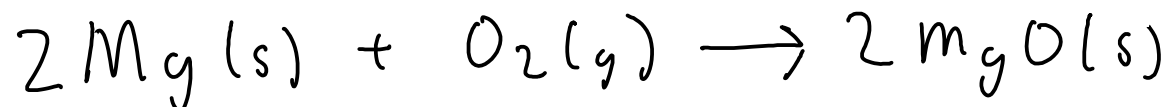
- COMBINATIONS (often but not always redox)

- DECOMPOSITIONS (often redox)

- SINGLE REPLACEMENT (always redox)



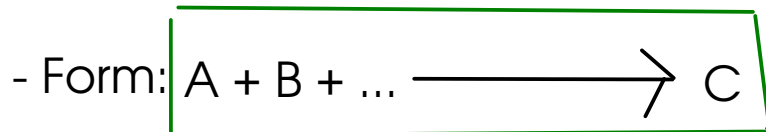
- COMBUSTION



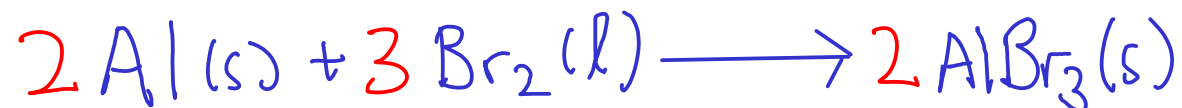
A review of the reaction types we just mentioned:

① COMBINATION REACTIONS

- Reactions that involve two or more simple substances COMBINING to form a SINGLE product
- Often involve large energy changes. Sometimes violent!



Example:



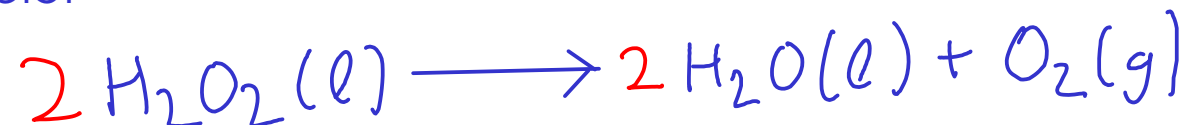
② DECOMPOSITION REACTIONS

- Reactions where a SINGLE REACTANT breaks apart into several products

- Form:



Example:

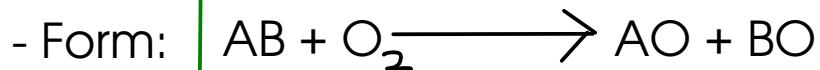


* This reaction is NOT a combustion reaction, even though O_2 is involved!

* Combustion reactions CONSUME O_2 , while this reaction PRODUCES O_2

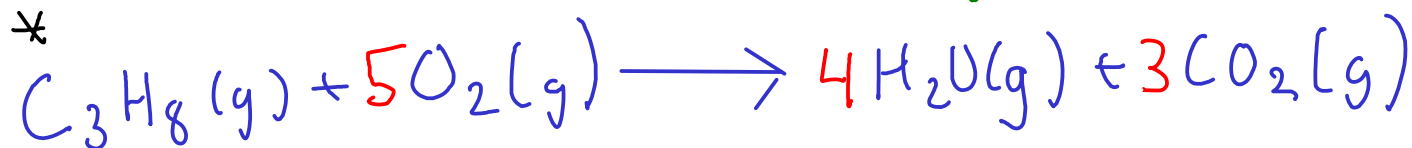
3 COMBUSTION REACTIONS

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



Oxide: a compound containing OXYGEN and one other element!

Examples:



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

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