

"Undissolved ionic compounds":

How can I tell if an ionic compound dissolves in water?

- consult experimental data: "solubility rules"!

A few of the "rules"...

- Compounds that contain a Group IA cation (or ammonium) are soluble
- Nitrates and acetates are soluble
- Carbonates, phosphates, and hydroxides tend to be insoluble

See p 129 9th edition (10th ed: p131)

... or see the web site for a solubility chart.



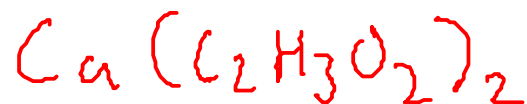
#8 - hydroxides generally insoluble, except Group IA, ammonium, calcium, strontium, barium

Conclusion: iron(III) hydroxide is insoluble.



#3 - Iodides usually dissolve, exceptions are silver, mercury, lead

Conclusion: silver(I) iodide is INSOLUBLE



#2 - acetates are soluble, no common exceptions.

Conclusion: calcium acetate is soluble.



#5 - Most carbonates are insoluble

Conclusion - barium carbonate is insoluble.

Exchange Chemistry

- Three kinds of exchange chemistry.

① PRECIPITATION

← Formation of IONIC SOLID

② ACID/BASE or NEUTRALIZATION

③ GAS FORMATION (formation of unstable molecules)

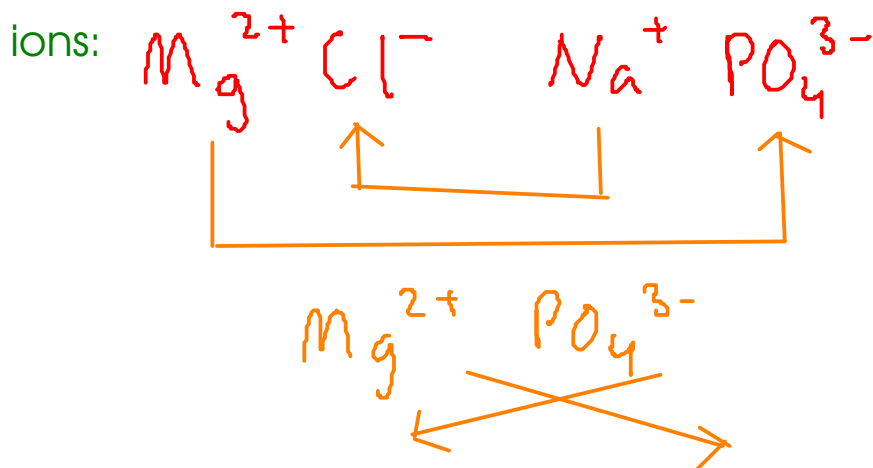
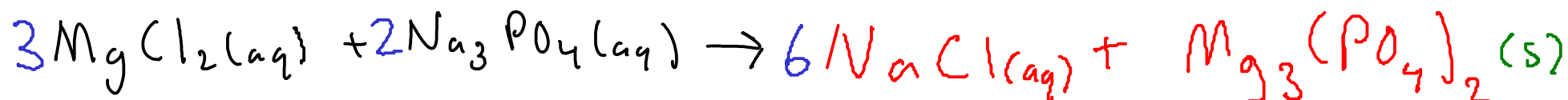
↪ SOME (but not all) reactions that form gases
are examples of exchange chemistry.

Formation of
MOLECULES!

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

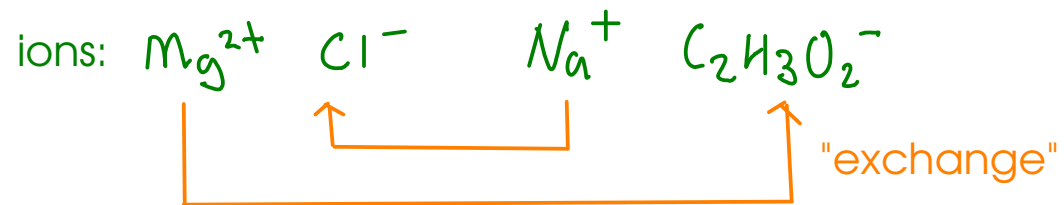
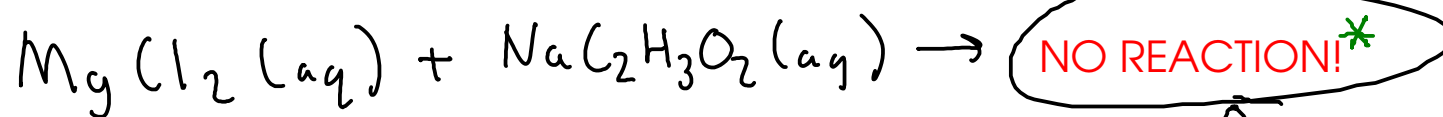
- driving force is the formation of an insoluble ionic compound.



This reaction is driven by the formation of SOLID magnesium phosphate

When you're trying to complete a precipitation reaction:

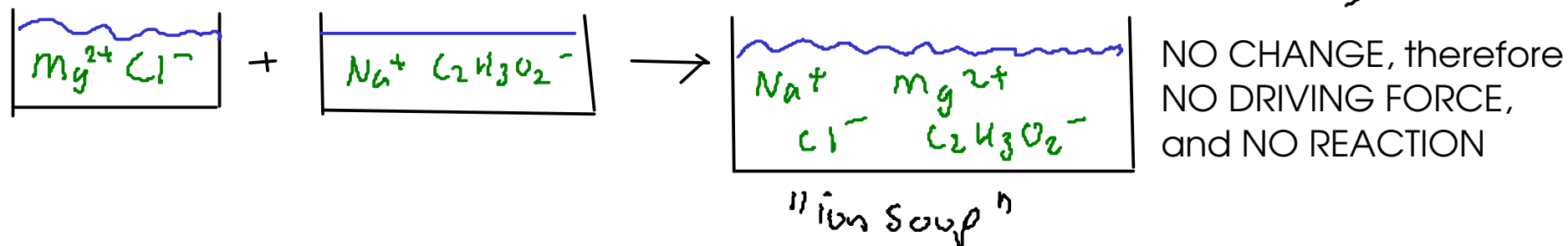
- ① Write the IONS that form when the reactants are dissolved.
- ② Make NEW compounds by pairing up cations with anions. Don't forget that the positive and negative charges must balance each other out!
- ③ Use the solubility rules to determine the PHASE of each new compound - solid or aqueous.
- ④ Balance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



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

NaCl ... dissolves in water

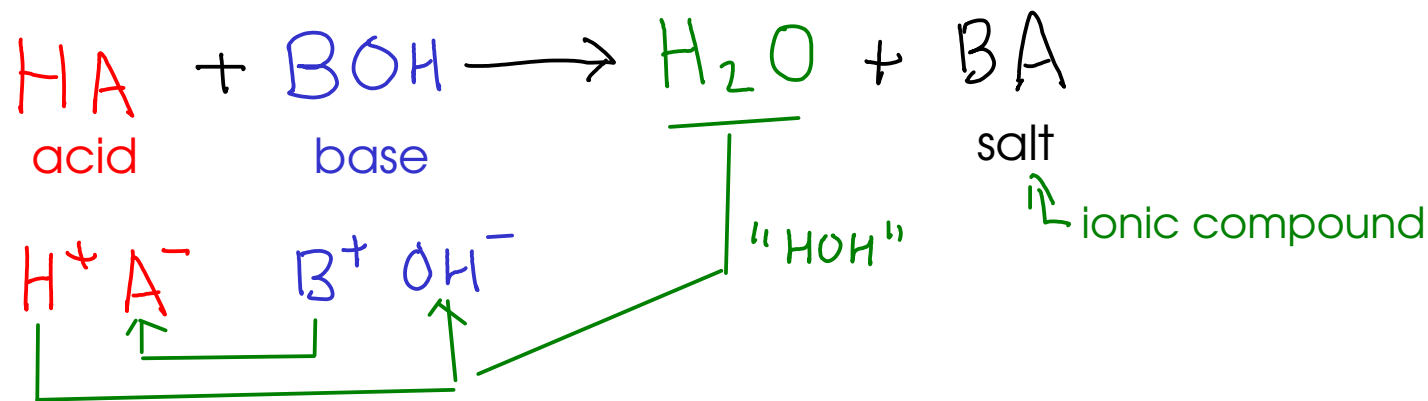
So, no solid forms here. All possible combinations of these four ions result in compounds that dissolve readily in water.



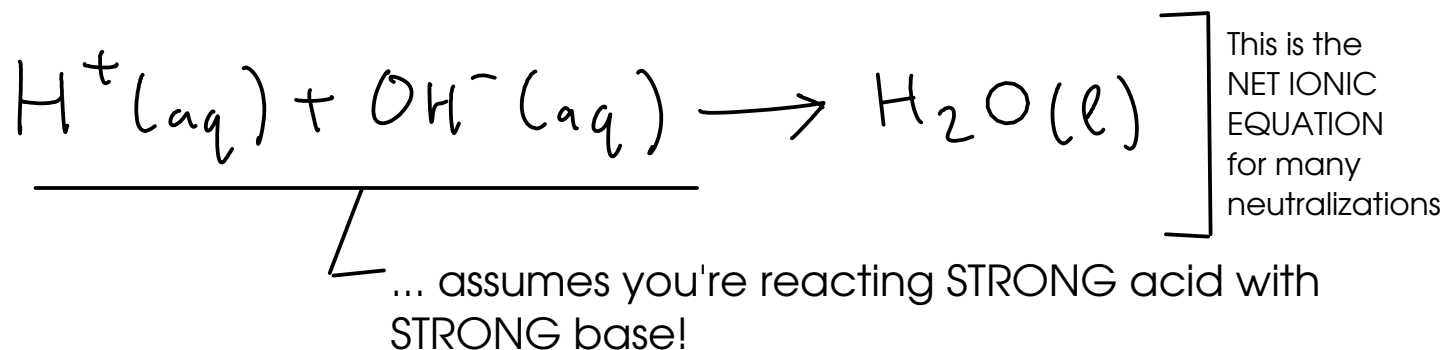
* We will learn about other driving forces than the formation of solid, but these driving forces do not apply to this reaction

ACID/BASE REACTIONS (also called NEUTRALIZATION REACTIONS)

- There are several stable molecules that may be formed in double replacement reactions, but the most common is WATER!
- Double replacement reactions that form water are also called "neutralizations"



* To make water (H_2O), you need a source of hydrogen ion (H^+) and hydroxide ion (OH^-)



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

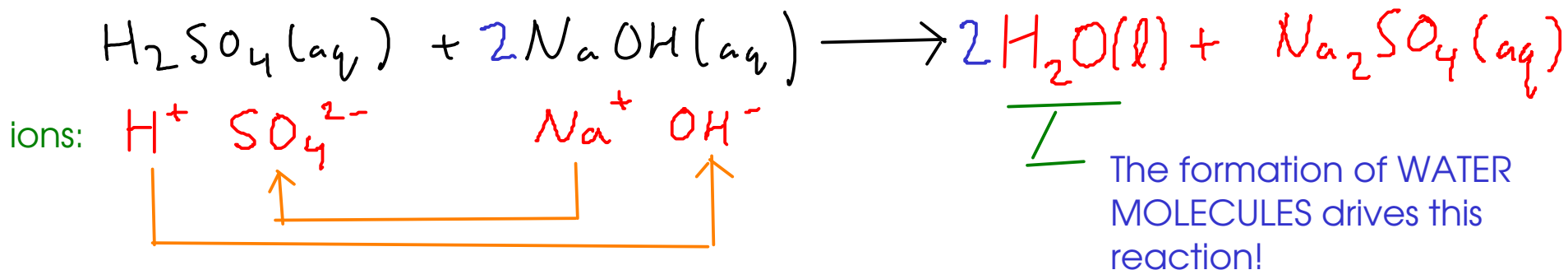
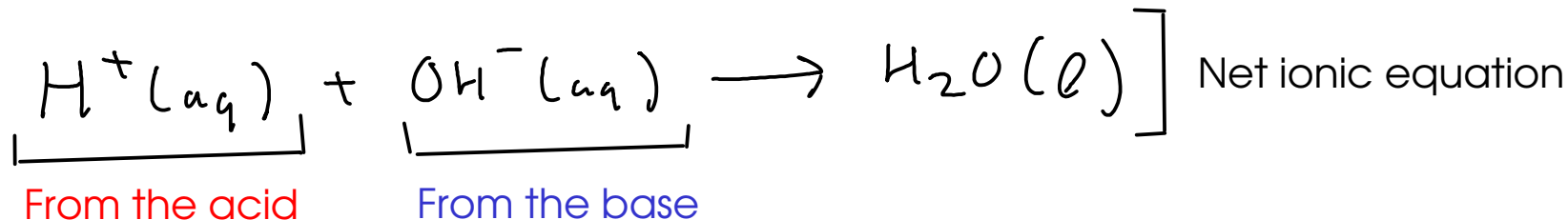
Properties of bases:

- 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!

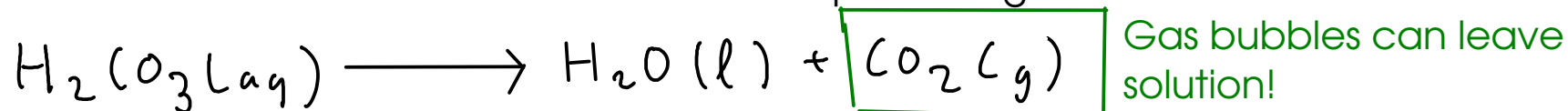
... formation of water is usually accompanied by a release of heat

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.

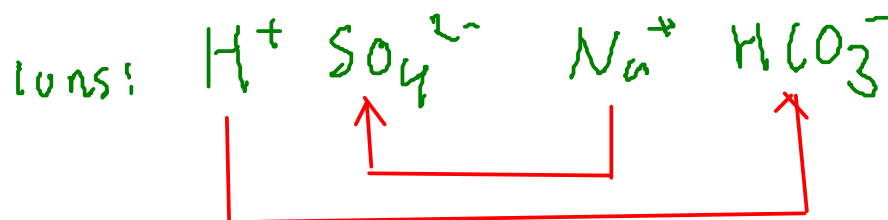
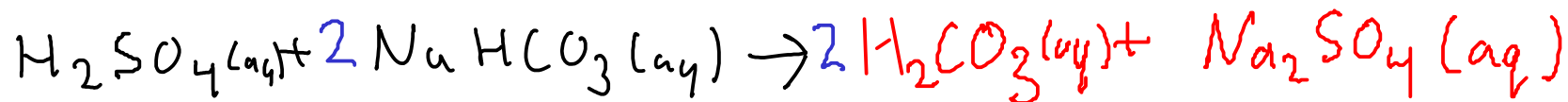


... but how would you form carbonic acid in an exchange-type reaction?

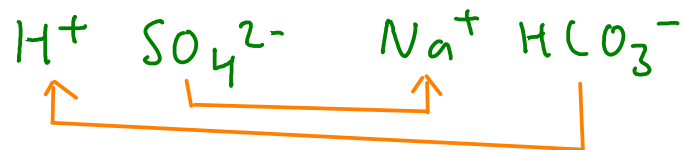
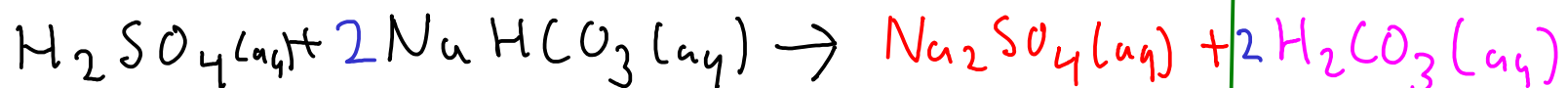
acid + carbonate CO_3^{2-}

OR

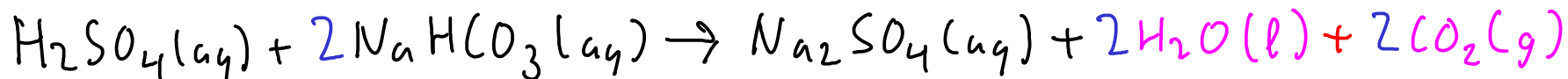
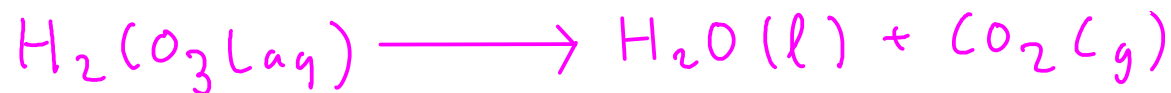
acid + bicarbonate HCO_3^-



Formation of carbonic acid drives the reaction ... BUT ...

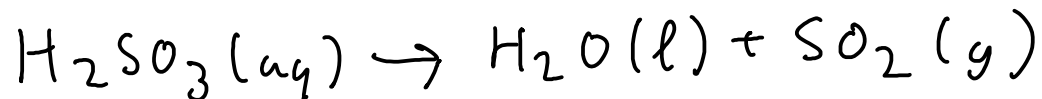


... but when we mix sulfuric acid and sodium bicarbonate, we observe BUBBLES. We need to write an equation that agrees with our observations. We know that carbonic acid decomposes, so we go ahead and put that into our equation.



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

