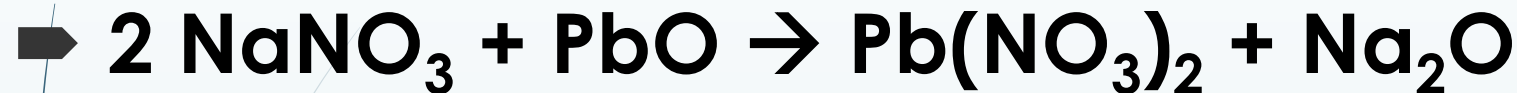


# Steps to Predicting the Products of Chemical Reactions

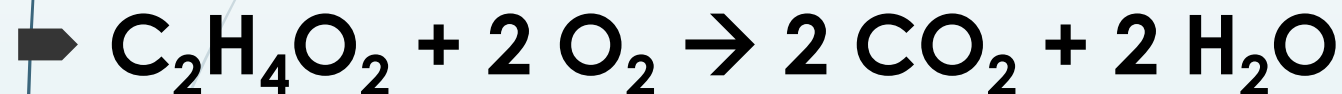


**CP Chemistry**

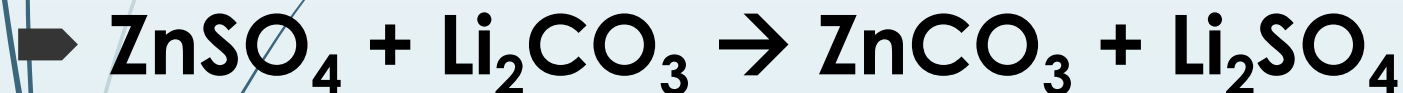
# TYPES OF REACTIONS REVIEW



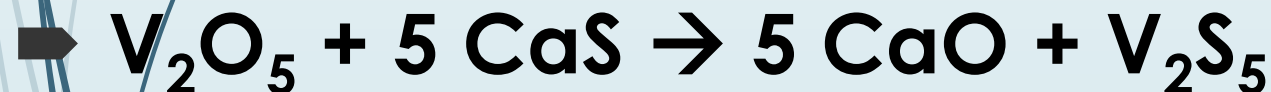
Double Displacement



Combustion



Double Displacement

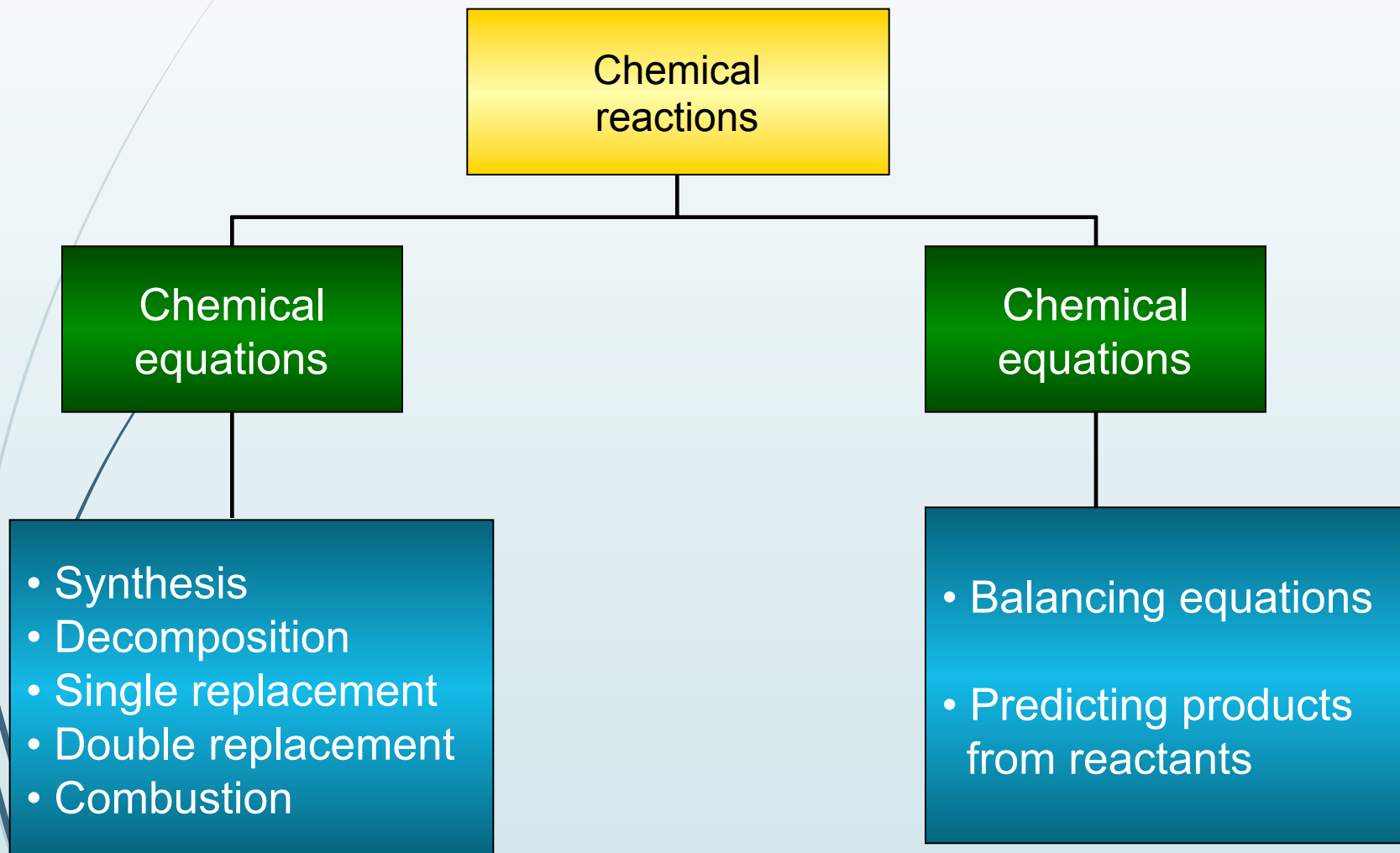


Double Displacement



Synthesis

# Organize Your Thoughts



# PREDICTING THE PRODUCTS

- ▶ We want to be able to predict the products for the following reaction types
  - ▶ Combustion
  - ▶ Single Displacement
  - ▶ Double Displacement

# RULES FOR PREDICTING PRODUCTS OF CHEMICAL REACTIONS

- ▶ Here are a few important things to remember when predicting products:
  - ▶ The compounds form must be neutral ionic compounds (which means you'll be paying attention to their charges)
  - ▶ You do NOT carry subscripts from the reactants to the products.
  - ▶ You always balance your equation LAST



# PREDICTING REACTION PRODUCTS: COMBUSTION REACTIONS

- ▶ A hydrocarbon and oxygen (O<sub>2</sub>) indicate a combustion reaction
- ▶ If it is combustion, then just write H<sub>2</sub>O and CO<sub>2</sub> as products
- ▶ Then, balance the equation (can be tricky)
- ▶ Examples:



# PREDICTING REACTION PRODUCTS: REPLACEMENT REACTIONS

- ▶ A metal will not always replace a metal in a compound dissolved in water because of differing reactivities
- ▶ An activity series can be used to predict if reactions will occur
  - ▶ To replace a metal, the other metal must be MORE REACTIVE
  - ▶ Same applies for halogens

|                     |   |               |
|---------------------|---|---------------|
| <b>Most active</b>  |   | <b>METALS</b> |
|                     |   | Lithium       |
|                     |   | Rubidium      |
|                     |   | Potassium     |
|                     |   | Calcium       |
|                     |   | Sodium        |
|                     |   | Magnesium     |
|                     |   | Aluminum      |
|                     |   | Manganese     |
|                     |   | Zinc          |
|                     |   | Iron          |
|                     |   | Nickel        |
|                     |   | Tin           |
|                     |   | Lead          |
|                     |   | Copper        |
| <b>Least active</b> | Silver  |               |
|                     | Platinum  |               |
|                     | Gold  |               |
|                     | <b>HALOGENS</b>   |               |
| <b>Most active</b>  |  | Fluorine      |
|                     |   | Chlorine      |
|                     |   | Bromine       |
| <b>Least active</b> |   | Iodine        |

# PREDICTING REACTION PRODUCTS: SINGLE REPLACEMENT REACTIONS

- To predict the products: Replace the single element with the corresponding element in the compound
  - A **metal** will replace the cation in the compound
  - A **non-metal** will replace the anion in the compound
- If the element is more reactive than the one it attempts to replace, then the reaction will be spontaneous and exothermic
- Otherwise, it will not be spontaneous and will be endothermic (NO REACTION)



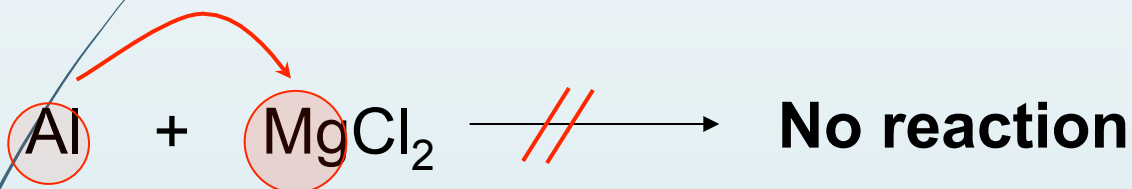
# PREDICT IF THESE REACTIONS WILL OCCUR



Can magnesium replace aluminum?

Activity Series

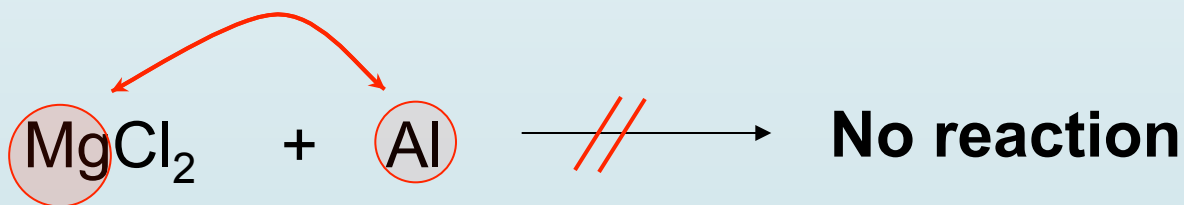
**YES**, magnesium is more reactive than aluminum.



Can aluminum replace magnesium? **NO**, aluminum is less reactive than magnesium.

Activity Series

Therefore, **no reaction** will occur.



Order of reactants  
**DOES NOT**  
determine how  
they react.

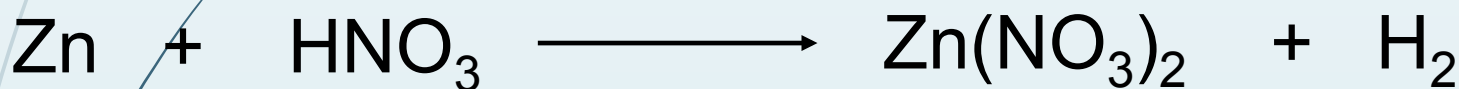
The question we must ask is can the single element replace its counterpart?  
metal replaces metal or nonmetal replaces nonmetal.

# PREDICTING REACTION PRODUCTS: SINGLE REPLACEMENT REACTIONS

Activity Series



*Can Fe replace Cu?*    **Yes**



*Can Zn replace H?*    **Yes**



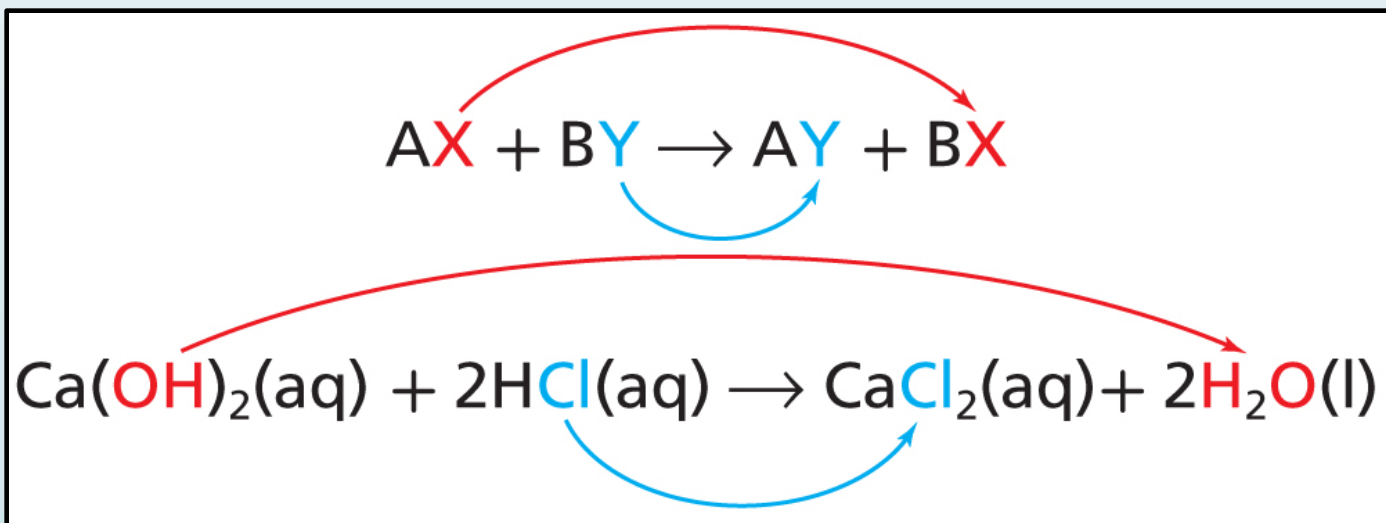
*Can Br replace Cl?*    **No**

Li  
Rb  
K  
Ba  
Ca  
Na  
Mg  
Al  
Mn  
Zn  
Cr  
Fe  
Ni  
Sn  
Pb  
H<sub>2</sub>  
Cu  
Hg  
Ag  
Pt  
Au

F<sub>2</sub>  
Cl<sub>2</sub>  
Br<sub>2</sub>  
I<sub>2</sub>

# PREDICTING REACTION PRODUCTS: DOUBLE REPLACEMENT REACTIONS

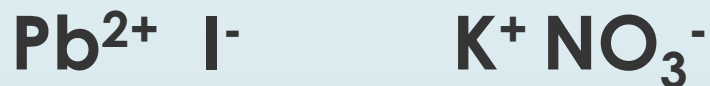
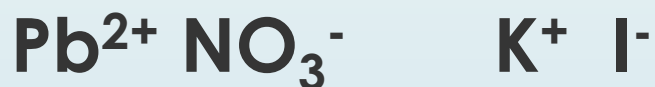
- ▶ If it is double replacement, then the cation and anions switch places
- ▶ It is helpful to separate each compound into their cation and anionic parts with their charges
- ▶ Then switch places, and criss cross the new compounds to make sure they are the correct neutral compound formulas



# PREDICTING REACTION PRODUCTS: DOUBLE REPLACEMENT REACTIONS

- ▶ AB and CD are both ionic compounds
- ▶ Separate each compound & write their charges
- ▶ Switch places and re-write new compounds

▶ Example:



▶ Balance at the end!!

# PREDICTING REACTION PRODUCTS: DOUBLE REPLACEMENT REACTIONS

- ▶ Not all double replacement reactions will occur
- ▶ In order for a double replacement reaction to take place:
  - ▶ Both of the reactants must be soluble in water
    - ▶ If a compound contains at least one of the ions that is proven soluble, then the compound will be at least moderately soluble
  - ▶ One product must be soluble and one product must be insoluble
    - ▶ The insoluble product is the precipitate that forms when the reaction takes place
    - ▶ Usually a precipitate is a solid, but it doesn't have to be

# SOLUBILITY TABLE

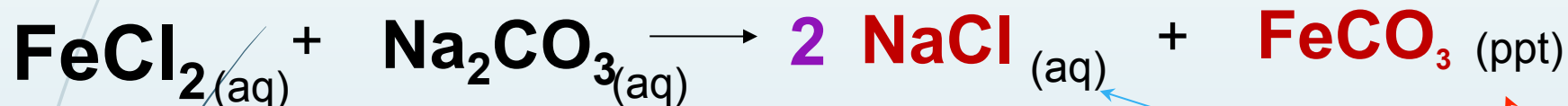
| <b>Compounds of:</b>  | <b>Rule</b>   |
|---|---|
| $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+$ | Always soluble  |
| $\text{NO}_3^-$ or $\text{C}_2\text{H}_3\text{O}_2^-$             | Always soluble  |
| $\text{Cl}^-$ , $\text{Br}^-$ , or $\text{I}^-$                   | Insoluble with $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , or $\text{Pb}^{2+}$ .<br>Soluble with any other ion.  |
| $\text{SO}_4^{2-}$  | Soluble with all the ions except $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , or $\text{Pb}^{2+}$ .   |
| $\text{CO}_3^{2-}$ or $\text{PO}_4^{3-}$                          | Soluble with $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+$ .<br>Insoluble with any other ion.   |
| $\text{OH}^-$ or $\text{S}^{2-}$                                  | Soluble with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Li}^+$ ,<br>$\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+$ .<br>Insoluble with any other ion. |

# PREDICTING REACTION PRODUCTS: DOUBLE REPLACEMENT REACTIONS

Predict if a reaction will occur when you combine aqueous solutions of iron (II) chloride with aqueous sodium carbonate solution.

If the reaction does occur, write a balanced chemical equation showing it.

iron (II) chloride + sodium carbonate  $\longrightarrow$  ????



Using a SOLUBILITY TABLE:  
Both reactants are soluble  
**SO REACTION OCCURS!**

Using a SOLUBILITY TABLE:  
sodium chloride is soluble  
iron (II) carbonate is  
**insoluble** so reaction  
occurs!!