

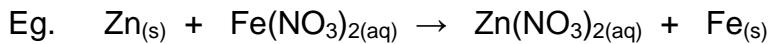
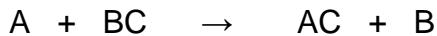
# SCH 3U

## SINGLE DISPLACEMENT & DOUBLE DISPLACEMENT

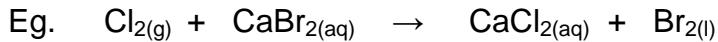
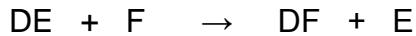
### ① SINGLE DISPLACEMENT REACTIONS

- one element in a compound is displaced by another element.

#### **A. metal replaces a metal cation in a compound**



#### **B. non-metal (halogen) replaces an anion in a compound**



More Examples:

- $Cu_{(s)} + AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + Ag_{(s)}$
- $Mg_{(s)} + HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$
- $Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2(g)}$

Use the following guidelines when analyzing single displacement reactions:

- treat hydrogen as a metal
- treat acids as ionic compounds  
For instance, treat HCl as  $H^+ Cl^-$   
treat  $H_2SO_4$  as  $H^+ H^+ SO_4^{2-}$
- treat water as ionic,  $H^+ OH^-$

## METAL ACTIVITY SERIES

- A reactive metal will displace any metal in a compound that is below it in the activity series – see chart of Reactivity of Metals



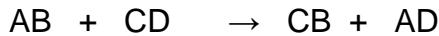
## HALOGEN ACTIVITY SERIES

- **F > Cl > Br > I**
- In general, the smaller the halogen atom, the more reactive it is.



## ② DOUBLE DISPLACEMENT REACTIONS

- involves the exchange of cations between two ionic compounds, usually in aqueous (water) solution.



- a double displacement reaction has taken place in the following cases:
  - a solid (precipitate) forms
  - a gas is produced
  - some double displacement reactions also form a molecular compound, such as water. It is difficult to notice when water is formed, because the reaction often takes place in water.

## A. D.D. Reactions that form a PRECIPITATE

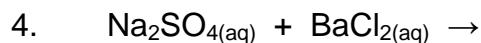
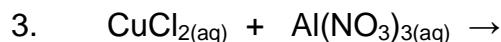
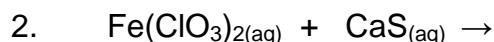
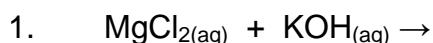
### 1. How do we determine the products?

- "deconstruct" the reactants
- switch the cations
- "reconstruct" the products using proper chemical formulas
- then balance the chemical equation

### 2. Which of the products -- if any -- will precipitate?

- The chart below is used to determine which of the products, if any, will form a precipitate -- the product that is insoluble in water will precipitate (form a solid)

Eg. Determine if the following reactions occur; if so, indicate the products and balance the reaction.



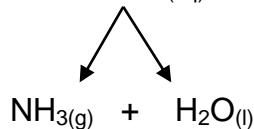
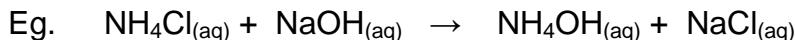
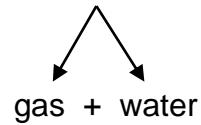
**Table 9.1** General Solubility Guidelines

Guideline	Cations	Anions	Result	Exceptions
1	$\text{Li}^+, \text{Na}^+, \text{K}^+, \text{Rb}^+, \text{Cs}^+, \text{NH}_4^+$	$\text{NO}_3^-$ , $\text{CH}_3\text{COO}^-$ , $\text{ClO}_3^-$	soluble	$\text{Ca}(\text{ClO}_3)_2$ is insoluble
2	$\text{Ag}^+, \text{Pb}^{2+}, \text{Hg}^+$	$\text{CO}_3^{2-}$ , $\text{PO}_4^{3-}$ , $\text{O}^{2-}$ , $\text{S}^{2-}$ , $\text{OH}^-$	insoluble	$\text{BaO}$ and $\text{Ba}(\text{OH})_2$ are soluble. Group 2 sulfides tend to decompose.
3		$\text{Cl}^-$ , $\text{Br}^-$ , $\text{I}^-$	soluble	
4	$\text{Ba}^{2+}$ , $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$		insoluble	
5	$\text{Mg}^{2+}$ , $\text{Cu}^{2+}$ , $\text{Zn}^{2+}$ , $\text{Fe}^{2+}$ , $\text{Fe}^{3+}$ , $\text{Al}^{3+}$	$\text{SO}_4^{2-}$	soluble	

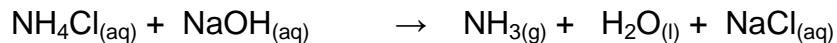
## B. D.D. Reactions That Produce a GAS

- a gas is formed when one of the products of the double displacement reaction decomposes to give water and a gas

2 compounds undergo  $\rightarrow$  aqueous salt + acid or base  
double displacement 



Therefore, the overall reaction would be written as follows:



## ACIDS THAT DECOMPOSE: $\text{H}_2\text{CO}_3$ and $\text{H}_2\text{SO}_3$

## **BASES THAT DECOMPOSE:      $\text{NH}_4\text{OH}$**

## C. NEUTRALIZATION Reactions

- special type of double displacement reaction

