

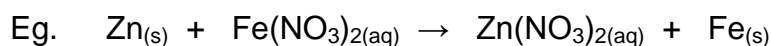
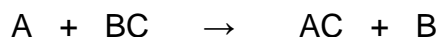
## SCH 3U

### SINGLE DISPLACEMENT & DOUBLE DISPLACEMENT

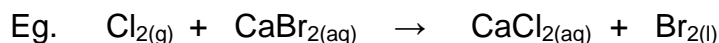
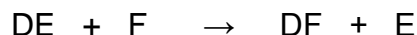
#### ① SINGLE DISPLACEMENT REACTIONS

- 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:

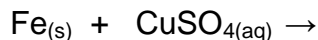
- $\text{Cu}_{(s)} + \text{AgNO}_{3(aq)} \rightarrow \text{Cu}(\text{NO}_3)_{2(aq)} + \text{Ag}_{(s)}$
- $\text{Mg}_{(s)} + \text{HCl}_{(aq)} \rightarrow \text{MgCl}_{2(aq)} + \text{H}_{2(g)}$
- $\text{Na}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{NaOH}_{(aq)} + \text{H}_{2(g)}$

Use the following guidelines when analyzing single displacement reactions:

- treat hydrogen as a metal
- treat acids as ionic compounds  
For instance, treat HCl as  $\text{H}^+ \text{Cl}^-$   
treat  $\text{H}_2\text{SO}_4$  as  $\text{H}^+ \text{H}^+ \text{SO}_4^{2-}$
- treat water as ionic,  $\text{H}^+ \text{OH}^-$

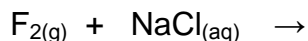
## METAL ACTIVITY SERIES

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



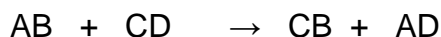
## HALOGEN ACTIVITY SERIES

- **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.** a solid (precipitate) forms
  - B.** a gas is produced
  - C.** 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

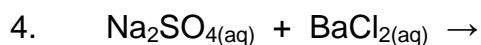
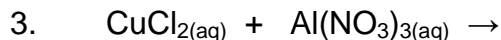
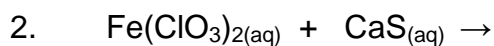
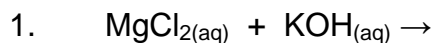
### 1. How do we determine the products?

- "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.

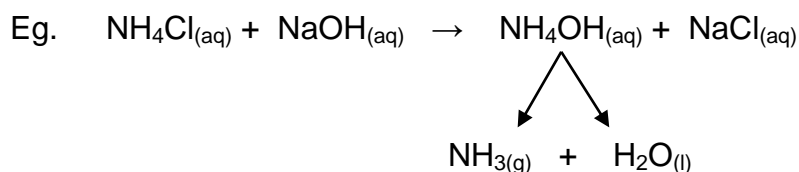
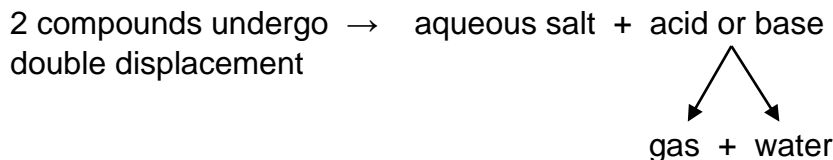


**Table 9.1** General Solubility Guidelines

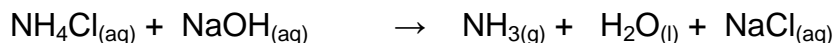
Guideline	Cations	Anions	Result	Exceptions
1	$\text{Li}^+, \text{Na}^+, \text{K}^+, \text{Rb}^+, \text{Cs}^+, \text{NH}_4^+$	$\text{NO}_3^-, \text{CH}_3\text{COO}^-, \text{ClO}_3^-$	soluble	$\text{Ca}(\text{ClO}_3)_2$ is insoluble
2	$\text{Ag}^+, \text{Pb}^{2+}, \text{Hg}^+$	$\text{CO}_3^{2-}, \text{PO}_4^{3-}, \text{O}^{2-}, \text{S}^{2-}, \text{OH}^-$	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



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

