

## Chapter 7: Reactions in Aqueous Solutions

These Notes are to SUPPLEMENT the Text, They do NOT Replace reading the Text Material. Additional material that is in the Text will be on your tests! To get the most information, READ THE CHAPTER prior to the Lecture, bring in these lecture notes and make comments on these notes. These notes alone are NOT enough to pass any test!

The author is providing these notes as an addition to the students reading the text book and listening to the lecture. Although the author tries to keep errors to a minimum, the student is responsible for correcting any errors in these notes.

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### Chemical reactions that are most important to us occur in water

Double Displacement:  $\underline{AB} + CD \rightarrow \underline{AD} + \underline{CB}$



**Note:** The Him's are always first – the Positive Charged species are first!

### Will a reaction Happen?

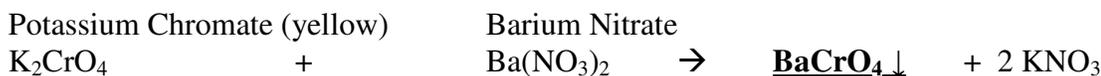
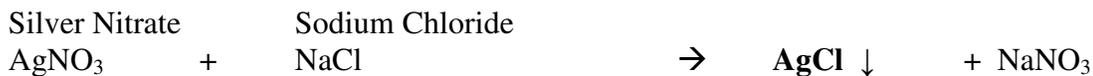
What are the Driving Forces for a reaction to occur?

Driving Forces are what make a reaction go, the driving forces you are responsible to know are:

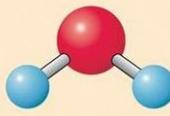
1. Formation of a solid ( ppt or ↓ )
2. Formation of a gas ( g or ↑ )
3. Formation of Water
4. REDOX Reactions, involve the transfer of Electrons - Oxidation – Reduction  
REDOX Reactions have a metal or other element from the Periodic Table in it
  - 4.1 Combustion
  - 4.2 Synthesis - combination
  - 4.3 Decomposition"

Will a Reaction go to Completion? Look at the Products.

### 1. Precipitation / precipitate / precipitation reaction / ppt / ↓



**Water:** H-O-H and V-Shape, 105 Deg, Polar Molecule

Water	
Molecular formula	H <sub>2</sub> O
Structural formula	H-O-H
Molecular model (ball-and-stick type)	

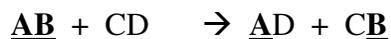
When a solid (Ionic Solid) dissolves in water, it forms ions

Strong electrolyte - each unit that dissolves produces separated ions



**Electrical conductivity** of aqueous solutions - pure water does not conduct electricity, it needs ions to conduct  
Dissolving an ionic compound in water and it does conduct electricity

**Balancing of equations** - decide what the products are:



When dissolving a solid ionic compound in water, the ions must have a net charge of zero.

Cations [ + + ] and Anions [ - ] neutralize each other out.

**Name each compound and what are Cations and Anions obtained** from dissolving the following in water:

NaCl

KOH

Na<sub>2</sub>SO<sub>4</sub>

NH<sub>4</sub>Cl

Na<sub>2</sub>CO<sub>3</sub>

AgCl

## SOLUBILITY

<b>Soluble</b>	Readily dissolves in water
<b>Insoluble</b>	Only a trace amount, if any, dissolves in water
<b>Slightly Soluble</b>	Same as Insoluble

### Solubility Table 7.1 p 170

#### The Following ARE Soluble

1.  $\text{NO}_3$  Most nitrates salts are soluble
2.  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{NH}_4^+$  Most salts of  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{NH}_4^+$  are soluble  
**This is really all of the Group One Ions and Ammonia**
3.  $\text{Cl}$ ,  $\text{Br}$ ,  $\text{I}$  Most Halogens salts are soluble **EXCEPT FOR for Ag, Pb, Hg**
4.  $\text{SO}_4$  Most  $\text{SO}_4$  are soluble **EXCEPT FOR Ba, Pb, Ca**

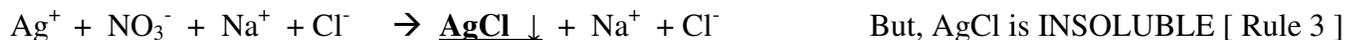
#### The Following Are INSOLUBLE

5.  $\text{OH}^-$  Most  $\text{OH}^-$  are insoluble *Except Na, K,  $\text{NH}_4$  [ rule 2 covers this ]*
6.  $\text{S}^{2-}$ ,  $\text{CO}_3^{2-}$ ,  $\text{PO}_4^{3-}$  Most Sulfide  $\text{S}^{2-}$  Carbonates  $\text{CO}_3^{2-}$  Phosphates  $\text{PO}_4^{3-}$  are insoluble *Except Na, K,  $\text{NH}_4$  [ rule 2 covers this ]*

**Predict Precipitates** when solutions of 2 ionic compounds are mixed:

#### Silver Nitrate and Sodium Chloride

1. Write the reactants. Salts dissolve to form ions, write out the ions



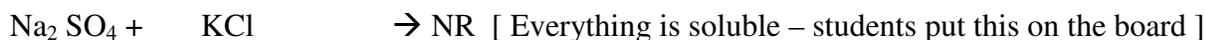
2. Consider the various salts that could form [ From the reaction above ]



3. Use the solubility table to verify the solubility



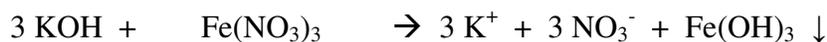
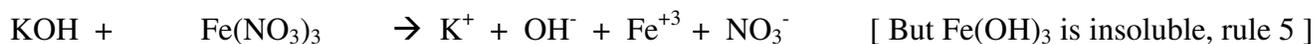
#### Sodium Sulfate and Potassium Chloride



#### Sodium Sulfate and Lead (II) Nitrate



## Potassium Hydroxide and Iron (III) Nitrate



## Describe Reactions in Aqueous Solutions

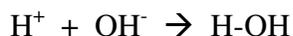
**1. Molecular Equation** A balanced equation



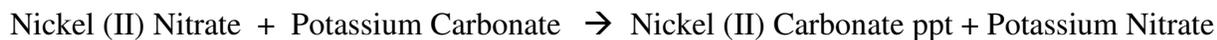
**2. Complete Ionic Equation** A balanced equation as ions



**3. Net Ionic** Only those that do something, those that do not are **Spectator Ions**



**Show the Complete Equations for the following:**



## How to predict if a reaction will go to completion

All Compounds Soluble  $\rightarrow$  All Compounds Soluble **NO REACTION**

One Cpd is Not Soluble  $\rightarrow$  All Compounds Soluble **NO REACTION**

All Compounds Soluble  $\rightarrow$  One Cpd is Not Soluble **REACTION**

## Reactions that form water - acids and bases

HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> dissolved in water behave as strong electrolytes

**Acid** - produces H<sup>+</sup> HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> are STRONG ACIDS and dissociates to 100% give ions

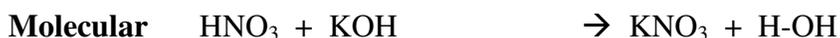


**Base** - produces OH<sup>-</sup> NaOH, KOH are strong bases and dissociate 100% to give ions



**Strong acids mixed with strong bases yield water** - a very stable compound

Write all 3 reactions for Nitric Acid and Potassium Hydroxide



**Note** besides water forming, Salt [ KNO<sub>3</sub> ] an Ionic Compound formed

## Summary of Strong Acids and Strong Bases:

1. Common strong acids are HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>
2. A strong acid is a substance that completely dissociates in water produces H<sup>+</sup>
3. A strong base is a Metal Hydroxide that is very soluble in water – NaOH, KOH dissociates to OH<sup>-</sup>
4. The net ionic equation for a strong acid and a strong base is H<sup>+</sup> + OH<sup>-</sup> → H-OH
5. Reactions of a strong acid and a strong base is water and an ionic compound called a salt
6. The reaction of H<sup>+</sup> and OH<sup>-</sup> is called an acid - base reaction, or neutralization

**Acids** - sour taste of citrus                      [ Don't try it! ]

**Base** - Alkali - bitter taste, slippery like soap [ Don't try it! ]

**Mineral Acids** - Sulfuric H<sub>2</sub>SO<sub>4</sub> and Nitric HNO<sub>3</sub>

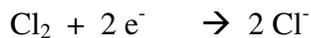
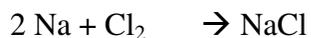
**Acid** is a H<sup>+</sup> donor

**Base** produces OH<sup>-</sup>

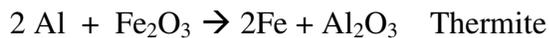
**Acid Base reaction produce water -or-**

**If water is produced, the reaction is probably an acid base reaction**

## 7.5 Reactions of Metals and NonMetals – **REDOX**, Oxidation – Reduction, Electron Transfer



The reaction of a Metal and a Non Metal to form an ionic compound involves a transfer of e<sup>-</sup>

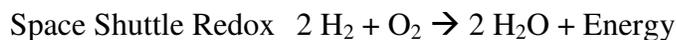


### SHOW HOW ELECTRONS ARE GAINED AND LOST

How many e<sup>-</sup> are gained / lost

#### **This occurs only with**

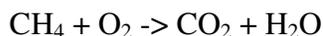
1. A metal and a non-metal
2. or by reacting with O<sub>2</sub>



### **Other ways to classify a reaction – DRIVING FORCES**

1. PPT or Gas formed
2. Acid - Base
3. Oxidation - Reduction - Redox"

#### 3a. Combustion Reactions



#### 3b. Synthesis or combination



#### 3c. Decomposition

