

**Qualitative Analysis**

*Chemicals that you must know the appearance and properties of:*

Potassium Permanganate

Potassium Chromate

Potassium Dichromate

Cobalt (II) Chloride

Iron Thiocyanate Complex Ion

Iron (III) Chloride

Silver (I) Nitrate

Sodium Chloride

Ammonium Chloride

Copper (II) Sulfate

**The Classic Qualitative Tests**

Lugol's Solution

Benedict's Solution

Phenolphthalein Solution

Solubility in water versus alcohol

**Solubility**

	NaCl	Na <sub>2</sub> S	Na <sub>2</sub> SO <sub>4</sub>	NaOH
AgNO <sub>3</sub>				
BaCl <sub>2</sub>				
NH <sub>4</sub> Cl				
HCl				
Pb(NO <sub>3</sub> ) <sub>2</sub>				

**Gases**

	Color	Smell	Splint Test	Special Tests
Nitrogen				
Oxygen				
Hydrogen				
Carbon Dioxide				
Ammonia				
Nitrogen Dioxide				

**Flame Tests**

Red	
Orange	
Yellow	
Green	
Blue	
Indigo	
Violet	

## CLASSES OF CHEMICAL REACTIONS

### Combination or Synthesis: $A + B \rightarrow AB$

- A) Metal oxides will react with water to form bases
- B) Some nonmetal oxides will react with water to form ternary acids
- C) Many elements will react with oxygen to form oxides
- D) Metals can combine with nonmetals to form ionic compounds

### Decomposition: $AB \rightarrow A + B$

- A) Metallic carbonates, when heated, form metal oxides, plus carbon dioxide
- B) Many metallic hydroxides, when heated, decompose into metallic oxides and water
- C) Metallic chlorates, when heated, decompose into metallic chlorides and oxygen
- D) Some acids, when heated, decompose into non-metallic oxides and water
- E) Some oxides, when heated decompose
- F) Some decomposition reactions are produced by electricity
- G) Ammonium salts decompose to give off ammonia gas

**Single Replacement:  $A + BC \rightarrow AC + B$  or  $D + BC \rightarrow C + BD$** 

- A) An active metal will replace hydrogen in water
- B) A metal may replace hydrogen in an acid
- C) A metal in a compound may be replaced by a more active metal
- D) A halogen will replace a halogen below it in the Periodic Table

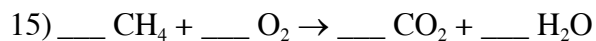
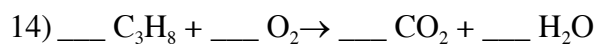
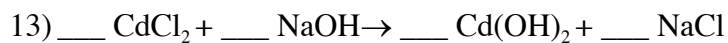
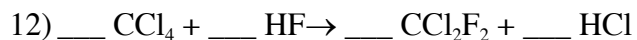
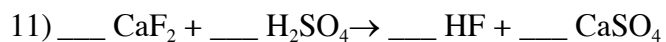
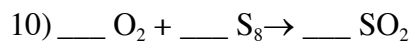
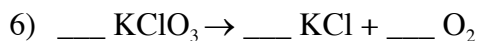
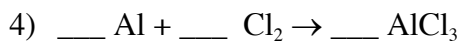
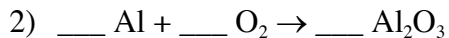
**Double Replacement:  $AB + CD \rightarrow AD + CB$** 

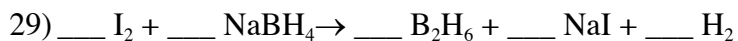
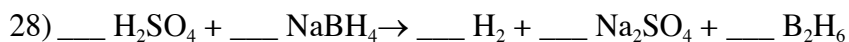
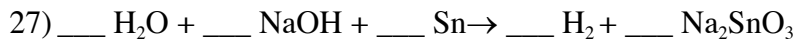
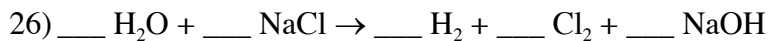
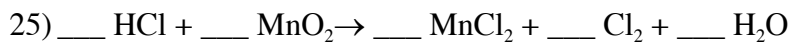
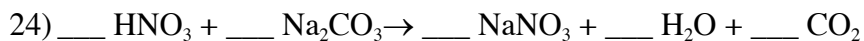
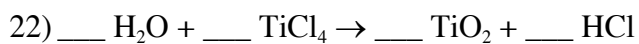
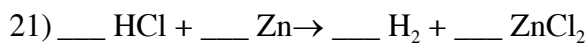
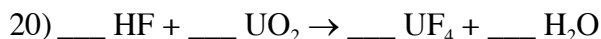
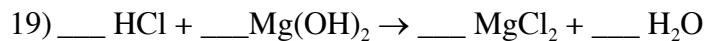
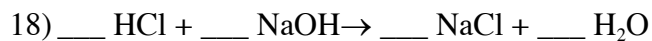
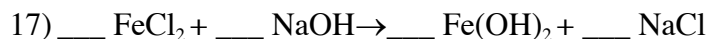
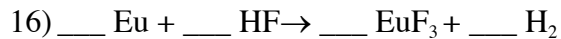
- A) An acid and a base will react to form a salt and water
- B) Two compounds may react to form a precipitate
- C) A metal oxide may react with an acid to form a salt and water
- D) Two compounds may react to form a gas

**Combustion:  $X + O_2 \rightarrow$** 

- A) Hydrocarbons can combust in oxygen to make carbon dioxide and water
- B) Metals can combine with oxygen to produce oxides.
- C) Non metals can combust to give oxides.

Balance the following equations by placing the appropriate coefficient on the lines.





**Acid/Base Reactions**

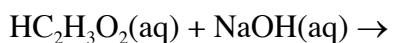
What are the six strong acids?

What are the strong bases?

Strong Acid/ Strong Base



Weak Acid/ Strong Base



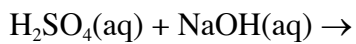
Weak Base/Strong Acid



Weak Acid/ Weak Base



Diprotic Acid

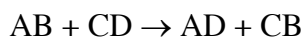




**Precipitation Reactions**

Table of Solubility Rules for Inorganic Compounds	
Soluble Compounds	Insoluble Compounds
compounds of Group 1 elements	carbonates ( $\text{CO}_3^{2-}$ ), chromates ( $\text{CrO}_4^{2-}$ ), oxalates ( $\text{C}_2\text{O}_4^{2-}$ ), and phosphates ( $\text{PO}_4^{3-}$ ), <u>except</u> those of the Group 1 elements and $\text{NH}_4^+$
ammonium ( $\text{NH}_4^+$ ) compounds	sulfides ( $\text{S}^{2-}$ ), <u>except</u> those of the Group 1 and Group 2 elements and $\text{NH}_4^+$
chlorides ( $\text{Cl}^-$ ), bromides ( $\text{Br}^-$ ), and iodides ( $\text{I}^-$ ), <u>except</u> those of $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+*}$	hydroxides ( $\text{OH}^-$ ) and oxides ( $\text{O}^{2-}$ ), <u>except</u> those of the Group 1 and Group 2 elements <sup>†</sup>
nitrates ( $\text{NO}_3^-$ ), acetates ( $\text{C}_2\text{H}_3\text{O}_2^-$ ), chlorates ( $\text{ClO}_3^-$ ), and perchlorates ( $\text{ClO}_4^-$ )	
sulfates ( $\text{SO}_4^{2-}$ ), <u>except</u> those of $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+\ddagger}$	
* $\text{PbCl}_2$ is slightly soluble. <sup>†</sup> $\text{Ca}(\text{OH})_2$ and $\text{Sr}(\text{OH})_2$ are sparingly soluble; $\text{Mg}(\text{OH})_2$ is only very slightly soluble. <sup>‡</sup> $\text{Ag}_2\text{SO}_4$ is slightly soluble	

Think of a double replacement reaction.



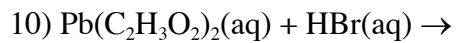
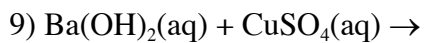
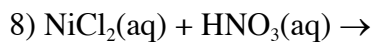
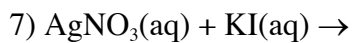
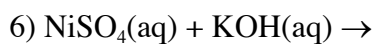
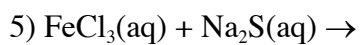
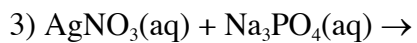
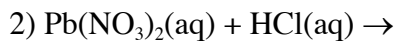
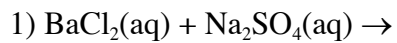
We must consider if only one of these products is of interest to us.



First the molecular equation:

Second the complete ionic equation:

Finally the net ionic:



**Oxidation and Reduction Reactions**

What are they?

Redox Reaction

**Oxidation**

Why do we call it oxidation?

**Reduction**

Why do we call it reduction?

Half Reaction

Who is an oxidizing agent? Why?

Who is a reducing agent? Why?

How do we keep track of who is oxidized and who is reduced?

Oxidation Number:

**Rules for Assigning Oxidation Numbers**

1)

2)

3)

4)

5)

What is the oxidation number for chlorine in the following situations:

a.  $\text{Cl}_2$  \_\_\_\_\_ d.  $\text{HClO}_2$  \_\_\_\_\_b.  $\text{HCl}$  \_\_\_\_\_ e.  $\text{HClO}_3$  \_\_\_\_\_c.  $\text{HOCl}$  \_\_\_\_\_ f.  $\text{HClO}_4$  \_\_\_\_\_

Assign an oxidation number to NITROGEN in each of the following compounds:

a.  $\text{Li}_3\text{N}$  \_\_\_\_\_ f.  $\text{NO}$  \_\_\_\_\_b.  $\text{N}_2$  \_\_\_\_\_ g.  $\text{HNO}_3$  \_\_\_\_\_c.  $\text{N}_2\text{O}$  \_\_\_\_\_ h.  $\text{NH}_3$  \_\_\_\_\_d.  $\text{NO}_3^-$  \_\_\_\_\_ i.  $\text{NO}_2^-$  \_\_\_\_\_e.  $\text{NO}_2$  \_\_\_\_\_ j.  $\text{N}_2\text{H}_4$  \_\_\_\_\_

Assign oxidation numbers to all the atoms in the following compounds:

 $\text{Fe}_3\text{O}_4$  $\text{H}_2\text{O}_2$  $\text{NaH}$  $\text{BeH}_2$

**Balancing Redox Equations**

## Rules for Balancing Redox Equations in Acid

1)

2)

3)

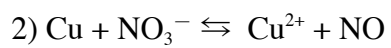
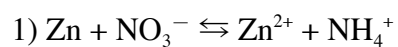
4)

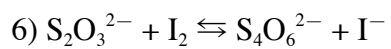
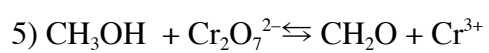
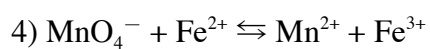
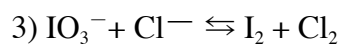
5)

6)

7)

Balance the following redox equations in acid:





## Rules for Balancing Redox Equations in Base

1)

2)

3)

4)

5)

6)

7)

Balance the following redox equation in base:

