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

Phenolphtalein Solution

Solubility in water versus alcohol

Solubility

	NaCl	Na_2S	Na_2SO_4	NaOH
$AgNO_3$				
$BaCl_2$				
NH_4Cl				
HCl				
$Pb(NO_3)_2$				

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 → 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 → 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 → AC + B or D + BC → 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 → 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.

1) ___ Ag + ___ S_8 → ___ Ag_2S

2) ___ Al + ___ O_2 → ___ Al_2O_3

3) ___ Al + ___ Br_2 → ___ Al_2Br_6

4) ___ Al + ___ Cl_2 → ___ $AlCl_3$

5) ___ Br_2 + ___ Ca → ___ $CaBr_2$

6) ___ $KClO_3$ → ___ KCl + ___ O_2

7) ___ K_2S + ___ O_2 → ___ K_2SO_3

8) ___ NO + ___ O_2 → ___ NO_2

9) ___ O_2 + ___ S → ___ SO_2

10) ___ O_2 + ___ S_8 → ___ SO_2

11) ___ CaF_2 + ___ H_2SO_4 → ___ HF + ___ $CaSO_4$

12) ___ CCl_4 + ___ HF → ___ CCl_2F_2 + ___ HCl

13) ___ $CdCl_2$ + ___ $NaOH$ → ___ $Cd(OH)_2$ + ___ $NaCl$

14) ___ C_3H_8 + ___ O_2 → ___ CO_2 + ___ H_2O

15) ___ CH_4 + ___ O_2 → ___ CO_2 + ___ H_2O

16) ___ Eu + ___ HF→ ___ EuF_3 + ___ H_2

17) ___ $FeCl_2$ + ___ NaOH→___ $Fe(OH)_2$ + ___ NaCl

18) ___ HCl + ___ NaOH→ ___ NaCl + ___ H_2O

19) ___ HCl + ___$Mg(OH)_2$ → ___ $MgCl_2$ + ___ H_2O

20) ___ HF + ___ UO_2 → ___ UF_4 + ___ H_2O

21) ___ HCl + ___ Zn→ ___ H_2 + ___ $ZnCl_2$

22) ___ H_2O + ___ $TiCl_4$ → ___ TiO_2 + ___ HCl

23) ___ CaO + ___ NH_4Cl → ___ NH_3 + ___ H_2O + ___ $CaCl_2$

24) ___ HNO_3 + ___ Na_2CO_3→ ___ $NaNO_3$ + ___ H_2O + ___ CO_2

25) ___ HCl + ___ MnO_2→ ___ $MnCl_2$ + ___ Cl_2 + ___ H_2O

26) ___ H_2O + ___ NaCl → ___ H_2 + ___ Cl_2 + ___ NaOH

27) ___ H_2O + ___ NaOH + ___ Sn→ ___ H_2 + ___ Na_2SnO_3

28) ___ H_2SO_4 + ___ $NaBH_4$→ ___ H_2 + ___ Na_2SO_4 + ___ B_2H_6

29) ___ I_2 + ___ $NaBH_4$→ ___ B_2H_6 + ___ NaI + ___ H_2

30) ___ NaF + ___ SCl_2 → ___ SF_4 + ___ S_2Cl_2 + ___ NaCl

Acid/Base Reactions

What are the six strong acids?

What are the strong bases?

Strong Acid/ Strong Base

$HCl(aq) + NaOH(aq) \rightarrow$

Weak Acid/ Strong Base

$HC_2H_3O_2(aq) + NaOH(aq) \rightarrow$

Weak Base/Strong Acid

$NH_3(aq) + HCl(aq) \rightarrow$

Weak Acid/ Weak Base

$NH_3(aq) + HC_2H_3O_2(aq) \rightarrow$

Diprotic Acid

$H_2SO_4(aq) + NaOH(aq) \rightarrow$

Precipitation Reactions

Table of Solubility Rules for Inorganic Compounds	
Soluble Compounds	Insoluble Compounds
compounds of Group 1 elements	carbonates (CO_3^{2-}), chromates (CrO_4^{2-}), oxalates ($C_2O_4^{2-}$), and phosphates (PO_4^{3-}), *except* those of the Group 1 elements and NH_4^+
ammonium (NH_4^+) compounds	sulfides (S^{2-}), *except* those of the Group 1 and Group 2 elements and NH_4^+
chlorides (Cl^-), bromides (Br^-), and iodides (I^-), *except* those of Ag^+, Hg_2^{2+}, and Pb^{2+}*	hydroxides (OH^-) and oxides (O^{2-}), *except* those of the Group 1 and Group 2 elements†
nitrates (NO_3^-), acetates ($C_2H_3O_2^-$), chlorates (ClO_3^-), and perchlorates (ClO_4^-)	
sulfates (SO_4^{2-}), *except* those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+, Hg_2^{2+}, and Pb^{2+}‡	
*$PbCl_2$ is slightly soluble. †$Ca(OH)_2$ and $Sr(OH)_2$ are sparingly soluble; $Mg(OH)_2$ is only very slightly soluble. ‡Ag_2SO_4 is slightly soluble	

Think of a double replacement reaction.

$AB + CD \rightarrow AD + CB$

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

$NaCl(aq) + AgNO_3(aq) \rightarrow$

First the molecular equation:

Second the complete ionic equation:

Finally the net ionic:

1) $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow$

2) $Pb(NO_3)_2(aq) + HCl(aq) \rightarrow$

3) $AgNO_3(aq) + Na_3PO_4(aq) \rightarrow$

4) $NaOH(aq) + Fe(NO_3)_3(aq) \rightarrow$

5) $FeCl_3(aq) + Na_2S(aq) \rightarrow$

6) $NiSO_4(aq) + KOH(aq) \rightarrow$

7) $AgNO_3(aq) + KI(aq) \rightarrow$

8) $NiCl_2(aq) + HNO_3(aq) \rightarrow$

9) $Ba(OH)_2(aq) + CuSO_4(aq) \rightarrow$

10) $Pb(C_2H_3O_2)_2(aq) + HBr(aq) \rightarrow$

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. Cl_2 _____ d. $HClO_2$ _____

b. HCl _____ e. $HClO_3$ _____

c. HOCl _____ f. $HClO_4$ _____

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

a. Li_3N _____ f. NO _____

b. N_2 _____ g. HNO_3 _____

c. N_2O _____ h. NH_3 _____

d. NO_3^- _____ i. NO_2^- _____

e. NO_2 _____ j. N_2H_4 _____

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

Fe_3O_4 H_2O_2 NaH 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:

1) $Zn + NO_3^- \leftrightarrows Zn^{2+} + NH_4^+$

2) $Cu + NO_3^- \leftrightarrows Cu^{2+} + NO$

3) $IO_3^- + Cl^- \leftrightarrows I_2 + Cl_2$

4) $MnO_4^- + Fe^{2+} \leftrightarrows Mn^{2+} + Fe^{3+}$

5) $CH_3OH + Cr_2O_7^{2-} \leftrightarrows CH_2O + Cr^{3+}$

6) $S_2O_3^{2-} + I_2 \leftrightarrows S_4O_6^{2-} + I^-$

Rules for Balancing Redox Equations in Base

1)

2)

3)

4)

5)

6)

7)

Balance the following redox equation in base:

1) $PO_3^{3-} + MnO_4^- \leftrightarrows PO_4^{3-} + MnO_2$

2) $NO_2^- + Al \leftrightarrows NH_3 + AlO_2^-$

3) $Al + MnO_4^- \leftrightarrows MnO_2 + Al(OH)_4^-$

4) $Mg + OCl^- \leftrightarrows Mg(OH)_2 + Cl^-$

5) $Cl_2 \leftrightarrows Cl^- + ClO^-$

6) $S^{2-} + Cl_2 \leftrightarrows SO_4^{2-} + Cl^-$