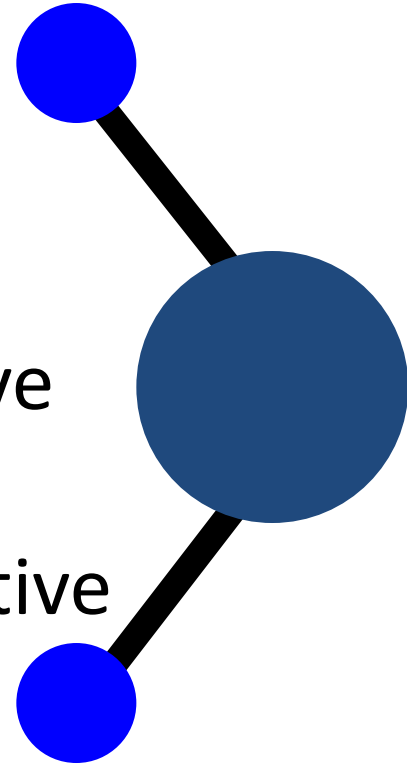


- Review Solubility Rules
- Review net ionic equations
- Know list of strong acids/bases

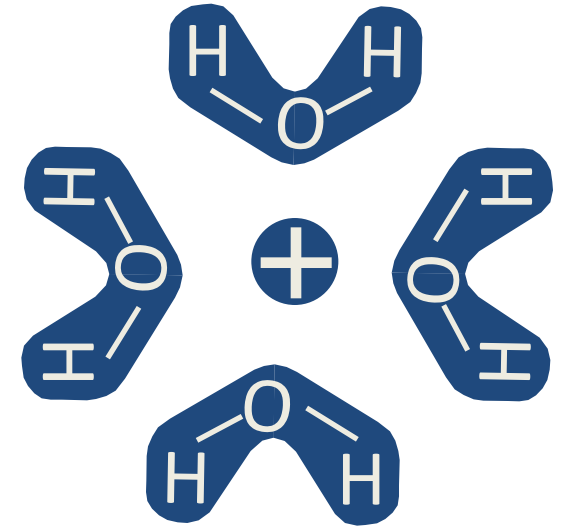
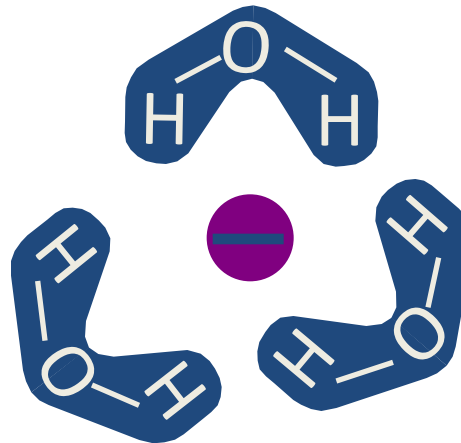
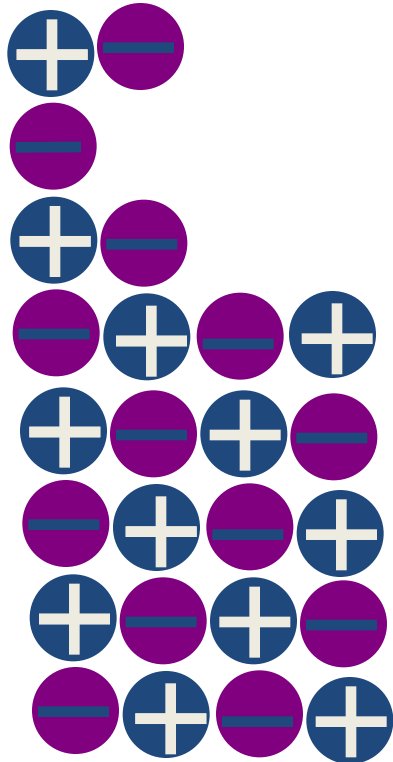
Water

- Consider water as HOH (H^+ , OH^-)
- Water is a good solvent because the molecules are polar.
- The oxygen atoms have a partial negative charge.
- The hydrogen atoms have a partial positive charge.
- The angle is 105°



How Ionic solids dissolve

[Click here for Animation](#)



Writing Net Ionic Equations

- All reactions will work, they never give you a reactions that doesn't proceed to products.
- Break up any IONIC compounds (salts, strong acids, strong bases...)
- Covalent compounds, weak electrolytes, weak acids and bases, solids, pure liquids, and gases are NOT broken into ions!
- Suspensions are NOT broken into ions.

Metathesis (Double Replacement)

Two compounds react to form two new compounds. No changes in oxidation numbers occur. All double replacement reactions must have a "driving force" that removes a pair of ions from solution.



Warm Up from HW

- 1. A solution of copper(II) sulfate is added to a solution of barium hydroxide.
- 2. Equal volumes of dilute equimolar solutions of sodium carbonate and hydrochloric acid are mixed.
- 3. Solid barium peroxide is added to cold dilute sulfuric acid.

Today's Agenda

- Question for today: What is a redox?
- Finish metathesis
- Displacement reactions
- Combustion reactions
- Combination/Decomposition
- Lab and test corrections due tomorrow. Leave notebooks in bin!

Metathesis Products

- **Precipitate** : insoluble substance formed by the reaction of two aqueous substances. Two ions bond together so strongly that water can not pull them apart.
 - i.e. Solutions of silver nitrate and lithium bromide are mixed
- **Gas** : Gases may form directly in a double replacement reaction or can form from the decomposition of a product such as H_2CO_3 or H_2SO_3 .
 - i.e. Excess hydrochloric acid solution is added to a solution of potassium sulfite
- **Molecular substance**: When a molecular substance such as water or acetic acid is formed, ions are removed from solution and the reaction "works".
 - i.e. Dilute solutions of lithium hydroxide and hydrobromic acid are mixed

Practice Problems

Sodium hydroxide is mixed with phosphoric acid.

Hydrogen sulfide is bubbled through a solution of silver nitrate.

Single Replacement (displacement)

Reaction where one element displaces another in a compound (Trivial redox).



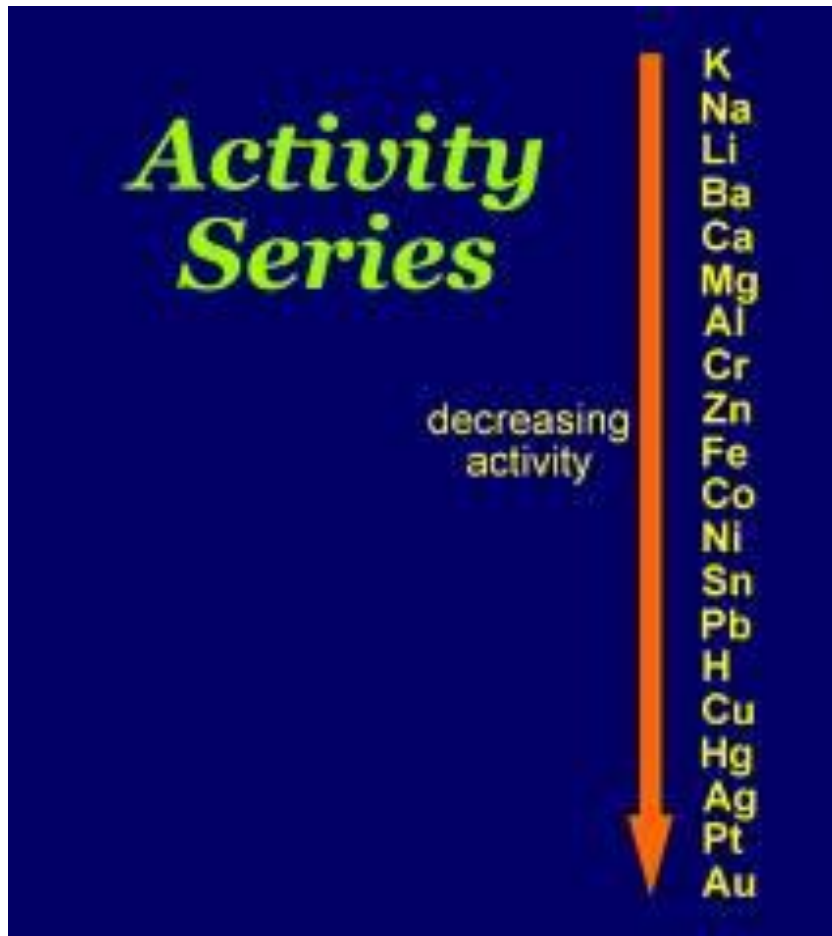
The more easily oxidized metal replaces the less easily oxidized metal.

The metal with the most negative reduction potential will be the most active.

Each halogen will displace less electronegative (heavier) halogens from their binary salts (F replaces Cl).

Remember there are **no** “no reactions”!!!

Most Active Metals on Top!



Reaction of Na^+ and K^+ with water...

Redox Review (or quick intro)

- In a redox reaction 1 substance is oxidized and the other is reduced.
- Oxidation – The substance that loses electrons
 - Charge becomes MORE positive!
- Reduction – The substance that gains electrons
 - Charge becomes LESS positive, (+ # decreases)

L.E.O. the lion says **G.E.R.**

Redox Practice



- Magnesium metal is added to a solution of iron (III) chloride.
- $3 \text{Mg}^0 + 2 \text{FeCl}_3 \rightarrow 2 \text{Fe}^0 + 3 \text{MgCl}_2$
– $3 \text{Mg}^0 + 2 \text{Fe}^{3+} + 6\text{Cl}^- \rightarrow 2 \text{Fe}^0 + 3 \text{Mg}^{2+} + 6\text{Cl}^-$
- Which is oxidized and which is reduced?

Try these

- Aluminum metal is added to a solution of copper (II) nitrate.
 - Which is oxidized and which is reduced?

- Fluorine gas is bubbled through a solution of potassium chloride.
 - Which is oxidized and which is reduced?

Special Cases

- **Non-aqueous:** gas over hot metal oxides – no net ionics
- **Weak acid/bases replaced by stronger acids/bases.** What indicates completion?
 - $\text{NH}_4\text{Cl} + \text{NaOH} \rightarrow \text{NH}_3 + \text{NaCl} + \text{H}_2\text{O}$ [molecular]
- **Polyprotic acids** i.e. H_3PO_4
 - weak polyprotic acids will only reform step-by-step. The extent to which the acid reforms depends on the amount of stronger acid added.
- Equal volumes of equimolar solutions of sodium hydrogen phosphate and hydrochloric acid are mixed :

- Equal volumes of 0.10 M sodium hydrogen phosphate and 0.20 M hydrochloric acid are mixed : 
 - Notice that in the second case there is twice as much H^+ available so the reaction goes an additional step.

Single and Double Displacement Practice

- Manganese(II) nitrate solution is mixed with sodium hydroxide solution
 - identify the spectator ions in this reaction; explain
- Solutions of zinc sulfate and sodium phosphate are mixed
 - if a wire loop is dipped into the final reaction mixture and placed in a flame, what color will the flame turn?
- Sulfur trioxide gas is bubbled into a solution of sodium hydroxide
 - is the temperature of the mixture likely to increase or decrease?

Combustion

- Reactions where elements or compounds combine with O_2
- **Hydrocarbons or alcohols** combine with O_2 to form CO_2 and H_2O .
- **Ammonia** (NH_3) combines with limited O_2 to produce NO and water **OR** excess O_2 to produce NO_2 and H_2O .
- **Nonmetallic sulfides** combine with oxygen to form oxides and SO_2 .

If you add EXCESS oxygen, you make XO_2 gases!

Combustion Practice

Carbon disulfide vapor is burned in excess O_2 .

Ethanol is burned completely in air.

Solid copper(II) sulfide is heated strongly in O_2 .

The hydrocarbon hexane (C_6H_{14}) is burned in
excess O_2



Warm Up

- Aluminum metal is added to a solution of copper (II) nitrate.
 - Which is oxidized and which is reduced?
- Fluorine gas is bubbled through a solution of potassium chloride.
 - Which is oxidized and which is reduced?

Today's Agenda

- Question: Can elements just combine, and is it the same but opposite as if compounds just decompose?
- Addition/Decomposition
- Anhydrides
- Homework Set 2/3: Only do addition/decomp and anhydride. (Combustion later)

Special Cases

- **Non-aqueous:** gas over hot metal oxides – no net ionics
- **Weak acid/bases replaced by stronger acids/bases.** What indicates completion?
 - $\text{NH}_4\text{Cl} + \text{NaOH} \rightarrow \text{NH}_3 + \text{NaCl} + \text{H}_2\text{O}$ [molecular]
- **Polyprotic acids** i.e. H_3PO_4
 - weak polyprotic acids will only reform step-by-step. The extent to which the acid reforms depends on the amount of stronger acid added.
- Equal volumes of equimolar solutions of sodium hydrogen phosphate and hydrochloric acid are mixed :

- Equal volumes of 0.10 M sodium hydrogen phosphate and 0.20 M hydrochloric acid are mixed : 
 - Notice that in the second case there is twice as much H^+ available so the reaction goes an additional step.

Addition/Combination Reactions

Two or more elements or compounds combine to form a single product

- Group IA or IIA metal may combine with a nonmetal to make a salt.
- Two nonmetals may combine to form a molecular compound.

Addition Reactions

- A metal oxide plus carbon dioxide yields a metal carbonate. (Carbon keeps the same oxidation state)
- A metal oxide plus sulfur dioxide yields a metal sulfite. (Sulfur keeps the same oxidation state)
- A metal oxide plus water yields a metallic hydroxide (base).
- A nonmetal oxide plus water yields an acid.

Addition Reaction Practice

- Solid calcium oxide is exposed to a stream of carbon dioxide gas.
- Calcium metal is heated strongly in nitrogen gas.
- A piece of lithium metal is dropped into a container of nitrogen gas
- Sulfur dioxide gas is passed over solid calcium oxide

Decomposition Reactions

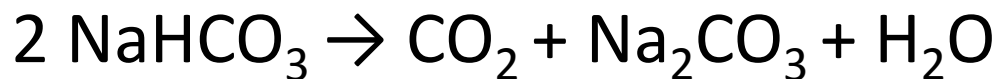
Basically, the opposite of a combination rxn.

- Common decomp's that you'll see:

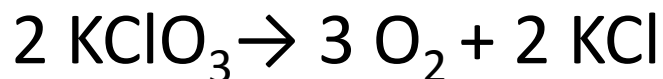
metal carbonates \rightarrow carbon dioxide + metal oxide



metal hydrogen carbonates \rightarrow CO_2 + metal carbonate + H_2O



metal halates \rightarrow oxygen + metal halide



metal sulfites \rightarrow sulfur dioxide + metal oxide



hydrogen peroxide \rightarrow oxygen + water



Decomposition Practice

solid potassium chlorate is heated in the presence of a manganese(IV) oxide catalyst, resulting in a change in the oxidation states of both the chlorine and the oxygen

- what is the oxidation number of chlorine before and after the reaction?

a solution of hydrogen peroxide is heated

– which element changes in oxidation state? How can there be only one?

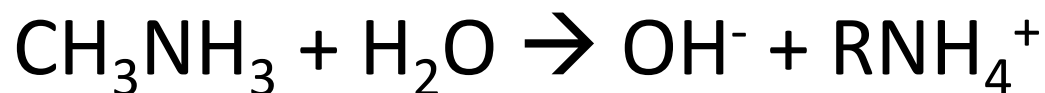
Anhydride Reactions

- Anhydride – without water. Water is a reactant in these equations.
- Nonmetal oxides (fake acid) plus water yield acids
i.e. Carbon dioxide is bubbled into water
- Metal oxides (fake base) plus water yield bases
i.e. Solid sodium oxide is added to water

Anhydride Reactions

- Metal hydride + $\text{H}_2\text{O} \rightarrow$ metal hydroxide + H_2
- Phosphorous halides + $\text{H}_2\text{O} \rightarrow$ hydrohalic acid + phosphorous containing acid.

- RNH_3 – amine, organic base



Anhydride Practice

- Excess water is added to solid calcium hydride
- Solid lithium hydride is added to water
- Solid dinitrogen pentoxide is added to water
- Phosphorus pentachloride solid is added to water
- Solid potassium oxide is added to water
- Methylamine gas is bubbled into distilled water

Acid/Base Neutralizations

- **Acids react with bases to produce salts and water.**

One mole of hydrogen ions react with one mole of hydroxide ions to produce one mole of water.

Watch out for information about quantities of each reactant! Remember which acids are strong (ionize completely) and which are weak (write as molecule).