

## AP REACTION TYPE NOTES

**IMPORTANT:** 15 point section (1 point for reactants and two points for products).

*Average Score for this section is five points.*

**I. SYNTHESIS (COMBINE ELEMENTS)** Make sure your compound on the product side has reasonable oxidation states for each element.

1. Hydrogen gas is burned in air. ( $\text{H}_2\text{O}$ )
2. Solid sulfur is burned in oxygen. ( $\text{SO}_2$ )
3. Solid magnesium is heated in nitrogen gas. ( $\text{Mg}_3\text{N}_2$ )
4. A piece of solid zinc is heated in chlorine gas. ( $\text{ZnCl}_2$ )
5. A piece of solid barium is placed in oxygen gas. ( $\text{BaO}$ )
6. A piece of solid sodium is placed in hydrogen gas ( $\text{NaH}$ )

**II. DECOMPOSITION REACTION** You will be given one reactant, so break it up. That guarantees you one point. REMEMBER: ***HYDROXIDES, CARBONATES, AND CHLORATES DECOMPOSE UPON HEATING!***

- A. Hydroxides form metal oxide and water.
- B. Chlorates form chloride salt and oxygen gas.
- C. Carbonates form metal oxide and carbon dioxide gas.

1. A solution of hydrogen peroxide is placed under a bright light. ( $\text{H}_2\text{O} + \text{O}_2$ )
2. Solid calcium carbonate is heated. ( $\text{CaO} + \text{CO}_2$ )
3. Solid potassium chlorate is heated in the presence of a catalyst. ( $\text{KCl} + \text{O}_2$ )
4. A Sample of solid ammonium carbonate is heated. ( $\text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O}$ ) *There is no such compound as ammonium oxide. Remember, when in doubt, change ammonia to ammonium hydroxide and water.*
5. A piece of solid potassium nitrate is heated. ( $\text{KNO}_2 + \text{O}_2$ ) *There is no water in this reaction so it cannot dissociate, so reduce the oxidation state of nitrogen.*

**III. WATER AS A REACTANT**

Generally, water will react with:

Metal to form a base

Nonmetal to produce an acid (Remember to dissociate strong acids/bases)

Basic rules:

- A. a pure metal or a metal hydride  $\rightarrow$  base and hydrogen gas
- B. a metal oxide (basic anhydride) in water  $\rightarrow$  base
- C. a nonmetal oxide (acidic anhydride) in water  $\rightarrow$  acid

Practice equations:

1. Sodium is added to distilled water  
 $\text{Na} + \text{H}_2\text{O} \rightarrow \text{Na}^{+1} + \text{OH}^{-1} + \text{H}_2$
2. Calcium metal is added to distilled water  
 $\text{Ca} + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$

3. Solid calcium hydride is added to water  
 $\text{CaH}_2 + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{H}_2$
4. Solid lithium hydride is added to distilled water  
 $\text{LiH} + \text{H}_2\text{O} \rightarrow \text{Li}^{+1} + \text{OH}^{-1} + \text{H}_2$
5. Solid potassium oxide is added to water  
 $\text{K}_2\text{O} + \text{H}_2\text{O} \rightarrow \text{K}^{+} + \text{OH}^{-1}$
6. Solid barium oxide is added to water  
 $\text{BaO} + \text{H}_2\text{O} \rightarrow \text{Ba}^{+2} + \text{OH}^{-1}$
7. Solid calcium oxide is added to water  
 $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
8. Solid lithium oxide is added to water  
 $\text{Li}_2\text{O} + \text{H}_2\text{O} \rightarrow \text{Li}^{+1} + \text{OH}^{-1}$
9. Solid dinitrogen pentoxide is added to water  
 $\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow \text{H}^{+1} + \text{NO}_3^{-1}$
10. Carbon dioxide gas is bubbled through water  
 $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{HCO}_3$
11. Solid phosphorous (V) oxide is bubbled through water  
 $\text{P}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4$
12. Sulfur dioxide gas is bubbled through water  
 $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{HSO}_3$
13. Sulfur trioxide gas is bubbled through water  
 $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}^{+1} + \text{HSO}_4^{-1}$

**V. MIXTURE OF TWO SALT SOLUTIONS (Ppt rxn, double displacement rxn)**

General Rules:

- A. DO NOT include any soluble ions.
- B. NO spectators!!!
- C. KNOW YOUR SOLUBILITY RULES!!!!!!!
- D. Write net ionic equations!!!!

Practice Equations:

1. Solutions of calcium nitrate and sodium sulfate are mixed.  
 $\text{Ca}^{+2} + \text{SO}_4^{-1} \rightarrow \text{CaSO}_4$

- A solution of silver nitrate is added to a solution of potassium iodide.  
 $\text{Ag}^{+1} + \text{I}^{-1} \rightarrow \text{AgI}$
- Solutions of lead (II) nitrate and tri-potassium phosphate are mixed.  
 $\text{Pb}^{+2} + \text{PO}_4^{-3} \rightarrow \text{Pb}(\text{PO}_4)_2$
- A solution of ammonium sulfide is added to a solution of magnesium iodide.  
 $\text{Mg}^{+2} + \text{S}^{-2} \rightarrow \text{MgS}$
- A solution of barium chloride is mixed with a solution of silver (I) sulfate.  
 $\text{Ba}^{+2} + \text{Cl}^{-1} + \text{Ag}^{+1} + \text{SO}_4^{-2} \rightarrow \text{BaSO}_4 + \text{AgCl}$

## VI. COMBUSTION REACTIONS

General Rules:

- Carbon compounds always burn to form oxide gases. (Even if you can't get the reactant formula from the name of a hydrocarbon compound, you can probably get the two product points by knowing that it produces carbon dioxide and water when it burns.)
- Products are always carbon dioxide and water.
- If carbon is bonded to an atom other than hydrogen, form the appropriate gas with that atom.

Practice Equations:

- Carbon disulfide gas is burned in excess oxygen  
 $\text{CS}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{SO}_2$  (no H for water, must use S)
- Ethane is burned in air  
 $\text{C}_2\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- Methanol is burned in oxygen  
 $\text{CH}_3\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- Propane is burned in air  
 $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

## VII. METALLIC OXIDE AND ACIDS

Metallic oxide + acid  $\rightarrow$  water + salt

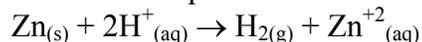
- Ferric oxide is added to hydrochloric acid.  
 $\text{Fe}_2\text{O}_{3(s)} + 6\text{H}^{+}_{(aq)} \rightarrow 2\text{Fe}^{+3}_{(aq)} + 3\text{H}_2\text{O}_{(l)}$
- Copper (II) oxide is added to nitric acid.  
 $\text{CuO}_{(s)} + 2\text{H}^{+}_{(aq)} \rightarrow \text{Cu}^{+2}_{(aq)} + \text{H}_2\text{O}_{(l)}$

## VIII. METALLIC OXIDE + NONMETALLIC OXIDE $\rightarrow$ SALT

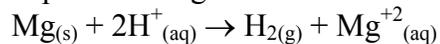
- Magnesium oxide is heated strongly in carbon dioxide gas.  
 $\text{MgO}_{(s)} + \text{CO}_{2(g)} \rightarrow \text{MgCO}_{3(s)}$
- Calcium oxide is heated in sulfur trioxide gas.  
 $\text{CaO}_{(s)} + \text{SO}_{3(g)} \rightarrow \text{CaSO}_{4(s)}$

**IX. ACID + METAL → SALT + HYDROGEN GAS (LAB)**

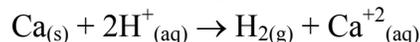
1. Solid zinc strip is added to sulfuric acid.



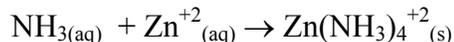
2. A piece of magnesium metal is dropped into hydrochloric acid.



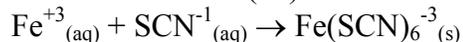
3. Calcium metal is added to 4M hydrochloric acid.

**X. OXIDIZED METAL + BASE → COMPLEX ION**

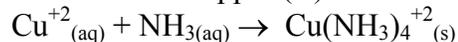
1. Concentrated ammonia is added to a solution of zinc nitrate.



2. A solution of iron (III) oxide is added to a solution of ammonia thiocyanate.



3. A solution of copper (II) nitrate is added to a strong solution of ammonia.



The ligands that have been used to form complex ions in AP reactions since 1980 and the complexes that have been formed are:

| <u>LIGAND</u>    | <u>COMPLEX ION FORMED</u>  |
|------------------|--|
| NH <sub>3</sub>  | Ag(NH <sub>3</sub> ) <sub>2</sub> <sup>+</sup><br>Cu(NH <sub>3</sub> ) <sub>4</sub> <sup>+2</sup><br>Zn(NH <sub>3</sub> ) <sub>4</sub> <sup>+2</sup> |
| OH <sup>-</sup>  | Zn(OH) <sub>4</sub> <sup>-</sup><br>Al(OH) <sub>4</sub> <sup>-</sup>   |
| CN <sup>-</sup>  | Ag(CN) <sub>2</sub> <sup>-</sup>   |
| SCN <sup>-</sup> | FeSCN <sup>+2</sup>  |