Review: Reaction Types in a Nut Shell...

**Synthesis Reaction:** Multiple reactants react to form a single, more complex product

\[ A + B \rightarrow AB \]
\[ Ca + Cl_2 \rightarrow CaCl_2 \]

**SINGLE PRODUCT**

**Decomposition Reaction:** Single reactant breaks down to form several simpler products.

\[ AB \rightarrow A + B \]
\[ 2 \ H_2O \rightarrow 2 \ H_2 + O_2 \]

**SINGLE REACTANT**

**Single Displacement Reaction:** Reactants are a single element and a compound...the single element will replace the atom that is similar in the product (by similar I mean metals will replace metals and nonmetals will replace nonmetals).

\[ Li + NaCl \rightarrow LiCl + Na \]
\[ A + BX \rightarrow AX + B \]
\[ Na + LiCl \rightarrow \]

**REACTANTS:**

**ELEMENT + COMPOUND**

Or

\[ AX + Y \rightarrow AY + X \]
\[ 2 \ NaCl + F_2 \rightarrow 2 \ NaF + Cl_2 \]

**Double Displacement Reaction:** This reaction begins with two compounds as the reactants. When the reaction takes place the cations (positive ions) exchange anions (negative ions) to form two new compounds.

\[ AX + BY \rightarrow AY + BX \]
\[ MgCl_2 + CaO \rightarrow CaCl_2 + MgO \]

**REACTANTS:**

**COMPOUND + COMPOUND**

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*A chemical equation is a combination of element symbols and numbers that represent the combination of elements, numbers of each element and the changes in arrangement that take place in a reaction or chemical change.*

**Coefficients represent the number of moles of each pure substance in the reaction**

**Subscripts represent the number of atoms of each element in the specific compound.**
Classification of Chemical Reactions

Classify the reactions below as synthesis, decomposition, single replacement, double replacement, or combustion. A few reactions are both synthesis and combustion.

1. \(2H_2 + O_2 \rightarrow 2H_2O\)

2. \(2H_2O \xrightarrow{\text{elect}} 2H_2 + O_2\)

3. \(Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2\)

4. \(2CO + O_2 \rightarrow 2CO_2\)

5. \(2HgO \xrightarrow{\Delta} 2Hg + O_2\)

6. \(2KBr + Cl_2 \rightarrow 2KCl + Br_2\)

7. \(CaO + H_2O \rightarrow Ca(OH)_2\)

8. \(AgNO_3 + NaCl \rightarrow AgCl + NaNO_3\)

9. \(2H_2O_2 \xrightarrow{\text{Pt}} 2H_2O + O_2\)

10. \(Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O\)
Types of Reactions Worksheet

Balance the following equations and indicate the type of reaction taking place:

1)  _____ NaBr + _____ H₃PO₄ → _____ Na₃PO₄ + _____ HBr
    Type of reaction: __________________________

2)  _____ Ca(OH)₂ + _____ Al₂(SO₄)₃ → _____ CaSO₄ + _____ Al(OH)₃
    Type of reaction: __________________________

3)  _____ Mg + _____ Fe₂O₃ → _____ Fe + _____ MgO
    Type of reaction: __________________________

4)  _____ C₂H₄ + _____ O₂ → _____ CO₂ + _____ H₂O
    Type of reaction: __________________________

5)  _____ PbSO₄ → _____ PbSO₃ + _____ O₂
    Type of reaction: __________________________

6)  _____ NH₃ + _____ I₂ → _____ N₂I₆ + _____ H₂
    Type of reaction: __________________________

7)  _____ H₂O + _____ SO₃ → _____ H₂SO₄
    Type of reaction: __________________________

8)  _____ H₂SO₄ + _____ NH₄OH → _____ H₂O + _____ (NH₄)₂SO₄
    Type of reaction: __________________________
Balancing Chemical Equations

Balance the equations below by placing the appropriate coefficients before each substance. Also, classify the reactions below as synthesis, decomposition, single replacement, double replacement, or combustion. A few reactions are both synthesis and combustion. Place your classification(s) in the blank.

1. \( \text{N}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g}) \)
2. \( \text{KClO}_3(\text{s}) \xrightarrow{\Delta} \text{KCl}(\text{s}) + \text{O}_2(\text{g}) \)
3. \( \text{NaCl}(\text{aq}) + \text{F}_2(\text{g}) \rightarrow \text{NaF}(\text{aq}) + \text{Cl}_2(\text{g}) \)
4. \( \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \)
5. \( \text{AgNO}_3(\text{aq}) + \text{MgCl}_2(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{Mg(NO}_3)_2(\text{aq}) \)
6. \( \text{AlBr}_3(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \rightarrow \text{KBr}(\text{aq}) + \text{Al}_2(\text{SO}_4)_3(\text{s}) \)
7. \( \text{CH}_4(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \)
8. \( \text{C}_3\text{H}_8(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \)
9. \( \text{C}_8\text{H}_{18}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \)
10. \( \text{FeCl}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{Fe(OH)}_3(\text{s}) + \text{NaCl}(\text{aq}) \)
11. \( \text{P}_4(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{P}_2\text{O}_5(\text{s}) \)
12. \( \text{Na}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NaOH}(\text{aq}) + \text{H}_2(\text{g}) \)
13. \[ \text{Ag}_2\text{O}(s) \xrightarrow{\Delta} \text{Ag}(s) + \text{O}_2(g) \]

14. \[ \text{S}_8(s) + \text{O}_2(g) \rightarrow \text{SO}_3(g) \]

15. \[ \text{CO}_2(g) + \text{H}_2\text{O}(l) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(s) + \text{O}_2(g) \]

16. \[ \text{K}(s) + \text{MgBr}_2(\text{aq}) \rightarrow \text{KBr}(\text{aq}) + \text{Mg}(s) \]

17. \[ \text{HCl}(\text{aq}) + \text{CaCO}_3(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(l) + \text{CO}_2(g) \]

17. Number 17 has two reactions happening...one then the other.

**Balancing Hints:**

- Only place coefficients in front. Never, never, never (and I mean NEVER) change the subscripts after the correct formula is written.
- For single and double replacement reactions, balance the polyatomic ions as a whole item if they appear on both sides of the equation.
- For single and double replacement reactions, change H\text{2}O to HOH and balance H\text{+} ions and OH\text{-} ions.
- Balance lone elements first. Lone elements are ones that only appear in one formula on each side. Leave the ones that appear more than once on a side until last.
- When you are done, the coefficients need to be in the lowest possible ratio. Always recheck this.
- Recheck that all atoms are balanced when you are done.
General Equations

Synthesis:
Metal + Nonmetal \rightarrow A \text{ salt (Ionic Compound)}

Nonmetal + Nonmetal \rightarrow \text{ Simplest Covalent Compound Possible}

Metal Oxide + Water \rightarrow \text{ Metal Hydroxide}

Nonmetal Oxide + Water \rightarrow \text{ Oxyacid}

Metal Oxide + Nonmetal Oxide \rightarrow A \text{ salt (Ionic Compound)}

Decomposition:
Metal Carbonate \rightarrow \text{ Metal Oxide + Carbon Dioxide}

Metal Chlorate \rightarrow \text{ Metal Chloride + Oxygen}

Metal Hydroxide \rightarrow \text{ Metal Oxide + Water}

Some metal oxides \rightarrow \text{ Metal + Oxygen}
SYNTHESIS

A synthesis reaction is recognized by two elements combining to form one product. For each, write the symbols or formulas for the elements and then write the correct formula of the product(s).

1. sodium + oxygen

2. potassium + oxygen

3. lithium + chlorine

4. cesium + bromine

5. zinc + oxygen

6. magnesium + chlorine

7. calcium + sulfur

8. strontium + oxygen

9. aluminum + iodine

10. aluminum + nitrogen
Decomposition Worksheet

Predict the products of the reaction below. Write the balanced equation. Include the phase information. Remember, ionic compounds are usually solid. Watch out for those diatomic molecules.

Example: \(2\text{H}_2\text{O}(l) \xrightarrow{\text{elect.}} 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})\)

Example: \(2\text{HgO}(s) \xrightarrow{\Delta} 2\text{Hg}(l) + \text{O}_2(\text{g})\)

1. \(\text{Fe}_2\text{O}_3(s) \xrightarrow{\text{elect.}} \)

2. \(\text{NaCl}(s) \xrightarrow{\text{elect.}} \)

3. \(\text{NH}_3(g) \xrightarrow{\Delta} \)

4. \(\text{CaF}_2(s) \xrightarrow{\text{elect.}} \)

5. \(\text{H}_2\text{O}_2(\text{aq}) \xrightarrow{\text{MnO}_2(s)} \)

When a metal carbonate is heated, it breaks down to produce a metal oxide and carbon dioxide gas.

6. \(\text{CaCO}_3(s) \xrightarrow{\Delta} \)

Metal hydroxides will often decompose when heated to yield metal oxides and water.

7. \(\text{Ca(OH)}_2(s) \xrightarrow{\Delta} \)

When a metal chlorate is heated, it decomposes to produce a metal chloride and oxygen.

8. \(\text{KClO}_3(s) \xrightarrow{\Delta} \)

Certain acids decompose into nonmetal oxides and water.

9. \(\text{H}_2\text{SO}_4(\text{aq}) \xrightarrow{\Delta} \)
Special Case Decomposition Reactions

metal chlorate $\rightarrow$ metal chloride + oxygen

$$2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$$

metal carbonate $\rightarrow$ metal oxide + carbon dioxide

$$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$$

$\rightarrow$ metal hydroxide $\rightarrow$ metal oxide + water

$$\text{Ca(OH)}_2 \rightarrow \text{CaO} + \text{H}_2\text{O}$$

metal bicarbonate $\rightarrow$ metal carbonate + water + carbon dioxide

$$\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$$
Single Replacement Worksheet

Directions:
- Predict the products of the following reactions. Check the activity series to be sure the element is active enough to replace the ion in the compound. If the element is not active enough to replace the ion in the compound, then write “No reaction”.
- Balance the equations.
- Include phase information.

**Hint** Be sure that a metal replaces a cation and a nonmetal replaces an anion.

1. Zn (s) + H₂SO₄ (aq) →

2. Al (s) + CaS (aq) →

3. KBr (aq) + Cl₂ (g) →

4. HC₂H₃O₂ (aq) +Mg (s) →

5. MgBr₂ (aq) + Cl₂ (g) →

6. MgBr₂ (aq) + K (s) →
Double Replacement Worksheet

Directions:
- Predict the products of the following reactions.
- Balance the equations.
- Include phase information, especially if it is a precipitate! (Look on the handout to determine solubility.)

1. NaBr (aq) + AgNO₃ (aq) →

2. Ni(NO₃)₂ (aq) + NaOH (aq) →

3. Pb(NO₃)₂ (aq) + K₃PO₄ (aq) →

4. LiC₂H₃O₂ (aq) + Hg(NO₃)₂ (aq) →

5. Na₂CO₃ (aq) + Ca(OH)₂ (aq) →
DOUBLE DISPLACEMENT EQUATIONS

Complete the following:

1. sodium hydroxide + hydrogen chloride ->

2. potassium hydroxide + hydrogen sulfate ->

3. iron (II) sulfide + nitric acid ->

4. copper (II) sulfate + sulfuric acid ->

5. sodium chloride + potassium nitrate ->

6. sodium carbonate + hydrochloric acid ->

7. ammonium chloride + calcium hydroxide ->

8. magnesium carbonate + hydrochloric acid ->

9. sodium sulfite + sulfuric acid ->

10. barium hydroxide + sulfurous acid (H2SO3) ->

11. silver nitrate + hydrogen sulfide ->

12. iron (III) sulfide + hydrogen sulfate ->

13. lead (II) nitrate + hydrosulfuric acid (H2S) ->

14. sulfuric acid + aluminum phosphate ->

15. calcium phosphate + sodium carbonate ->

16. iron (III) chloride + potassium hydroxide ->

17. zinc hydroxide + phosphoric acid ->
REACTION PREDICTION WS

(a) Identify the type of reaction is expected.
(b) Write the balanced formula & word equations for the reactions that do take place; write the symbols and formulas of the reactants if no reaction.

1. aluminum plus hydrochloric acid
2. calcium hydroxide plus nitric acid
3. aluminum plus magnesium
4. magnesium plus zinc nitrate
5. mercury plus oxygen
6. zinc chloride plus hydrosulfic acid
7. dinitrogen pentoxide plus water
8. silver chloride plus sodium nitrate
9. sodium chlorate (heated)
10. barium nitrate plus sodium chromate
11. sodium bromide plus silver nitrate
12. calcium phosphate plus aluminum sulfate
13. zinc carbonate (heated)
14. mercury(I) sulfate plus ammonium nitrate
15. potassium plus fluorine
16. potassium nitrate plus zinc phosphate
17. lithium oxide plus water
18. sodium chloride (electrolyzed)
19. silver plus barium
20. iron(III) hydroxide plus phosphoric acid
21. sodium plus nitric acid
22. iron(III) iodide plus cupric nitrate
23. copper plus sulfuric acid
24. lead plus potassium chlorate
REACTION PREDICTION WS

25. sulfur dioxide plus water
26. oxygen plus sulfur
27. sodium sulfate plus barium chloride
28. ammonium phosphate plus lithium hydroxide
29. hydrogen plus oxygen
30. mercury plus nitric acid
31. sodium oxide plus water
32. calcium carbonate plus lithium chloride
33. mercury(I) sulfate plus hydrochloric acid
34. potassium nitrate (heated)
35. chlorine plus bromine
36. mercury(I) nitrate plus sodium carbonate
37. magnesium plus hydrochloric acid
38. water (electrolyzed)
39. ammonium nitrite plus barium hydroxide
40. ammonium sulfate plus calcium hydroxide
41. mercury(II) oxide (heated)
42. ammonium phosphate plus aluminum chloride
43. barium oxide plus water
44. iron (III) hydroxide plus nitric acid
45. calcium plus oxygen
46. calcium plus phosphoric acid
47. calcium chloride plus ammonium hydroxide
48. aluminum sulfide plus hydrochloric acid
49. magnesium plus sulfur
50. calcium plus aluminum chloride