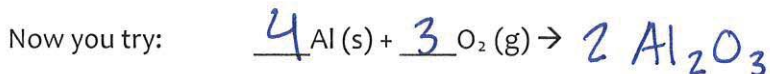
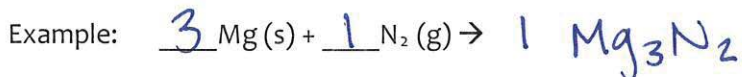


Unit 7 Part 4: Types of Chemical Reactions

1. Synthesis Reactions



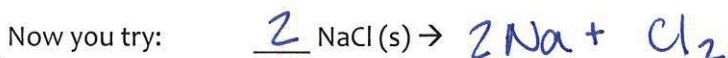
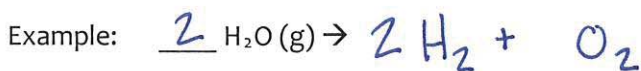
- Also called combination reactions
- Two elements, or compounds combine to make one compound.
- We can predict the product if the reactants are two elements.



2. Decomposition Reactions

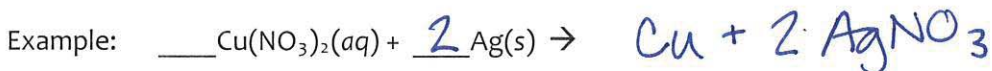
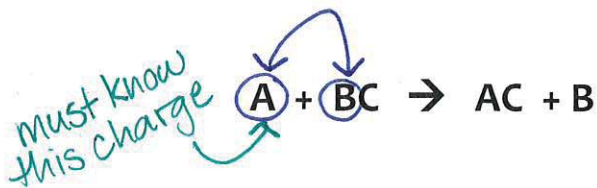


- Decompose = break down
- One compound (reactant) decomposes into two or more elements or compounds.
- Usually requires energy
- We can predict the products if the reactants break apart into two elements.



3. Single Replacement

- Also referred to as single displacement
- One element replaces another
- Reactants must be an element and a compound
- Products will be a different element and a different compound
- We can predict the products if we know the charge on the cation in the compound being formed:



Uh Oh! Not every Single Replacement Reaction Occurs!!!!

How to check if a single replacement reaction will occur:

- Is the single element reactant higher than the corresponding element in the reactant compound?
 - Yes → The reaction occurs!
 - No → No reaction (No rxn)

Activity Series of Metals				Activity Series of Nonmetals			
Metal	Half Reaction	E_{ox}° (V)	Nonmetal	Half Reaction	E_{red}° (V)		
Lithium	$Li(s) \rightarrow Li^{+}(aq) + e^{-}$	+3.05	Fluorine	$F_2(g) + 2e^{-} \rightarrow 2F^{-}(aq)$	+2.87		
Rubidium	$Rb(s) \rightarrow Rb^{+}(aq) + e^{-}$	+2.93	Chlorine	$Cl_2(g) + 2e^{-} \rightarrow 2Cl^{-}(aq)$	+1.36		
Potassium	$K(s) \rightarrow K^{+}(aq) + e^{-}$	+2.92	Bromine	$Br_2(l) + 2e^{-} \rightarrow 2Br^{-}(aq)$	+1.07		
Barium	$Ba(s) \rightarrow Ba^{2+}(aq) + 2e^{-}$	+2.90	Iodine	$I_2(s) + 2e^{-} \rightarrow 2I^{-}(aq)$	+0.53		
Calcium	$Ca(s) \rightarrow Ca^{2+}(aq) + 2e^{-}$	+2.87	(Hydrogen)	$2H^{+}(aq) + 2e^{-} \rightarrow H_2(g)$	0.00		
Sodium	$Na(s) \rightarrow Na^{+}(aq) + e^{-}$	+2.71					
Magnesium	$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^{-}$	+2.37					
Aluminum	$Al(s) \rightarrow Al^{3+}(aq) + 3e^{-}$	+1.66					
Manganese	$Mn(s) \rightarrow Mn^{2+}(aq) + 2e^{-}$	+1.18					
Zinc	$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^{-}$	+0.76					
Chromium	$Cr(s) \rightarrow Cr^{3+}(aq) + 3e^{-}$	+0.74					
Iron	$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^{-}$	+0.44					
Cobalt	$Co(s) \rightarrow Co^{2+}(aq) + 2e^{-}$	+0.28					
Nickel	$Ni(s) \rightarrow Ni^{2+}(aq) + 2e^{-}$	+0.25					
Tin	$Sn(s) \rightarrow Sn^{2+}(aq) + 2e^{-}$	+0.14					
Lead	$Pb(s) \rightarrow Pb^{2+}(aq) + 2e^{-}$	+0.13					
(Hydrogen)	$H_2(g) \rightarrow 2H^{+}(aq) + 2e^{-}$	0.00					
Copper	$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^{-}$	-0.34					
Silver	$Ag(s) \rightarrow Ag^{+}(aq) + e^{-}$	-0.80					
Mercury	$Hg(l) \rightarrow Hg^{2+}(aq) + 2e^{-}$	-0.85					
Platinum	$Pt(s) \rightarrow Pt^{2+}(aq) + 2e^{-}$	-1.20					
Gold	$Au(s) \rightarrow Au^{3+}(aq) + 3e^{-}$	-1.50					

Examples:

- Can iron replace manganese in a single replacement reaction? No Why/ why not?
Iron is lower than activity, so it cannot replace higher activity manganese.
- Can bromine replace fluorine in a single replacement reaction? No Why/ why not?
Bromine is lower in activity.
- What do you notice about the location of metals commonly used to make jewelry (such as silver, gold, platinum and copper)? Why would that make sense for metals people wear?

Low activity - you don't want your jewelry to always be reacting with everything

Practice Makes Perfect!

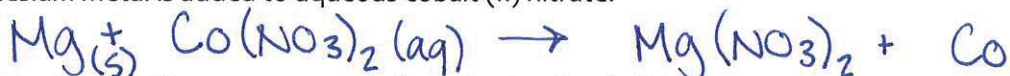
Use the appropriate activity series to determine if the following reaction will occur. If the reaction will occur, write the products and balance the equation. If the reaction will not occur, write No Reaction (NR).



2. Solid aluminum is placed in water vapor.



3. Solid magnesium metal is added to aqueous cobalt (II) nitrate.



4. Liquid bromine is added to an aqueous solution of potassium iodide.

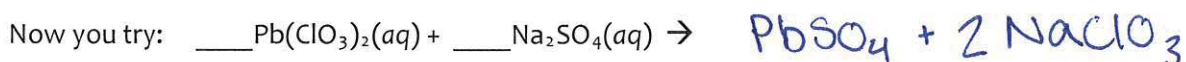
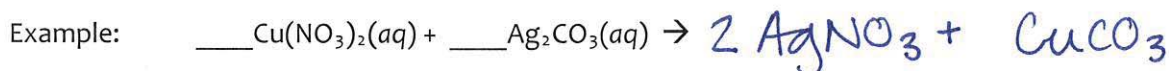


4. Double Replacement

- Two things replace each other.
- Reactants must be two compounds -or



- Usually in an aqueous solution
- Two types of DR reactions: precipitate & acid/base
- We can always predict the products of a DR reaction:

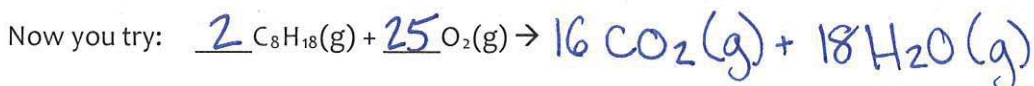
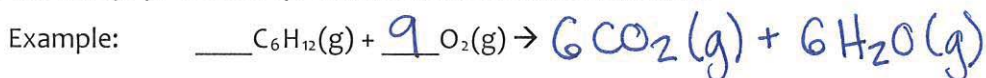


5. Combustion

- A reaction in which a compound (often carbon) reacts with oxygen gas and usually produces carbon dioxide and water vapor.



- We can always predict the products of a combustion reaction:



How to recognize each type of reaction

1. Look at the reactants:

- element + element = synthesis
- compound = decomposition
- element + compound = single replacement
- compound + compound = double replacement
- C_xH_y or $C_xH_yO_z + O_2 =$ combustion

2. Look at the products: $CO_2 + H_2O =$ combustion

Practice Makes Perfect!

Directions: Balance the following equations by placing coefficients in the blanks. Classify the reaction.

- | | Type of Reaction: |
|--|---------------------------|
| 1. $\underline{\quad}$ Zn(s) + $\underline{2}$ HCl(aq) \rightarrow $\underline{\quad}$ ZnCl ₂ (aq) + $\underline{\quad}$ H ₂ (g) | <u>single replacement</u> |
| 2. $\underline{\quad}$ C ₃ H ₈ (g) + $\underline{5}$ O ₂ (g) \rightarrow $\underline{3}$ CO ₂ (g) + $\underline{4}$ H ₂ O(g) | <u>combustion</u> |
| 3. $\underline{2}$ KClO ₃ (s) \rightarrow $\underline{2}$ KCl(s) + $\underline{3}$ O ₂ (g) | <u>decomposition</u> |
| 4. $\underline{\quad}$ BaCl ₂ (aq) + $\underline{2}$ KIO ₃ (aq) \rightarrow $\underline{\quad}$ Ba(IO ₃) ₂ (s) + $\underline{2}$ KCl(aq) | <u>double replacement</u> |
| 5. $\underline{3}$ Fe(s) + $\underline{4}$ H ₂ O(g) \rightarrow $\underline{\quad}$ Fe ₃ O ₄ (s) + $\underline{4}$ H ₂ (g) | <u>single replacement</u> |
| 6. $\underline{4}$ Fe(s) + $\underline{3}$ O ₂ (g) \rightarrow $\underline{2}$ Fe ₂ O ₃ (s) | <u>synthesis</u> |
| 7. $\underline{4}$ C(s) + $\underline{6}$ H ₂ (g) + $\underline{\quad}$ O ₂ (g) \rightarrow $\underline{2}$ C ₂ H ₆ O(s) | <u>synthesis</u> |
| 8. $\underline{19}$ O ₂ (g) + $\underline{2}$ C ₆ H ₁₄ (g) \rightarrow $\underline{14}$ H ₂ O(g) + $\underline{12}$ CO ₂ (g) | <u>combustion</u> |
| 9. $\underline{2}$ HNO ₃ (aq) + $\underline{\quad}$ Mg(OH) ₂ (aq) \rightarrow $\underline{2}$ H ₂ O(l) + $\underline{\quad}$ Mg(NO ₃) ₂ (aq) | <u>double replacement</u> |

Practice Predicting Products!

Directions:

1. Determine type: single replacement (SR), double replacement (DR), synthesis (S), decomposition (D), or combustion (C)
2. Predict the products and write the correct chemical formula for each product. (Don't worry about states of matter!)
3. Balance each reaction using the correct coefficients.

Type?

