Chemistry

Unit 6

Chemical Reactions

Balancing Equations - Notes

1. _____ Fe + _____ S --> _____ FeS

2. _____ H_2 + _____ Cl_2 → _____ HCl

3. _____ Mg + _____ O_2 → _____ MgO

4. _____ O_2 + _____ H_2 → _____ H_2O

5. _____ HgO --> _____ Hg + _____ O_2

6. _____ Ca + _____ H_2O → _____ $Ca(OH)_2$ + _____ H_2

7. _____ CH_4 + _____ O_2 → _____ CO_2 + _____ H_20

8. _____ Na_2O_2 + _____ H_2SO_4 → _____ Na_2SO_4 + _____ H_2O_2

9. _____ N_2 + _____ H_2 → _____ NH_3

10. _____ Al + _____ O_2 → _____ Al_2O_3

11. _____ $KMnO_4$ → _____ K_2O + _____ MnO + _____ O_2

Balancing Chemical Equations Worksheet

Directions: Write a balanced equation on a separate piece of paper.

1. _____ H_2 + _____ O_2 → _____ H_2O
2. _____ N_2 + _____ H_2 → _____ NH_3
3. _____ S_8 + _____ O_2 → _____ SO_3
4. _____ N_2 + _____ O_2 → _____ N_2O
5. _____ HgO → _____ Hg + _____ O_2
6. _____ CO_2 + _____ H_2O → _____ $C_6H_{12}O_6$ + _____ O_2
7. _____ Zn + _____ HCl → _____ $ZnCl_2$ + _____ H_2
8. _____ $SiCl_4$ + _____ H_2O → _____ H_4SiO_4 + _____ HCl
9. _____ Na + _____ H_2O → _____ $NaOH$ + _____ H_2
10. _____ H_3PO_4 → _____ $H_4P_2O_7$ + _____ H_2O
11. _____ $C_{10}H_{16}$ + _____ Cl_2 → _____ C + _____ HCl
12. _____ CO_2 + _____ NH_3 → _____ $OC(NH_2)_2$ + _____ H_2O
13. _____ Si_2H_3 + _____ O_2 → _____ SiO_2 + _____ H_2O_3
14. _____ $Al(OH)_3$ + _____ H_2SO_4 → _____ $Al_2(SO_4)_3$ + _____ H_2O
15. _____ Fe + _____ O_2 → _____ Fe_2O_3
16. _____ $Fe_2(SO_4)_3$ + _____ KOH → _____ K_2SO_4 + _____ $Fe(OH)_3$
17. _____ $C_7H_6O_2$ + _____ O_2 → _____ CO_2 + _____ H_2O
18. _____ H_2SO_4 + _____ HI → _____ H_2S + _____ I_2 + _____ H_2O
19. _____ FeS_2 + _____ O_2 → _____ Fe_2O_3 + _____ SO_2
20. _____ Al + _____ FeO → _____ Al_2O_3 + _____ Fe
21. _____ Fe_2O_3 + _____ H_2 → _____ Fe + _____ H_2O
22. _____ Na_2CO_3 + _____ HCl → _____ $NaCl$ + _____ H_2O + _____ CO_2
23. _____ K + _____ Br_2 → _____ KBr
24. _____ C_7H_{16} + _____ O_2 → _____ CO_2 + _____ H_2O
25. _____ P_4 + _____ O_2 → _____ P_2O_5

WORD EQUATIONS:

Write the word equations below as chemical equations and balance. Be sure to **balance the charges** on each molecule.

Example: iron(III)chloride and sodium hydroxide → iron(III)hydroxide and sodium chloride

First, Identify each symbol and charge:

$Fe^{+3} + Cl^{-1} + Na^{+1} + OH^{-1} \rightarrow Fe^{+3} + OH^{-1} + Na^{+1} + Cl^{-1}$

Second, balance the charges on each molecule: $Fe\ Cl_3 + Na\ OH \rightarrow Fe\ (OH)_3 + Na\ Cl$

Lastly, balance the equations for both reactants and products:

_____ $FeCl_3$ + **3** $NaOH \rightarrow$ _____ $Fe(OH)_3$ + **3** $NaCl$

I. magnesium metal reacts with nickel(III) nitrate to form magnesium nitrate and nickel metal.

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1) zinc metal reacts lead(II) nitrate to yield zinc nitrate and lead metal.

2) aluminum bromide and chlorine gas yields aluminum chloride and liquid bromine

3) sodium phosphate and calcium chloride yields calcium phosphate and sodium chloride

4) potassium chlorate when heated yields potassium chloride and oxygen gas

5) aluminum metal and hydrochloric acid forms aluminum chloride and hydrogen gas.

6) calcium hydroxide and phosphoric acid react to form calcium phosphate and water.

7) copper metal and sulfuric acid yields copper(I) sulfate and water and sulfur dioxide

8) hydrogen gas and nitrogen monoxide react to form gaseous water and nitrogen gas

9) sodium phosphate reacts with lead(II) acetate to produce lead(II) phosphate and sodium acetate.

Notes

Combustion, Synthesis, and Decomposition Reactions Worksheet
Complete each of the following equations, write formulas for and balance the chemical reaction equation.

Combustion Reaction: $C_xH_y + O_2 \dashrightarrow CO_2 + H_2O$

1) Methane _____

2) Ethene _____

3) Methanol _____

4) Heptane _____

5)Propyne _____

Synthesis Reaction: A + B → AB

1) Barium + Sulfur _____

2) Silver + oxygen _____

3) Aluminum + Oxygen _____

4) Hydrogen + Oxygen _____

5) Hydrogen + Nitrogen _____

Decompostion Reaction: AB → A + B

1) Potassium chloride _____

2) Calcium oxide _____

3) Mercury (II) oxide _____

4) Sodium chloride _____

5) Copper (I) bromide _____

Combustion, Decomposition, & Synthesis Reactions Worksheet

Instructions: 1) Identify the reaction type as a synthesis, decomposition, or combustion
2) Write the chemical formula's for the reactants and predict the products
3) Balance the reactions

	Type	Balanced Reaction
1) Sodium + Oxygen		
2) Butane		
3) Iron (III) Chloride		
4) Copper (II) + Oxygen		
5) Propene		
6) Silver + Chlorine		
7) Aluminum oxide		
8) Tin (VI) + Chloride		
9) 2 - Propanol		
10) Barium Oxide		
11) Glucose ($C_6H_{12}O_6$)		
12) Potassium+Chlorine		
13) Lead (II) Oxide		
14) Ethyne		
15) Iron (III) + Sulfur		
16) Octane		
17) Silver + Oxygen		
18) Hydrogen+ Nitrogen		
19) 3 - Hexene		
20) Copper (I) Bromide		
21) Mercury (II) Oxide		
22) 1 - Pentanol		
23) Magnesium+Oxygen		
24) Sodium Chloride		
25) Calcium + Sulfur		

Single / Double Replacement

SHOW ALL WORK, ALL EQUATIONS, and **ALL UNITS**
Chemical Equations & Reaction Types:

PREDICT the products and write the BALANCED EQUATION for each for each of these reactions.

SINGLE REPLACEMENT:

Example I: _____ $Al_{(s)}$ + _____ $Pb(NO_3)_{2\,(aq)} \rightarrow$

Example II: _____ $Cl_{2\,(g)}$ + _____ $CuI_{2\,(aq)} \rightarrow$

Example III: _____ $Ag_{(s)}$ + _____ $Ca(IO_3)_{2\,(aq)} \rightarrow$

1. _____ $Zn_{(s)}$ + _____ $CuSO_{4\,(aq)} \rightarrow$

2. _____ $Cl_{2\,(g)}$ + _____ $KI_{(aq)} \rightarrow$

3. _____ $Ni_{(s)}$ + _____ $MgSO_{4\,(aq)} \rightarrow$

4. _____ $Br_{2\,(aq)}$ + _____ $CaCl_{2\,(s)} \rightarrow$

5. _____ $F_{2\,(aq)}$ + _____ $ZrCl_{4\,(s)} \rightarrow$

DOUBLE REPLACEMENT:

Example IV: _____ $AlBr_{3\,(aq)}$ + _____ $NaOH_{(aq)} \rightarrow$

Example V: _____ $BaCl_{2\,(g)}$ + _____ $K_2SO_{4\,(aq)} \rightarrow$

Example VI: _____ $(NH_4)_2S_{(s)}$ + _____ $LiC_2H_3O_{2\,(aq)} \rightarrow$

6. _____ $FeCl_{2\,(aq)}$ + _____ $K_2S_{(aq)} \rightarrow$

7. _____ $CuSO_{4\,(aq)}$ + _____ $AgNO_{3\,(aq)} \rightarrow$

8. _____ $AlCl_{3\,(aq)}$ + _____ $Na_2CO_{3\,(aq)} \rightarrow$

9. _____ $(NH_4)_2SO_{4\,(aq)}$ + _____ $BaCl_{2\,(aq)} \rightarrow$

10. _____ $K_3PO_{4\,(aq)}$ + _____ $Fe_2O_{3\,(aq)} \rightarrow$

CHEMISTRY **SINGLE REPLACEMENT REACTION WORKSHEET**

Practice Reactions:

1. $Ag + KNO_3$ ----->

2. $Zn + AgNO_3$ ----->

3. $Al + H_2SO_4$ ----->

4. $Cl_2 + KI$ ----->

5. $Li + H_2O$ ----->

6. $Cu + FeSO_4$ ----->

7. $Na + H_2O$ ----->

8. $Fe + Pb(NO_3)_2$ ----->

9. $Cu + H_2O$ ----->

10. $Cu + Al_2(SO_4)_3$ ---->

CHEMISTRY **SINGLE REPLACEMENT REACTION WORKSHEET**

11. Al + $Pb(NO_3)_2$ ---->

12. Cl_2 + NaI --->

13. Fe + $AgC_2H_3O_2$ --->

14. Al + $CuCl_2$ --->

15. Br_2 + CaI_2 --->

16. Al + HCl --->

17. Mg + HCl --->

18. Zn + H_2SO_4 --->

19. Fe + $CuSO_4$ --->

20. Cl_2 + MgI_2 --->

CHEMISTRY **DOUBLE REPLACEMENT REACTION WORKSHEET**

PRACTICE REACTIONS

1) $Ca(OH)_2 + H_3PO_4$ --->

2) $K_2CO_3 + BaCl_2$ --->

3) $Cd_3(PO_4)_2 + (NH_4)_2S$ --->

4) $Co(OH)_3 + HNO_3$ --->

5) $AgNO_3 + KCl$ --->

6) $Na_2CO_3 + H_2SO_4$ --->

7) $Al(OH)_3 + HC_2H_3O_2$ --->

8) $Al_2(SO_4)_3 + Ca_3(PO_4)_2$ --->

9) $Cr_2(SO_3)_3 + H_2SO_4$ --->

10) $AgC_2H_3O_2 + K_2CrO_4$ --->

11) $FeBr_2 + K2CO_3$ --->

12) $Ag_2S + CuCl_2$ --->

13) $Pb(NO_3)_2 + HI$ --->

14) $Ba(ClO_3)_2 + H_2SO_4$ --->

15) $CuS + KCl$ --->

For PreAp - Must use Activity Series @ end of packet

Predict the product and write a balanced equation for each of the following. Write N.R. if no reaction occurs.

11. _____ $Zn_{(s)}$ + _____ $MgSO_{4\,(aq)}$ →

12. _____ $Zn_{(s)}$ + _____ $Ni(NO_3)_{2\,(aq)}$ →

13. _____ $KCl_{(aq)}$ + _____ $AgNO_{3\,(aq)}$ →

14. _____ $Mg_{(s)}$ + _____ $AlCl_{3\,(aq)}$ →

15. _____ $Cl_{2\,(g)}$ + _____ $KBr_{(aq)}$ →

16. _____ $Li_2SO_{4\,(aq)}$ + _____ $BaCl_{2\,(aq)}$ →

17. _____ $Pb(NO_3)_{2\,(aq)}$ + _____ $NaCl_{(aq)}$ →

18. _____ $Zn_{(s)}$ + _____ $CuCl_{2\,(aq)}$ →

19. _____ $AlCl_{3\,(aq)}$ + _____ $Pb(NO_3)_{2\,(aq)}$ →

20. _____ $Cu_{(s)}$ + _____ $Pb(NO_3)_{2\,(aq)}$ →

OIL RIG
Balancing Redox Equations

Early in the year you learned to classify chemical reactions in order to help you predict the products that would occur. You learned about composition (synthesis), decomposition, single replacement, double displacement, and combustion reactions. There is another classification method that involves determining whether electrons have been transferred from one chemical to another. These reactions are called oxidation reduction reactions, or REDOX if you are talking "chemist's slang". Many of the reactions that we have studied, and classified in another way, are also redox reactions.

In this lesson you will learn to classify reactions as "redox", and learn a new method of balancing some of the more difficult reactions.

We identify which is substance is oxidized and which is reduced by using the mnemonic "OIL RIG". We are talking about electrons, so just remember:

Oxidation
Is
Losing electrons

Reduction
Is
Gaining electrons

Of course it might not seem logical to you that when you reduce something you gain electrons. However, remember that the electrons are negative, so when you gain a negative particle, the oxidation state goes down, or is reduced in value.

PURPOSE

In this activity you will learn to recognize redox reactions and will learn the half-reaction method of balancing these equations.

MATERIALS

paper
white board
paper towel
pencil
dry erase marker

PROCEDURE

1. The first exercise on your student page asks you to mark the oxidation states on each atom, determine whether any of those states change from reactants to products, and indicate which chemical is oxidized and which is reduced. Complete this exercise now. The rules for determining oxidation states are below, just in case you have forgotten them.

RULES FOR DETERMINING OXIDATION STATES

Definition: An oxidation state is the charge that an atom would have IF all of its bonds were ionic. That means that sometimes oxidation states are real, and sometimes they are just an accounting method that we have for keeping track of electrons in a chemical reaction.

1. The oxidation state of a free element is zero.

2. The oxidation state for a monatomic ion is equal to its charge.

3. The algebraic sum of the oxidation states of all of the atoms in a compound must be zero.

4. The oxidation state for alkali metals in compounds is +1; the oxidation state for alkaline earth metals in compounds is +2.

5. In compounds, the more electronegative element is always negative.

6. In compounds, hydrogen is usually +1 unless it is more electronegative than the element that it is bonded with. In that case, it is a hydride and has a charge of −1.

7. In compounds, oxygen is usually −2.

8. Oxidation states do not have to be the ones found on the periodic table. They do not even have to be whole numbers. **Rule three may not be violated!** Remember, oxidation states are the charge that an atom would have IF all of its bonds were ionic. Many compounds are covalent.

Name _____

Period _____

OIL RIG
Balancing Redox Equations

EXERCISE 1: IS THIS A REDOX REACTION OR NOT?

In this exercise, you need to mark the oxidation states of each atom in every compound in the equation. If any of these oxidation states change from the reactants to the products, then the reaction is a redox and you should write the word "redox" in the blank that is found at the left of the reaction. If it is not a redox reaction, write "no" beside the reaction. If the reaction is redox, determine which atoms are reduced and which are oxidized, and write those atoms in the proper blanks. If the reaction is not redox, leave the blanks for "oxidized" and "reduced" blank.

1. _____ $2\ Na + Cl_2 \rightarrow 2\ NaCl$

   Oxidized _____

   Reduced _____

2. _____ $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

   Oxidized _____

   Reduced _____

3. _____ $CO_2 + H_2 \rightarrow 2\ CO + 4\ H_2O$

   Oxidized _____

   Reduced _____

4. _____ $AgNO_3 + KCl \rightarrow AgCl + KNO_3$

   Oxidized _____

   Reduced _____

5. _____ $Fe_2O_3 + H_2 \rightarrow Fe + H_2O$

   Oxidized _____

   Reduced _____

6. _____ $NaOH + HCl \rightarrow NaCl + H_2O$

Oxidized _____

Reduced _____

7. _____ $2\ Mg + O_2 \rightarrow 2\ MgO$

Oxidized _____

Reduced _____

8. _____ $Ca(OH)_2 \rightarrow CaO + H_2O$

Oxidized _____

Reduced _____

9. _____ $Cu + 2\ AgNO_3 \rightarrow Cu(NO_3)_2 + 2\ Ag$

Oxidized _____

Reduced _____

10. _____ $KMnO_4 + FeSO_4 + H_2SO_4 \rightarrow MnSO_4 + Fe_2(SO_4)_3 + K_2SO_4 + H_2O$

Oxidized _____

Reduced _____

Name: _____ Date: _____

Physical and Chemical Change Worksheet

True or False. If false, correct the underlined portion of the statement so that it is true.

1. A physical change is a change of matter from one form to another without a change in chemical properties.

2. A physical change is a change that occurs when a substance changes composition by forming one or more new substances.

3. Color change is evidence that a chemical change may have occurred.

4. Fizzing or foaming is evidence that a chemical change may have occurred.

5. Production of light is evidence that a physical change may have occurred.

6. Production of heat or light is evidence that a chemical change may have occurred.

7. A change in odor is evidence that a physical change may have occurred.

8. Chemical changes can be reversed by physical changes.

Identify each of the following as either a Physical change (P) or a chemical change (C).

1. You cut your hair. _____
2. Making a peanut, pretzel and cereal mixture. _____
3. Baking soda reacts with vinegar and forms a gas. _____
4. A piece of metal is bent in half. _____
5. An aspirin is crushed into fine powder. _____
6. Copper turns green when exposed to the environment. _____
7. Two clear liquids are mixed and a yellow color forms. _____
8. Baking cookies. _____
9. Diamonds are used to scratch glass. _____
10. A tree burns to form ashes. _____
11. A piece of paper is crumpled up. _____
12. Water freezes to form ice. _____
13. Food spoiling. _____
14. A candle burning. _____
15. A candle melting. _____

Name: _____ Date: _____

A Thought Experiment

A sealed flask of a clear, colorless liquid is left sitting on an interior sunny windowsill. After about an hour, there are droplets of a clear liquid on the glass above the solution, which has turned yellow. After two hours, the solution is dark brown with clear, colorless droplets of liquid on the glass. After sitting on the windowsill for a week, the walls of the flask have a silvery lining and both the solution and the droplets are clear and colorless.

6. Which of the following is <u>not</u> an indication that a chemical reaction has occurred?
   (a) formation of liquid droplets above the solution
   (b) the solution color changing from clear to yellow
   (c) the solution color changing from brown to clear
   (d) formation of a silvery metallic foil on the walls of the flask

7. The formation of the silvery lining is an example of which of the following indicators of chemical change?
   (a) evolution of a gas
   (b) distinct color change
   (c) precipitate formation
   (d) temperature change

8. *(Short answer)* There is only one reaction taking place in the flask. What is one possible reason for all of the color changes?

9. *(Short answer)* An observant chemistry student is enjoying a glass of iced tea during lunch (not in the lab!), and she notices that the color of her drink changes as the ice in the glass melts. Is a chemical reaction occurring? Why or why not?

Study Guide

A Voyage through Equations

After working on this worksheet, you should be able to do the following:

1) Given an equation, you should be able to tell what kind of reaction it is.

2) Predict the products of a reaction when given the reactants.

Section 1: Identify the type of reaction

For the following reactions, indicate whether the following are examples of synthesis, decomposition, combustion, single replacement, or double replacement:

1) $Na_3PO_4 + 3\ KOH \rightarrow 3\ NaOH + K_3PO_4$ _____

2) $MgCl_2 + Li_2CO_3 \rightarrow MgCO_3 + 2\ LiCl$ _____

3) $C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ _____

4) $Pb + FeSO_4 \rightarrow PbSO_4 + Fe$ _____

5) $CaCO_3 \rightarrow CaO + CO_2$ _____

6) $P_4 + 3\ O_2 \rightarrow 2\ P_2O_3$ _____

7) $2\ RbNO_3 + BeF_2 \rightarrow Be(NO_3)_2 + 2\ RbF$ _____

8) $2\ AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2\ Ag$ _____

9) $C_3H_6O + 4\ O_2 \rightarrow 3\ CO_2 + 3\ H_2O$ _____

10) $2\ C_5H_5 + Fe \rightarrow Fe(C_5H_5)_2$ _____

11) $SeCl_6 + O_2 \rightarrow SeO_2 + 3Cl_2$ _____

12) $2\ MgI_2 + Mn(SO_3)_2 \rightarrow 2\ MgSO_3 + MnI_4$ _____

13) $O_3 \rightarrow O^{\cdot} + O_2$ _____

14) $2\ NO_2 \rightarrow 2\ O_2 + N_2$ _____

Section 2: Practicing equation balancing

Before you can write a balanced equation for a problem which asks you to predict the products of a reaction, you need to know how to balance an equation. Because some of you may not fully remember how to balance an equation, here are some practice problems:

1) __ C_6H_6 + __ O_2 → __ H_2O + __ CO_2

2) __ NaI + __ $Pb(SO_4)_2$ → __ PbI_4 + __ Na_2SO_4

3) __ NH_3 + __ O_2 →__ NO + __ H_2O

4) __ $Fe(OH)_3$ → __ Fe_2O_3 + __ H_2O

5) __ HNO_3 + __ $Mg(OH)_2$ → __H_2O + __ $Mg(NO_3)_2$

6) __ H_3PO_4 + __ NaBr → __ HBr + __ Na_3PO_4

7) __ C + __ H_2 → __ C_3H_8

8) __ CaO + __ MnI_4 → __ MnO_2 + __ CaI_2

9) __ Fe_2O_3 + __ H_2O → __ $Fe(OH)_3$

10) __ C_2H_2 + __ H_2 → __ C_2H_6

11) __ VF_5 + __ HI → __ V_2I_{10} + __ HF

12) __ OsO_4 + __ $PtCl_4$ → __ PtO_2 + __ $OsCl_8$

13) __ CF_4 + __ Br_2 → __ CBr_4 + __ F_2

14) __ Hg_2I_2 + __ O_2 → __ Hg_2O + __ I_2

15) __ $Y(NO_3)_2$ + __ $GaPO_4$ → __ YPO_4 + __ $Ga(NO_3)_2$

Section 3: Predicting the products of chemical reactions

Predict the products of the following reactions:

1) __ Ag + __ $CuSO_4$ →

Type:_____

2) __ NaI + __ $CaCl_2$ →

Type:_____

3) __ O_2 + __ H_2 →

Type:_____

4) __ HNO_3 + __ $Mn(OH)_2$ →

Type:_____

5) __ $AgNO_2$ + __ $BaSO_4$ →

Type:_____

6) __ HCN + __ $CuSO_4$ →

Type:_____

7) __ H_2O + __ AgI →

Type:_____

8) __ HNO_3 + __ $Fe(OH)_3$ →

Type:_____

9) __ $LiBr$ + __ $Co(SO_3)_2$ →

Type:_____

10) __ $LiNO_3$ + __ Ag →

Type:_____

11) __ N_2 + __ O_2 →

Type:_____

12) __ H_2CO_3 →

Type:_____

13) __ $AlCl_3$ + __ Cs →

Type:_____

14) __ $Al(NO_3)_3$ + __ Ga →

Type:_____

15) __ H_2SO_4 + __ NH_4OH →

Type:_____

16) __ CH_3COOH + __ O_2 →

Type:_____

17) __ C_4H_8 + __ O_2 →

Type:_____

18) __ KCl + __ $Mg(OH)_2$ →

Type:_____

19) __ Zn + __ $Au(NO_2)_2$ →

Type:_____

20) __ KOH + __ H_2SO_4 →

Type:_____

21) __ BaS + __ $PtCl_2$ →

Type:_____

22) __ Na_2O →

Type:_____

STUDENT REFERENCE PAGE - ACTIVITY SERIES AND SOLUBILITY RULES

Activity Series of Metals

Li
K
Ca
Na
Mg
Al
Mn
Zn
Cr
Fe
Cd
Co
Ni
Sn
Pb
H (a nonmetal)
Sb (a metalloid)
Cu
Hg
Ag
Pt

Solubility Rules

1. All nitrates and acetates are soluble.
2. All chlorides, bromides, and iodides are soluble except those of Pb^{2+}, Ag^{+}, and Hg^{2+},
3. All sulfates are soluble except those of Ba^{2+}, Sr^{2+}, and Pb^{2+}.
4. All hydroxide are insoluble except those of Group I in the periodic table, NH_4^{+}, and Ba^{2+}.
5. All carbonates and phosphates are insoluble except those of Group I and NH_4^{+}.
6. All sulfides are insoluble except those of Group I and Group II on the periodic table and NH_4^{+}.

In addition, keep in mind the following: when H_2CO_3, H_2SO_3, and NH_4OH are formed as products:

7. H_2CO_3 decomposes into $CO_2 + H_2O$
8. H_2SO_3 decomposes into $SO_2 + H_2O$
9. NH_4OH decomposes into $NH_3 + H_2O$

POLYATOMIC IONS YOU MUST MEMORIZE

NAME	FORMULA
acetate	$C_2H_3O_2^{-1}$
ammonium	NH_4^{+1}
carbonate	CO_3^{-2}
bicarbonate or hydrogen carbonate	HCO_3^{-1}
chromate	CrO_4^{-2}
chlorate	ClO_3^{-1}
cyanide	CN^{-1}
hydroxide	OH^{-1}
nitrate	NO_3^{-1}
permanganate	MnO_4^{-1}
phosphate	PO_4^{-3}
peroxide	O_2^{-2}
sulfate	SO_4^{-2}

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