

Chemical Reaction Types

KEY

Name _____

Period _____

Identify each chemical reaction as a synthesis (combination), decomposition, single-replacement, double-replacement, or combustion reaction.

1. $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ synthesis
2. $\text{Al}_2(\text{SO}_4)_3 + 3\text{Ca}(\text{OH})_2 \rightarrow 2\text{Al}(\text{OH})_3 + 3\text{CaSO}_4$
3. $2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O}$
4. $\text{Mg} + 2\text{AgNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + 2\text{Ag}$
5. $3\text{Ba}(\text{NO}_3)_2 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Ba}_3(\text{PO}_4)_2 + 6\text{HNO}_3$
6. $\text{Mg}(\text{ClO}_3)_2 \rightarrow \text{MgCl}_2 + 3\text{O}_2$
7. $2\text{Be} + \text{O}_2 \rightarrow 2\text{BeO}$
8. $2\text{Al} + 3\text{CuSO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{Cu}$
9. $2\text{PbO}_2 \rightarrow 2\text{PbO} + \text{O}_2$
10. $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

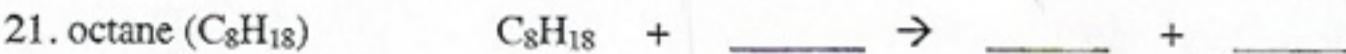
Complete the chemical equations for the following SYNTHESIS (COMBINATION) reactions.

11. $\text{Mg} + \text{O}_2 \rightarrow$
12. $\text{Ca} + \text{S} \rightarrow$
13. $\text{Na} + \text{O}_2 \rightarrow$
14. $\text{Na} + \text{Cl}_2 \rightarrow$
15. $\text{Al} + \text{O}_2 \rightarrow$

Use the activity series of metals to complete the following SINGLE-REPLACEMENT reactions. Write "NR" if there is no reaction.

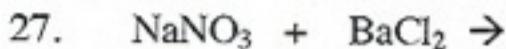
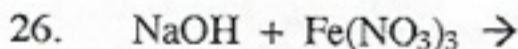
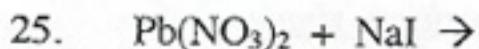
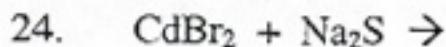
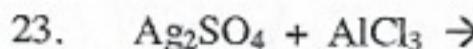
16. $\text{Zn(s)} + \text{AgNO}_3 \rightarrow$
17. $\text{Au(s)} + \text{KNO}_3 \rightarrow$
18. $\text{Al(s)} + \text{H}_2\text{SO}_4 \rightarrow$
19. $\text{Cu(s)} + \text{H}_2\text{O} \rightarrow$
20. $\text{Al(s)} + \text{CuSO}_4 \rightarrow$

Write the chemical equation for the complete COMBUSTION of the following compounds.

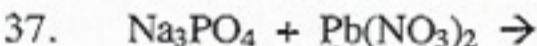
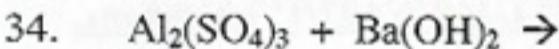
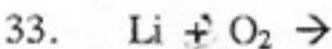
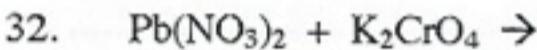
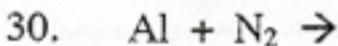
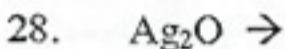


Chemistry I

Complete the chemical equations for the following DOUBLE-REPLACEMENT reactions.



Write the type of reaction on the line. Then, predict the products of each reaction to complete the chemical equation. Write the correct formulas of the products after the arrow. Write "NR" if there is no reaction.



Write the chemical equation for the following reactions. Remember the diatomics. Use appropriate state symbols .

38. Solid silver carbonate decomposes into solid silver oxide and gaseous carbon dioxide when heated.

39. Adding chlorine gas to a solution of potassium iodide gives solid iodine and a solution of potassium chloride.

40. Iodine crystals react with chlorine gas to form solid iodine trichloride.

Chemical Reaction Types

Name _____
Period _____

Identify each chemical reaction as a synthesis (combination), decomposition, single-replacement, double-replacement, or combustion reaction.

1. $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$
2. $\text{Al}_2(\text{SO}_4)_3 + 3\text{Ca}(\text{OH})_2 \rightarrow 2\text{Al}(\text{OH})_3 + 3\text{CaSO}_4$
3. $2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O}$
4. $\text{Mg} + 2\text{AgNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + 2\text{Ag}$
5. $3\text{Ba}(\text{NO}_3)_2 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Ba}_3(\text{PO}_4)_2 + 6\text{HNO}_3$
6. $\text{Mg}(\text{ClO}_3)_2 \rightarrow \text{MgCl}_2 + 3\text{O}_2$
7. $2\text{Be} + \text{O}_2 \rightarrow 2\text{BeO}$
8. $2\text{Al} + 3\text{CuSO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{Cu}$
9. $2\text{PbO}_2 \rightarrow 2\text{PbO} + \text{O}_2$
10. $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

Synthesis

Double

Combustion

Single

Double

Decomposition

Synthesis

Single

Decomposition

Combustion

Complete the chemical equations for the following SYNTHESIS (COMBINATION) reactions.

11. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$
12. $\text{Ca} + \text{S} \rightarrow \text{CaS}$
13. $2\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}$
14. $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$
15. $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$

Use the activity series of metals to complete the following SINGLE-REPLACEMENT reactions. Write "NR" if there is no reaction.

16. $\text{Zn}(\text{s}) + \text{AgNO}_3 \rightarrow \text{ZnNO}_3 + \text{Ag}$
17. $\text{Au}(\text{s}) + \text{KNO}_3 \rightarrow \text{No Rx}$
18. $2\text{Al}(\text{s}) + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2$
19. $\text{Cu}(\text{s}) + \text{H}_2\text{O} \rightarrow$
20. $2\text{Al}(\text{s}) + 3\text{CuSO}_4 \rightarrow \text{No Rx}$
 $\text{Al}_2(\text{SO}_4)_3 + 3\text{Cu}$

Write the chemical equation for the complete COMBUSTION of the following compounds.

21. octane (C_8H_{18}) $\text{C}_8\text{H}_{18} + 25\frac{1}{2}\text{O}_2 \rightarrow 8\text{CO}_2 + 9\text{H}_2\text{O}$
22. glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$

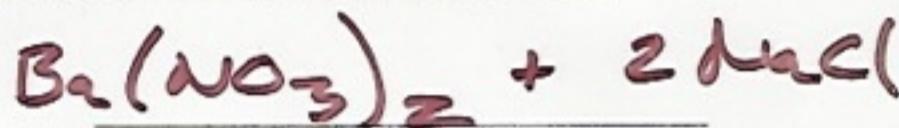
Chemistry I

Complete the chemical equations for the following DOUBLE-REPLACEMENT reactions.

23. $3\text{Ag}_2\text{SO}_4 + \text{AlCl}_3 \rightarrow 6\text{AgCl} + \text{Al}_2(\text{SO}_4)_3$
24. $\text{CdBr}_2 + \text{Na}_2\text{S} \rightarrow \text{CdS} + 2\text{NaBr}$
25. $\text{Pb}(\text{NO}_3)_2 + \text{NaI} \rightarrow \text{PbI}_2 + 2\text{NaNO}_3$
26. $3\text{NaOH} + \text{Fe}(\text{NO}_3)_3 \rightarrow \text{Fe(OH)}_3 + 3\text{NaNO}_3$
27. $2\text{NaNO}_3 + \text{BaCl}_2 \rightarrow \text{Ba}(\text{NO}_3)_2 + 2\text{NaCl}$

Write the type of reaction on the line. Then, predict the products of each reaction to complete the chemical equation. Write the correct formulas of the products after the arrow. Write "NR" if there is no reaction.

28. $\text{Ag}_2\text{O} \rightarrow$
29. $\text{C}_4\text{H}_8 + \text{O}_2 \rightarrow$
30. $\text{Al} + \text{N}_2 \rightarrow$
31. $\text{Zn} + \text{CuSO}_4 \rightarrow$
32. $\text{Pb}(\text{NO}_3)_2 + \text{K}_2\text{CrO}_4 \rightarrow$
33. $\text{Li} + \text{O}_2 \rightarrow$
34. $\text{Al}_2(\text{SO}_4)_3 + \text{Ba}(\text{OH})_2 \rightarrow$
35. $\text{Cu} + \text{CaCO}_3 \rightarrow$
36. $\text{C}_3\text{H}_6 + \text{O}_2 \rightarrow$
37. $\text{Na}_3\text{PO}_4 + \text{Pb}(\text{NO}_3)_2 \rightarrow$



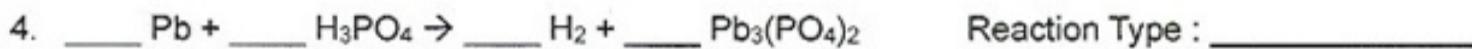
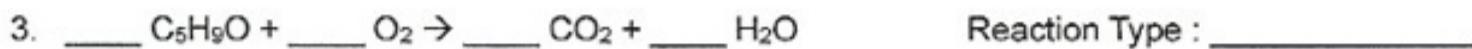
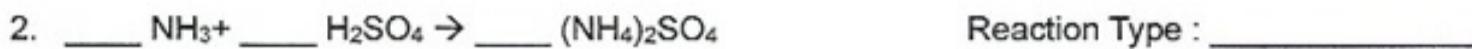
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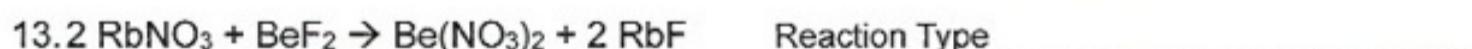
Name: _____ Date: _____ Period: 1 2 3 4 5 6 7

Types of Chemical Reaction Worksheet

Balance the reactions 1 to 6 and indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented:



Indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented in 7 to 20.





Name: _____ Date: _____ Period: 1 2 3 4 5 6 7

Types of Chemical Reaction Worksheet

Balance the reactions 1 to 6 and indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented:

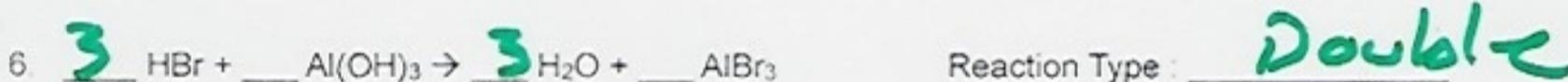
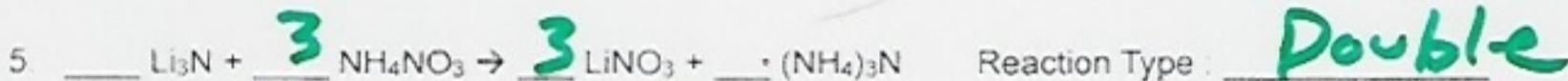
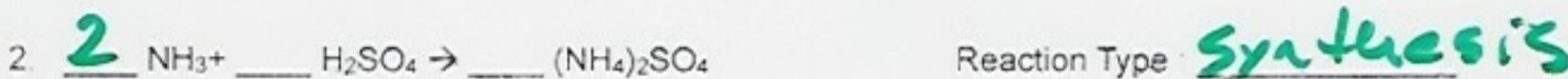
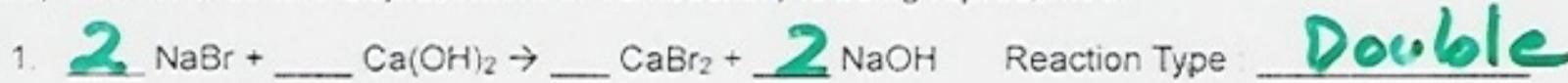
1. $2 \text{NaBr} + \text{Ca(OH)}_2 \rightarrow \text{CaBr}_2 + 2 \text{NaOH}$ Reaction Type: Double
2. $2 \text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$ Reaction Type: Synthesis
3. $\cancel{2 \text{C}_2\text{H}_2 + 5 \text{O}_2 \rightarrow 2 \text{CO}_2 + \text{H}_2\text{O}}$ Reaction Type: Combustion
4. $3 \text{Pb} + 2 \text{H}_3\text{PO}_4 \rightarrow 3 \text{H}_2 + \text{Pb}_3(\text{PO}_4)_2$ Reaction Type: Single replacement
5. $\text{Li}_3\text{N} + 3 \text{NH}_4\text{NO}_3 \rightarrow 3 \text{LiNO}_3 + (\text{NH}_4)_3\text{N}$ Reaction Type: Double
6. $3 \text{HBr} + \text{Al(OH)}_3 \rightarrow 3 \text{H}_2\text{O} + \text{AlBr}_3$ Reaction Type: Double

Indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented in 7 to 20.

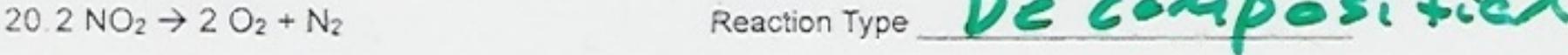
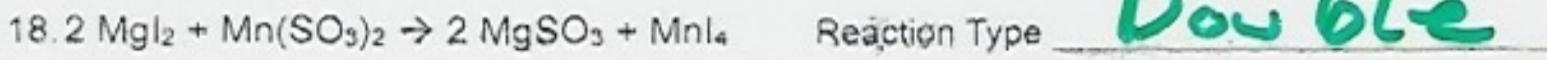
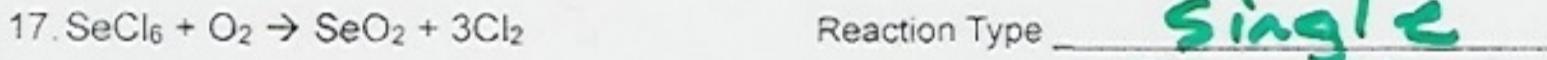
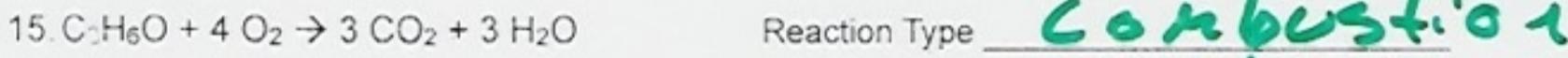
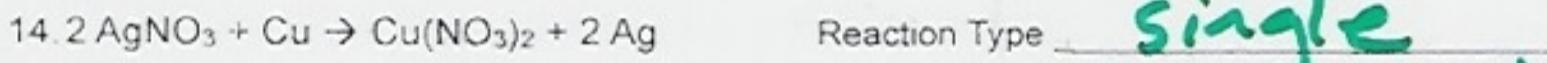
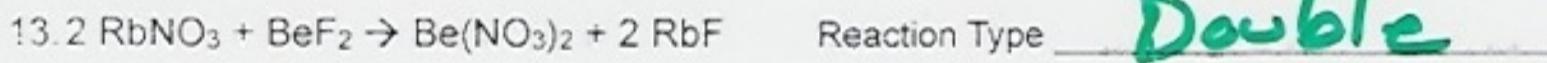
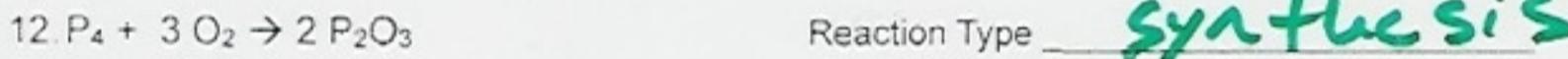
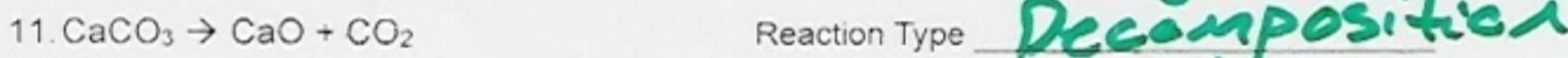
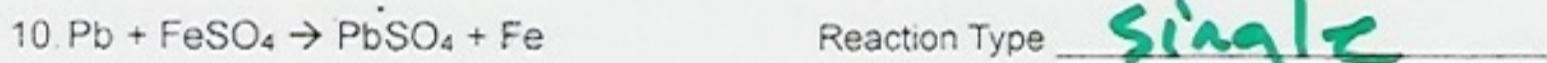
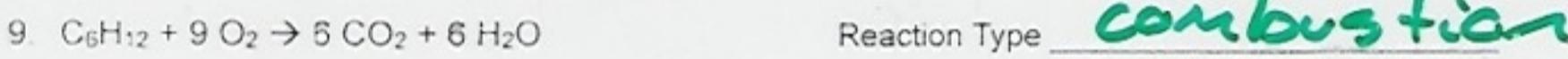
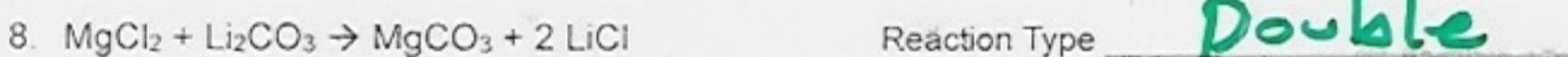
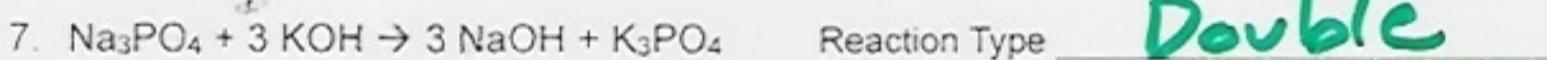
7. $\text{Na}_3\text{PO}_4 + 3 \text{KOH} \rightarrow 3 \text{NaOH} + \text{K}_3\text{PO}_4$ Reaction Type: Double
8. $\text{MgCl}_2 + \text{Li}_2\text{CO}_3 \rightarrow \text{MgCO}_3 + 2 \text{LiCl}$ Reaction Type: Double
9. $\text{C}_6\text{H}_{12} + 9 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$ Reaction Type: Combustion
10. $\text{Pb} + \text{FeSO}_4 \rightarrow \text{PbSO}_4 + \text{Fe}$ Reaction Type: Single
11. $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ Reaction Type: Decomposition
12. $\text{P}_4 + 3 \text{O}_2 \rightarrow 2 \text{P}_2\text{O}_3$ Reaction Type: Synthesis
13. $2 \text{RbNO}_3 + \text{BeF}_2 \rightarrow \text{Be(NO}_3)_2 + 2 \text{RbF}$ Reaction Type: Double
14. $2 \text{AgNO}_3 + \text{Cu} \rightarrow \text{Cu(NO}_3)_2 + 2 \text{Ag}$ Reaction Type: Single
15. $\text{C}_3\text{H}_6\text{O} + 4 \text{O}_2 \rightarrow 3 \text{CO}_2 + 3 \text{H}_2\text{O}$ Reaction Type: Combustion
16. $2 \text{C}_5\text{H}_5 + \text{Fe} \rightarrow \text{Fe(C}_5\text{H}_5)_2$ Reaction Type: Synthesis
17. $\text{SeCl}_6 + \text{O}_2 \rightarrow \text{SeO}_2 + 3\text{Cl}_2$ Reaction Type: Single
18. $2 \text{MgI}_2 + \text{Mn}(\text{SO}_3)_2 \rightarrow 2 \text{MgSO}_3 + \text{MnI}_4$ Reaction Type: Double
19. $\text{O}_3 \rightarrow \text{O} + \text{O}_2$ Reaction Type: Decomposition
20. $2 \text{NO}_2 \rightarrow 2 \text{O}_2 + \text{N}_2$ Reaction Type: Decomposition

Types of Chemical Reaction Worksheet

Balance the reactions 1 to 6 and indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented:



Indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented in 7 to 20.



11.3**REACTIONS IN AQUEOUS SOLUTION****Section Review****Objectives**

- Describe the information found in a net ionic equation
- Predict the formation of a precipitate in a double-replacement reaction

Vocabulary

- complete ionic equation
- spectator ion
- net ionic equation

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

Many important chemical reactions take place in 1,

1. _____

which makes up 66 percent of the human body. Reactions in water are said to take place in 2 solution.

2. _____

3. _____

A double-replacement reaction can be written as a 3,

4. _____

which shows dissolved ionic compounds as their free ions. Ions that appear on both sides of the equation and are not directly involved in the reaction are called 4. Canceling these ions from the equation leaves the 5, which indicates only those particles that take part in the reaction.

5. _____

6. _____

7. _____

8. _____

9. _____

When balancing a net ionic equation, it is necessary to balance the electric 6 as well as the number of 7.

When mixing solutions of ions, it is possible to predict the formation of a 8. This prediction can be made using the general rules for 9 of ionic compounds.

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

10. A precipitate is formed when two ionic solutions are mixed.
11. Spectator ions are not part of a net ionic equation.
12. Balancing the atoms in a net ionic equation will cause the charges to balance.
13. A net ionic equation shows all ions present.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A

14. complete ionic equation
15. spectator ions
16. net ionic equation
17. precipitate
18. aqueous reaction
19. ionic solubility rules

Column B

- a. equation that indicates only the particles that take part in a reaction
- b. solid product of reaction in solution
- c. reaction that occurs in water
- d. equation that shows dissolved ionic compounds as free ions
- e. used to predict whether a precipitate will form in an aqueous reaction
- f. ions that do not participate in a reaction

Part D Questions and Problems

Answer the following in the space provided.

20. Identify the spectator ion(s) and write a balanced net ionic equation for this reaction.



21. Predict which precipitate, if any, will form in the following reactions:

- a. $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow$
- b. $\text{CaCl}_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow$
- c. $\text{Fe}(\text{NO}_3)_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow$
- d. $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow$

11.3**REACTIONS IN AQUEOUS SOLUTION****Section Review****Objectives**

- Describe the information found in a net ionic equation
- Predict the formation of a precipitate in a double-replacement reaction

Vocabulary

- complete ionic equation
- spectator ion
- net ionic equation

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A double-replacement reaction can be written as a 3, which shows dissolved ionic compounds as their free ions. Ions that appear on both sides of the equation and are not directly involved in the reaction are called 4. Canceling these ions from the equation leaves the 5, which indicates only those particles that take part in the reaction.

When balancing a net ionic equation, it is necessary to balance the electric 6 as well as the number of 7.

When mixing solutions of ions, it is possible to predict the formation of a 8. This prediction can be made using the general rules for 9 of ionic compounds.

- water
- aqueous
- complete
- spectator
- net ionic
- charge
- atoms
- precipitate
- solubility

11.2**TYPES OF CHEMICAL REACTIONS****Section Review****Objectives**

- Describe the five general types of reactions
- Predict the products of the five general types of reactions

Vocabulary

- | | |
|-------------------------------|-------------------------------|
| • combination reaction | • activity series |
| • decomposition reaction | • double-replacement reaction |
| • single-replacement reaction | • combustion reaction |

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

It is possible to 1 the products of some chemical reactions. In order to do this, you must be able to recognize at least five general types of reactions. For example, in a 2 reaction, the reactants are two or more 3 and/or compounds and there is always a 4 product. In a 5 reaction, a single compound is broken down into two or more simpler substances.

In a 6 reaction, the reactants and products are an element and a compound. The 7 can be used to predict whether most single-replacement reactions will take place.

A 8 reaction involves the exchange of ions between two compounds. This reaction generally takes place between two ionic compounds in 9 solution. One of the reactants in a combustion reaction is 10. The products of the complete combustion of a hydrocarbon are 11 and 12.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

11.2**TYPES OF CHEMICAL REACTIONS****Section Review****Objectives**

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Vocabulary

- | | |
|-------------------------------|-------------------------------|
| • combination reaction | • activity series |
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Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

It is possible to 1 the products of some chemical reactions. In order to do this, you must be able to recognize at least five general types of reactions. For example, in a 2 reaction, the reactants are two or more 3 and/or compounds and there is always a 4 product. In a 5 reaction, a single compound is broken down into two or more simpler substances.

In a 6 reaction, the reactants and products are an element and a compound. The 7 can be used to predict whether most single-replacement reactions will take place.

A 8 reaction involves the exchange of ions between two compounds. This reaction generally takes place between two ionic compounds in 9 solution. One of the reactants in a combustion reaction is 10. The products of the complete combustion of a hydrocarbon are 11 and 12.

- predict
- Synthesis
- Elements
- Single
- Decomposition
- Single Replace
- Activity scr.
- Double
- aqueous
- O₂
- H₂O
- CO₂

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

AT

13. In a decomposition reaction, there is a single reactant.

NT

14. The activity series of metals can be used to predict products in double-replacement reactions.

AT

15. Carbon dioxide and water are the products of the combustion of hexane (
- C_6H_{14}
-).

ST

16. A nonmetal can replace another nonmetal from a compound in a single-replacement reaction.

ST

17. One of the products of a double-replacement reaction is a gas that bubbles out of the mixture.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A**B**

18. combination reaction

D

19. decomposition reaction

A

20. single-replacement reaction

C

21. combustion reaction

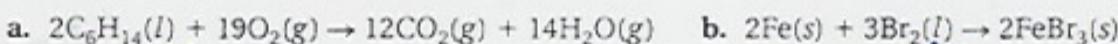
Column B

- a. reaction in which atoms of one element replace atoms of a second element in a compound
- b. a reaction in which two or more substances combine to form a single substance
- c. reaction of a compound with oxygen to produce energy
- d. reaction in which a single compound is broken down into two or more products

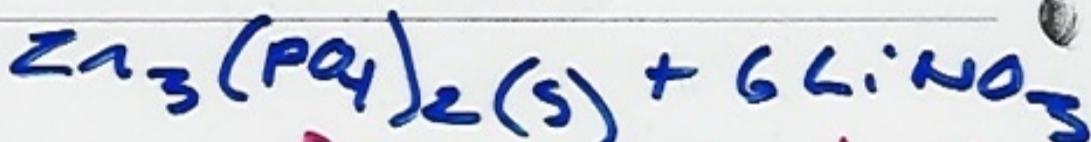
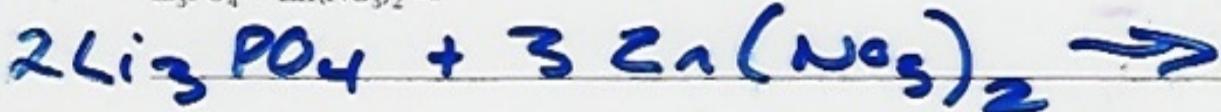
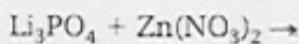
Part D Questions and Problems

Answer the following in the space provided.

22. Identify the type of each of the following reactions.

combustionsynthesis

23. Complete and balance the following equation. What must be true of one of the products?

one of the products is
a solid.

PRACTICE PROBLEMS ON NET IONIC EQUATIONS

Show the total ionic and net ionic forms of the following equations. If all species are spectator ions, please indicate that no reaction takes place. Note! You need to make sure the original equation is balanced before proceeding! A set of solubility rules are given at the end of this document.

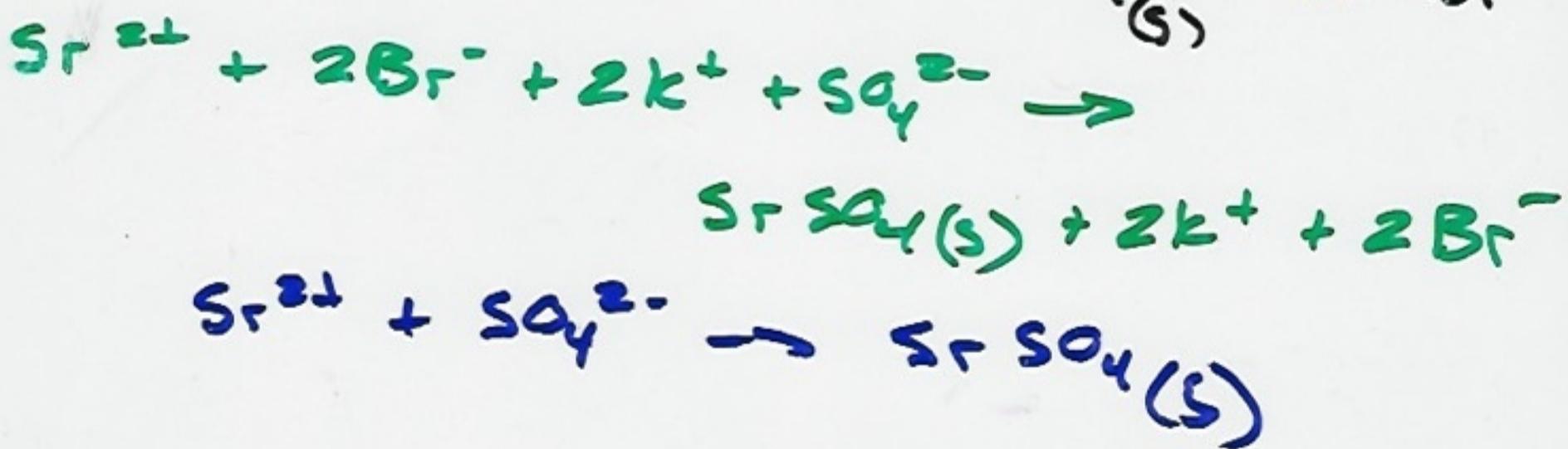
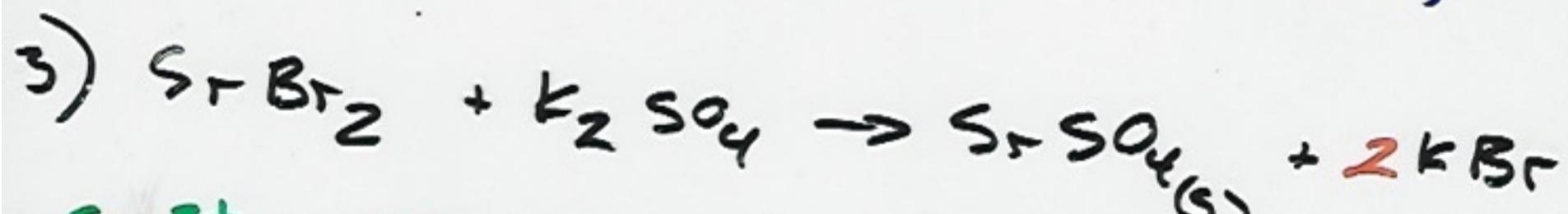
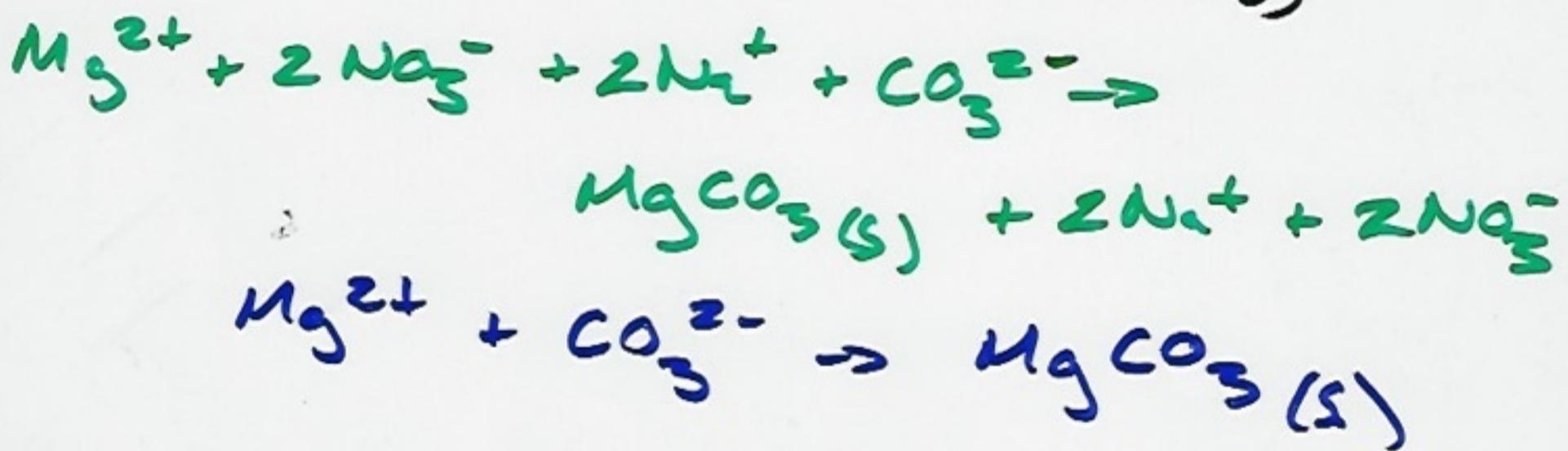
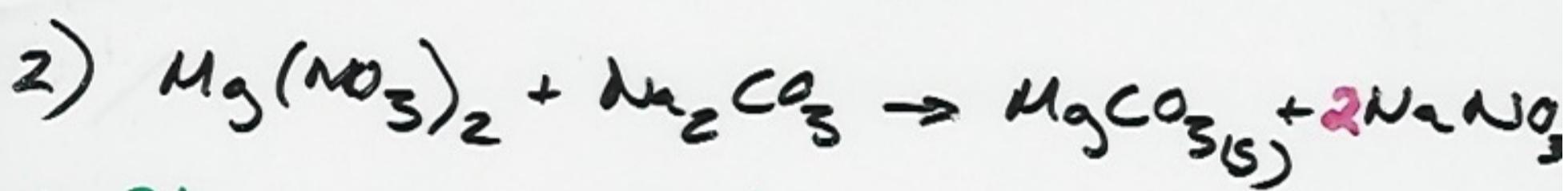
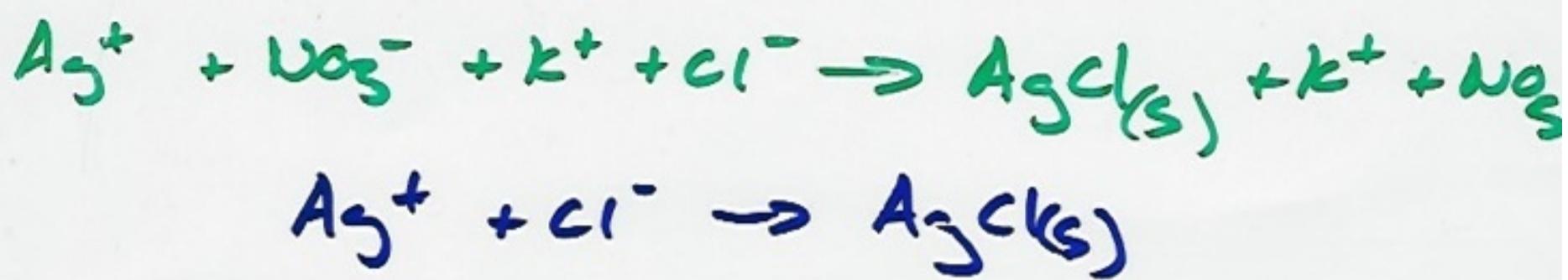
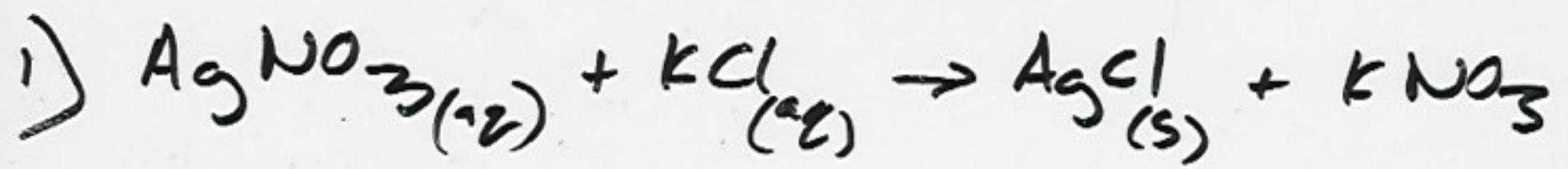
1. $\text{AgNO}_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{KNO}_3(\text{aq})$
2. $\text{Mg}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{MgCO}_3(\text{s}) + \text{NaNO}_3(\text{aq})$
3. strontium bromide(aq) + potassium sulfate(aq) \rightarrow strontium sulfate(s) + potassium bromide(aq)
4. manganese(II)chloride(aq) + ammonium carbonate(aq) \rightarrow manganese(II)carbonate(s) + ammonium chloride(aq)
5. chromium(III)nitrate(aq) + iron(II)sulfate(aq) \rightarrow chromium(III)sulfate(aq) + iron(II)nitrate(aq)

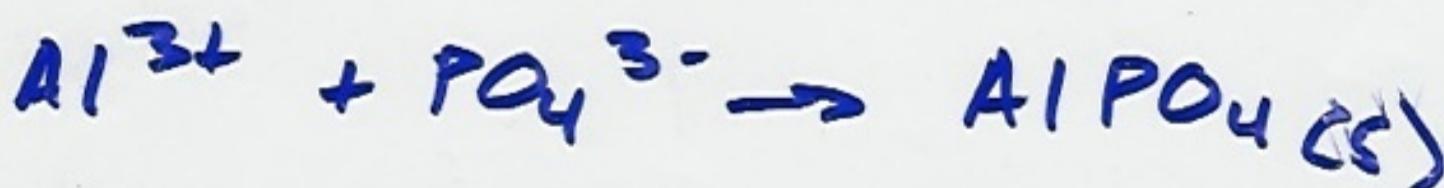
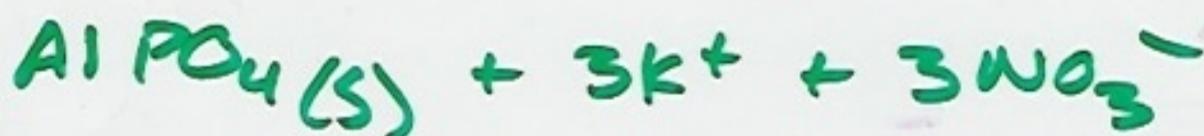
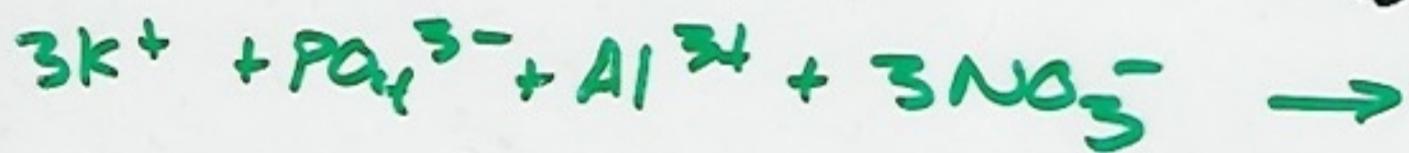
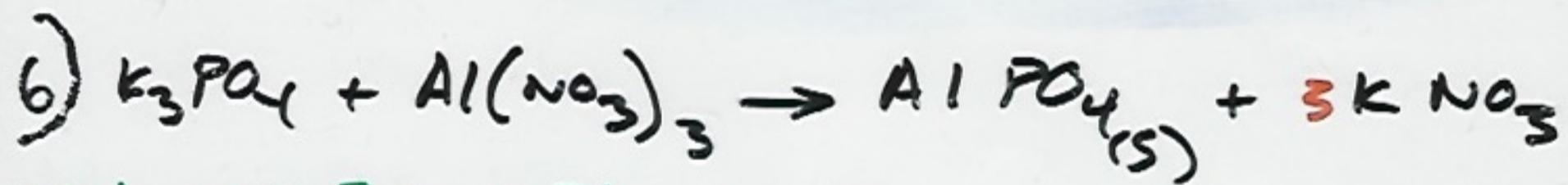
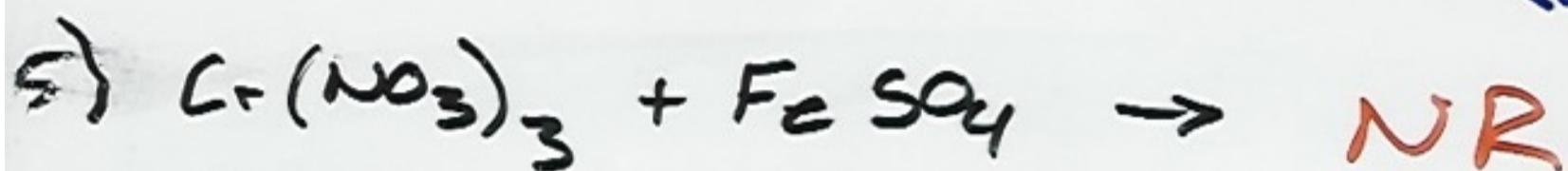
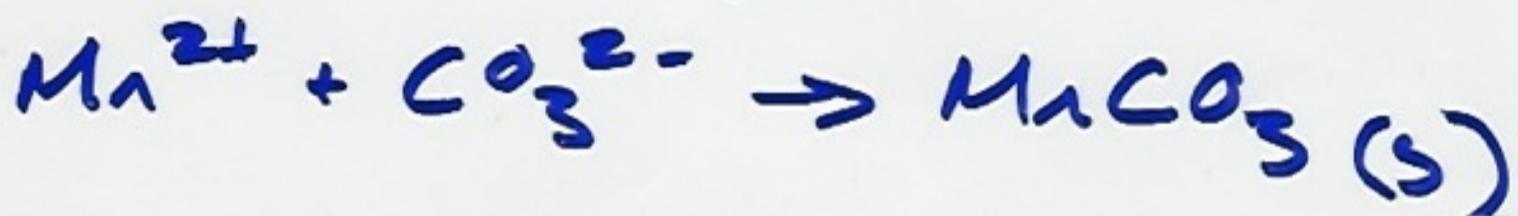
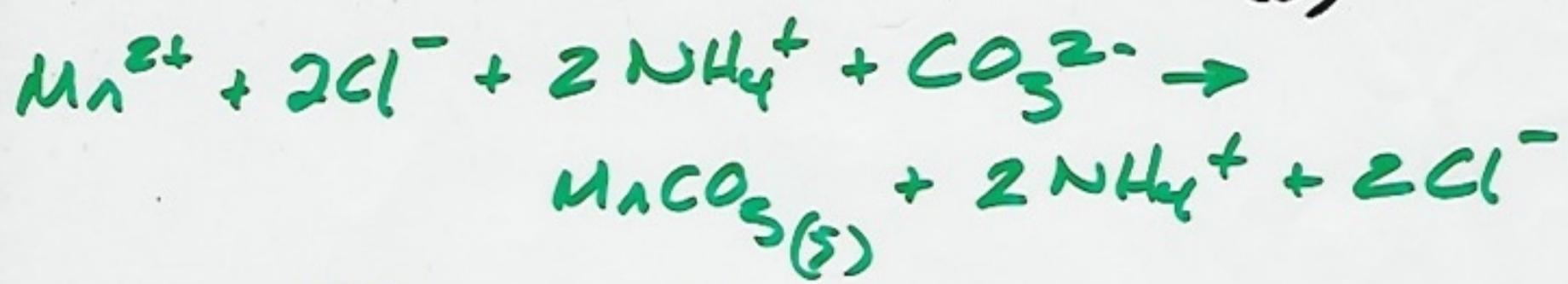
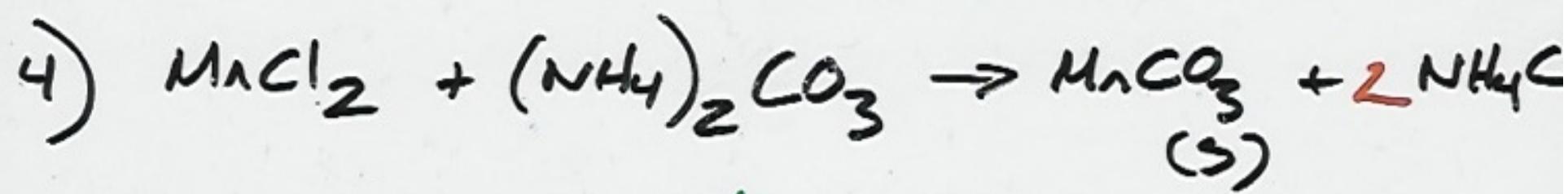
Please complete the following reactions, and show the total ionic and net ionic forms of the equation:

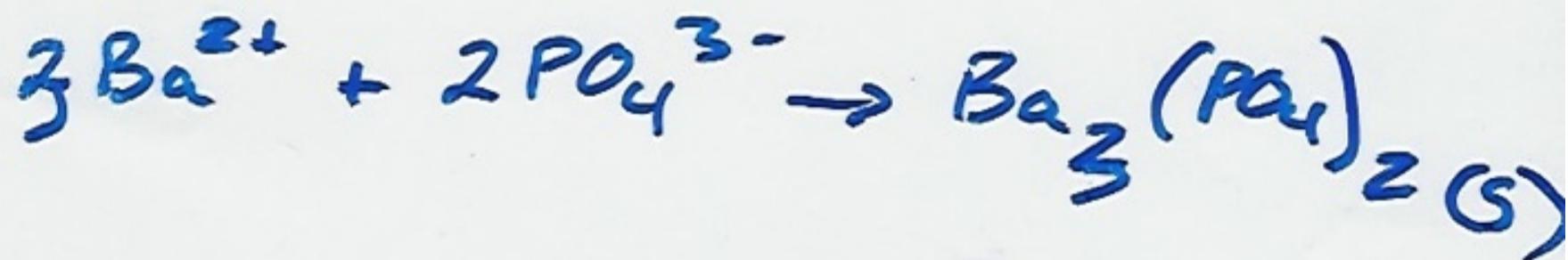
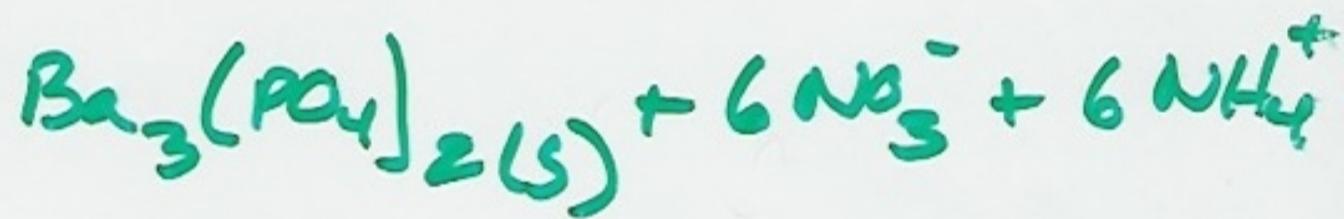
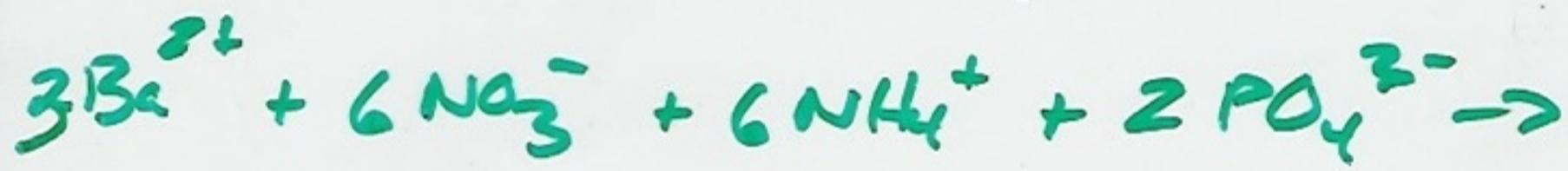
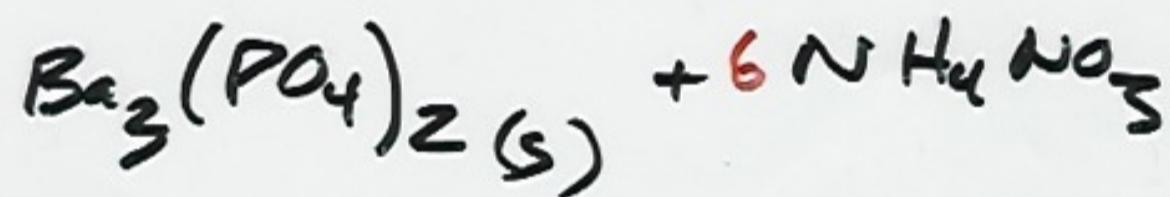
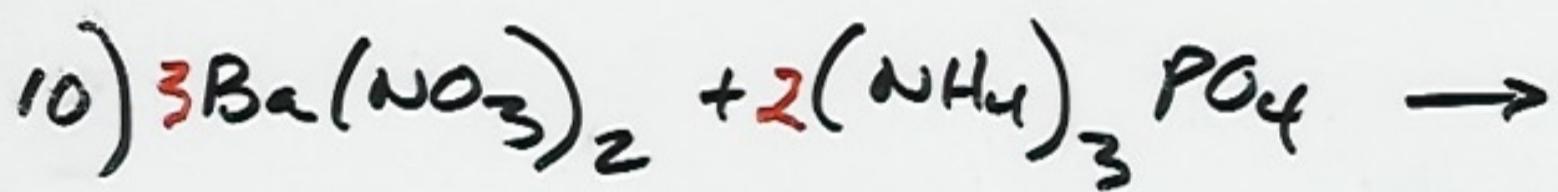
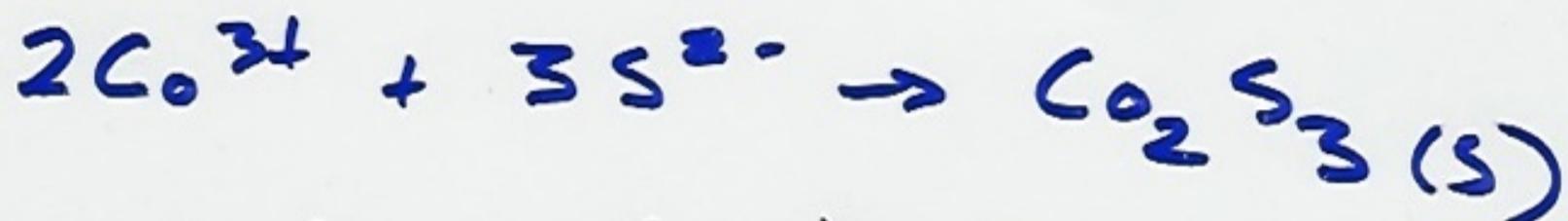
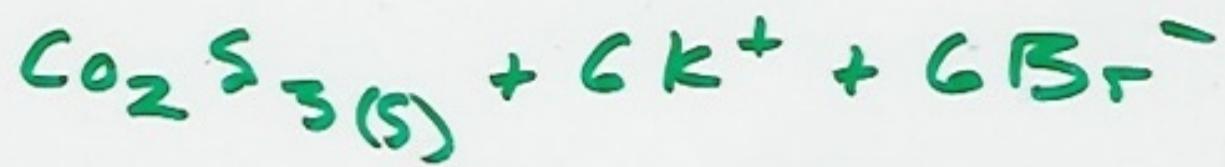
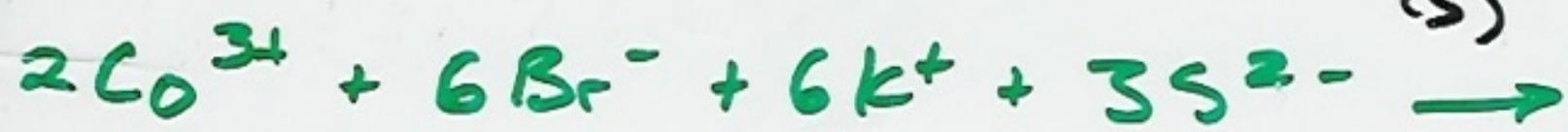
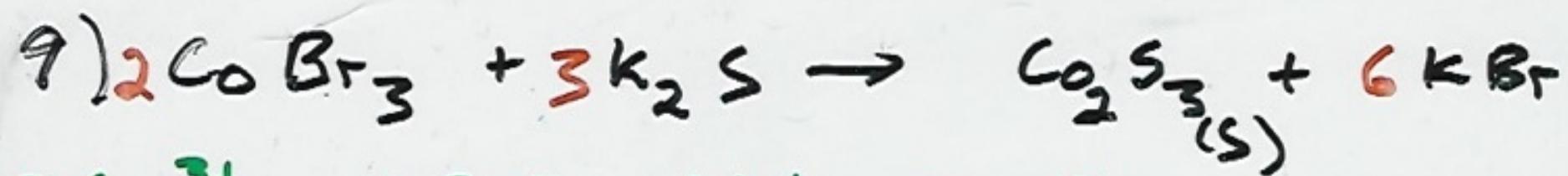
6. $\text{K}_3\text{PO}_4(\text{aq}) + \text{Al}(\text{NO}_3)_3(\text{aq}) \rightarrow$
7. $\text{BeI}_2(\text{aq}) + \text{Cu}_2\text{SO}_4(\text{aq}) \rightarrow$
8. $\text{Ni}(\text{NO}_3)_3(\text{aq}) + \text{KBr}(\text{aq}) \rightarrow$
9. cobalt(III)bromide + potassium sulfide \rightarrow
10. barium nitrate + ammonium phosphate \rightarrow
11. calcium hydroxide + iron(III)chloride \rightarrow
12. rubidium fluoride + copper(II)sulfate \rightarrow

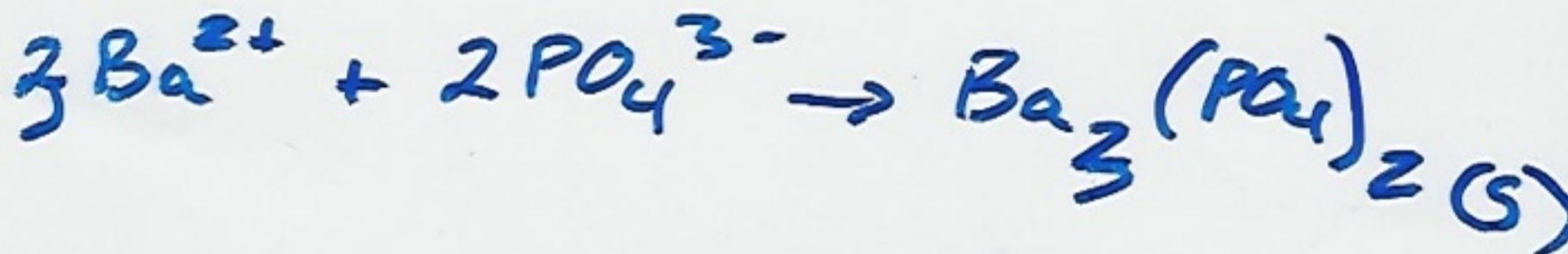
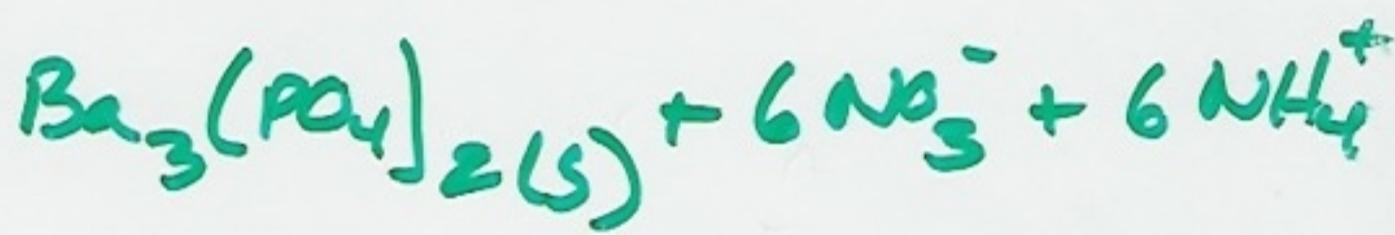
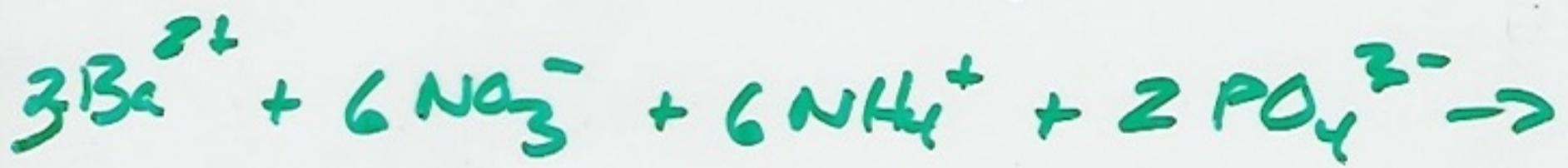
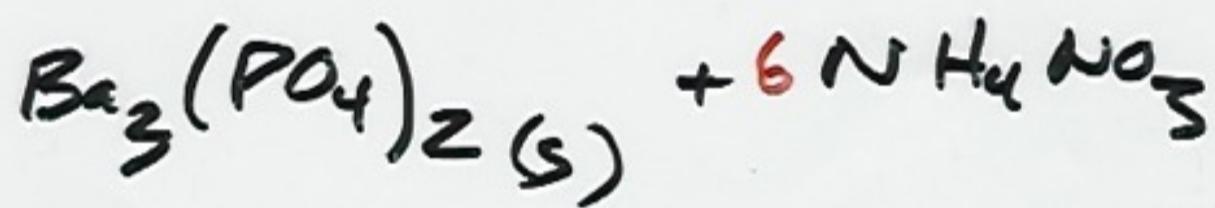
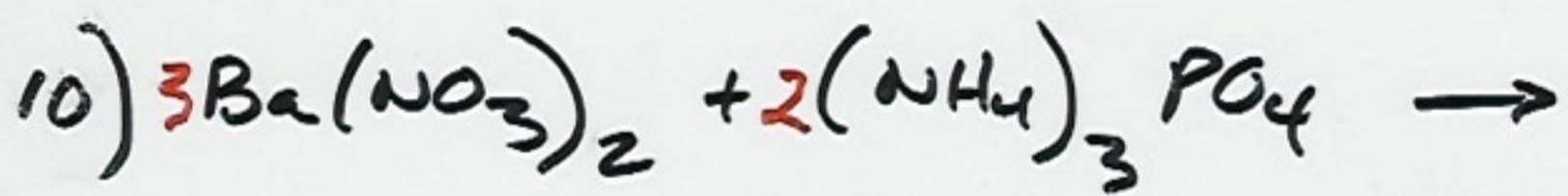
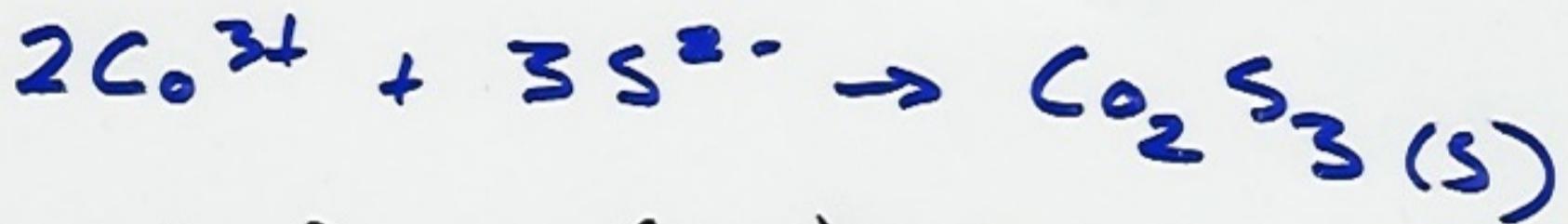
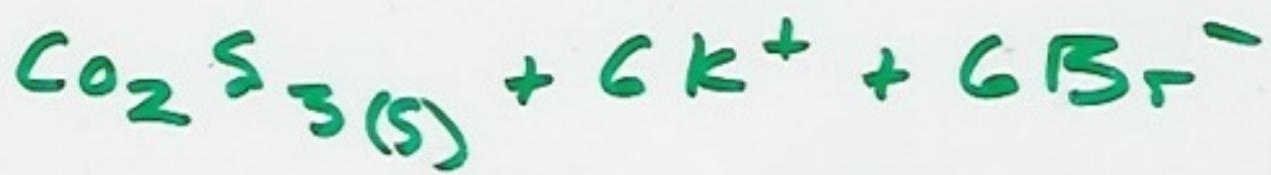
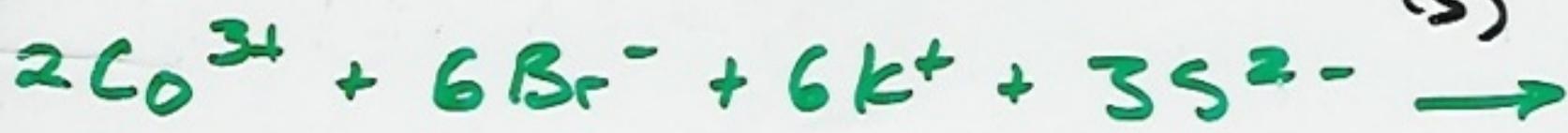
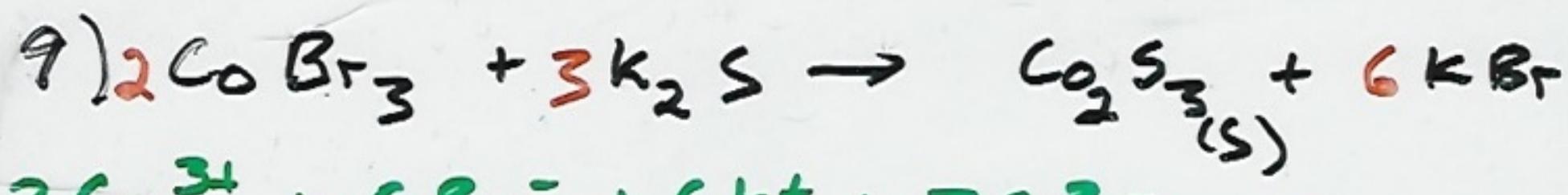
Solubility Rules

1. All salts of Group IA, and ammonium are soluble.
2. All salts of nitrates, chlorates and acetates are soluble.
3. All salts of halides are soluble except those of silver(I), copper(I), lead(II), and mercury(I).
4. All salts of sulfate are soluble except for barium sulfate, lead(II) sulfate, and strontium sulfate.
5. All salts of carbonate, phosphate and sulfite are insoluble, except for those of group IA and ammonium.
6. All oxides and hydroxides are insoluble except for those of group IA, calcium, strontium and barium.
7. All salts of sulfides and insoluble except for those of Group IA and IIA elements and of ammonium.









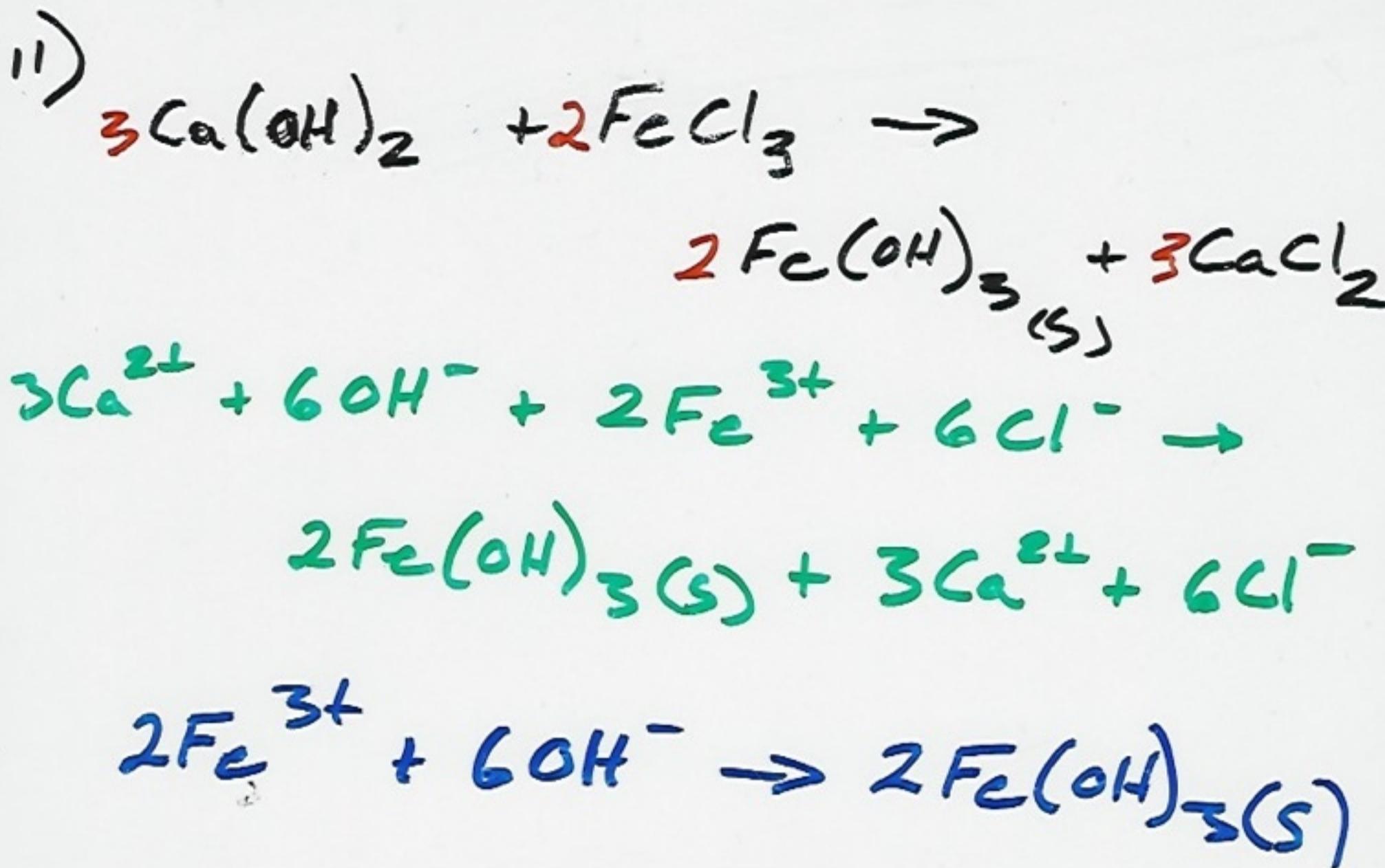


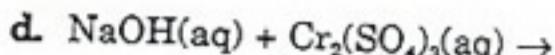
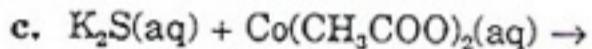
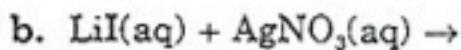
Table 3.3 Solubility characteristics of ionic compounds in water at 25°C

1. All alkali metal (Group 1A) compounds are soluble.
2. All ammonium (NH_4^+) compounds are soluble.
3. All compounds containing nitrate (NO_3^-), chlorate (ClO_3^-), and perchlorate (ClO_4^-) are soluble.
4. Most hydroxides (OH^-) are insoluble. The exceptions are the alkali metal hydroxides and barium hydroxide [$\text{Ba}(\text{OH})_2$]. Calcium hydroxide [$\text{Ca}(\text{OH})_2$] is slightly soluble.
5. Most compounds containing chlorides (Cl^-), bromides (Br^-), or iodides (I^-) are soluble. The exceptions are those containing Ag^+ , Hg_2^{2+} , and Pb^{2+} .
6. All carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), and sulfides (S^{2-}) are insoluble; the exceptions are those of alkali metals and the ammonium ion.
7. Most sulfates (SO_4^{2-}) are soluble. Calcium sulfate (CaSO_4) and silver sulfate (Ag_2SO_4) are slightly soluble. Barium sulfate (BaSO_4), mercury(II) sulfate (HgSO_4), and lead sulfate (PbSO_4) are insoluble.

Identify each of the following substances as a strong electrolyte, a weak electrolyte, or a nonelectrolyte: (a) H_2O , (b) KCl , (c) HNO_3 , (d) CH_3COOH , (e) $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, (f) $\text{Ba}(\text{NO}_3)_2$, (g) Ne , (h) NH_3 , (i) NaOH .

Characterize the following compounds as soluble or insoluble in water: (a) $\text{Ca}_3(\text{PO}_4)_2$, (b) $\text{Mn}(\text{OH})_2$, (c) AgClO_3 , (d) K_2S , (e) CaCO_3 , (f) ZnSO_4 , (g) $\text{Hg}(\text{NO}_3)_2$, (h) HgSO_4 , (i) NH_4ClO_4 .

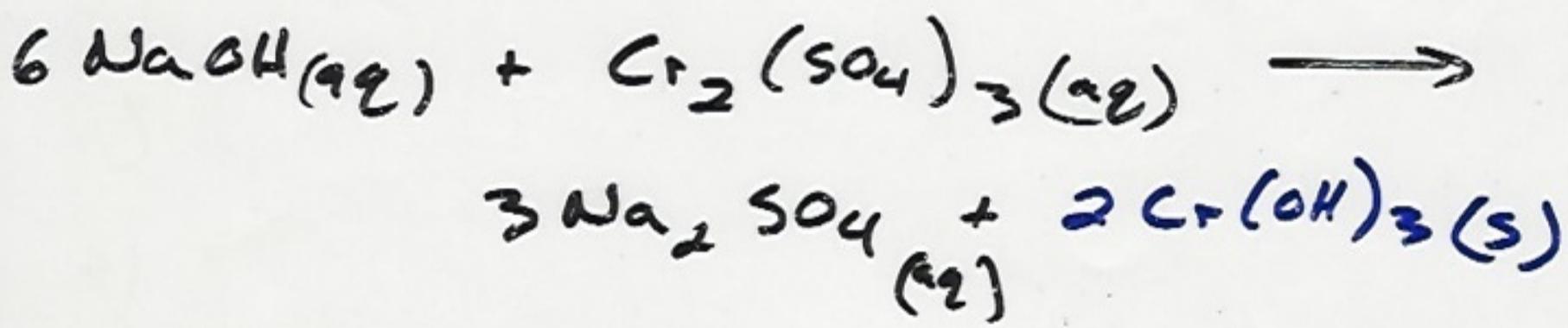
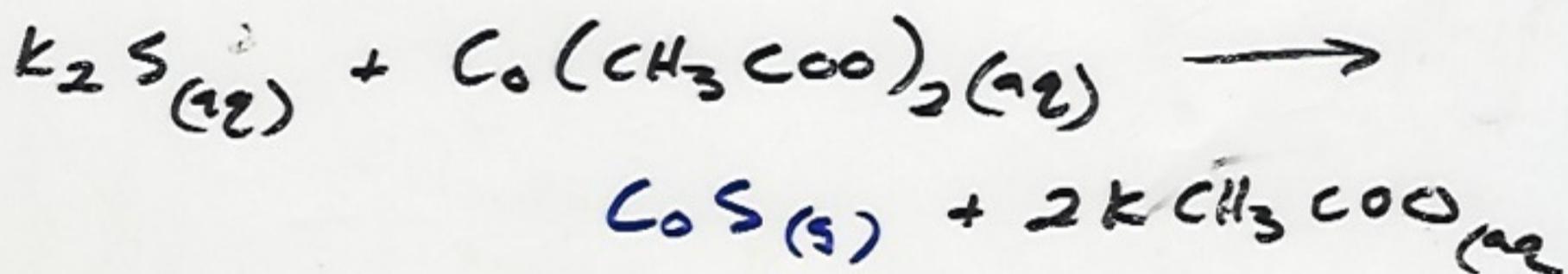
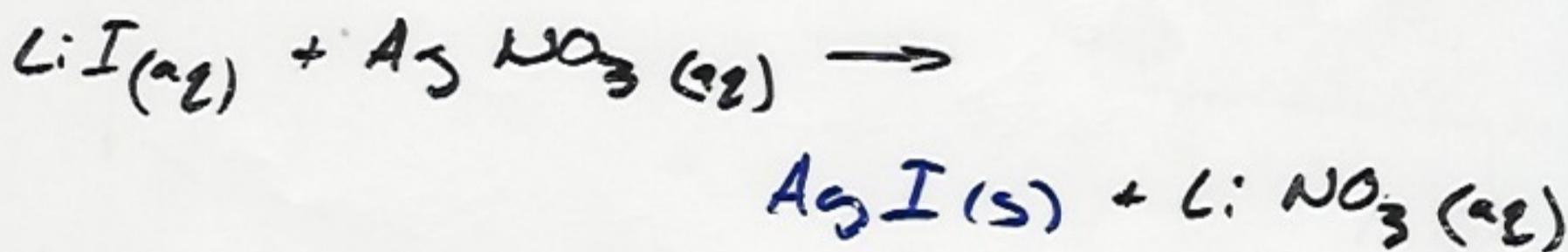
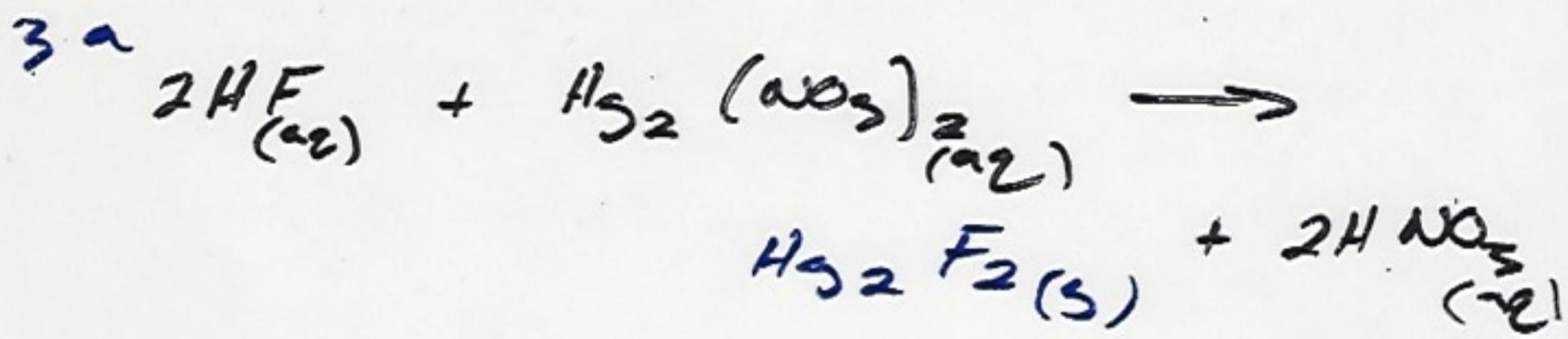
Predict the result of each of the following reactions.



work sheet #1

1) A	NaI / very weak	H ₂ O
B	KCl	strong
C	HNO ₃	strong
D	CH ₃ COH	weak
E	Sugar	NaI
F	Ba(NO ₃) ₂	strong
G	NC	NaI
H	NH ₃	weak
I	NaOH	strong

2	A	Ca ₃ (PO ₄) ₂	In sol.
	B	Mn(OH) ₂	In sol.
	C	Ag ClO ₃	sol.
	D	K ₂ S	sol.
	E	Ca CO ₃	In sol.
	F	Zn SO ₄	sol
	G	Hg (NO ₃) ₂	sol.
	H	Hg SO ₄	In sol
	I	NaHg ClO ₄	sol



Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- _____ 13. In a decomposition reaction, there is a single reactant.
- _____ 14. The activity series of metals can be used to predict products in double-replacement reactions.
- _____ 15. Carbon dioxide and water are the products of the combustion of hexane (C_6H_{14}).
- _____ 16. A nonmetal can replace another nonmetal from a compound in a single-replacement reaction.
- _____ 17. One of the products of a double-replacement reaction is a gas that bubbles out of the mixture.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A

- _____ 18. combination reaction
- _____ 19. decomposition reaction
- _____ 20. single-replacement reaction
- _____ 21. combustion reaction

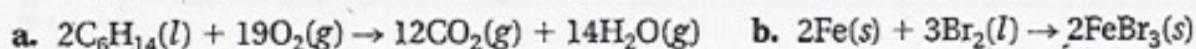
Column B

- a. reaction in which atoms of one element replace atoms of a second element in a compound
- b. a reaction in which two or more substances combine to form a single substance
- c. reaction of a compound with oxygen to produce energy
- d. reaction in which a single compound is broken down into two or more products

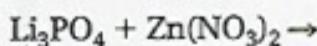
Part D Questions and Problems

Answer the following in the space provided.

22. Identify the type of each of the following reactions.



23. Complete and balance the following equation. What must be true of one of the products?



Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- _____ 10. A precipitate is formed when two ionic solutions are mixed.
- _____ 11. Spectator ions are not part of a net ionic equation.
- _____ 12. Balancing the atoms in a net ionic equation will cause the charges to balance.
- _____ 13. A net ionic equation shows all ions present.

Part C Matching

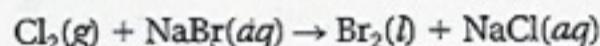
Match each description in Column B to the correct term in Column A.

Column A	Column B
_____ 14. complete ionic equation	a. equation that indicates only the particles that take part in a reaction
_____ 15. spectator ions	b. solid product of reaction in solution
_____ 16. net ionic equation	c. reaction that occurs in water
_____ 17. precipitate	d. equation that shows dissolved ionic compounds as free ions
_____ 18. aqueous reaction	e. used to predict whether a precipitate will form in an aqueous reaction
_____ 19. ionic solubility rules	f. ions that do not participate in a reaction

Part D Questions and Problems

Answer the following in the space provided.

20. Identify the spectator ion(s) and write a balanced net ionic equation for this reaction.



21. Predict which precipitate, if any, will form in the following reactions:

- a. $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow$
- b. $\text{CaCl}_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow$
- c. $\text{Fe}(\text{NO}_3)_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow$
- d. $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow$

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

AT

13. In a decomposition reaction, there is a single reactant.

NT

14. The activity series of metals can be used to predict products in double-replacement reactions.

AT

15. Carbon dioxide and water are the products of the combustion of hexane (C_6H_{14}).

ST

16. A nonmetal can replace another nonmetal from a compound in a single-replacement reaction.

ST

17. One of the products of a double-replacement reaction is a gas that bubbles out of the mixture.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A**B**

18. combination reaction

D

19. decomposition reaction

A

20. single-replacement reaction

C

21. combustion reaction

Column B

- a. reaction in which atoms of one element replace atoms of a second element in a compound

- b. a reaction in which two or more substances combine to form a single substance

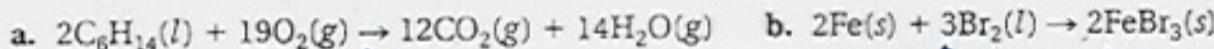
- c. reaction of a compound with oxygen to produce energy

- d. reaction in which a single compound is broken down into two or more products

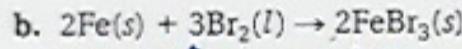
Part D Questions and Problems

Answer the following in the space provided.

22. Identify the type of each of the following reactions.

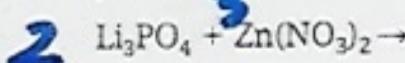


combustion



synthesis / combination

23. Complete and balance the following equation. What must be true of one of the products?



$Zn_3(Po_4)_2(s) + 6LiNO_3$

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

ST

10. A precipitate is formed when two ionic solutions are mixed.

AT

11. Spectator ions are not part of a net ionic equation.

AT

12. Balancing the atoms in a net ionic equation will cause the charges to balance.

NT

13. A net ionic equation shows all ions present.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A**Column B****D**

14. complete ionic equation

- a. equation that indicates only the particles that take part in a reaction

F

15. spectator ions

- b. solid product of reaction in solution

A

16. net ionic equation

- c. reaction that occurs in water

B

17. precipitate

- d. equation that shows dissolved ionic compounds as free ions

C

18. aqueous reaction

- e. used to predict whether a precipitate will form in an aqueous reaction

E

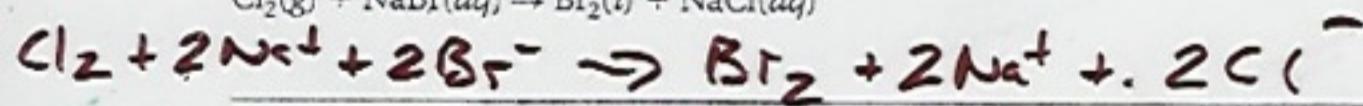
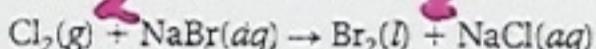
19. ionic solubility rules

- f. ions that do not participate in a reaction

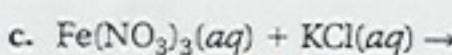
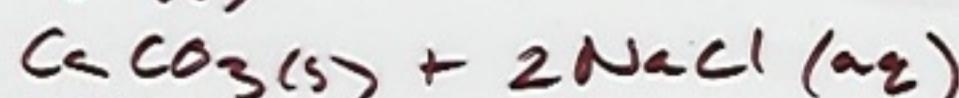
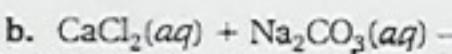
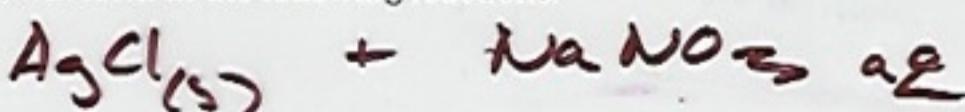
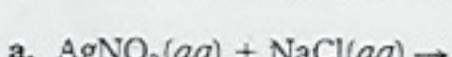
Part D Questions and Problems

Answer the following in the space provided.

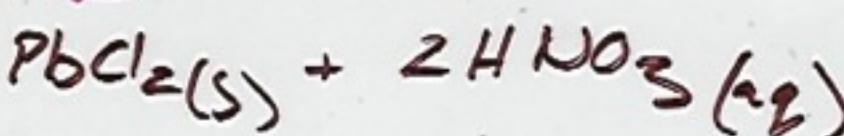
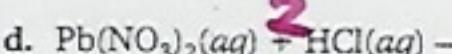
20. Identify the spectator ion(s) and write a balanced net ionic equation for this reaction.



21. Predict which precipitate, if any, will form in the following reactions:



NR



When two solutions of ionic compounds are mixed, a solid may form. This type of reaction is called a **precipitation reaction**, and the solid produced in the reaction is known as the **precipitate**. You can predict whether a precipitate will form using a list of solubility rules such as those found in the table below. When a combination of ions is described as insoluble, a precipitate forms.

There are three types of equations that are commonly written to describe a precipitation reaction. The **molecular equation** shows each of the substances in the reaction as compounds with physical states written next to the chemical formulas. The **complete ionic equation** shows each of the compounds as separate ions if they are water soluble. Insoluble substances are not separated and these have the symbol (*s*) written next to them.

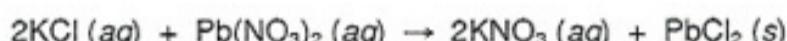
Notice that there are ions that are present on both sides of the reaction arrow – that is, they do not react. These ions are known as **spectator ions** and they are commonly eliminated from complete ionic equation by crossing them out. The remaining equation is known as the **net ionic equation**.

Solubility Rules

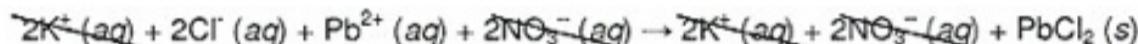
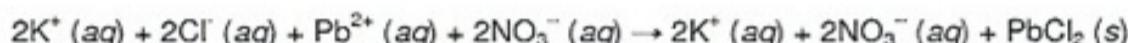
Rule 1 supercedes rule 2, rule 2 supercedes rule 3, etc.

1. Nitrate (NO_3^-) salts are soluble
2. Salts containing the alkali metal ions (Li^+ , Na^+ , K^+ , Rb^+ , Cs^+) and the ammonium ion (NH_4^+) are soluble
3. Most chloride, bromide, and iodide salts are soluble. Notable exceptions are salts containing the ions Ag^+ , Pb^{2+} , Hg_2^{2+}
4. Most sulfate salts are soluble. Notable exceptions are BaSO_4 , PbSO_4 , Hg_2SO_4 and CaSO_4 .
5. Most hydroxide salts are slightly soluble (insoluble). Exceptions include $\text{Ba}(\text{OH})_2$, $\text{Sr}(\text{OH})_2$, and $\text{Ca}(\text{OH})_2$.
6. Most sulfide (S^{2-}), carbonate (CO_3^{2-}), chromate (CrO_4^{2-}), and phosphate (PO_4^{3-}) salts are insoluble.

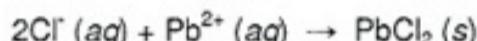
Molecular Equation:



Complete Ionic Equation:



Net Ionic Equation:



Write the **complete ionic equation** and cross out the spectator ions to give the **net ionic equation** for each of the reactions below. Include **physical states** for each species.

1. $\text{LiCl}(\text{l}) + \text{AgNO}_3(\text{l}) \rightarrow \text{AgCl}(\text{l}) + \text{LiNO}_3(\text{l})$
2. $\text{Na}_2\text{S}(\text{l}) + \text{CaCl}_2(\text{l}) \rightarrow 2\text{NaCl}(\text{l}) + \text{CaS}(\text{l})$
3. $\text{ZnCl}_2(\text{l}) + 2\text{KOH}(\text{l}) \rightarrow \text{Zn}(\text{OH})_2(\text{l}) + 2\text{KCl}(\text{l})$
4. $\text{Na}_2\text{CO}_3(\text{l}) + \text{Co}(\text{NO}_3)_2(\text{l}) \rightarrow 2\text{NaNO}_3(\text{l}) + \text{CoCO}_3(\text{l})$
5. $2\text{NaOH}(\text{l}) + \text{MnBr}_2(\text{l}) \rightarrow 2\text{NaBr}(\text{l}) + \text{Mn}(\text{OH})_2(\text{l})$
6. $\text{FeCl}_3(\text{l}) + (\text{NH}_4)_3\text{PO}_4(\text{l}) \rightarrow 3\text{NH}_4\text{Cl}(\text{l}) + \text{FePO}_4(\text{l})$

Write the **net ionic equation** for each of the following reactions. List all spectator ions.

7. A solution of aluminum bromide, AlBr_3 reacts with a solution of sodium hydroxide, NaOH to form the precipitate aluminum hydroxide, $\text{Al}(\text{OH})_3$.
8. Aqueous copper (II) nitrate, $\text{Cu}(\text{NO}_3)_2$ reacts with aqueous potassium carbonate, K_2CO_3 forming solid copper (II) carbonate, $\text{Cu}(\text{CO}_3)_2$.
9. A solution of barium chloride, BaCl_2 reacts with a solution of magnesium sulfate, MgSO_4 to form the precipitate barium sulfate, BaSO_4 .
10. Aqueous potassium sulfide, K_2S reacts with a solution of cadmium chloride, CdCl_2 to form solid cadmium sulfide, CdS .

