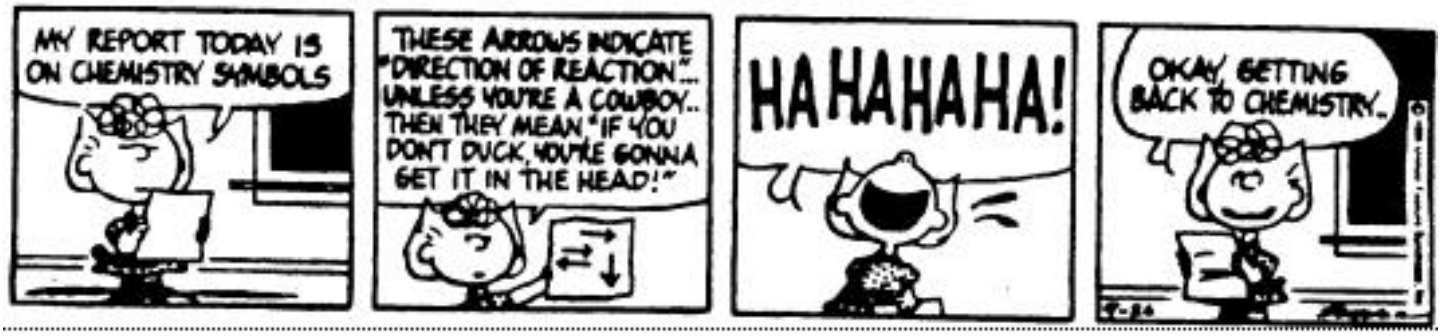

A. Learn the meaning of these arrows.

B. The chemical equation is the shorthand notation for a chemical reaction. A chemical equation shows the molar quantities of reactants and products in a reaction.

1 Reactants —— react to produce ——→ **1** Products

the number out in front of a substance in a balanced reaction is a molar quantity known as a molar coefficient

B. Law of Conservation of Mass - Matter cannot be gained or lost in the process of a chemical reaction. The law of conservation of mass states that we must have a balanced equation.

C. List five factors involved in the construction of an equation or "chemical recipe."

1.	The identity of products and reactants must be specified.
2.	Reactants are written to the left of the reaction arrow (————>) and products to the right.
3.	The physical state of reactants and products is shown in parentheses; (s), (l), (g), and (aq)
4.	The symbol Δ over the reaction arrow mean that heat energy is necessary for the reaction to occur.
5.	The equation must be balanced.

Steps for balancing a chemical equation

Step 1: Count the number of atoms of each element on both the product and reactant side.

Step 2: Determine which atoms are not balanced.

Step 3: Balance one atom at a time, using coefficients. Start with atoms that appear only once in the reactants and only once in the products. Usually leave Hydrogen atoms followed by Oxygen atoms until last.

Step 4: After you believe that you have successfully balanced the equation, repeat Step 1, to be certain that mass conservation has been achieved.

Note: DO NOT Change subscripts in a molecular formula (i.e., 2 NaCl —X→ Na_2Cl_2)

Double Displacement Reactions Demonstration
Dr. Gergens - SD Mesa College

Using the solubility rules for ionic salts (see your periodic table, front cover), predict whether mixing the two aqueous ionic salts (or aqueous strong acid) will produced an insoluble precipitate.

	$CuSO_4$ (aq)	$NaNO_3$ (aq)	HCl (aq)	$AgNO_3$ (aq)	Na_2CO_3 (aq)
copper (II) sulfate $CuSO_4$ (aq)		all soluble	all soluble	Ag_2SO_4 (s) silver (I) sulfate	$CuCO_3$ (s) copper (II) carbonate
sodium nitrate $NaNO_3$ (aq)			all soluble	all soluble	all soluble
hydrochloric acid HCl (aq)				AgCl (s) silver (I) chlroide	H_2O(l)+ CO_2 (g)
silver (I) nitrate $AgNO_3$ (aq)					Ag_2CO_3 (s) silver (I) carbonate
sodium carbonate Na_2CO_3 (aq)					

A. $CuSO_4$ (aq) + $NaNO_3$ (aq) ------> No Reaction (NR)

B. $CuSO_4$ (aq) + HCl (aq) ------> NR

C. 1 $CuSO_4$ (aq) + 2 $AgNO_3$ (aq) ------> 1 Ag_2SO_4 (s) + 1 $Cu(NO_3)_2$ (aq)

D. $CuSO_4$ (aq) + Na_2CO_3 (aq) ------> NR

E. $NaNO_3$ (aq) + HCl (aq) ------> NR

F. 1 HCl (aq) + 1 $AgNO_3$ (aq) ------> 1 AgCl (s) + 1 $NaNO_3$ (aq)

G. 2 HCl (aq) + 1 Na_2CO_3 (aq) ------> 2 NaCl (aq) + 1 CO_2 (g) + 1 H_2O(l)

H. $NaNO_3$ (aq) + $AgNO_3$ (aq) ------> NR

I. $NaNO_3$ (aq) + Na_2CO_3 (aq) ------> NR

BALANCING PRACTICE

Dr. Gergens - SD Mesa College

a. Balance each of the following equations by adjusting the coefficients in front of the chemical formulas.
b. List the physical state of each compound.
c. Determine the driving force for each reaction.
d. Classify each reaction in as many ways as possible.

1.	$Cu_{(s)}$ oxidized copper metal	+	$2\ AgNO_{3\ (aq)}$ reduced silver (I) nitrate	------>	$Cu(NO_3)_{2\ (aq)}$ copper (II) nitrate	+	$2\ Ag_{(s)}$ silver metal	Transfer of Electrons Single Replacement Redox
2.	$2\ Al_{(s)}$ oxidized aluminum meta	+	$3\ S_{(s)}$ reduced sulfur nonmetal	------>	$Al_2S_{3\ (s)}$ aluminum sulfide			Transfer of Electrons Combination (Synthesis) Redox
3.	$Na_2CO_{3\ (aq)}$ sodium carbonate	+	$CaCl_{2\ (aq)}$ calcium chloride	------>	$CaCO_{3\ (s)}$ calcium carbonate	+	$2\ NaCl_{(aq)}$ sodium chloride	Precipitation of $CaCO_3$ Double Replacement
4.	$3\ Fe_{(s)}$ oxidized iron metal	+	$3\ Cl_{2\ (g)}$ reduced chlorine gas nonmetal	------>	$2\ FeCl_{3\ (s)}$ iron (III) chloride			Transfer of Electrons Combination (Synthesis) Redox
5.	$2\ Na_3PO_{4\ (aq)}$ sodium phosphate	+	$3\ BaCl_{2\ (aq)}$ barium chloride	------>	$Ba_3(PO_4)_{2\ (s)}$ barium phoshpate	+	$6\ NaCl_{(aq)}$ sodium chloride	Precipitation of $Ba_3(PO_4)_2$ Double Replacement
6.	$2\ NaOH_{(aq)}$	+	$CuSO_{4\ (aq)}$	------>	$Na_2SO_{4\ (aq)}$	+	$Cu(OH)_{2\ (s)}$	Precipitation of $Cu(OH)_2$ Double Replacement
7.	$Mg(OH)_{2\ (s)}$	+	$H_2SO_{4\ (aq)}$	------>	$MgSO_{4\ (aq)}$	+	$2\ H_2O_{(l)}$	Water Formation Double Replacement Acid-Base Reaction
8.	$2\ Al_{(s)}$ oxidized	+	$6\ HCl_{(aq)}$ reduced	------>	$2\ AlCl_{3\ (aq)}$	+	$3\ H_{2\ (g)}$	Hydrogen Gas Formation Single Replacement Redox
9.	$3\ Mg_{(s)}$ oxidized	+	$2\ H_3PO_{4\ (aq)}$ reduced	------>	$Mg_3(PO_4)_{2\ (s)}$	+	$3\ H_{2\ (g)}$	$Mg_3(PO_4)_2$ ppt & H_2 Gas Single Replacement Redox
10.	$Br_{2\ (l)}$ reduced	+	$2\ CuI_{(aq)}$ oxidized	------>	$2\ CuBr_{(aq)}$	+	$I_{2\ (s)}$	Transfer of Electrons Single Replacement Redox
11.	$3\ NaOH_{(aq)}$	+	$FeCl_{3\ (aq)}$	------>	$3\ NaCl_{(aq)}$	+	$Fe(OH)_{3\ (s)}$	Precipitation of $Fe(OH)_3$ Double Replacement
12.	$2\ KBr_{(aq)}$	+	$Pb(NO_3)_{2\ (aq)}$	------>	$2\ KNO_{3\ (aq)}$	+	$PbBr_{2\ (s)}$	Precipitation of $PbBr_2$ Double Replacement
13.	$2\ AlCl_{3\ (aq)}$	+	$3\ H_2SO_{4\ (aq)}$	------>	$Al_2(SO_4)_{3\ (s)}$	+	$6\ HCl_{(aq)}$	Precipitation of $Al_2(SO_4)_3$ Double Replacement
14.	$Al_2(SO_4)_{3\ (aq)}$	+	$3\ BaCl_{2\ (aq)}$	------>	$3\ BaSO_{4\ (s)}$	+	$2\ AlCl_{3\ (aq)}$	Precipitation of $BaSO_4$ Double Replacement
15.	$Cd(NO_3)_{2\ (aq)}$	+	$H_2S_{(l)}$	------>	$CdS_{(s)}$	+	$2\ HNO_{3\ (aq)}$	Precipitation of CdS Double Replacement

DOUBLE REPLACEMENT REACTIONS AND PREDICTIONS PRACTICE

Dr. Gergens - Mesa College

a. Complete and balance each of the following equations for double replacement reactions.
b. List the physical state of each compound.
c. Determine the driving force for each reaction.

1. $NaCl_{(aq)} + AgNO_{3\,(aq)} \longrightarrow NaNO_{3\,(aq)} + AgCl_{(s)}$ Precipitation of AgCl

2. $BaCl_{2\,(aq)} + H_2SO_{4\,(aq)} \longrightarrow BaSO_{4\,(s)} + 2\,HCl_{(aq)}$ Precipitation of $BaSO_4$

3. $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$ Water Formation

4. $Na_2CO_{3\,(aq)} + 2\,HCl_{(aq)} \longrightarrow 2\,NaCl_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$ Water & Gas

5. $H_2SO_{4\,(aq)} + 2\,NaOH_{(aq)} \longrightarrow 2\,H_2O_{(l)} + Na_2SO_{4\,(aq)}$ Water Formation

6. $FeCl_{3\,(aq)} + 3\,KOH_{(aq)} \longrightarrow Fe(OH)_{3\,(s)} + 3\,KCl_{(aq)}$ Precipitation of $Fe(OH)_3$

7. $Na_2SO_{3\,(aq)} + 2\,HCl_{(aq)} \longrightarrow 2\,NaCl_{(aq)} + H_2SO_{3\,(l)}$ Special Strong to Weak Acid

8. $K_2CrO_{4\,(aq)} + Pb(NO_3)_{2\,(aq)} \longrightarrow 2\,KNO_{3\,(aq)} + PbCrO_{4\,(s)}$ Precipitation of $PbCrO_4$

9. $NaC_2H_3O_{2\,(aq)} + HNO_{3\,(aq)} \longrightarrow HC_2H_3O_{2\,(l)} + NaNO_{3\,(aq)}$ Special Strong to Weak Acid

10. $NaOH_{(aq)} + NH_4Cl_{(aq)} \longrightarrow NaCl_{(aq)} + NH_{3\,(g)} + H_2O_{(l)}$ Water & Gas

11. $2\,BiCl_{3\,(aq)} + 3\,H_2S_{(l)} \longrightarrow Bi_2S_{3\,(s)} + 6\,HCl_{(aq)}$ Precipitation of Bi_2S_3

12. $K_2C_2O_{4\,(aq)} + 2\,HCl_{(aq)} \longrightarrow 2\,KCl_{(aq)} + H_2C_2O_{4\,(l)}$ Special Strong to Weak Acid

13. $2\,H_3PO_{4\,(aq)} + 3\,Ca(OH)_{2\,(aq)} \longrightarrow 6\,H_2O_{(l)} + Ca_3(PO_4)_{2\,(s)}$ Water & ppt of $Ca_3(PO_4)_2$

14. $(NH_4)_2CO_{3\,(aq)} + 2\,HBr_{(aq)} \longrightarrow 2\,NH_4Br_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$ Water & Gas

15. $(NH_4)_2CO_{3\,(aq)} + CaCl_{2\,(aq)} \longrightarrow 2\,NH_4Cl_{(aq)} + CaCO_{3\,(s)}$ Precipitation of $CaCO_3$

MORE BALANCING PRACTICE
Dr. Gergens - Mesa College

a. Balance each of the following equations by adjusting the coefficients in front of the chemical formulas.
b. List the physical state of each compound.
c. Determine the driving force for each reaction.
d. Classify each reaction in as many ways as possible.

1.	2 $Mg_{(s)}$ oxidized	+	$O_{2\ (g)}$ reduced	——————>	2 $MgO_{(s)}$			Transfer of Electrons Combination (Synthesis) Redox
2.			2 $KClO_{3\ (s)}$ reduced oxidized	——————>	2 $KCl_{(s)}$	+	3 $O_{2\ (g)}$	Transfer of Electrons Decomposition Redox
3.	3 $Fe_{(s)}$ oxidized	+	2 $O_{2\ (g)}$ reduced	——————>	$Fe_3O_{4\ (s)}$			Transfer of Electrons Combination (Synthesis) Redox
4.	$Mg_{(s)}$ oxidized	+	2 $HCl_{(aq)}$ reduced	——————>	$MgCl_{2\ (aq)}$	+	$H_{2\ (g)}$	Transfer of Electrons Single Replacement Redox
5.	2 $Na_{(s)}$ oxidized	+	2 $H_2O_{(l)}$ reduced	——————>	2 $NaOH_{(aq)}$	+	$H_{2\ (g)}$	Transfer of Electrons Single Replacement Redox
6.	3 $Fe_{(s)}$ oxidized	+	4 $H_2O_{(l)}$ reduced	——————>	$Fe_3O_{4\ (s)}$	+	4 $H_{2\ (g)}$	Transfer of Electrons Single Replacement Redox

Beneath each word equation write the formula equation and balance it.

7.	2 $S_{(s)}$ oxidized	+	$O_{2\ (g)}$ reduced	——————>	$SO_{2\ (g)}$			Transfer of Electrons Combination (Synthesis) Redox
8.	$Zn_{(s)}$ oxidized	+	$H_2SO_{4\ (aq)}$ reduced	——————>	$ZnSO_{4\ (aq)}$	+	$H_{2\ (g)}$	Transfer of Electrons Single Replacement Redox
9.	$C_{(s)}$ oxidized	+	$O_{2\ (g)}$ reduced	——————>	$CO_{2\ (g)}$			Transfer of Electrons Combination (Synthesis) Redox
10.	2 $H_{2\ (g)}$ oxidized	+	$O_{2\ (g)}$ reduced	——————>	2 $H_2O_{(l)}$			Transfer of Electrons Combination (Synthesis) Redox
11.	2 $Al_{(s)}$ oxidized	+	6 $HCl_{(aq)}$ reduced	——————>	2 $AlCl_{3\ (aq)}$	+	3 $H_{2\ (g)}$	Transfer of Electrons Single Replacement Redox
12.	2 $K_{(s)}$ oxidized	+	2 $H_2O_{(l)}$ reduced	——————>	2 $KOH_{(aq)}$	+	$H_{2\ (g)}$	Transfer of Electrons Single Replacement Redox
13.	$NaHCO_{3\ (s)}$	+	$HC_2H_3O_{2\ (aq)}$	——————>	$NaC_2H_3O_{2\ (aq)}$	+	$H_2O_{(l)}$ + $CO_{2\ (g)}$	Double Replacement **NO** transfer of electrons

You can try this chemical reaction at home!

2. $2\ AgNO_3\ (aq) + CaBr_2\ (aq) \longrightarrow 2\ AgBr\ (s) + Ca(NO_3)_2\ (aq)$

a. $2\ Ag^+\ (aq) + 2\ NO_3^-\ (aq) + 2\ Ca^{2+}\ (aq) + 2\ Br^-\ (aq) \longrightarrow 2\ AgBr\ (s) + Ca^{2+}\ (aq) + NO_3^-\ (aq)$

b. $Ag^+\ (aq) + Br^-\ (aq) \longrightarrow AgBr\ (s)$

3. $NaCN\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + HCN\ (g,aq)$

a. $Na^+\ (aq) + CN^-\ (aq) + H^+\ (aq) + Cl^-\ (aq) \longrightarrow Na^+\ (aq) + Cl^-\ (aq) + HCN\ (g,aq)$

b. $H^+\ (aq) + CN^-\ (aq) \longrightarrow HCN\ (g,aq)$

4. $AgCN\ (aq) + HCl\ (aq) \longrightarrow AgCl\ (s) + HCN\ (g,aq)$

a. $Ag^+\ (aq) + CN^-\ (aq) + H^+\ (aq) + Cl^-\ (aq) \longrightarrow AgCl\ (s) + HCN\ (g,aq)$

b. $Ag^+\ (aq) + CN^-\ (aq) + H^+\ (aq) + Cl^-\ (aq) \longrightarrow AgCl\ (s) + HCN\ (g,aq)$

5. $Ba(OH)_2\ (aq) + Na_2SO_4\ (aq) \longrightarrow BaSO_4\ (s) + 2\ NaOH\ (aq)$

a. $Ba^{2+}\ (aq) + 2\ OH^-\ (aq) + 2\ Na^+\ (aq) + SO_4^{2-}\ (aq) \longrightarrow BaSO_4\ (s) + 2\ Na^+\ (aq) + 2\ OH^-\ (aq)$

b. $Ba^{2+}\ (aq) + SO_4^{2-}\ (aq) \longrightarrow BaSO_4\ (s)$

6. $Na_2S\ (aq) + Hg(NO_3)_2\ (aq) \longrightarrow 2\ NaNO_3\ (aq) + HgS\ (s)$

a. $2\ Na^+\ (aq) + S^{2-}\ (aq) + Hg^{2+}\ (aq) + 2\ NO_3^-\ (aq) \longrightarrow 2\ Na^+\ (aq) + 2\ NO_3^-\ (aq) + HgS\ (s)$

b. $Hg^{2+}\ (aq) + S^{2-}\ (aq) \longrightarrow HgS\ (s)$

7. $ZnCl_2\ (aq) + H_2S\ (aq, g) \longrightarrow ZnS\ (s) + 2\ HCl\ (aq)$

a. $Zn^{2+}\ (aq) + 2\ Cl^-\ (aq) + 2\ H^+\ (aq) + S^{2-}\ (aq) \longrightarrow ZnS\ (s) + 2\ H^+\ (aq) + 2\ Cl^-\ (aq)$

b. $Zn^{2+}\ (aq) + S^{2-}\ (aq) \longrightarrow ZnS\ (s)$

8. $Na_2S\ (aq) + 2\ HCl\ (aq) \longrightarrow 2\ NaCl\ (aq) + H_2S\ (aq, g)$

a. $2\ Na^+\ (aq) + S^{2-}\ (aq) + 2\ H^+\ (aq) + 2\ Cl^-\ (aq) \longrightarrow 2\ Na^+\ (aq) + 2\ Cl^-\ (aq) + H_2S\ (aq, g)$

b. $2\ H^+\ (aq) + S^{2-}\ (aq) \longrightarrow H_2S\ (aq, g)$

9. $2\ KC_2H_3O_2\ (aq) + H_2SO_4\ (aq) \longrightarrow K_2SO_4\ (aq) + 2\ HC_2H_3O_2\ (l)$

a. $2\ K^+\ (aq) + 2\ C_2H_3O_2^-\ (aq) + 2\ H^+\ (aq) + SO_4^{2-}\ (aq) \longrightarrow 2\ K^+\ (aq) + SO_4^{2-}\ (aq) + 2\ HC_2H_3O_2\ (l)$

b. $H^+\ (aq) + C_2H_3O_2^-\ (aq) \longrightarrow HC_2H_3O_2\ (l)$

10. $HC_2H_3O_2$ (l) + KOH (aq) -------> H_2O (l) + $KC_2H_3O_2$ (aq)

a. $HC_2H_3O_2$ (l) + K^+ (aq) + OH^- (aq) -------> H_2O (l) + K^+ (aq) + $C_2H_3O_2^-$ (aq)

b. $C_2H_3O_2$ (l) + OH^- (aq) -------> H_2O (l) + $C_2H_3O_2^-$ (aq)

11. NH_4OH (aq) + HCl (aq) --------> NH_4Cl (aq) + H_2O (l)

a. NH_4^+ (aq) + OH^- (aq) + H^+ (aq) + Cl^- (aq) -------> NH_4^+ (aq) + Cl^- (aq) + H_2O (l)

b. H^+ (aq) + OH^- (aq) -------> H_2O (l)

12. 3 NH_4OH (aq) + $FeCl_3$ (aq) --------> 3 NH_4Cl (aq) + $Fe(OH)_3$ (s)

a. 3 NH_4^+ (aq) + 3 OH^- (aq) + Fe^{3+} (aq) + 3 Cl^- (aq) -------> 3 NH_4^+ (aq) + 3 Cl^- (aq) + $Fe(OH)_3$ (s)

b. Fe^{3+} (aq) + 3 OH^- (aq) -------> $Fe(OH)_3$ (s)

13. 2 HNO_3 (aq) + $Ca(OH)_2$ (aq) --------> 2 H_2O (l) + $Ca(NO_3)_2$ (aq)

a. 2 H^+ (aq) + 2 NO_3^- (aq) + Ca^{2+} (aq) + 2 OH^- (aq) -------> 2 H_2O (l) + Ca^{2+} (aq) + 2 NO_3^- (aq)

b. H^+ (aq) + OH^- (aq) -------> H_2O (l)

14. 2 $AgNO_3$ (aq) + Na_2S (aq) --------> Ag_2S (s) + 2 $NaNO_3$ (aq)

a. 2 Ag^+ (aq) + 2 NO_3^- (aq) + 2 Na^+ (aq) + S^{2-} (aq) -------> Ag_2S (s) + 2 Na^+ (aq) + 2 NO_3^- (aq)

b. Ag^+ (aq) + S^{2-} (aq) -------> Ag_2S (s)

15. $Cu(CN)_2$ (aq) + 2 HCl (aq) --------> $CuCl_2$ (aq) + 2 HCN (g,aq)

a. Cu^{2+} (aq) + 2 CN^- (aq) + 2 H^+ (aq) + 2 Cl^- (aq) -------> Cu^{2+} (aq) + 2 Cl^- (aq) + 2 HCN (g,aq)

b. H^+ (aq) + CN^- (aq) -------> HCN (g,aq)

16. 3 $Pb(NO_3)_2$ (aq) + 2 $AlCl_3$ (aq) --------> 3 $PbCl_2$(s) + 2 $Al(NO_3)_3$ (aq)

a. 3 Pb^{2+} (aq) + 6 NO_3^- (aq) + 2 Al^{3+} (aq) + 6 Cl^- (aq) -------> 3 $PbCl_2$ (s) + 2 Al^{3+} (aq) + 6 NO_3^- (aq)

b. Pb^{2+} (aq) + 2 Cl^- (aq) -------> $PbCl_2$ (s)

17. 2 $AgC_2H_3O_2$ (aq) + $MgSO_4$ (aq) --------> Ag_2SO_4 (s) + $Mg(C_2H_3O_2)_2$ (aq)

a. 2 Ag^+ (aq) + 2 $C_2H_3O_2^-$ (aq) + Mg^{2+} (aq) + SO_4^{2-} (aq) -------> Ag_2SO_4 (s) + Mg^{2+} (aq) + 2 $C_2H_3O_2^-$ (aq)

b. 2 Ag^+ (aq) + SO_4^{2-} (aq) -------> Ag_2SO_4 (s)

18. $HC_2H_3O_2$ (l) + NH_4OH (aq) -------> H_2O (l) + $NH_4C_2H_3O_2$ (aq)

a. $HC_2H_3O_2$ (l) + NH_4^+ (aq) + OH^- (aq) -------> H_2O (l) + NH_4^+ (aq) + $C_2H_3O_2^-$ (aq)

b. $HC_2H_3O_2$ (l) + OH^- (aq) -------> H_2O (l) + $C_2H_3O_2^-$ (aq)

19. $Fe(NO_3)_3$ (aq) + K_3PO_4 (aq) -------> $FePO_4$ (s) + 3 KNO_3 (aq)

a. Fe^{3+} (aq) + 3 NO_3^- (aq) + 3 K^+ (aq) + PO_4^{3-} (aq) -------> $FePO_4$ (s) + 3 K^+ (aq) + 3 NO_3^- (aq)

b. Fe^{3+} (aq) + PO_4^{3-} (aq) -------> $FePO_4$ (s)

20. Na_2CO_3 (aq) + H_2SO_4 (aq) -------> Na_2SO_4 (aq) + H_2O (l) + CO_2 (g)

a. 2 Na^+ (aq) + CO_3^{2-} (aq) + 2 H^+ (aq) + SO_4^{2-} (aq) -------> 2 Na^+ (aq) + SO_4^{2-} (aq) + H_2O (l) + CO_2 (g)

b. 2 H^+ (aq) + CO_3^{2-} (aq) -------> H_2O (l) + CO_2(g)

21. $Cu(NO_3)_2$ (aq) + 2 NaOH (aq) -------> $Cu(OH)_2$ (s) + 2 $NaNO_3$ (aq)

a. Cu^{2+} (aq) + 2 NO_3^- (aq) + 2 Na^+ (aq) + 2 OH^- (aq) -------> $Cu(OH)_2$ (s) + 2 Na^+ (aq) + 2 NO_3^- (aq)

b. Cu^{2+} (aq) + 2 OH^- (aq) -------> $Cu(OH)_2$ (s)

Explain why each of the following mixing of reactants affords no reaction, NR.

22. $NaNO_3$ (aq) + HCl (aq) -------> NR Both products are soluble

23. $Pb(NO_3)_2$ (aq) + $Hg(NO_3)_2$ (aq) -------> NR Both products are reactants

24. CsCl (aq) + $(NH_4)_2SO_4$ (aq) -------> NR Both products are soluble

25. K_2SO_4 (aq) + $NaClO_4$ (aq) -------> NR Both products are soluble