ANSWER KEY

BALANCING CHEMICAL EQUATIONS (I)

Name _____

Rewrite and balance the equations below.

1. $N_2 + H_2 \rightarrow NH_3$ — $N_2 + 3H_2 \rightarrow 2NH_3$
2. $KClO_3 \rightarrow KCl + O_2$ — $2KClO_3 \rightarrow 2KCl + 3O_2$
3. $NaCl + F_2 \rightarrow NaF + Cl_2$ — $2NaCl + F_2 \rightarrow 2NaF + Cl_2$
4. $H_2 + O_2 \rightarrow H_2O$ — $2H_2 + O_2 \rightarrow 2H_2O$
5. $AgNO_3 + MgCl_2$ — $2AgNO_3 + MgCl_2 \rightarrow 2AgCl + Mg(NO_3)_2$
6. $AlBr_3 + K_2SO_4$ — $2AlBr_3 + 3K_2SO_4 \rightarrow 6KBr + Al_2(SO_4)_3$
7. $CH_4 + O_2 \rightarrow CO_2 + H_2O$ — $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
8. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$ — $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
9. $C_8H_{18} + O_2 \rightarrow 10_2 + H_2O$ — $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$
10. $FeCl_3 + 3aOH$ — $FeCl_3 + 3NaOH \rightarrow Fe(OH)_3 + 3NaCl$
11. $P + O_2 \rightarrow P_2O_5$ — $4P + 5O_2 \rightarrow 2P_2O_5$
12. $Na + H_2O \rightarrow NaOH + H_2$ — $2Na + 2H_2O \rightarrow 2NaOH + H_2$
13. $Ag_2O \rightarrow Ag + O_2$ — $2Ag_2O \rightarrow 4Ag + O_2$
14. $S_8 + O_2 \rightarrow SO_3$ — $S_8 + 12O_2 \rightarrow 8SO_3$
15. $CO_2 + H_2O \rightarrow$ — $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
16. $K + MgBr_2 \rightarrow$ — $2K + MgBr_2 \rightarrow 2KBr + Mg$
17. $HCl + CaCO_3$ — $2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

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WORD EQUATIONS (I)

Name _____

Write the word equations below as chemical equations and balance.

1. zinc + lead (II) nitrate yield zinc nitrate + lead
   $Zn + Pb(NO_3)_2 \rightarrow Zn(NO_3)_2 + Pb$
2. aluminum bromide + chlorine yield aluminum chloride + bromine
   $2AlBr_3 + 3Cl_2 \rightarrow 2AlCl_3 + 3Br_2$
3. sodium phosphate + calcium chloride yield calcium phosphate + sodium chloride
   $2Na_3PO_4 + 3CaCl_2 \rightarrow Ca_3(PO_4)_2 + 6NaCl$
4. potassium chlorate when heated yields potassium chloride + oxygen gas
   $2KClO_3 \rightarrow 2KCl + 3O_2(g)$
5. aluminum + hydrochloric acid yield aluminum chloride + hydrogen gas
   $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2(g)$
6. calcium hydroxide + phosphoric acid yield calcium phosphate + water
   $3Ca(OH)_2 + 2H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6H_2O$
7. copper + sulfuric acid yield copper (II) sulfate + water + sulfur dioxide
   $Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$
8. hydrogen + nitrogen monoxide yield water + nitrogen
   $2H_2 + 2NO \rightarrow 2H_2O + N_2$

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BALANCING EQUATIONS (II)

Name _____

Balance the following chemical equations.

1. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
2. $2Na + I_2 \rightarrow 2NaI$
3. $2N_2 + O_2 \rightarrow 2N_2O$
4. $N_2 + 3H_2 \rightarrow 2NH_3$
5. $2KI + Cl_2 \rightarrow 2KCl + I_2$
6. $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$
7. $2KClO_3 \rightarrow 2KCl + 3O_2$
8. $K_3PO_4 + 3HCl \rightarrow 3KCl + H_3PO_4$
9. $2S + 3O_2 \rightarrow 2SO_3$
10. $2KI + Pb(NO_3)_2 \rightarrow 2KNO_3 + PbI_2$
11. $3CaSO_4 + 2AlBr_3 \rightarrow 3CaBr_2 + Al_2(SO_4)_3$
12. $2H_2O_2 \rightarrow 2H_2O + O_2$
13. $2Na + 2H_2O \rightarrow 2NaOH + H_2$
14. $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
15. $3Mg(NO_3)_2 + 2K_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6KNO_3$

WORD EQUATIONS (II)

Name _____

Write and balance the following chemical equations.

1. Hydrogen plus oxygen yields water. $2H_2 + O_2 \rightarrow 2H_2O$
2. Nitrogen plus hydrogen yields ammonia. $N_2 + 3H_2 \rightarrow 2NH_3$
3. Aluminum bromide plus chlorine yields aluminum chloride and bromine. $2AlBr_3 + 3Cl_2 \rightarrow 2AlCl_3 + 3Br_2$
4. Hydrochloric acid plus sodium hydroxide yields sodium chloride plus water. $HCl + NaOH \rightarrow NaCl + H_2O$
5. Iron plus lead (II) sulfate react forming iron (II) sulfate plus lead. $Fe + PbSO_4 \rightarrow FeSO_4 + Pb$
6. Potassium chlorate when heated produces potassium chloride plus oxygen gas. $2KClO_3 \rightarrow 2KCl + 3O_2$
7. Sulfuric acid decomposes to form sulfur trioxide gas plus water. $H_2SO_4 \rightarrow SO_3 + H_2O$
8. Sodium oxide combines with water to make sodium hydroxide. $Na_2O + H_2O \rightarrow 2NaOH$
9. Potassium iodide reacts with bromine forming potassium bromide plus iodine. $2KI + Br_2 \rightarrow 2KBr + I_2$
10. Sodium phosphate reacts with calcium nitrate to produce sodium nitrate plus calcium phosphate. $2Na_3PO_4 + 3Ca(NO_3)_2 \rightarrow 6NaNO_3 + Ca_3(PO_4)_2$
11. Zinc reacts with iron (III) chloride yielding zinc chloride plus iron precipitate. $3Zn + 2FeCl_3 \rightarrow 3ZnCl_2 + 2Fe$
12. Ammonium carbonate and magnesium sulfate react to yield ammonium sulfate plus magnesium carbonate. $(NH_4)_2CO_3 + MgSO_4 \rightarrow (NH_4)_2SO_4 + MgCO_3$
13. Phosphoric acid plus calcium hydroxide react forming solid calcium phosphate plus water. $2H_3PO_4 + 3Ca(OH)_2 \rightarrow Ca_3(PO_4)_2 + 6H_2O$
14. Aluminum plus oxygen gas form aluminum oxide under certain conditions. $4Al + 3O_2 \rightarrow 2Al_2O_3$
15. Nitrogen gas plus oxygen gas react and form dinitrogen pentoxide. $2N_2 + 5O_2 \rightarrow 2N_2O_5$

PREDICTING PRODUCTS OF CHEMICAL REACTIONS

Name _____

Predict the products of the reactions below. Then, write the balanced equation and classify the reaction.

1. magnesium bromide + chlorine
2. aluminum + iron (III) oxide
3. silver nitrate + zinc chloride
4. hydrogen peroxide (catalyzed by manganese dioxide)
5. zinc + hydrochloric acid
6. sulfuric acid + sodium hydroxide
7. sodium + hydrogen
8. acetic acid + copper

CLASSIFYING CHEMICAL REACTIONS Name _____

Classify the following reactions as synthesis, decomposition, single replacement or double replacement.

1. $2KClO_3 \rightarrow 2KCl + 3O_2$ decomposition
2. $HCl + NaOH \rightarrow NaCl + H_2O$ double replacement
3. $Mg + 2HCl \rightarrow MgCl_2 + H_2$ single replacement
4. $2H_2 + O_2 \rightarrow 2H_2O$ synthesis
5. $2Al + 3NiBr_2 \rightarrow 2AlBr_3 + 3Ni$ single replacement
6. $4Al + 3O_2 \rightarrow 2Al_2O_3$ synthesis
7. $2NaCl \rightarrow 2Na + Cl_2$ decomposition
8. $CoCl_2 + F_2 \rightarrow CoF_2 + Cl_2$ single replacement
9. $AgNO_3 + KCl \rightarrow AgCl + KNO_3$ double replacement
10. $N_2 + 3H_2 \rightarrow 2NH_3$ synthesis
11. $2H_2O_2 \rightarrow 2H_2O + O_2$ decomposition
12. $(NH_4)SO_4 + Ba(NO_3)_2 \rightarrow BaSO_4 + 2NH_4NO_3$ double replacement
13. $MgI_2 + Br_2 \rightarrow MgBr_2 + I_2$ single replacement
14. $SO_3 + H_2O \rightarrow H_2SO_4$ synthesis
15. $6KCl + Zn_3(PO_4)_2 \rightarrow 3ZnCl_2 + 2K_3PO_4$ double replacement

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PREDICTING PRODUCTS OF CHEMICAL REACTIONS Name _____

Predict the products of the reactions below. Then, write the balanced equation and classify the reaction.

1. magnesium bromide + chlorine — anionic single replacement
$MgBr_2 + Cl_2 \rightarrow MgCl_2 + Br_2$
2. aluminum + iron (III) oxide — Cationic single replacement
$Al + Fe_2O_3 \rightarrow Fe + Al_2O_3$
3. silver nitrate + zinc chloride — double replacement
$2AgNO_3 + ZnCl_2 \rightarrow 2AgCl + Zn(NO_3)_2$
4. hydrogen peroxide (catalyzed by manganese dioxide) — decomposition
$2H_2O_2 \xrightarrow{MnO_2} 2H_2O + O_2$
5. zinc + hydrochloric acid — Cationic single replacement
$Zn + 2HCl \rightarrow ZnCl_2 + H_2$
6. sulfuric acid + sodium hydroxide — double replacement (neutralization)
$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
7. sodium + hydrogen — synthesis
$2Na + H_2 \rightarrow 2NaH$
8. acetic acid + copper — cationic single replacement
$CH_3COOH + Cu \rightarrow$ no reaction (or $HC_2H_3O_2$)

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CLASSIFICATION OF CHEMICAL REACTIONS Name _____

Classify the reactions below as synthesis, decomposition, single replacement (cationic or anionic) or double replacement.

1. $2H_2 + O_2 \rightarrow 2H_2O$ synthesis
2. $2H_2O \rightarrow 2H_2 + O_2$ decomposition
3. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ cationic single replacement
4. $2CO + O_2 \rightarrow 2CO_2$ synthesis
5. $2H_2O \rightarrow 2H_2 + O_2$ decomposition
6. $2KBr + Cl_2 \rightarrow 2KCl + Br_2$ anionic single replacement
7. $CaO + H_2O \rightarrow Ca(OH)_2$ synthesis
8. $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$ double replacement
9. $2H_2O_2 \rightarrow 2H_2O + O_2$ decomposition
10. $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$ double replacement

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Key

Single Replacement Reactions and the Activity Series

A cation will replace any less reactive cation in a cationic single replacement reaction. An anion will replace any less reactive anion in an anionic single replacement reaction

Use the chart to predict **if** the following will occur. If it does, predict the products and complete the balanced equation.

a) $3Pb(NO_3)_2\ (aq) + 2Al\ (s) \rightarrow 2Al(NO_3)_{3\ (aq)} + 3Pb\ (s)$

b) $Pb(NO_3)_2\ (aq) + Ag\ (s) \rightarrow$ no rxn

c) $MgSO_4\ (aq) + Ca\ (s) \rightarrow CaSO_4\ (s) + Mg\ (s)$

d) $Br_2\ (l) + NaCl\ (s) \rightarrow$ no rxn

e) $3Zn\ (s) + 2Au(NO_3)_3\ (aq) \rightarrow 3Zn(NO_3)_{2\ (aq)} + 2Au\ (s)$

Precipitation Reactions

A low solubility compound will not dissolve in water, and will form a solid called a precipitate if it is created in a reaction. A soluble compound will dissolve in water and will be in the aqueous phase if in the presence of water in a reaction.

A) Using the chart provided in the data book, decide if each of the following compounds will dissolve in water:

a) calcium chloride (yes) b) calcium sulphide (yes) c) calcium sulphate (no) d) cesium hydroxide (yes)

e) copper (I) phosphate (no) f) copper (II) phosphate (no) g) ammonium carbonate (yes)

B) Assume that the following solid compounds are mixed together in the presence of water (so the reactants could be dissolved). Complete the chemical equations, including phases and balancing:

a) copper (II) nitrate and sodium sulphite

$Cu(NO_3)_{2\ (aq)} + Na_2SO_{3\ (aq)} \longrightarrow CuSO_{3\ (s)} + 2NaNO_{3\ (aq)}$

b) Barium sulphide and zinc sulphate

$BaS\ (aq) + ZnSO_{4\ (aq)} \longrightarrow BaSO_{4\ (s)} + ZnS\ (s)$

c) silver acetate and magnesium bromide

$2AgCH_3COO\ (aq) + MgBr_{2\ (aq)} \rightarrow 2AgBr\ (s) + Mg(CH_3COO)_{2\ (aq)}$

Answers

1. (a) $H_2SO_4 + 2\,NaOH \longrightarrow Na_2SO_4 + 2\,H_2O$
   (b) $H_3PO_4 + 3\,KOH \longrightarrow K_3PO_4 + 3\,H_2O$
   (c) $3\,H_2SO_4 + 2\,Fe(OH)_3 \longrightarrow Fe_2(SO_4)_3 + 6\,H_2O$
   (d) $H_4P_2O_7 + 2\,Ca(OH)_2 \longrightarrow Ca_2P_2O_7 + 4\,H_2O$
   (e) $H_2SO_4 + Ba(OH)_2 \longrightarrow BaSO_4 + 2\,H_2O$

2. (a) $2\,C_2H_2 + 5\,O_2 \longrightarrow 4\,CO_2 + 2\,H_2O$ (combustion)
   (b) $Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$ (single replacement)
   (c) $4\,Na + O_2 \longrightarrow 2\,Na_2O$ (synthesis)
   (d) $2\,Fe(NO_3)_3 + 3\,MgS \longrightarrow Fe_2S_3 + 3\,Mg(NO_3)_2$ (double replacement)
   (e) $2\,N_2O \longrightarrow 2\,N_2 + O_2$ (decomposition)
   (f) $Sn(OH)_4 + 4\,HBr \longrightarrow 4\,H_2O + SnBr_4$ (neutralization)
   (g) $Cl_2 + 2\,KI \longrightarrow 2\,KCl + I_2$ (single replacement)
   (h) $2\,Al + 3\,S \longrightarrow Al_2S_3$ (synthesis)
   (i) $C_6H_{12}O_6 + 6\,O_2 \longrightarrow 6\,CO_2 + 6\,H_2O$ (combustion)
   (j) $3\,HF + Fe(OH)_3 \longrightarrow FeF_3 + 3\,H_2O$ (neutralization)
   (k) $2\,H_2O_2 \longrightarrow 2\,H_2O + O_2$ (decomposition)
   (l) $FeCl_2 + K_2S \longrightarrow FeS + 2\,KCl$ (double replacement)
   (m) $2\,Ca + O_2 \longrightarrow 2\,CaO$ (synthesis)
   (n) $H_2SO_4 + 2\,NaOH \longrightarrow Na_2SO_4 + 2\,H_2O$ (neutralization)
   (o) $C_2H_5OH + 3\,O_2 \longrightarrow 2\,CO_2 + 3\,H_2O$ (combustion)
   (p) $4\,Cr + 3\,SnCl_4 \longrightarrow 4\,CrCl_3 + 3\,Sn$ (single replacement)
   (q) $Pb(NO_3)_2 + K_2CrO_4 \longrightarrow PbCrO_4 + 2\,KNO_3$ (double replacement)
   (r) $Fe + I_2 \longrightarrow FeI_2$ (synthesis)
   (s) $C_3H_6OS_2 + 6\,O_2 \longrightarrow 3\,CO_2 + 3\,H_2O + 2\,SO_2$ (combustion)
   (t) $MgCl_2 \longrightarrow Mg + Cl_2$ (decomposition)
   (u) $Co(NO_3)_2 + H_2S \longrightarrow CoS + 2\,HNO_3$ (double replacement)
   (v) $H_4P_2O_7 + 4\,KOH \longrightarrow K_4P_2O_7 + 4\,H_2O$ (neutralization)
   (w) $Mg + 2\,HCl \longrightarrow H_2 + MgCl_2$ (single replacement)
   (x) $2\,HI \longrightarrow H_2 + I_2$ (decomposition)

3. (a) $2\,HNO_3 + Sr(OH)_2 \longrightarrow Sr(NO_3)_2 + 2\,H_2O$ (neutralization)
   (b) $2\,C_6H_4(OH)_2 + 13\,O_2 \longrightarrow 12\,CO_2 + 6\,H_2O$ (combustion)
   (c) $Zn + Ni(NO_3)_2 \longrightarrow Ni + Zn(NO_3)_2$ (single replacement)
   (d) $2\,AlCl_3 + 3\,Na_2CO_3 \longrightarrow Al_2(CO_3)_3 + 6\,NaCl$ (double replacement)
   (e) $4\,Al + 3\,O_2 \longrightarrow 2\,Al_2O_3$ (synthesis)
   (f) $Ba(OH)_2 + H_2SO_4 \longrightarrow BaSO_4 + 2\,H_2O$ (neutralization)
   (g) $2\,NO_2 \longrightarrow N_2 + 2\,O_2$ (decomposition)
   (h) $Cl_2 + CaBr_2 \longrightarrow Br_2 + CaCl_2$ (single replacement)
   (i) $C_9H_{20}O_4S_2 + 14\,O_2 \longrightarrow 9\,CO_2 + 10\,H_2O + 2\,SO_2$ (combustion)
   (j) $ZnSO_4 + SrCl_2 \longrightarrow SrSO_4 + ZnCl_2$ (double replacement)
   (k) $8\,Zn + S_8 \longrightarrow 8\,ZnS$ (synthesis)
   (l) $2\,NH_3 \longrightarrow N_2 + 3\,H_2$ (decomposition)
   (m) $HCl + KOH \longrightarrow KCl + H_2O$ (neutralization)
   (n) $2\,ICl \longrightarrow I_2 + Cl_2$ (decomposition)
   (o) $2\,Na_3PO_4 + 3\,Ca(OH)_2 \longrightarrow Ca_3(PO_4)_2 + 6\,NaOH$ (double replacement)
   (p) $C_4H_8S + 7\,O_2 \longrightarrow 4CO_2 + 4\,H_2O + SO_2$ (combustion)
   (q) $Mg + ZnSO_4 \longrightarrow Zn + MgSO_4$ (single replacement)
   (r) $4\,Li + O_2 \longrightarrow 2\,Li_2O$ (synthesis)