Key

KEY

Chemistry: *Balancing Chemical Equations*

*Directions: First, balance each of the chemical equations below. Then, classify each reaction as **synthesis**, **decomposition**, **single-replacement**, or **double-replacement**. To earn full credit, write the words out when classifying.*

	Balance the equation…	**…and classify it.**
1.	__2__ Sb + __3__ Cl_2 → __2__ $SbCl_3$	synthesis
2.	__2__ Mg + ____ O_2 → __2__ MgO	synthesis
3.	____ $CaCl_2$ → ____ Ca + ____ Cl_2	decomposition
4.	__2__ $NaClO_3$ → __2__ NaCl + __3__ O_2	decomposition
5.	____ Fe + __2__ HCl → ____ $FeCl_2$ + ____ H_2	single replacement
6.	____ CuO + ____ H_2 → ____ Cu + ____ H_2O	single replacement
7.	__2__ Al + __3__ H_2SO_4 → ____ $Al_2(SO_4)_3$ + __3__ H_2	single replacement
8.	____ $MgBr_2$ + ____ Cl_2 → ____ $MgCl_2$ + ____ Br_2	single replacement
9.	____ SnO_2 + __2__ C → ____ Sn + __2__ CO	single replacement
10.	____ $Pb(NO_3)_2$ + ____ H_2S → ____ PbS + __2__ HNO_3	double replacement
11.	__2__ HgO → __2__ Hg + ____ O_2	decomposition
12.	__2__ $KClO_3$ → __2__ KCl + __3__ O_2	decompostion
13.	____ N_2 + __3__ H_2 → __2__ NH_3	synthesis
14.	__2__ NaBr + ____ Cl_2 → __2__ NaCl + ____ Br_2	single replacement
15.	____ Zn + __2__ $AgNO_3$ → ____ $Zn(NO_3)_2$ + __2__ Ag	single replacement
16.	____ Sn + __2__ Cl_2 → ____ $SnCl_4$	synthesis
17.	____ $Ba(OH)_2$ → ____ BaO + ____ H_2O	decomposition

Word Equations – Answer Key

1) Zinc and lead (II) nitrate react to form zinc nitrate and lead.

$$Zn + Pb(NO_3)_2 \rightarrow Zn(NO_3)_2 + Pb$$

2) Aluminum bromide and chlorine gas react to form aluminum chloride and bromine gas.

$$2\ AlBr_3 + 3\ Cl_2 \rightarrow 2\ AlCl_3 + 3\ Br_2$$

3) Sodium phosphate and calcium chloride react to form calcium phosphate and sodium chloride.

$$2\ Na_3PO_4 + 3\ CaCl_2 \rightarrow 6\ NaCl + Ca_3(PO_4)_2$$

4) Potassium metal and chlorine gas combine to form potassium chloride.

$$2\ K + Cl_2 \rightarrow 2\ KCl$$

5) Aluminum and hydrochloric acid react to form aluminum chloride and hydrogen gas.

$$2\ Al + 6\ HCl \rightarrow 3\ H_2 + 2\ AlCl_3$$

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

$$3\ Ca(OH)_2 + 2\ H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ H_2O$$

7) Copper and sulfuric acid react to form copper (II) sulfate and water and sulfur dioxide.

$$Cu + 2\ H_2SO_4 \rightarrow CuSO_4 + 2\ H_2O + SO_2$$

8) Hydrogen gas and nitrogen monoxide react to form water and nitrogen gas.

$$2\ H_2 + 2\ NO \rightarrow 2\ H_2O + N_2$$

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Worksheet: Writing Equations

Write equations for the following reactions:

1) The reaction of ammonia with iodine to form nitrogen triiodide (NI_3) and hydrogen gas.

$$2\ 3\ NH_3 + 3\ I_2 \rightarrow 2\ NI_3 + 3\ H_2$$

2) The combustion of propane (C_3H_8).

$$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

3) The incomplete combustion of propane to form CO and water.

$$2\ C_3H_8 + 7\ O_2 \rightarrow 6\ CO + 8\ H_2O$$

4) The reaction of nitric acid with potassium hydroxide.

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

5) The reaction of copper (II) oxide with hydrogen to form copper metal and water.

$$CuO + H_2 \rightarrow Cu + H_2O$$

6) The reaction of iron metal with oxygen to form iron (III) oxide.

$$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$$

7) The complete combustion of 2,2-dimethylpropane (C_4H_{10}) in oxygen.

$$2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$$

8) The reaction of $AlBr_3$ with $Mg(OH)_2$

$$2\ AlBr_3 + 3\ Mg(OH)_2 \rightarrow 2\ Al(OH)_3 + 3\ MgBr_2$$

9) The decomposition of hydrogen peroxide to form water and oxygen.

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

10) The reaction of ammonia with sulfuric acid.

$$2\ NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

KEY #4

Worksheet #4: Single-Replacement Reactions

Step 1 - Write the formulas of the reactants on the left of the yield sign
Step 2 - Look at the Activity Series on page 266 to determine if the replacement can happen
Step 3 - If the replacement can occur, complete the reaction and balance it. If the reaction cannot happen, write N.R. (no rxn) on the product side.

1. lead + zinc acetate →

   $Pb + Zn(C_2H_3O_2)_2 \rightarrow$ N.R.

2. iron + aluminum oxide →

   $Fe + Al_2O_3 \rightarrow$ N.R.

3. silver nitrate + nickel → nickel(II) nitrate + silver

   $2AgNO_3 + Ni \rightarrow Ni(NO_3)_2 + 2Ag$

4. sodium bromide + iodine →

   $NaBr + I_2 \rightarrow$ N.R.

5. aluminum bromide + chlorine → aluminum chloride + bromine

   $2AlBr_3 + 3Cl_2 \rightarrow 2AlCl_3 + 3Br_2$

6. sodium iodide + bromine → sodium bromide + iodine

   $2NaI + Br_2 \rightarrow 2NaBr + I_2$

7. calcium + hydrochloric acid → calcium chloride + hydrogen

   $Ca + 2HCl \rightarrow CaCl_2 + H_2$

8. magnesium + nitric acid → magnesium nitrate + hydrogen

   $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

9. silver + sulfuric acid →

   $Ag + H_2SO_4 \rightarrow$ N.R.

10. potassium + water → potassium hydroxide + hydrogen

    $2K + 2H_2O \rightarrow 2KOH + H_2$

    HOH

11. sodium + water → sodium hydroxide + hydrogen

    $2Na + 2H_2O \rightarrow 2NaOH + H_2$

    HOH

KEY #5

Worksheet #5: Double-Replacement Reactions

In these reactions, all you do is look at the names of the reactants, and "switch partners". Just be sure that the new pairs come out with the positive ion named first, and paired with a negative ion.

1. aluminum iodide + mercury(II) chloride → aluminum chloride + mercury(II) iodide

   $2AlI_3 + 3HgCl_2 \rightarrow 2AlCl_3 + 3HgI_2(ppt)$

2. silver nitrate + potassium phosphate → silver phosphate + potassium nitrate

   $3AgNO_3 + K_3PO_4 \rightarrow Ag_3PO_4(ppt) + 3KNO_3$

3. copper(II) bromide + aluminum chloride → copper(II) chloride + aluminum bromide

   $3CuBr_2 + 2AlCl_3 \not\rightarrow 3CuCl_2 + 2AlBr_3$

4. calcium acetate + sodium carbonate → calcium carbonate + sodium acetate

   $Ca(C_2H_3O_2)_2 + Na_2CO_3 \rightarrow CaCO_3(ppt) + 2NaC_2H_3O_2$

5. ammonium chloride + mercury(I) acetate → ammonium acetate + mercury(I) chloride

   $2NH_4Cl + Hg_2(C_2H_3O_2)_2 \rightarrow 2NH_4C_2H_3O_2 + Hg_2Cl_2(ppt)$

6. calcium nitrate + hydrochloric acid → calcium chloride + nitric acid

   $Ca(NO_3)_2 + 2HCl \not\rightarrow CaCl_2 + 2HNO_3$

7. iron(II) sulfide + hydrochloric acid → iron(II) chloride + hydrogen sulfide (g)

   $FeS + 2HCl \rightarrow FeCl_2 + H_2S$

8. copper(II) hydroxide + acetic acid → copper(II) acetate + water

   $Cu(OH)_2 + 2HC_2H_3O_2 \rightarrow Cu(C_2H_3O_2)_2 + 2H_2O$

9. calcium hydroxide + phosphoric acid → calcium phosphate + water

   $3Ca(OH)_2 + 2H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6H_2O$

10. calcium bromide + potassium hydroxide → calcium hydroxide + potassium bromide

    $CaBr_2 + 2KOH \not\rightarrow Ca(OH)_2 + 2KBr$

Examine the products of the reactions on this page, and determine in each whether a gas, water, or a precipitate is formed. Use the solubility table in Appendix A of your textbook to determine the solubilities of the reaction products. If there is no gas, water, or precipitate produced, put an "X" through the yield sign, because no reaction occurs.

Predicting the products of chemical reactions

4Q #7

1) $2\ Ag + 1\ CuSO_4 \not\rightarrow 1\ Ag_2SO_4 + 1\ Cu$ no RXN — Type: Single Displacement

2) $2\ NaI + 1\ CaCl_2 \rightarrow 2\ NaCl + 1\ CaI_2$ — Type: Double Displacement

3) $1\ O_2 + 1\ H_2 \rightarrow 2\ H_2O$ — Type: Synthesis

4) $2\ HNO_3 + 1\ Mn(OH)_2 \rightarrow 2\ H_2O + 1\ Mn(NO_3)_2$ — Type: Acid-Base DR

5) $2\ AgNO_2 + 1\ BaSO_4 \rightarrow 1\ Ag_2SO_4 + 1\ Ba(NO_2)_2$ — Type: Double Displacement

6) $2\ HCN + 1\ CuSO_4 \rightarrow 1\ H_2SO_4 + 1\ Cu(CN)_2$ — Type: Double Displacement

7) $1\ H_2O + 1\ AgI \rightarrow 1\ HI + 1\ AgOH$ — Type: Double Displacement

8) $3\ HNO_3 + 1\ Fe(OH)_3 \rightarrow 3\ H_2O + 1\ Fe(NO_3)_3$ — Type: Acid-Base DR

9) $4\ LiBr + 1\ Co(SO_3)_2 \rightarrow 2\ Li_2SO_3 + 1\ CoBr_4$ — Type: Double Displacement

10) $1\ LiNO_3 + 1\ Ag \rightarrow 1\ AgNO_3 + 1\ Li$ – NO RXN — Type: Single Displacement

11) $1\ N_2 + 2\ O_2 \rightarrow 2\ NO_2$ — Type: Synthesis

12) $1\ H_2CO_3 \rightarrow 1\ CO_2 + 1\ H_2O$ — Type: Decomposition

13) $1\ AlCl_3 + 3\ Cs \rightarrow 3\ CsCl + 1\ Al$ — Type: Single Displacement

14) $1\ Al(NO_3)_3 + 1\ Ga \rightarrow 1\ Ga(NO_3)_3 + 1\ Al$ — Type: Single Displacement

15) $1\ H_2SO_4 + 2\ NH_4OH \rightarrow 2\ H_2O + 1\ (NH_4)_2SO_4$ — Type: Acid-Base DR

16) $1\ CH_3COOH + 1\ O_2 \rightarrow 1\ CO_2 + 2\ H_2O$ — Type: Combustion

17) $1\ C_4H_8 + 6\ O_2 \rightarrow 4\ CO_2 + 4\ H_2O$ — Type: Combustion

18) $2\ KCl + 1\ Mg(OH)_2 \rightarrow 2\ KOH + 1\ MgCl_2$ — Type: Double Displacement

19) $1\ Zn + 1\ Au(NO_2)_2 \rightarrow 1\ Zn(NO_2)_2 + 1\ Au$ — Type: Single Displacement

20) $2\ KOH + 1\ H_2SO_4 \rightarrow 1\ K_2SO_4 + 2\ H_2O$ — Type: Acid-Base DR

21) $1\ BaS + 1\ PtCl_2 \rightarrow 1\ BaCl_2 + 1\ PtS$ — Type: Double Displacement

22) $2\ Na_2O \rightarrow 4\ Na + 1\ O_2$ — Type: Decomposition

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Worksheet #6: Combustion Reactions
We will focus on the combustion of hydrocarbons. Hydrocarbons react with oxygen to form carbon dioxide and water.

1. methane (CH_4) + oxygen → carbon dioxide + water

   $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

2. ethane (C_2H_6) + oxygen → carbon dioxide + water

   $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

3. propane (C_3H_8) + oxygen → carbon dioxide + water

   $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

4. butane (C_4H_{10}) + oxygen → carbon dioxide + water

   $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

5. pentane (C_5H_{12}) + oxygen → carbon dioxide + water

   $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$

6. hexane (C_6H_{14}) + oxygen → carbon dioxide + water

   $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

7. ethene (C_2H_4) + oxygen → carbon dioxide + water

   $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

8. ethyne (C_2H_2) + oxygen → carbon dioxide + water

   $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

9. benzene (C_6H_6) + oxygen → carbon dioxide + water

   $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$

NET IONIC EQUATIONS Key

Write the molecular, total ionic, and net ionic equations for the following reactions:

1. Aqueous solutions of potassium phosphate and calcium nitrate are mixed.

ME $2K_3PO_4 + 3Ca(NO_3)_2 \rightarrow 6KNO_3 + Ca_3(PO_4)_2$

TIE $\cancel{6K^+} + 2PO_4^{3-} + 3Ca^{2+} + \cancel{6NO_3^-} \rightarrow \cancel{6K^+} + \cancel{6NO_3^-} + Ca_3(PO_4)_2$

NIE $2PO_4^{3-} + 3Ca^{2+} \rightarrow Ca_3(PO_4)_2$

2. Aqueous solutions of barium chloride and sodium sulfate are mixed.

ME $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

TIE $Ba^{2+} + 2Cl^- + \cancel{2Na^+} + SO_4^{2-} \rightarrow BaSO_4 + \cancel{2Na^+} + \cancel{2Cl^-}$

NIE $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

3. Magnesium is added to an aqueous solution of chromium (III) iodide.

ME $3Mg_{(s)} + 2CrI_3 \rightarrow 3MgI_2 + 2Cr$

TIE $3Mg + 2Cr^{3+} + \cancel{6I^-} \rightarrow 3Mg^{2+} + \cancel{6I^-} + 2Cr$

NIE $3Mg + 2Cr^{3+} \rightarrow 3Mg^{2+} + 2Cr$

4. Silver hydroxide is added to an aqueous phosphoric acid solution.

ME $3AgOH + H_3PO_4 \rightarrow Ag_3PO_4 + 3H_2O$

TIE $3AgOH + 3H^+ + PO_4^{3-} \rightarrow Ag_3PO_4 + 3H_2O$

NIE $3AgOH + 3H^+ + PO_4^{3-} \rightarrow Ag_3PO_4 + 3H_2O$

5. Aqueous solutions of sodium fluoride and hydrochloric acid are mixed.

ME $NaF + HCl \rightarrow NaCl + HF$

TIE $Na^+ + \cancel{F^-} + \cancel{H^+} + Cl^- \rightarrow Na^+ + Cl^- + H^+ + F^-$

NIE

6. Aqueous solutions of potassium dichromate and ammonium cyanide are mixed.

ME $K_2Cr_2O_7 + 2NH_4CN \rightarrow 2KCN + (NH_4)_2Cr_2O_7$

TIE $\cancel{2K^+} + Cr_2O_7^{2-} + 2NH_4^+ + 2CN^- \rightarrow \cancel{2K^+} + \cancel{2CN^-} + \cancel{2NH_4^+} + Cr_2O_7^{2-}$

NIE

7. Cesium carbonate is added to an aqueous solution of chromium (II) acetate.

ME $Cs_2CO_3 + Cr(C_2H_3O_2)_2 \rightarrow 2CsC_2H_3O_2 + CrCO_3$

TIE $2Cs^+ + CO_3^{2-} + Cr^{2+} + \cancel{2C_2H_3O_2^-} \rightarrow 2Cs^+ + \cancel{2C_2H_3O_2^-} + CrCO_3$

NIE $CO_3^{2-} + Cr^{2+} \rightarrow CrCO_3$

8. Zinc is added to an aqueous hydrobromic acid solution.

ME $Zn + 2HBr \rightarrow ZnBr_2 + H_2$

TIE $Zn + 2H^+ + \cancel{2Br^-} \rightarrow Zn^{2+} + \cancel{2Br^-} + H_2$

NIE $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$

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Net Ionic Equations Worksheet Name Key

BALANCE the following equations, then write the NET IONIC EQUATION for each one. Identify the spectator ions. Remember that solids, liquids (such as plain H_2O), and gases do not become ions.

1. ____ Zn (s) + 2 $AgNO_3$ (aq) → ____ $Zn(NO_3)_2$ (aq) + 2 Ag (s)

$Zn_{(s)} + 2Ag^+ + 2NO_3^- \rightarrow Zn^{2+} + 2NO_3^- + 2Ag_{(s)}$

$Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$

2. 2 Na (s) + 2 H_2O (l) → 2 NaOH (aq) + ____ H_2 (g)

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2Na^+ + 2OH^- + H_{2(g)}$

3. ____ NaCl (aq) + ____ $AgC_2H_3O_2$ (aq) → ____ $NaC_2H_3O_2$ (aq) + ____ AgCl (s)

$Na^+ + Cl^- + Ag^+ + C_2H_3O_2^- \rightarrow Na^+ + C_2H_3O_2^- + AgCl_{(s)}$

$Cl^- + Ag^+ \rightarrow AgCl$

4. ____ $BaCl_2$ (aq) + ____ Na_2SO_4 (aq) → 2 NaCl (aq) + ____ $BaSO_4$ (s)

$Ba^{2+} + 2Cl^- + 2Na^+ + SO_4^{2-} \rightarrow 2Na^+ + 2Cl^- + BaSO_4$

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

5. 2 $AgNO_3$ (aq) + ____ K_2CO_3 (aq) → ____ Ag_2CO_3 (s) + 2 KNO_3 (aq)

$2Ag^+ + 2NO_3^- + 2K^+ + CO_3^{2-} \rightarrow Ag_2CO_{3(s)} + 2K^+ + 2NO_3^-$

$2Ag^+ + CO_3^{2-} \rightarrow Ag_2CO_3$

6. ____ $MgBr_2$ (aq) + 2 KOH (aq) → 2 KBr (aq) + ____ $Mg(OH)_2$ (s)

$Mg^{2+} + 2Br^- + 2K^+ + 2OH^- \rightarrow 2K^+ + 2Br^- + Mg(OH)_{2(s)}$

$Mg^{2+} + 2OH^- \rightarrow Mg(OH)_{2(s)}$

7. ____ Zn (s) + 2 HCl (aq) → ____ $ZnCl_2$ (aq) + ____ H_2 (g)

$Zn_{(s)} + 2H^+ + 2Cl^- \rightarrow Zn^{2+} + 2Cl^- + H_{2(g)}$

$Zn_{(s)} + 2H^+ \rightarrow Zn^{2+} + H_{2(g)}$

8. ____ $AlCl_3$ (aq) + ____ K_3PO_4 (aq) → 3 KCl (aq) + ____ $AlPO_4$ (s)

$Al^{3+} + 3Cl^- + 3K^+ + PO_4^{3-} \rightarrow 3K^+ + 3Cl^- + AlPO_{4(s)}$

$Al^{3+} + PO_4^{3-} \rightarrow AlPO_{4(s)}$