Balancing Equations #1

1. $2\ Al + 3\ S \rightarrow Al_2S_3$
2. $Sn + 2\ Cl_2 \rightarrow SnCl_4$
3. $2\ ZnO \rightarrow 2\ Zn + O_2$
4. $2\ H_2 + O_2 \rightarrow 2\ H_2O$
5. $2\ Cu_2O \rightarrow 4\ Cu + O_2$
6. $16\ Cu + S_8 \rightarrow 8\ Cu_2S$
7. $P_4 + 5\ O_2 \rightarrow P_4O_{10}$
8. $2\ NO_2 \rightarrow N_2 + 2\ O_2$
9. $H_2 + I_2 \rightarrow 2\ HI$
10. $2\ HgO \rightarrow 2\ Hg + O_2$
11. $3\ H_2 + N_2 \rightarrow 2\ NH_3$
12. $2\ NaCl + Br_2 \rightarrow 2\ NaBr + Cl_2$
13. $SiO_2 + 4\ HF \rightarrow SiF_4 + 2\ H_2O$
14. $2\ Fe_2O_3 \rightarrow 4\ Fe + 3\ O_2$
15. $2\ K + Br_2 \rightarrow 2\ KBr$
16. $Ca + 2\ HI \rightarrow CaI_2 + H_2$
17. $4\ Na + O_2 \rightarrow 2\ Na_2O$
18. $2\ BiCl_3 \rightarrow 2\ Bi + 3\ Cl_2$
19. $2\ CO + O_2 \rightarrow 2\ CO_2$
20. $Mg + 2\ HCl \rightarrow H_2 + MgCl_2$
21. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
22. $2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$
23. $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$
24. $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

Balancing Equations #2

1. $CaS + 2\ KCl \rightarrow CaCl_2 + K_2S$
2. $2\ Na + Cl_2 \rightarrow 2\ NaCl$
3. $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
4. $2\ AlN + 3\ CaO \rightarrow Al_2O_3 + Ca_3N_2$
5. $2\ AlCl_3 \rightarrow 2\ Al + 3\ Cl_2$
6. $N_2 + 6\ NH_4Cl \rightarrow 2\ (NH_4)_3N + 3\ Cl_2$
7. $2\ AlN \rightarrow 2\ Al + N_2$
8. $Na_2CO_3 + Ca \rightarrow CaCO_3 + 2\ Na$
9. $2\ Al(NO_3)_3 + 3\ Na_2CO_3 \rightarrow 6\ NaNO_3 + Al_2(CO_3)_3$
10. $(NH_4)_2O + Ca(NO_3)_2 \rightarrow 2\ NH_4NO_3 + CaO$
11. $2\ AgNO_3 + K_2S \rightarrow 2\ KNO_3 + Ag_2S$
12. $BaCl_2 + Na_2CO_3 \rightarrow BaCO_3 + 2\ NaCl$
13. $3\ Ca(NO_3)_2 + 2\ Li_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ LiNO_3$
14. $Mg + CuSO_4 \rightarrow MgSO_4 + Cu$
15. $2\ NH_4Br + Cl_2 \rightarrow 2\ NH_4Cl + Br_2$
16. $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$
17. $I_2 + 2\ KF \rightarrow 2\ KI + F_2$
18. $2\ Ag + Cl_2 \rightarrow 2\ AgCl$
19. $Ba + 4\ S \rightarrow BaS_4$
20. $Li_2O + SO_2 \rightarrow Li_2SO_3$
21. $2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$
22. $2\ Al + 3\ FeO \rightarrow Al_2O_3 + 3\ Fe$
23. $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$
24. $N_2 + 3\ H_2 \rightarrow 2\ NH_3$
25. $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$

Balancing Equations #3

1. $XeF_6 + 3\ H_2O \rightarrow XeO_3 + 6\ HF$
2. $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$
3. $CaC_2 + 2\ O_2 \rightarrow Ca + 2\ CO_2$
4. $Fe_3O_4 + 4\ H_2 \rightarrow 3\ Fe + 4\ H_2O$
5. $2\ BN + 3\ F_2 \rightarrow 2\ BF_3 + N_2$
6. $2\ H_2O \rightarrow 2\ H_2 + O_2$
7. $Zn + 2\ HCl \rightarrow H_2 + ZnCl_2$
8. $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$
9. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
10. $2\ H_2S \rightarrow 2\ H_2 + S_2$
11. $2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$
12. $2\ NI_3 \rightarrow N_2 + 3\ I_2$
13. $FeCl_3 + 3\ NaOH \rightarrow Fe(OH)_3 + 3\ NaCl$
14. $Br_2 + CaI_2 \rightarrow CaBr_2 + I_2$
15. $2\ Mg + O_2 \rightarrow 2\ MgO$
16. $2\ TiO_2 + B_4C + 3\ C \rightarrow 2\ TiB_2 + 4\ CO$
17. $Pb(NO_3)_2 + 2\ KI \rightarrow PbI_2 + 2\ KNO_3$
18. $Cr_2(SO_4)_3 + 6\ NaOH \rightarrow 2\ Cr(OH)_3 + 3\ Na_2SO_4$
19. $2\ Fe_2O_3 + 3\ C \rightarrow 4\ Fe + 3\ CO_2$
20. $Cu + 2\ AgNO_3 \rightarrow 2\ Ag + Cu(NO_3)_2$
21. $C_4H_8 + 6\ O_2 \rightarrow 4\ CO_2 + 4\ H_2O$
22. $2\ NaN_3 \rightarrow 2\ Na + 3\ N_2$
23. $3\ NH_4Cl + Na_3PO_4 \rightarrow (NH_4)_3PO_4 + 3\ NaCl$
24. $4\ NpF_3 + O_2 + 4\ HF \rightarrow 4\ NpF_4 + 2\ H_2O$
25. $Sb_2S_3 + 12\ HCl \rightarrow 2\ H_3SbCl_6 + 3\ H_2S$

Balancing Equations #4

1. $C_6H_{12} + 9\ O_2 \rightarrow 6\ H_2O + 6\ CO_2$
2. $K_2SO_4 + BaCl_2 \rightarrow 2\ KCl + BaSO_4$
3. $2\ KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$
4. $Ca(OH)_2 + 2\ NH_4Cl \rightarrow 2\ NH_4OH + CaCl_2$
5. $5\ C + 2\ SO_2 \rightarrow CS_2 + 4\ CO$
6. $Mg_3N_2 + 6\ H_2O \rightarrow 3\ Mg(OH)_2 + 2\ NH_3$
7. $V_2O_5 + 5\ Ca \rightarrow 5\ CaO + 2\ V$
8. $2\ Na_2O_2 + 2\ H_2O \rightarrow 4\ NaOH + O_2$
9. $Fe_3O_4 + 4\ H_2 \rightarrow 3\ Fe + 4\ H_2O$
10. $Cu + 2\ H_2SO_4 \rightarrow CuSO_4 + 2\ H_2O + SO_2$
11. $2\ Al + 3\ H_2SO_4 \rightarrow 3\ H_2 + Al_2(SO_4)_3$
12. $2\ Si_4H_{10} + 13\ O_2 \rightarrow 8\ SiO_2 + 10\ H_2O$
13. $4\ NH_3 + O_2 \rightarrow 2\ N_2H_4 + 2\ H_2O$
14. $2\ C_{15}H_{30} + 45\ O_2 \rightarrow 30\ H_2O + 30\ CO_2$
15. $2\ BN + 3\ F_2 \rightarrow 2\ BF_3 + N_2$
16. $2\ C_{12}H_{26} + 37\ O_2 \rightarrow 26\ H_2O + 24\ CO_2$
17. $C_7H_6O_3 + 7\ O_2 \rightarrow 3\ H_2O + 7\ CO_2$
18. $9\ Na + 4\ ZnI_2 \rightarrow 8\ NaI + NaZn_4$
19. $HBrO_3 + 5\ HBr \rightarrow 3\ H_2O + 3\ Br_2$
20. $Al_4C_3 + 12\ H_2O \rightarrow 4\ Al(OH)_3 + 3\ CH_4$
21. $CH_3NO_2 + 3\ Cl_2 \rightarrow CCl_3NO_2 + 3\ HCl$
22. $C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$
23. $Ca_3(PO_4)_2 + 3\ SiO_2 + 5\ C \rightarrow 3\ CaSiO_3 + 5\ CO + 2\ P$
24. $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$
25. $4\ NaPb + 4\ C_2H_5Cl \rightarrow Pb(C_2H_5)_4 + 3\ Pb + 4\ NaCl$

Writing and Balancing Synthesis, Decomposition and Combustion Reactions

For each of the following reactions, use the information that is given to write balanced chemical equations. Include the states of all reactants and products. Classify each reaction by its type.

1. Silver oxide is formed from its elements.

   $4\ Ag\ (s) + O_2\ (g) \rightarrow 2\ Ag_2O\ (s)$

2. Magnesium metal burns in air.

   $2\ Mg\ (s) + O_2\ (g) \rightarrow 2\ MgO\ (s)$

3. When pure sodium hydrogen carbonate is heated, it decomposes into pure sodium oxide, carbon dioxide gas and water vapour.

   $2\ NaHCO_3\ (s) \rightarrow Na_2O\ (s) + 2\ CO_2\ (g) + H_2O\ (v)$

4. Write the equation for the combustion of liquid pentane (C_5H_{12}) in air.

   $C_5H_{12}\ (l) + 8\ O_2\ (g) \rightarrow 5\ CO_2\ (g) + 6\ H_2O\ (v)$

5. Liquid ethanol (C_2H_6O) is "burned" by an alcoholic's body.

   $C_2H_6O\ (l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ (v)$

6. Write the chemical equation that shows ammonia gas (NH_3) decomposing into its elements.

   $2\ NH_3\ (g) \rightarrow 3\ H_2\ (g) + N_2\ (g)$

7. Write the decomposition reaction for powdered lead (II) sulfide into it elements.

   $PbS\ (s) \rightarrow Pb\ (s) + S\ (s)$

8. Write the combustion reaction that occurs when acetylene gas (C_2H_2) is burned in a welder's torch.

   $2\ C_2H_2\ (g) + 5\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 2\ H_2O\ (v)$

9. Write the equation showing the formation of sulfurous acid from sulfur dioxide gas and water.

   $SO_2\ (g) + H_2O\ (l) \rightarrow H_2SO_3\ (aq)$

10. Lead (IV) nitride is formed from its elements.

    $3\ Pb\ (s) + 2\ N_2\ (g) \rightarrow Pb_3N_4\ (s)$

11. Sodium azide (NaN_3) decomposes into its elements in a car's airbag.

    $2\ NaN_3\ (s) \rightarrow 3\ N_2\ (g) + 2\ Na\ (s)$

Writing and Balancing Double Displacement Reactions

1. Classify each of the substances as being soluble (aq) or insoluble precipitates (s) in water.

a) potassium bromide	(aq)	f) silver iodide	(s)	k) $Mg_3(PO_4)_2$	(s)
b) lead(II) carbonate	(s)	g) cadmium sulfide	(s)	l) $K_2Cr_2O_7$	(aq)
c) barium sulfate	(s)	h) zinc carbonate	(s)	m) $NiCl_2$	(aq)
d) zinc hydroxide	(s)	i) silver acetate	(aq)	n) NH_4OH	(aq)
e) sodium acetate	(aq)	j) copper (II) sulfide	(s)	o) Hg_2SO_4	(s)

2. The following aqueous solutions were mixed.
a) Complete the **word equation** to show the products of the double displacement reactions that occurs.
b) Underneath the word equation, write the chemical formulas for the reactants and products.
c) Balance the reaction.
d) Use the solubility rules to determine whether the products are soluble (aq) or insoluble precipitates (s).

a) magnesium hydroxide + zinc nitrate → zinc hydroxide + magnesium nitrate

$Mg(OH)_2$ (aq) + $Zn(NO_3)_2$ (aq) → $Zn(OH)_2$ (s) + $Mg(NO_3)_2$ (aq)

b) strontium hydroxide + silver sulfate → silver hydroxide + strontium sulfate

$Sr(OH)_2$ (aq) + Ag_2SO_4 (aq) → 2 AgOH (s) + $SrSO_4$ (s)

c) ammonium chloride + lead (II) chlorate → ammonium chlorate + lead (II) chloride

2 NH_4Cl (aq) + $Pb(ClO_3)_2$ (aq) → 2 NH_4ClO_3 (aq) + $PbCl_2$ (s)

d) calcium acetate + sodium sulfide → sodium acetate + calcium sulfide

$Ca(CH_3COO)_2$ (aq) + Na_2S (aq) → 2 $NaCH_3COO$ (aq) + CaS (aq)

e) lithium phosphate + mercury (I) nitrate → lithium nitrate + mercury (I) phosphate

Li_3PO_4 (aq) + 3 $HgNO_3$ (aq) → 3 $LiNO_3$ (aq) + Hg_3PO_4 (s)

f) potassium carbonate + tin (IV) bromide → potassium bromide + tin (IV) carbonate

2 K_2CO_3 (aq) + $SnBr_4$ (aq) → 4 KBr (aq) + $Sn(CO_3)_2$ (s)

3. Write the neutralization reaction that occurs when hydrobromic acid is mixed with pure iron (III) hydroxide.

3 HBr (aq) + $Fe(OH)_3$ (s) → $FeBr_3$ (aq) + 3 H_2O (l)

4. Write the reaction that occurs when powdered barium hydroxide is added to sulfuric acid.

$Ba(OH)_2$ (s) + H_2SO_4 (aq) → $BaSO_4$ (s) + 2 H_2O (l)

5. Write the reaction that occurs when phosphoric acid is added to a solution of sodium hydroxide.

H_3PO_4 (aq) + 3 NaOH (aq) → Na_3PO_4 (aq) + 3 H_2O (l)

Writing Chemical Equations for Single Displacement Reactions of Non-metals

Single Displacement Reactions are chemical reactions in which the atoms of a pure element replace similar atoms from a compound to form two new products.

For non-metals: more reactive pure non-metals will replace less reactive non-metals from a compound. If the pure non-metal is less reactive than the non-metal in the compound, no reaction will occur. The reactivity of non-metals can be predicted from the Periodic Table.

The general form of single displacement reactions of **non-metals** is:

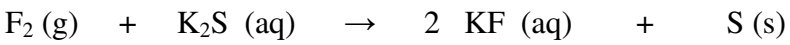
eg. Pure bromine is added to a solution of potassium iodide. If a reaction will take place, write the balanced chemical equation. If no reaction will occur, write "NR".

eg. Pure sulfur is added to a solution of aluminum fluoride. If a reaction will take place, write the balanced chemical equation. If no reaction will occur, write "NR".

eg. Pure argon is bubbled through a solution of sodium iodide. If a reaction will take place, write the balanced chemical equation. If no reaction will occur, write "NR".

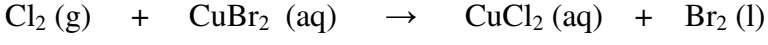
Homework: For the following combinations, predict if a reaction will occur. If a reaction will occur, write and balance the chemical equation. If there is no reaction, write "NR".

1. Pure fluorine mixed with a solution of potassium sulfide.



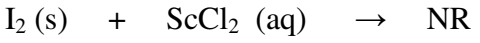
$F_2\ (g) + K_2S\ (aq) \rightarrow 2\ KF\ (aq) + S\ (s)$

2. Chlorine is bubbled through a solution of copper (II) bromide.



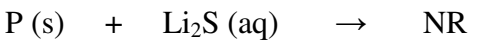
$Cl_2\ (g) + CuBr_2\ (aq) \rightarrow CuCl_2\ (aq) + Br_2\ (l)$

3. Pure iodine is added to a solution of scandium chloride.



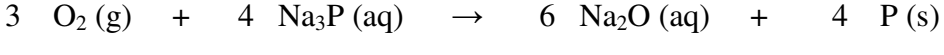
$I_2\ (s) + ScCl_2\ (aq) \rightarrow NR$

4. Pure phosphorus is added to a solution of lithium sulfide.



$P\ (s) + Li_2S\ (aq) \rightarrow NR$

5. Pure oxygen is bubbled into a solution of sodium phosphide.



$3\ O_2\ (g) + 4\ Na_3P\ (aq) \rightarrow 6\ Na_2O\ (aq) + 4\ P\ (s)$

Writing Chemical Equations for Single Displacement Reactions of Metals

Single Displacement Reactions are chemical reactions in which the atoms of a pure element replace similar atoms from a compound to form two new products.

For metals: more reactive pure metal atoms will replace less reactive metal ions from a compound. If the pure metal atoms are less reactive than the metal ions in the compound, no reaction (NR) will occur. You will be given the activity series for metals.

Lithium
Potassium
Barium
Calcium
Sodium
Magnesium
Aluminum
Zinc
Iron
Nickel
Tin
Lead
Hydrogen
Copper
Silver
Gold

The general form of single displacement reactions of **metals** is:

eg. Use the activity series of metals to predict if a reaction will occur when copper metal is added to aqueous silver nitrate. If a reaction will occur, write the balanced chemical equation. If no reaction will occur, write NR.

eg. Iron metal is added to a solution of aluminum chlorate.

Homework: For the following combinations, predict if a reaction will occur. If a reaction will occur, write and balance the chemical equation. If there is no reaction, write "NR". Include the states of all reactants and products. Use the solubility rules to determine the solubility of any new compounds that form.

1. Magnesium metal is placed in a solution of copper (I) acetate.

   $Mg\ (s) + 2\ CuCH_3COO\ (aq) \rightarrow Mg(CH_3COO)_2\ (aq) + 2\ Cu\ (s)$

2. Copper metal is placed in a solution of lead (II) chlorate.

   $Cu\ (s) + Pb(ClO_3)_2\ (aq) \rightarrow NR$

3. A piece of aluminum is dipped into aqueous silver nitrate.

   $Al\ (s) + 3\ AgNO_3\ (aq) \rightarrow Al(NO_3)_3\ (aq) + 3\ Ag\ (s)$

4. Pure sodium is added to a solution of calcium chloride.

   $Na\ (s) + CaCl_2\ (aq) \rightarrow NR$

5. Pure zinc is placed in a beaker of aqueous nickel (II) bromide.

   $Zn\ (s) + NiBr_2\ (aq) \rightarrow ZnBr_2\ (aq) + Ni\ (s)$