

Supplemental Chemical Reactions 3-1

Predicting the Products of Chemical Reactions

The symbol “M” represents any metal or positive radical except hydrogen. The symbol “X” represents any nonmetal or negative radical except oxygen or hydroxide. The standard symbols for H, O, and OH are used. Remember that in their template forms, these reactions are not necessarily balanced.

Synthesis (Direct Combination)

Formation of Binary Salts:	$M + X \rightarrow MX$
Formation of Ternary Salts:	$MO + XO_n \rightarrow MXO_{n+1}$
Formation of metallic oxides: (M must not be Ag, Au or Pt)	$M + O_2 \rightarrow MO$
Formation of Binary Acids:	$H_2 + X \rightarrow HX$
Formation of Ternary Acids: (Water plus nonmetallic oxide forms an oxy acid)	$H_2O + XO_n \rightarrow HXO_{n+1}$
Formation of Bases: (M must be group IA or IIA)	$MO + H_2O \rightarrow MOH$

Decomposition (Analysis)

(Requires energy or catalyst, “Δ”)

Metallic oxides: (M must be Hg, Ag, Au or Pt)	$MO \rightarrow M + O_2$
Bases: (M cannot be from group IA)	$MOH \rightarrow MO + H_2O$
Ternary Acids:	$H_2XO_n \rightarrow XO_{n-1} + H_2O$
Chlorates:	$MClO_3 \rightarrow MCl + O_2$
Nitrates: If M is from group IA: If M is any other metal:	$MNO_3 \rightarrow MNO_2 + O_2$ $MNO_3 \rightarrow MO + NO_2 + O_2$
Sulfates: If M is in group IA or IIA: If M is any other metal:	$MSO_4 \rightarrow NR$ $MSO_4 \rightarrow MO + SO_3$
Carbonates: (M must not be from group I) ¹	$MCO_3 \rightarrow MO + CO_2$

Single Replacement (Substitution)

Metal and water: (M is Mg or above in activity series)	$M + H_2O \rightarrow MOH + H_2$
Metal and acid: (M must be above H in activity series)	$M + HX_{(aq)} \rightarrow MX + H_2$
Metal and salt solution: (M must be above M' in activity series)	$M + M'X \rightarrow MX + M'$
Nonmetal and salt solution: (X must be above X' in halogen activity series)	$X_2 + MX' \rightarrow MX + X_2'$

Double Replacement (Metathesis)

Two Aqueous Solutions: (One of the products must be insoluble – use the solubility rules to determine which it is)	$MX_{(aq)} + M'X'_{(aq)} \rightarrow MX'_{(aq)} + M'X_{(s)}$
Neutralization of Acid and Base:	$HX + MOH \rightarrow MX + H_2O$
Formation of A Gas:	$MX' + HX \rightarrow MX + HX'_{(g)}$

Combustion

Combustion of a Hydrocarbon: (z can equal zero)	$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$
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¹ An exception to this rule is that after silver carbonate decomposes into carbon dioxide and silver oxide, the silver oxide then decomposes into silver and oxygen.