

Types of Reactions Summary

I. Metathesis Reactions (Double Replacement Reactions)

A. Precipitation Reactions: $AB(aq) + CD(aq) \rightarrow AD + CB$ – one of these must be a solid for reaction to occur

Example: Zinc nitrate + sodium phosphate \rightarrow sodium nitrate (aq) + zinc phosphate (s)
 $3Zn(NO_3)_2(aq) + 2Na_3PO_4(aq) \rightarrow 6NaNO_3(aq) + Zn_3(PO_4)_2(s)$

Solubility rules

1. Salts containing Group I elements are soluble (Li^+ , Na^+ , K^+ , Cs^+ , Rb^+). Exceptions to this rule are rare. Salts containing the ammonium ion (NH_4^+) are also soluble.

2. Salts containing nitrate ion (NO_3^-) and acetates ($C_2H_3O_2^-$) are generally soluble.

3. Salts containing Cl^- , Br^- , I^- are generally soluble. Important exceptions to this rule are halide salts of Ag^+ , Pb^{2+} , and Hg_2^{2+} . Thus, $AgCl$, $PbBr_2$, and Hg_2Cl_2 are all insoluble.

4. Most sulfate salts are soluble. Important exceptions to this rule include $BaSO_4$, $PbSO_4$, Hg_2SO_4 and $CaSO_4$.

5. Most hydroxide salts are only slightly soluble. Hydroxide salts of Group I elements are soluble. Hydroxide salts of Group II elements (Ca, Sr, and Ba) are slightly soluble. Hydroxide salts of transition metals and Al^{3+} are insoluble. Thus, $Fe(OH)_3$, $Al(OH)_3$, $Co(OH)_2$ are not soluble.

6. Most sulfides, carbonates, chromates, and phosphates are insoluble except for those containing alkali metals and NH_4^+ .

The rules above are summarized in the following table:

Ion	Solubility	Exceptions
Group 1A ions	Soluble	None
NH_4^+	Soluble	None
NO_3^-	Soluble	None
$C_2H_3O_2^-$	Soluble	None
Cl^- , Br^- , and I^-	Soluble	Ag^+ , Pb^{2+} , Cu^+ , Hg_2^{2+}
SO_4^{2-}	Soluble	Pb^{2+} , Ca^{2+} , Ba^{2+} , and Hg_2^{2+}
OH^-	Insoluble	Group 1A; Ca^{2+} , Sr^{2+} , and Ba^{2+} are slightly soluble
S^{2-} , CO_3^{2-} , CrO_4^{2-} and PO_4^{3-}	Insoluble	Group 1A and NH_4^+

B. Acid Base Reactions

1. Acid + Base \rightarrow Salt + Water

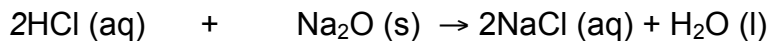
Example: Hydrochloric acid + sodium hydroxide \rightarrow sodium chloride + water
 $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

2. Acid + Carbonate Base \rightarrow Salt + Water + Carbon Dioxide

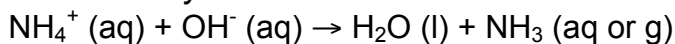
Example: Hydrochloric acid + sodium carbonate \rightarrow sodium chloride + water + carbon dioxide
 $2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

3. Acid + Metal Oxide → Salt + Water

Example: Hydrochloric acid + sodium oxide → sodium chloride + water

**4. Bronstead-Lowry Rxn (transfer of a proton)**

Example: Ammonium + hydroxide → water + ammonia

**II. Oxidation-Reduction Reactions****A. Displacement****1. Metal A + Metal B Salt → Metal A Salt + Metal B**

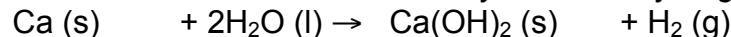
Example: Zinc metal + copper(II) sulfate → zinc sulfate + copper

**2. Metal + Acid → Metal salt + hydrogen gas**

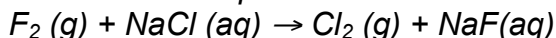
Example: Zinc metal + hydrochloric acid → zinc chloride + hydrogen gas

**3. Metal + Water → Metal hydroxide + hydrogen gas**

Example: Calcium metal + water → Calcium hydroxide + hydrogen gas

**4. Active Halogen + Metal Halogen Salt → Less Active Halogen + Metal Halogen Salt**

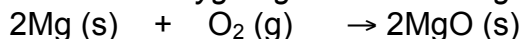
Example: Fluorine + Aqueous Sodium Chloride → chlorine + sodium fluoride

**B. Combination (Composition) [A + B → AB]**

Example: Metal + Oxygen → Metal Oxide

OR Nonmetal + Oxygen → Nonmetal oxide

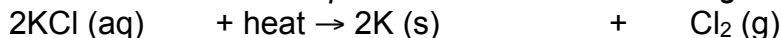
Example: Magnesium metal + oxygen gas → solid magnesium oxide

**C. Decomposition [AB → A + B]**

Examples: Metal Salt + heat → Metal + gas

or Metal Chlorate/Perchlorate + heat → Metal Salt + O₂ (g)

Example: potassium chloride + heat → potassium metal + chlorine gas



Example: potassium perchlorate + heat → potassium chloride + oxygen gas

**D. Combustion**

Hydrocarbon + oxygen gas → Carbon Dioxide + Water

Example: C₄H₁₀ + oxygen gas → carbon dioxide + water (can be l or g)

