

Types of Reactions

Reactants \longrightarrow Products

TYPE 1



TYPE 2



- | | | | | |
|--------------------|-------------------|----------------|---|------------------|
| a) binary compound | \longrightarrow | element | + | element |
| b) metal hydroxide | \longrightarrow | metal oxide | + | H ₂ O |
| c) metal chlorate | \longrightarrow | metal chloride | + | O ₂ |
| d) metal carbonate | \longrightarrow | metal oxide | + | CO ₂ |

TYPE 3

COMBUSTION

Hydrocarbon + O₂



TYPE 4

SINGLE REPLACEMENT
 Element + Compound

- a) metal + XZ \longrightarrow metal Z + X
- b) halogen + XZ \longrightarrow X halogen + Z

TYPE 5

DOUBLE REPLACEMENT
 Compound + Compound



- s = solid
 l = liquid
 g = gas
 aq = aqueous
 (water solution)

NOTES

Honors Chemistry

http://alex.state.al.us/lesson_view.php?id=26220

Diatomic Molecules

- H₂
 O₂
 N₂
 F₂
 Cl₂
 Br₂
 I₂

Type of Reaction	Reactant Characteristic(s)	Product Characteristic(s)	Other Possible Types
Synthesis/Composition	2 or more	only 1	redox, combustion
Decomposition	only 1	2 or more	redox
Single Replacement/Displacement	1 element + 1 compound	new element + new compound	redox
Double Replacement/Displacement	2 compounds	switch, 2 new compounds	precipitation, acid-base
Combustion	fuel + O ₂	CO ₂ + H ₂ O	redox, synthesis
Redox/Oxidation-Reduction	O ₂ possible, metal loses electrons, nonmetal gains electrons	O ₂ possible, metal loses electrons, nonmetal gains electrons	synthesis, combustion, single replacement
Precipitation	2 aqueous compounds	1 solid and 1 aqueous compound	acid-base, double replacement
Acid-Base	H = acid, OH = base	salt + water	double replacement, precipitation

Type of Reaction	General Equation	Helpful Hints
Synthesis/Composition	$A + X \rightarrow AX$	check charges of ions
Decomposition	$AX \rightarrow A + X$	gas usually produced
Single Replacement/Displacement	$A + BX \rightarrow AX + B$	use the activity series
Double Replacement/Displacement	$AX + BY \rightarrow BX + AY$	positives bond with negatives
Combustion	Hydrocarbon + O ₂ → CO ₂ + H ₂ O	no CO ₂ for flammable gases or metals
Redox/Oxidation-Reduction	$\text{metal} - e^- \rightarrow \text{metal}^{+\text{charge}}$ $\text{metal}^{+\text{charge}} - e^- \rightarrow \text{metal}^{\text{more} + \text{charge}}$ $\text{nonmetal} + e^- \rightarrow \text{nonmetal}^{-\text{charge}}$ $\text{nonmetal}^{-\text{charge}} + e^- \rightarrow \text{nonmetal}^{\text{more} - \text{charge}}$	OIL RIG: oxidation is the loss of electrons, reduction is the gain of electrons
Precipitation	2 aqueous compounds → solid compound + aqueous compound	use the solubility chart
Acid-Base	$HX + AOH \rightarrow AX + H_2O$	look for H and OH as reactants

Table 8.1

General Rules for Solubility of Ionic Compounds (Salts) in Water at 25 °C

1. Most nitrate (NO_3^-) salts are soluble.
2. Most salts of Na^+ , K^+ , and NH_4^+ are soluble.
3. Most chloride salts are soluble. Notable exceptions are AgCl , PbCl_2 , and Hg_2Cl_2 .
4. Most sulfate salts are soluble. Notable exceptions are BaSO_4 , PbSO_4 , and CaSO_4 .
5. Most hydroxide compounds are only slightly soluble.* The important exceptions are NaOH and KOH . $\text{Ba}(\text{OH})_2$ and $\text{Ca}(\text{OH})_2$ are moderately soluble.
6. Most sulfide (S^{2-}), carbonate (CO_3^{2-}), and phosphate (PO_4^{3-}) salts are only slightly soluble.*

*The terms *insoluble* and *slightly soluble* really mean the same thing: such a tiny amount dissolves that it is not possible to detect it with the naked eye.

(a) Soluble compounds

 NO_3^- salts

 Na^+ , K^+ , NH_4^+ salts

 Cl^- , Br^- , I^- salts

 Except for those containing Ag^+ , Hg_2^{2+} , Pb^{2+}
 SO_4^{2-} salts

 Except for those containing Ba^{2+} , Pb^{2+} , Ca^{2+}

(b) Insoluble compounds

 S^{2-} , CO_3^{2-} , PO_4^{3-} salts

 OH^- salts

 Except for those containing Na^+ , K^+ , Ca^{2+}

Figure 8.3

Solubilities of common compounds

TABLE 8-3 Activity Series of the Elements

Activity of metals	Activity of halogen nonmetals
Li Rb React with cold H_2O and acids, replacing hydrogen. K Ba React with oxygen, forming oxides. Sr Ca Na	F_2 Cl_2 Br_2 I_2
Mg Al React with steam (but not cold water) and acids, replacing hydrogen. Mn Zn React with oxygen, forming oxides. Cr Fe Cd	
Co Do not react with water. Ni React with acids, replacing hydrogen. Sn Pb React with oxygen, forming oxides.	
H_2 Sb React with oxygen, forming oxides. Bi Cu Hg	
Ag Fairly unreactive, forming oxides only indirectly. Pt Au	

Solubility Table

	acetate	arsenate	bromide	carbonate	chloride	chromate	hydroxide	iodide	nitrate	dichromate	oxide	phosphate	sulfate	sulfide	sulfite
Al	S	I	S		S		I	S	S		I	I	S		
NH ₄ ⁺	S	S	S	S	S	S	S	S	S	S		S	S	S	S
Ba	S	I	S	I	S	I	S	S	S	I	S	I	I	d	I
Bi		s	d	I	d		I	I	d	I	I	s	d	I	
Ca	S	I	S	I	S		I(s)	S	S	I	I	I	I	d	I
Co ²⁺	S	I	S	I	S	I	I	S	S	I	I	I	S	I	I
Cu ²⁺	S	I	S	I	S	I	I		S	I	I	I	S	I	
Fe ²⁺	S	I	S	s	S		I	S	S	I	I	I	S	I	s
Fe ³⁺	I	I	S	I	S		I		S	S	I	I	S	I	
Pb ²⁺	S	I	I	I	I	I	I	I	S	I	I	I	I	I	I
Mg	S	d	S	I	S	S	I	S	S	I	I	I	S		s
Hg ²⁺	S	I	I	I	S	s		I	S	I	I	I	d	I	
K	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Ag ⁺	I	I	I	I	I	I	d	I	S	I	I	I	I(s)	I	I
Na	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Zn ²⁺	S	I	S	I	S	I	I	S	S	I	I	I	S	I	I

SOLUBILITY OF THINGS

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Water solubility table (chart)

	Silver	Aluminum	Arsenic	Barium	Bismuth	Calcium	Cadmium	Cobalt	Chromium (III)	Copper (I)	Copper (II)	Iron (II)	Iron (III)	Hydrogen	Lithium	Mercury (I)	Mercury (II)	Potassium	Magnesium	Manganese (II)	Sodium	Ammonium	Nickel (II)
	Ag ⁺	Al ⁺³	As ⁺³	Ba ⁺²	Bi ⁺³	Ca ⁺²	Cd ⁺²	Co ⁺²	Cr ⁺³	Cu ⁺	Cu ⁺²	Fe ⁺²	Fe ⁺³	H ⁺	Li ⁺	Hg ₂ ⁺²	Hg ⁺²	K ⁺	Mg ⁺²	Mn ⁺²	Na ⁺	NH ₄ ⁺	Ni ⁺²
Acetate	S	S	U	U	S	I	S	S	S	U	S	U	S	S	S	S	S	S	S	S	I	S	S
Arsenate	I	I	X	I	I	I	I	I	I	X	I	I	I	X	X	I	I	I	I	I	S	S	I
Arsenite	I	U	X	I	U	I	U	I	U	X	I	I	I	X	X	I	I	I	I	I	S	S	I
Bromide	S	S	D	D	S	D	S	S	S	S	S	S	S	S	S	I	I	I	I	I	S	S	S
Carbonate	U	S	U	U	I	U	I	I	U	I	I	U	I	I	S	I	I	I	I	I	I	I	I
Chlorate	S	S	U	U	S	U	S	S	U	U	S	U	S	U	S	S	S	S	S	X	S	S	I
Chloride	S	S	S	D	S	D	S	S	S	I	S	S	S	S	S	I	I	S	S	S	S	S	S
Ferricyanide	I	U	X	S	U	S	I	I	U	X	I	I	S	X	X	U	I	I	S	S	I	S	I
Ferrocyanide	I	S	X	S	S	S	U	I	U	X	I	I	I	X	X	U	U	I	S	I	S	S	I
Fluoride	S	S	X	I	S	I	S	S	S	X	I	I	S	S	S	X	X	S	I	S	S	S	I
Hydroxide	I	U	U	U	S	D	I	I	I	I	I	I	I	I	I	I	I	I	I	I	U	I	S
Iodide	S	S	D	S	S	I	S	S	I	I	S	U	U	S	S	I	I	S	I	I	I	S	S
Nitrate	S	S	U	U	S	D	S	S	S	U	S	S	S	S	S	S	S	S	S	S	D	S	S
Oxalate	I	I	I	U	I	D	I	I	S	I	I	S	I	I	S	I	I	I	I	S	I	I	S
Oxide	I	U	I	I	S	I	I	I	I	I	I	I	I	I	S	I	I	I	I	I	I	I	D
Phosphate	I	S	U	U	I	I	I	I	I	U	I	I	I	I	S	I	I	I	U	I	U	I	S
Silicate	I	U	U	U	S	I	I	I	U	X	I	U	U	I	X	I	I	I	U	I	U	U	S
Sulfate	S	S	D	U	I	D	S	I	S	D	S	S	S	S	S	I	I	S	D	S	I	S	S
Sulfide	D	S	D	I	D	I	I	I	I	I	I	I	I	I	S	I	I	S	I	I	I	I	S
Sulfite	U	S	U	U	I	U	I	I	I	X	I	S	U	I	X	I	I	S	U	I	U	I	S
Thiocyanate	I	U	X	S	U	S	S	S	S	S	I	S	S	X	X	I	I	S	S	S	S	S	S
Thiosulfate	S	U	X	S	U	S	U	U	U	X	U	S	U	X	X	U	U	S	S	S	S	S	U

† Ksp solubility constant for common salts

