

NOMENCLATURE OF COMPOUNDS				
Binary-2 elements (-ide suffix)			Ternary-3 or more elements (-ate or -ite suffix)	
Type I—Ionic -Type I metal + nonmetal -Groups I & II, Al^{3+} , Zn^{2+} , Cd^{2+} , Ag^{1+} , NH_4^+ -write the cation, then the anion root + ide -no prefixes -no roman numerals	Type II—Ionic -Type II metal + nonmetal -All other metals -no prefixes -roman numerals <u>-two names!</u> (old system also) -for the new system, write the cation, its charge as a roman numeral in parentheses, then the anion ending in -ide -for the old system, write the old name of the cation, then the anion ending in -ide	Type III-Covalent -a nonmetal + a nonmetal -use prefixes mono hexa di hepta tri octa tetra nona penta deca -do not use mono before a cation	Type I—Ionic -type I metal + polyatomic ion <u>-two names!</u> (old system also) -for the new system, write the cation, its charge as a roman numeral in parentheses, then the polyatomic ion-ammonium) then the negatively charged polyatomic ion	Type II—Ionic -type II metal + polyatomic ion <u>-two names!</u> (old system also) -for the new system, write the cation, its charge as a roman numeral in parentheses, then the polyatomic ion -for the old system, write the old name of the cation then the polyatomic ion

OLD NAMES

chromium (II)	chromous	lead (II)	plumbous
chromium (III)	chromic	lead (IV)	plumbic
cobalt (II)	cobaltous	mercury (I)	mercurous (Hg^{2+})
cobalt (III)	cobaltic	mercury (II)	mercuric
copper (I)	cuprous	tin (II)	stannous
copper (II)	cupric	tin (IV)	stannic
iron(II)	ferrous		
iron(III)	ferric		

THE ELBOW	
Inside	-ate = 3 O
	-ite = 2 O
Outside	-ate = 4 O
	-ite = 3 O

COMMON POLYATOMIC IONS

Acetate	$\text{C}_2\text{H}_3\text{O}_2^{-1}$	Nitrate	NO_3^{1-}
Ammonium	NH_4^{1+}	Nitrite	NO_2^{-1}
Carbonate	CO_3^{2-}	Permanganate	MnO_4^{1-}
Hydrogen carbonate (bicarbonate)	HCO_3^{1-}	Peroxide	O_2^{2-}
Perchlorate	ClO_4^{1-}	Phosphate	PO_4^{3-}
Chlorate	ClO_3^{1-}	Hydrogen phosphate	HPO_4^{2-}
Chlorite	ClO_2^{1-}	Dihydrogen phosphate	$\text{H}_2\text{PO}_4^{-}$
Hypochlorite	ClO^{1-}	Sulfate	SO_4^{2-}
Chromate	CrO_4^{2-}	Sulfite	SO_3^{2-}
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$	Hydrogen sulfate (bisulfate)	HSO_4^{1-}
Cyanide	CN^{1-}	Thiocyanate	SCN^{1-}
Hydroxide	OH^{-1}	Oxalate	$\text{C}_2\text{O}_4^{2-}$

ACID NOMENCLATURE

Binary Acids
 hydro + root of nonmetal + ic + acid
 ex. HCl = hydrochloric acid

Ternary Acids (Oxyacids)
 most oxygen per + root nonmetal + ic + acid
 more oxygen root nonmetal + ic + acid
 less oxygen root nonmetal + ous + acid
 least oxygen hypo + root nonmetal + ous + acid

ex. HBrO_4 perbromic acid
 HBrO_3 bromic acid
 HBrO_2 bromous acid
 HBrO hypobromous acid

SALT NOMENCLATURE

Binary Salts
 cation + root nonmetal + ide
 ex. NaCl = sodium chloride

Ternary Salts (Oxysalts)
 cation + root nonmetal + ate (ic) or ite (ous)
 ex. H_2CO_3 carbonic acid → Na_2CO_3 sodium carbonate
 HClO hypochlorous acid → NaClO sodium hypochlorite

SOLUBILITY RULES

Soluble	Except (slightly soluble)	Except (insoluble)	Insoluble	Except (slightly soluble)	Except (soluble)
Group I ions, NH_4^+			CO_3^{2-} , PO_4^{3-} , BO_3^{3-} , SO_3^{2-} , CrO_4^{2-} , AsO_4^{2-}	MgSO_4	Group 1, NH_4^{1+} , MgCrO_4
NO_3^- , ClO_3^- , $\text{C}_2\text{H}_3\text{O}_2^-$	$\text{AgC}_2\text{H}_3\text{O}_2$		S^{2-}	BaS , CaS , MgS	Group 1, NH_4^{1+}
Cl^{1-} , Br^{1-} , I^- (Group 7 ex. F^-)	$\text{Hg}_2^{2+}\text{I}_2$	Pb^{2+} , Ag^{1+}	OH^{1-}	$\text{Ca}(\text{OH})_2$, $\text{Ba}(\text{OH})_2$, $\text{Sr}(\text{OH})_2$	Na^{1+} , K^{1+} , NH_4^{1+} (very soluble), Other Group 1's
SO_4^{2-}	Ag^{1+}	Pb^{2+} , Hg_2^{2+} , Ba^{2+} , Ca^{2+} , Sr^{2+}	O^{2-}		Group 1, NH_4^{1+}

NINE REACTION RULES

1. ammonia + acid \rightarrow ammonium salt
2. water + metal oxide \rightarrow metal hydroxide (base)
3. water + non-metal oxide \rightarrow acid
4. active metal + water \rightarrow metal hydroxide + hydrogen
5. metal chlorate $\Delta \rightarrow$ metal chloride + oxygen
6. metal carbonate $\Delta \rightarrow$ metal oxide + carbon dioxide
7. metal hydroxide $\Delta \rightarrow$ metal oxide + water
8. acid $\Delta \rightarrow$ non-metal oxide + water
9. hydrocarbon (C_xH_y) \rightarrow carbon dioxide gas + water vapor

REACTIONS OF COORDINATION COMPOUNDS AND IONS

Ligands are generally electron-pair donors (Lewis bases) which bond to a central atom that is usually the positive ion of a transition metal. Complex ions and coordination compounds are formed. Important ligands are ammonia NH_3 , cyanide ion CN^- , and hydroxide ion OH^- .

A useful approximation for the AP Exam is that the number of ligands attached to a central metal ion is often twice the oxidation number of the central metal. It is not important in the scoring for the AP Exam that you know the correct number of ligands. *It is important* that the charge on the ion is correct.

The breakup of complex ions is frequently achieved by adding an acid. The products are the metal ion and the species formed when hydrogen ions from the acid react with the ligand (a Lewis bases).

Ammonia	'Excess' hydroxide ion	Cyanide ion	Others
$\text{Ag}(\text{NH}_3)_2^+$	$\text{Al}(\text{OH})_4^{1-}$	$\text{Ag}(\text{CN})_2^{1-}$	FeSCN^{2+}
$\text{Cu}(\text{NH}_3)_4^{2+}$	$\text{Zn}(\text{OH})_4^{2-}$	$\text{Cd}(\text{CN})_4^{2-}$	AgCl_2^{1-}
$\text{Ni}(\text{NH}_3)_6^{2+}$	$\text{Cr}(\text{OH})_6^{3-}$	$\text{Fe}(\text{CN})^3-$	
$\text{Co}(\text{NH}_3)_6^{3+}$		$\text{Hg}(\text{CN})_4^{2-}$	
$\text{Zn}(\text{NH}_3)_4^{2+}$			

—Tetraammine copper (II) ions = $\text{Cu}(\text{NH}_3)_4^{2+}$

COMMON GASES		C_2H_2	K	F
H_2S		Cl_2	Ca	O
CO_2		F_2	Na	Cl
CO		H_2	Mg	Br
NO		N_2	Al	I
NO_2		O_2	Zn	
N_2O	HOH (water vapor)		Cr	
NH_3	HCl (composition only)		Fe	
STRONG ACIDS		HCl	Cd	
		H_2SO_4	Co	
		HNO_3	Ni	
		HI	Sn	
		HBr	Pb	
		HClO_4	H	
STRONG BASES		Group 1 hydroxides	Sb	
		Ag	Cu	
		Pt	Hg	
		Au		

REVERSIBLE REACTIONS

1. $\text{HOH}^{(l)} + \text{CO}_2^{(g)} \leftrightarrow \text{H}_2\text{CO}_3^{(aq)}$
2. $\text{HOH}^{(l)} + \text{SO}_2^{(g)} \leftrightarrow \text{H}_2\text{SO}_3^{(aq)}$
3. $\text{NH}_3^{(g)} + \text{HOH}^{(l)} \leftrightarrow \text{NH}_4\text{OH}^{(aq)}$

UNSTABLE PRODUCTS—DECOMPOSITION & DOUBLE DISPLACEMENT

1. $\text{CaCO}_3^{(aq)} + \text{H}_2\text{SO}_4^{(aq)} \rightarrow \text{CaSO}_4^{(s)} + \text{HOH}^{(l)} + \text{CO}_2^{(g)}$
2. $\text{Na}_2\text{SO}_3^{(aq)} + \text{H}_2\text{SO}_4^{(aq)} \rightarrow \text{Na}_2\text{SO}_4^{(aq)} + \text{HOH}^{(l)} + \text{SO}_2^{(g)}$
3. $\text{NaOH}^{(aq)} + \text{NH}_4\text{Cl}^{(aq)} \rightarrow \text{NaCl}^{(aq)} + \text{NH}_3^{(g)} + \text{HOH}^{(l)}$

OXIDIZING AGENTS (OXIDATION NUM DECREASES)		REDUCING AGENTS (OXIDATION NUM INCREASES)	
Ox. Agent (Reduced)	Formed by the reaction	Red. Agent (Oxidized)	Formed by the reaction
MnO_4^{1-} in acid	Mn^{2+}	Free halogens (Br_2)	Hypohalite ions in dilute basic sol'n (BrO^{1-})
MnO_4^{1-} in neutral	MnO_2	Free halogens (Cl_2)	Halite ions in conc. basic sol'n (ClO_2^{1-})
MnO_4^{1-} in basic	MnO_4^{2-}		
Mn dioxide in acid (MnO_2)	Mn^{2+}		
HNO_3 concentrated	NO_2	Nitrite ions (NO_2^{1-})	Nitrate ions (NO_3^{1-})
HNO_3 dilute	NO		
H_2SO_4 hot, concentrated	SO_2	Sulfite ions (SO_3^{2-} or $\text{SO}_2^{(aq)}$)	Sulfate ions (SO_4^{2-})
Metal-ic ions (Sn^{4+})	Metal-ous ions (Sn^{2+})	Metal-ous ions (Fe^{2+})	Metal-ic ions (Fe^{3+})
Free halogens (Cl_2)	Halide ions (Cl^{1-})	Halide ions (Br^-)	Free halogen (Br_2)
Peroxides (Na_2O_2 , H_2O_2)	NaOH , HOH	Free metals (Na)	Metal ions (Na^{1+})
Perchloric acid (HClO_4)	Chloride ion (Cl^{1-})		
Dichromate in acid $\text{Cr}_2\text{O}_7^{2-}$	Chromium(III) ion (Cr^{3+})		