Things to Know for AP Chemistry
Things to Memorize

1. Common Ions

Positive ions (cations)	**Negative ions (anions)**
+1 Charge	***-1 Charge***
ammonium (NH_4^+)	acetate ($C_2H_3O_2^-$)
copper (I) or cuprous (Cu^+)	cyanide (CN^{-1})
hydrogen (H^+) "proton"	dihydrogen phosphate ($H_2PO_4^-$)
hydronium ion (H_3O^+)	hydrogen carbonate or bicarbonate(HCO_3^-)
silver (Ag^+)	hydrogen sulfate or bisulfate (HSO_4^-)
Group 1 (Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+)	hydroxide (OH^-)
	nitrate (NO_3^-)
+2 Charge	nitrite (NO_2^-)
cadmium (Cd^{2+})	perchlorate (ClO_4^-)
chromium (II) or chromous (Cr^{2+})	chlorate (ClO_3^-)
cobalt(II) or cobaltous (Co^{2+})	chlorite (ClO_2^-)
copper(II) or cupric (Cu^{2+})	hypochlorite (ClO^-)
iron(II) or ferrous (Fe^{2+})	permanganate (MnO_4^-)
lead(II) or plumbous (Pb^{2+})	thiocyanate (SCN^-)
manganese(II) or manganous (Mn^{2+})	Group 17 anions (F^-, Cl^-, Br^-, I^-,)
Mercury(I) or mercurous (Hg_2^{2+})	
Mercury(II) or mercuric (Hg^{2+})	***-2 charge***
nickel (Ni^{2+})	carbonate (CO_3^{2-})
tin(II) or stannous (Sn^{2+})	Chromate (CrO_4^{2-})
zinc (Zn^{2+})	dichromate($Cr_2O_7^{2-}$)
Group 2 (Be^{2+},Mg^{2+},Ca^{2+},Sr^{2+},Ba^{2+},Ra^{2+})	Hydrogen phosphate (HPO_4^{2-})
	oxalate ($C_2O_4^{2-}$)
+3 Charge	oxide (O_2^-)
aluminum (Al^{3+})	peroxide (O_2^{2-})
chromium(III) or chromic (Cr^{3+})	sulfate (SO_4^{2-})
iron(III) or ferric (Fe^{3+})	sulfite (SO_3^{2-})
	sulfide (S^{2-})
+4 Charge	thiosulfate ($S_2O_3^{2-}$)
lead(IV) or plumbic (Pb^{4+})	
tin(IV) or stannic (Sn^{4+})	***-3 Charge***
	Arsenate (AsO_4^{3-})
	phosphate (PO_4^{3-})
	Phosphite (PO_3^{3-})
	Group 15 -nitride (N^{3-}), phosphide (P^{3-})

Summary of metal cations with more than one possible charge:
Cu^{1+},Cu^{2+};Hg_2^{2+},Hg^{2+};Co^{2+},Co^{3+},Cr^{2+},Cr^{3+};Fe^{2+},Fe^{3+};Mn^{2+},Mn^{3+};Pb^{2+},Pb^{4+};Sn^{2+},Sn^{4+}
Manganese and some other metals can form several ions with different charges. You should know the ones listed.

2. Solubility Rules

1 All common compounds of Group 1 and ammonium ions are soluble.
2 All nitrates, acetates, and chlorates are soluble.
3 All binary compounds of the halogens (other than F) are soluble, **except** those of Ag, Hg(I), and Pb.
4 All sulfates are soluble, **except** those of barium, strontium, calcium, lead.
5 Sulfides and hydroxide are insoluble **except** for Ca, Ba, Sr, ammonium and the alkali metals.
6 Except for rule 1, carbonates, oxides, silicates, and phosphates are insoluble.

Note: You can apply the solubility rules to predict whether the product of a double replacement reaction will be a precipitate or not. If the compound is soluble, it will dissociate into free ions in solution. If the compound is insoluble, it will be a precipitate. Example: When $AgNO_3(aq)$ and $NaCl(aq)$ are mixed, the products will be AgCl and $NaNO_3$. AgCl is insoluble (rule 3) and will precipitate out. $NaNO_3$ is soluble and will remain in solution (rules 1 &2).

Study Suggestion: Prepare flash cards (which can be found on my website) of the common ions with the formula on one side and the name on the other. Use these to quiz yourself on the names and formulas. To practice the solubility rules randomly pair a cation and an anion and predict if the resulting compound is soluble or not. Have the rules available as you are learning and then cover them up and quiz yourself!

3. Acids and Bases

Common Acids
hydrochloric acid – $HCl(aq)$
nitric acid – $HNO_3(aq)$
sulfuric acid - $H_2SO_4(aq)$
phosphoric acid – $H_3PO_4(aq)$
Carbonic acid – $H_2CO_3(aq)$
Acetic acid (ethanoic acid) $HC_2H_3O_2(aq)$ or $CH_3COOH(aq)$

7 Strong Acids
$HCl(aq)$
$HBr(aq)$
$HI(aq)$
$HNO_3(aq)$
$HclO_3(aq)$
$HclO_4(aq)$
$H_2SO_4(aq)$

Common Bases
sodium hydroxide – $NaOH(aq)$
potassium hydroxide – $KOH(aq)$
calcium hydroxide - $Ca(OH)_2(aq)$
aqueous ammonia – $NH_3(aq)$

7 Strong Bases
$LiOH(aq)$
$NaOH(aq)$
$KOH(aq)$
$RbOH(aq)$
$Ca(OH)_2(aq)$
$Sr(OH)_2(aq)$
$Ba(OH)_2(aq)$

Note: Strong acids and bases are those that dissociate completely in water.

Example: $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

$Ca(OH)_2(aq) \rightarrow Ca^{2+}(aq) + 2OH^-(aq)$

Weak acids and bases do not dissociate completely, and will be present as the compound in water.

Example: $HC_2H_3O_2(aq) \Leftrightarrow H^+(aq) + C_2H_3O_2^-(aq)$

$NH_3(aq) \Leftrightarrow NH_4^+(aq) + OH^-(aq)$

4. Rules for Assigning Oxidation Numbers

1 The oxidation number of any element in its free state (uncombined with other elements) is zero. e.g., Fe in a bar of iron is zero. O_2 and N_2 in the Earth's atmosphere both have oxidation numbers of zero. When an element has equal numbers of protons and electrons, its overall charge is zero.

2 The oxidation number of alkali metals **in a compound** is always 1+, e.g., LiCl, Na_3P, K_2S, etc.

3 The oxidation number of alkaline **earth** metals **in a compound** is always 2+, e.g., $MgCl_2$, CaF_2, SrO, etc.

4 Fluorine is always assigned a value of 1-**in a compound**, e.g., NaF

5 The oxidation number of oxygen is almost always 2-in a compound. Exceptions to this rule would be peroxides, O_2 where the oxidation number of **each** oxygen is 1-, and superperoxides, O_2 where the oxidation number of each oxygen is ½-. Neither peroxides nor superperoxides are common. Peroxides are only known to form compounds with the elements in the first two columns of the periodic table, e.g., H_2O_2, Na_2O_2, CaO_2, etc. Potassium, rubidium, and cesium are the only elements that form superperoxides, e.g., KO_2.

6 In covalent compounds (with nonmetals), hydrogen is assigned an oxidation number of 1+, e.g., HCl, H_2O, NH_3, CH_4. The exception to this rule is when hydrogen combines with a metal to form a hydride. Under these conditions, which are rare, hydrogen is assigned an oxidation number of 1-, e.g., NaH.

7 In metallic halides the halogen (F, Cl, Br, I, At) always has an oxidation number equal to 1-.

8 Sulfide, selenide, telluride, and polonide are always 2-in binary salts.

9 Nitrides, phosphides, and arsenides are always 3-in binary salts.

10 All other oxidation numbers are assigned so that the sum of the oxidation numbers of each element equals the net charge on the molecule or polyatomic ion. In neutral compounds, the sum of the positive and negative charges must equal zero.

5. Oxidation and Reduction

Loss **o**f **e**lectrons, **G**ain is **r**eduction. (LEO goes GRRRRRR!!!!)

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Strong Oxidizing agents

MnO_4^- in acid solution → $Mn^{2+} + H_2O$
MnO_4^- in neutral or basic solution → MnO_2
$Cr_2O_7^{2-}$ in acid solution → $Cr^{3+} + H_2O$
$Cr_2O_7^{2-}$ in basic solution → $CrO_4^{2-} + H_2O$
HNO_3 (concentrated) → $NO_2 + H_2O$
H_2SO_4 (concentrated) → $SO_2 + H_2O$
H_2O_2 in acid solution → H_2O
Free halogens (Cl_2) → Halide ions (Cl^-)

Strong Reducing Agents

Halide ions (Cl^-) → Free halogens (Cl_2)
Free metals (Mg) → Metal ions (Mg^{2+})
"-ite" ions (SO_3^{2-}) → "-ate" ions (SO_4^{2-})

Study Suggestion: You may not completely understand this right now, but it will make sense later in the year. For know, learn the oxidizing and reducing agents in bold and the products formed when they react. Predicting products is very important in AP chem!

6. Intermolecular Forces

Forces between molecules that keep solids together.

Network Covalent	Directional covalent bonds C (graphite, diamond) Si, SiO_2(sand)	Strongest
Ionic (electrostatic attraction)	Forces between adjacent ions (Na^+ --Cl)	
Metallic	Forces between metal nuclei (Cu, Ag)	
Hydrogen bonding	Forces between adjacent molecules with H & F, O, N or Cl. (H_2O, NH_3)	
Dipole-dipole	Forces between adjacent polar molecules (CO, NF_3)	
London Dispersion Force	Forces between adjacent nonpolar molecules (CO_2, Cl_2)	Weakest

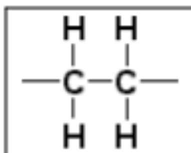
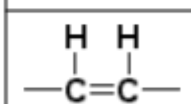
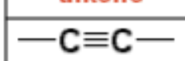
7. Organic Chemistry

Organic chemistry is the study of carbon based compounds. The nomenclature of organic compounds is based on the number of carbon atoms present in the molecule (prefix) and the presence of functional groups (ending).

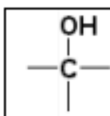
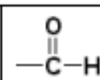
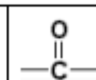
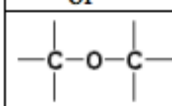
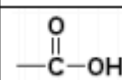
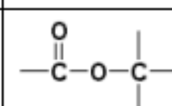
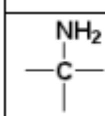
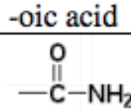
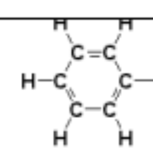
Examples:

CH_4 – one carbon atom "meth-" & C_nH_{2n+2} … "methane"
C_2H_5OH -two carbon atoms "eth-" & an alcohol (-OH) … "ethanol"
$C_3H_7NH_2$ -three carbon atoms "prop-" & an amine ($-NH_2$) … "propylamine"

Prefix	Number of C
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

 alkane	C_nH_{2n+2} -ane
 alkene	C_nH_{2n} -ene
 alkyne	C_nH_{2n-2} -yne

Functional Groups:

 alcohol -ol	 aldehyde -al	 ketone -one
 ether	 carboxylic acid -oic acid	 ester
 amine	 amide	 Benzene C_6H_6

8. Colors:

Flame Test Colors

Barium – green
Calcium – orange
Copper – blue/green
Lithium – red
Potassium – lavender
Sodium – yellow/orange
Strontium – orange/red

Colors of some aqueous ions

Co^{2+}	pink
Cu^{2+}	blue green
Fe^{2+}	olive green
Ni^{2+}	bright green
Fe^{3+}	brown
CrO_4^{2-}	orange
$Cr_2O_7^{2-}$	yellow

Common Precipitate colors

WHITE	BLUE	YELLOW	BLACK	GREEN	RED/BROWN
AgCl	Many Copper (II) ppt's.	AgI	Many Sulfides	Many Fe(II) ppt's.	Many Fe(III) ppt's.
$BaSO_4$		PbI_2			
$PbCl_2$					
Many non-transition metal hydroxides					
Many non-transition metal carbonates					
Many non-transition metal sulfates					

9. Calculating the Molar Mass

Chemistry happens in moles and the easiest way to solve problems is using moles. Since we can't directly measure the number of moles we need to take something we can measure, mass, and turn that into moles. This makes calculating molar mass (the mass in grams of a substance which contains one mole of that substance) an important first step in many problems.

All year long we will use the official AP Chemistry Periodic Table for this and will report our molar mass to the hundredths place (X.XX). You will be given one and a copy of the official Periodic Table is included as a separate file for download and printing.

Use the complete atomic mass from the periodic table. Only round the final answer to the hundredths place.

Example: NH_3

NH_3 is 1x N + 3 x H = molar mass

1 x 14.007 + 3 x 1.0079 = 17.0307

Example: $Ca(NO_3)_2$ $Ca(NO_3)_2$ is 1 x Ca + 2 x N + 6 x O = molar mass

1 x 40.08 + 2 x 14.007 + 6 x 16.00 = 164.094