

# STUFF I SHOULD KNOW FOR THE AP TEST BUT DO NOT KNOW YET

## IONS LIST

acetate	$C_2H_3O_2^-$	ferric	$Fe^{3+}$ (yellow)	oxalate	$C_2O_4^{2-}$
aluminum	$Al^{3+}$	ferrous	$Fe^{2+}$ (green)	oxide	$O^{2-}$
ammonium	$NH_4^+$	fluoride	$F^-$	perbromate	$BrO_4^-$
barium	$Ba^{2+}$	hydrogen	$H^+$	perchlorate	$ClO_4^-$
bicarbonate	$HCO_3^-$	hydronium	$H_3O^+$	periodate	$IO_4^-$
bisulfate	$HSO_4^-$	hydroxide	$OH^-$	permanganate	$MnO_4^-$ (purple)
bisulfide	$HS^-$	hypobromite	$BrO^-$	peroxide	$O_2^{2-}$
bisulfite	$HSO_3^-$	hypochlorite	$ClO^-$	phosphate	$PO_4^{3-}$
bromate	$BrO_3^-$	hypoiodite	$IO^-$	phosphide	$P^{3-}$
bromide	$Br^-$	iodate	$IO_3^-$	phosphite	$PO_3^{3-}$
bromite	$BrO_2^-$	iodide	$I^-$	potassium	$K^+$
calcium	$Ca^{2+}$	iodite	$IO_2^-$	silver	$Ag^+$
carbonate	$CO_3^{2-}$	lead	$Pb^{2+}$	sodium	$Na^+$
chlorate	$ClO_3^-$	lithium	$Li^+$	stannic	$Sn^{4+}$
chloride	$Cl^-$	magnesium	$Mg^{2+}$	stannous	$Sn^{2+}$
chlorite	$ClO_2^-$	manganese	$Mn^{2+}$	strontium	$Sr^{2+}$
chromate	$CrO_4^{2-}$ (yellow)	mercuric	$Hg^{2+}$	sulfate	$SO_4^{2-}$
chromium	$Cr^{3+}$	mercurous	$Hg_2^{2+}$	sulfide	$S^{2-}$
cupric	$Cu^{2+}$ (blue)	nickel	$Ni^{2+}$ (green)	sulfite	$SO_3^{2-}$
cuprous	$Cu^+$ (green)	nitrate	$NO_3^-$	thiocyanate	$SCN^-$
cyanide	$CN^-$	nitride	$N^{3-}$	thiosulfate	$S_2O_3^{2-}$
dichromate	$Cr_2O_7^{2-}$ (orange)	nitrite	$NO_2^-$	zinc	$Zn^{2+}$

## SOLUBILITY RULES

*Always soluble:*

alkali metal ions ( $Li^+$ ,  $Na^+$ ,  $K^+$ ,  $Rb^+$ ,  $Cs^+$ ),  $NH_4^+$ ,  
 $NO_3^-$ ,  $ClO_3^-$ ,  $ClO_4^-$ ,  $C_2H_3O_2^-$ ,  $HCO_3^-$

*Generally soluble:* (mnemonics)

$Cl^-$ ,  $Br^-$ ,  $I^-$  Soluble except  $Ag^+$ ,  $Pb^{2+}$ ,  $Hg_2^{2+}$  (AP/H)  
 $F^-$  Soluble except  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ ,  $Pb^{2+}$ ,  $Mg^{2+}$   
 (CBS-PM)

$SO_4^{2-}$  Soluble except  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ ,  $Pb^{2+}$  (CBS/PBS)

*Generally insoluble:*

$O^{2-}$ ,  $OH^-$  Insoluble except alkali metal ions and  $NH_4^+$   
 $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$  (CBS) somewhat soluble

$CO_3^{2-}$ ,  $PO_4^{3-}$ ,  $S^{2-}$ ,  $SO_3^{2-}$ ,  $C_2O_4^{2-}$ ,  $CrO_4^{2-}$   
 Insoluble except alkali metals and  $NH_4^+$

## GASES THAT FORM

$\rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$        $\rightarrow NH_4OH \rightarrow NH_3 + H_2O$

$\rightarrow H_2SO_3 \rightarrow SO_2 + H_2O$        $\rightarrow H_2S$

$\rightarrow 2HNO_2 \rightarrow NO + NO_2 + H_2O$        $\rightarrow HCN$

## WEAK ELECTROLYTES

Weak Acids (*esp.*  $HC_2H_3O_2$  and HF)

(Memorize the 8 strong acids... all others are weak)

HCl	hydrochloric acid	$HNO_3$	nitric acid
HBr	hydrobromic acid	$HIO_4$	periodic acid
HI	hydroiodic acid	$H_2SO_4$	sulfuric acid
$HClO_4$	perchloric acid	$HClO_3$	chloric acid

Ammonium Hydroxide ( $NH_4OH \approx NH_3(aq)$ )      Water ( $H_2O$ )

## DRIVING FORCES — Double Replacement

- Insoluble Solid (Precipitate)
- Weak Electrolyte ( $H_2O$  or Weak Acid)
- Gas Formation

## STRONG OXIDIZERS (Oxidizing Agents)

$MnO_4^-$  in acid solution       $\rightarrow Mn^{2+} + H_2O$

$MnO_2$  in acid solution       $\rightarrow Mn^{2+} + H_2O$

$MnO_4^-$  in neutral or basic sol'n       $\rightarrow MnO_2$

$Cr_2O_7^{2-}$  in acid solution       $\rightarrow Cr^{3+} + H_2O$

$Cr_2O_7^{2-}$  with a base       $\rightarrow CrO_4^{2-} + H_2O$

$CrO_4^{2-}$  in basic solution       $\rightarrow CrO_2^- + H_2O$

$HNO_3$ , concentrated       $\rightarrow NO_2 + H_2O$

$HNO_3$ , dilute (e.g. 6 M)       $\rightarrow NO + H_2O$

$H_2SO_4$ , hot, concentrated       $\rightarrow SO_2 + H_2O$

Free halogens (e.g.  $Cl_2$ )       $\rightarrow$  halide ions ( $Cl^-$ )

$H_2O_2$  in acid solution       $\rightarrow H_2O$

Note:  $H_2O_2$  decomposes       $\rightarrow H_2O + O_2$

$Na_2O_2$        $\rightarrow NaOH$

$HClO_4$        $\rightarrow Cl^- + H_2O$

*Other Oxidizers*

Metal-"ic" ions (e.g.  $Sn^{4+}$ ,  $Fe^{3+}$ )       $\rightarrow$  "-ous" ions ( $Sn^{2+}$ ,  $Fe^{2+}$ )

$H_2O$        $\rightarrow H_2 + OH^-$

## STRONG REDUCERS (Reducing Agents)

Halide ions (e.g.  $Cl^-$ )       $\rightarrow$  Free halogen ( $Cl_2$ )

Free metals       $\rightarrow$  metal ions

"ites"  $SO_3^{2-}$  or  $SO_2$ ,  $NO_2^-$        $\rightarrow$  "ates"  $SO_4^{2-}$ ,  $NO_3^-$

Free halogens, dil. basic sol'n       $\rightarrow$  hypohalite ions ( $ClO^-$ )

Free halogens, conc. basic sol'n       $\rightarrow$  halate ions ( $ClO_3^-$ )

$S_2O_3^{2-}$        $\rightarrow S_4O_6^{2-}$

*Other Reducers*

Metal-"ous" ions (e.g.  $Sn^{2+}$ )       $\rightarrow$  "-ic" ions ( $Sn^{4+}$ )

$H_2O$        $\rightarrow O_2 + H^+$

# Stuff I Should Know (Page 2)

## Complex Ions & Common Ligands

Ligands	polar molecules & anions	NH <sub>3</sub> , H <sub>2</sub> O, OH <sup>-</sup> , CN <sup>-</sup> , Cl <sup>-</sup>	Odd example: Fe <sup>3+</sup> + SCN <sup>-</sup> ⇌ FeSCN <sup>2+</sup>
Central Ions	transition metals and Al <sup>3+</sup>	Ag <sup>+</sup> , Cu <sup>2+</sup> , Ni <sup>2+</sup> , Zn <sup>2+</sup> , etc. & Al <sup>3+</sup>	
Examples	usually twice the number of ligands as the charge on the central ion. Key Words: "excess, concentrated"	Ag(CN) <sub>2</sub> <sup>-</sup> , Cu(NH <sub>3</sub> ) <sub>4</sub> <sup>2+</sup> , Ni(OH) <sub>4</sub> <sup>2-</sup> , Zn(NH <sub>3</sub> ) <sub>4</sub> <sup>2+</sup> , Al(OH) <sub>6</sub> <sup>3-</sup>	Reaction with Acid: Cu(NH <sub>3</sub> ) <sub>4</sub> <sup>2+</sup> + H <sup>+</sup> → Cu <sup>2+</sup> + NH <sub>4</sub> <sup>+</sup>

## Organic Chemistry & Functional Groups

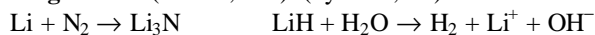
alkanes C <sub>n</sub> H <sub>2n+2</sub>	alkenes C <sub>n</sub> H <sub>2n</sub>	alkynes C <sub>n</sub> H <sub>2n-2</sub>	aromatics (benzene) C <sub>6</sub> H <sub>6</sub>
alcohol R—OH	aldehyde R—C(=O)—H	ketone R—C(=O)—R	ether R—O—R
carboxylic acid R—C(=O)—OH	ester R—C(=O)—O—R	amine R—NH <sub>2</sub>	amide R—C(=O)—NH <sub>2</sub>
Substituted benzene:	ortho = 1,2	meta = 1,3	para = 1,4

nuclear chem	DH DS Spont.?
alpha <sup>4</sup> He <sub>2</sub>	- + at all temps + + high temps - - low temps + - no temps Note: DS in J DG & DH in kJ
beta/electron <sup>0</sup> e <sub>-1</sub>	
neutron <sup>1</sup> n <sub>0</sub>	
positron <sup>0</sup> e <sub>+1</sub>	
	K <sub>sp</sub> & Solubility, s 1:1 K <sub>sp</sub> = s <sup>2</sup> 1:2 K <sub>sp</sub> = 4s <sup>3</sup> 1:3 K <sub>sp</sub> = 27s <sup>4</sup> 2:3 K <sub>sp</sub> = 108s <sup>5</sup>

## Lewis Acids & Bases

BF<sub>3</sub> + NH<sub>3</sub> → BF<sub>3</sub>NH<sub>3</sub>  
 acid anhydrides (oxides of nonmetals, CO<sub>2</sub>)  
 basic anhydrides (oxides of metals, MgO)  
 MgO + CO<sub>2</sub> → MgCO<sub>3</sub>  
 decomposition reactions: MgCO<sub>3</sub> → MgO + CO<sub>2</sub>  
 Strange Examples: P<sub>4</sub>O<sub>10</sub> + H<sub>2</sub>O → H<sub>3</sub>PO<sub>4</sub>

## Strange Ions: (nitride, N<sup>3-</sup>) (hydride, H<sup>-</sup>)



## Flame Test Colors

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

## Quantum Numbers

n	1, 2, 3, ...
l	0 ... (n-1)
m <sub>l</sub>	-l ... +l
m <sub>s</sub>	+1/2, -1/2
l	0 = s, 1 = p, 2 = d, 3 = f

## Writing Lewis Structures

hint: use one valence electron to connect F's or Cl's then determine lone pairs (Ex: XeF<sub>4</sub>)

## Product-Favored (Spontaneous) Reactions

$$\Delta G < 0 \quad E^\circ > 0 \quad K_{eq} > 1$$

## Properties Indicate Strength of Intermolecular Forces (IMF's)

IMF	BP	FP	H <sub>vap</sub>	H <sub>fus</sub>	VP
IMF	BP	FP	H <sub>vap</sub>	H <sub>fus</sub>	VP

## Orders of Reactions & Graphs That Give Straight Lines

0 Order	1 <sup>st</sup> Order	2 <sup>nd</sup> Order
[R] vs. Time	ln[R] vs. Time	1/[R] vs. Time
slope = -k	slope = -k	slope = k

## Electrochemical Cells

anode	cathode
oxidation	reduction
- side	+ side
lower E°	higher E°
e <sup>-</sup> leave	e <sup>-</sup> enter

## Bond Orders

bond	B.O.	
single	1	σ
double	2	σ+π
triple	3	σ+π+π

## SN & hybridization & shape

Steric Number	hybridization	basic shape
1	s	—
2	sp	linear
3	sp <sup>2</sup>	Δ planar
4	sp <sup>3</sup>	tetrahedral
5	sp <sup>3</sup> d	Δ bipyramidal
6	sp <sup>3</sup> d <sup>2</sup>	octahedral

## IMF's

London	nonpolar molecules, ex: CH <sub>4</sub> , He
dipole-dipole	polar molecules, ex: H <sub>2</sub> S, SO <sub>2</sub>
hydrogen bonding	H-F, H-O-, H-N-, NH <sub>3</sub> , H <sub>2</sub> O amines and alcohols
metallic	metals, Ag, Pb
ionic	salts, NaCl, CaCO <sub>3</sub> (Note: "ates" contain covalent bonds)
covalent network	C(graphite), C(diamond), SiO <sub>2</sub> , WC, Si, SiC (Note: graphite = London, too)

## Activity of Metals (Four Groups)

Metals	React with...
Groups I & II	H <sub>2</sub> O ex: Li + H <sub>2</sub> O → Li <sup>+</sup> + OH <sup>-</sup> + H <sub>2</sub>
all others	Non-oxidizing Acid, ex: HCl Zn + 2HCl → H <sub>2</sub> + ZnCl <sub>2</sub>
Cu, Ag, Hg	Oxidizing Acid, HNO <sub>3</sub> or H <sub>2</sub> SO <sub>4</sub> (conc.) Cu + HNO <sub>3</sub> → NO <sub>2</sub> + H <sub>2</sub> O + Cu <sup>2+</sup>
Au, Pt, Ir	Aqua Regia (HNO <sub>3</sub> + HCl)