

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

### IONS LIST

acetate	$\text{C}_2\text{H}_3\text{O}_2^-$	ferric	$\text{Fe}^{3+}$	oxalate	$\text{C}_2\text{O}_4^{2-}$
aluminum	$\text{Al}^{3+}$	ferrous	$\text{Fe}^{2+}$	oxide	$\text{O}^{2-}$
ammonium	$\text{NH}_4^+$	fluoride	$\text{F}^-$	perbromate	$\text{BrO}_4^-$
barium	$\text{Ba}^{2+}$	hydrogen	$\text{H}^+$	perchlorate	$\text{ClO}_4^-$
bicarbonate	$\text{HCO}_3^-$	hydronium	$\text{H}_3\text{O}^+$	periodate	$\text{IO}_4^-$
bisulfate	$\text{HSO}_4^-$	hydroxide	$\text{OH}^-$	permanganate	$\text{MnO}_4^- \text{ (purple)}$
bisulfide	$\text{HS}^-$	hypobromite	$\text{BrO}^-$	peroxide	$\text{O}_2^{2-}$
bisulfite	$\text{HSO}_3^-$	hypochlorite	$\text{ClO}^-$	phosphate	$\text{PO}_4^{3-}$
bromate	$\text{BrO}_3^-$	hypoiodite	$\text{IO}^-$	phosphide	$\text{P}^{3-}$
bromide	$\text{Br}^-$	iodate	$\text{IO}_3^-$	phosphite	$\text{PO}_3^{3-}$
bromite	$\text{BrO}_2^-$	iodide	$\text{I}^-$	potassium	$\text{K}^+$
calcium	$\text{Ca}^{2+}$	iodite	$\text{IO}_2^-$	silver	$\text{Ag}^+$
carbonate	$\text{CO}_3^{2-}$	lead	$\text{Pb}^{2+}$	sodium	$\text{Na}^+$
chlorate	$\text{ClO}_3^-$	lithium	$\text{Li}^+$	stannic	$\text{Sn}^{4+}$
chloride	$\text{Cl}^-$	magnesium	$\text{Mg}^{2+}$	stannous	$\text{Sn}^{2+}$
chlorite	$\text{ClO}_2^-$	manganese	$\text{Mn}^{2+}$	strontium	$\text{Sr}^{2+}$
chromate	$\text{CrO}_4^{2-} \text{ (yellow)}$	mercuric	$\text{Hg}^{2+}$	sulfate	$\text{SO}_4^{2-}$
chromium	$\text{Cr}^{3+}$	mercurous	$\text{Hg}_2^{2+}$	sulfide	$\text{S}^{2-}$
cupric	$\text{Cu}^{2+} \text{ (blue)}$	nickel	$\text{Ni}^{2+} \text{ (green)}$	sulfite	$\text{SO}_3^{2-}$
cuprous	$\text{Cu}^+ \text{ (blue)}$	nitrate	$\text{NO}_3^-$	thiocyanate	$\text{SCN}^-$
cyanide	$\text{CN}^-$	nitride	$\text{N}^{3-}$	thiosulfate	$\text{S}_2\text{O}_3^{2-}$
dichromate	$\text{Cr}_2\text{O}_7^{2-} \text{ (orange)}$	nitrite	$\text{NO}_2^-$	zinc	$\text{Zn}^{2+}$

### SOLUBILITY RULES

*Always soluble:*

alkali metal ions ( $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ ,  $\text{Cs}^+$ ),  $\text{NH}_4^+$ ,  $\text{NO}_3^-$ ,  $\text{ClO}_3^-$ ,  $\text{ClO}_4^-$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$

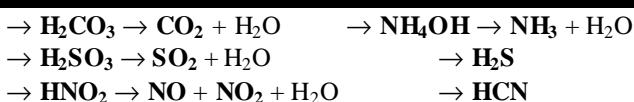
*Generally soluble:* (mnemonics)

$\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$  Soluble except  $\text{Ag}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Hg}_2^{2+}$  (AP/H)  
 $\text{F}^-$  Soluble except  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Mg}^{2+}$   
 $\text{SO}_4^{2-}$  Soluble except  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Pb}^{2+}$  (CBS/PBS)

*Generally insoluble:*

$\text{O}^{2-}$ ,  $\text{OH}^-$  Insoluble except and alkali metals, and  $\text{NH}_4^+$   
 $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$  (CBS) somewhat soluble  
 $\text{CO}_3^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{CrO}_4^{2-}$   
Insoluble except alkali metals and  $\text{NH}_4^+$

### GASES THAT FORM



### WEAK ELECTROLYTES

Weak Acids (esp.  $\text{HC}_2\text{H}_3\text{O}_2$  and HF)

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

HCl	hydrochloric acid	$\text{HNO}_3$	nitric acid
HBr	hydrobromic acid	$\text{HIO}_4$	periodic acid
HI	hydroiodic acid	$\text{H}_2\text{SO}_4$	sulfuric acid
$\text{HClO}_4$	perchloric acid	$\text{HClO}_3$	chloric acid

Ammonium Hydroxide ( $\text{NH}_4\text{OH} \approx \text{NH}_3(\text{aq})$ ) Water ( $\text{H}_2\text{O}$ )

### DRIVING FORCES -- Double Replacement

- Insoluble Solid (Precipitate)
- Weak Electrolyte ( $\text{H}_2\text{O}$  or Weak Acid)
- Gas Formation

### STRONG OXIDIZERS (Oxidizing Agents)

$\text{MnO}_4^-$ in acid solution	$\rightarrow \text{Mn}^{2+} + \text{H}_2\text{O}$
$\text{MnO}_2$ in acid solution	$\rightarrow \text{Mn}^{2+} + \text{H}_2\text{O}$
$\text{MnO}_4^-$ in neutral or basic sol'n	$\rightarrow \text{MnO}_2$
$\text{Cr}_2\text{O}_7^{2-}$ in acid solution	$\rightarrow \text{Cr}^{3+} + \text{H}_2\text{O}$
$\text{Cr}_2\text{O}_7^{2-}$ with a base	$\rightarrow \text{CrO}_4^{2-} + \text{H}_2\text{O}$
$\text{CrO}_4^{2-}$ in basic solution	$\rightarrow \text{CrO}_2^- + \text{H}_2\text{O}$
$\text{HNO}_3$ , concentrated	$\rightarrow \text{NO}_2 + \text{H}_2\text{O}$
$\text{HNO}_3$ , dilute (e.g. 6 M)	$\rightarrow \text{NO} + \text{H}_2\text{O}$
$\text{H}_2\text{SO}_4$ , hot, concentrated	$\rightarrow \text{SO}_2 + \text{H}_2\text{O}$
Free halogens (e.g. $\text{Cl}_2$ )	$\rightarrow$ halide ions ( $\text{Cl}^-$ )
$\text{H}_2\text{O}_2$ in acid solution	$\rightarrow \text{H}_2\text{O}$
Note: $\text{H}_2\text{O}_2$ decomposes	$\rightarrow \text{H}_2\text{O} + \text{O}_2$
$\text{Na}_2\text{O}_2$	$\rightarrow \text{NaOH}$
$\text{HClO}_4$	$\rightarrow \text{Cl}^- + \text{H}_2\text{O}$

### Other Oxidizers

Metal-“ic” ions (e.g.  $\text{Sn}^{4+}$ ,  $\text{Fe}^{3+}$ )  $\rightarrow$  “-ous” ions ( $\text{Sn}^{2+}$ ,  $\text{Fe}^{2+}$ )  
 $\text{H}_2\text{O}$   $\rightarrow \text{H}_2 + \text{OH}^-$

### STRONG REDUCERS (Reducing Agents)

Halide ions (e.g. $\text{Cl}^-$ )	$\rightarrow$ Free halogen ( $\text{Cl}_2$ )
Free metals	$\rightarrow$ metal ions
“ites” $\text{SO}_3^{2-}$ or $\text{SO}_2$ , $\text{NO}_2^-$	$\rightarrow$ “ates” $\text{SO}_4^{2-}$ , $\text{NO}_3^-$
Free halogens, dil. basic sol'n	$\rightarrow$ hypohalite ions ( $\text{ClO}^-$ )
Free halogens, conc. basic sol'n	$\rightarrow$ halate ions ( $\text{ClO}_3^-$ )
$\text{S}_2\text{O}_3^{2-}$	$\rightarrow \text{S}_4\text{O}_6^{2-}$

### Other Reducers

Metal-“ous” ions (e.g.  $\text{Sn}^{2+}$ )  $\rightarrow$  “-ic” ions ( $\text{Sn}^{4+}$ )  
 $\text{H}_2\text{O}$   $\rightarrow \text{O}_2 + \text{H}^+$

# Stuff I Should Know (Page 2)

2nd DRAFT

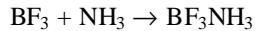
## Complex Ions & Common Ligands

Ligands	polar molecules & anions	$\text{NH}_3$ , $\text{H}_2\text{O}$ , $\text{OH}^-$ , $\text{CN}^-$ , $\text{Cl}^-$	Odd example: $\text{Fe}^{3+} + \text{SCN}^- \rightleftharpoons \text{FeSCN}^{2+}$
Central ions	transition metals and $\text{Al}^{3+}$	$\text{Ag}^+$ , $\text{Cu}^{2+}$ , $\text{Ni}^{2+}$ , $\text{Zn}^{2+}$ , etc. & $\text{Al}^{3+}$	
Examples	usually twice the number of ligands as the charge on the central ion. Key Words: "excess, concentrated"	$\text{Ag}(\text{CN})_2^-$ , $\text{Cu}(\text{NH}_3)_4^{2+}$ , $\text{Ni}(\text{OH})_4^{2-}$ , $\text{Zn}(\text{NH}_3)_4^{2+}$ , $\text{Al}(\text{OH})_6^{3-}$	Reaction with Acid: $\text{Cu}(\text{NH}_3)_4^{2+} + \text{H}^+ \rightarrow \text{Cu}^{2+} + \text{NH}_4^+$

## Organic Chemistry & Functional Groups

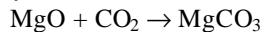
alkanes $\text{C}_n\text{H}_{2n+2}$	alkenes $\text{C}_n\text{H}_{2n}$	alkynes $\text{C}_n\text{H}_{2n-2}$	aromatics (benzene) $\text{C}_6\text{H}_6$	nuclear chem alpha ${}^4_2\text{He}$
alcohol $\text{R}-\text{OH}$	aldehyde $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{H} \end{array}$	ketone $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{R} \end{array}$	ether $\text{R}-\text{O}-\text{R}$	beta/electron ${}^0_{-1}\text{e}$
carboxylic acid $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{OH} \end{array}$	ester $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{O}-\text{R} \end{array}$	amine $\text{R}-\text{NH}_2$	amide $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{NH}_2 \end{array}$	neutron ${}^1_0\text{n}$
Substituted benzene:	ortho = 1,2	meta = 1,3	para = 1,4	positron ${}^0_{+1}\text{e}$

## Lewis Acids & Bases



acid anhydrides (oxides of nonmetals,  $\text{CO}_2$ )

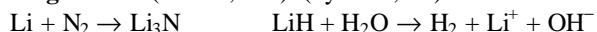
basic anhydrides (oxides of metals,  $\text{MgO}$ )



decomposition reactions:  $\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$

Strange Examples:  $\text{P}_4\text{O}_{10} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4$

Strange Ions: (nitride,  $\text{N}^{3-}$ ) (hydride,  $\text{H}^-$ )



## Flame Test Colors

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

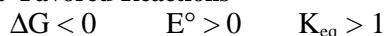
## Quantum Numbers

$n$	1, 2, 3, ...
$l$	0 ... ( $n-1$ )
$m_l$	$-l \dots +l$
$m_s$	$+\frac{1}{2}, -\frac{1}{2}$
$ $	$0 = s, 1 = p, 2 = d, 3 = f$

## Writing Lewis Structures

hint: use one valence electron to connect F's or Cl's then determine lone pairs (Ex:  $\text{XeF}_4$ )

## Product- Favored Reactions



IMF	BP	FP	$\text{H}_{\text{vap}}$	$\text{H}_{\text{fus}}$	VP
IMF	BP	FP	$\text{H}_{\text{vap}}$	$\text{H}_{\text{fus}}$	VP

## Orders of Reactions & Graphs That Give Straight Lines

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

nuclear chem alpha ${}^4_2\text{He}$
beta/electron ${}^0_{-1}\text{e}$
neutron ${}^1_0\text{n}$
positron ${}^0_{+1}\text{e}$

## Electrochemical Cells

anode	cathode
oxidation	reduction
– side	+ side
lower $E^\circ$	higher $E^\circ$
$e^-$ leave	$e^-$ enter

## Bond Orders

bond	B.O.	
single	1	$\sigma$
double	2	$\sigma + \pi$
triple	3	$\sigma + \pi + \pi$

## SN & hybridization & shape

Steric Number	hybridization	basic shape
1	s	—
2	sp	linear
3	$sp^2$	$\triangle$ planar
4	$sp^3$	tetrahedral
5	$sp^3d$	$\triangle$ bipyramidal
6	$sp^3d^2$	octahedral

## IMF's

London	nonpolar molecules, ex: $\text{CH}_4, \text{He}$
dipole-dipole	polar molecules, ex: $\text{H}_2\text{S}, \text{SO}_2$
hydrogen bonding	$\text{H}-\text{F}, \text{H}-\text{O}-, \text{H}-\text{N}-, \text{NH}_3, \text{H}_2\text{O}$ amines and alcohols
metallic	metals, $\text{Ag}, \text{Pb}$
ionic	salts, $\text{NaCl}, \text{CaCO}_3$ (Note: "ates" contain covalent bonds)
covalent network	$\text{C}(\text{graphite}), \text{C}(\text{diamond}), \text{SiO}_2, \text{WC}, \text{Si}, \text{SiC}$ (Note: graphite = London, too)

## Activity of Metals (Four Groups)

Metals	React with...
Groups I & II	$\text{H}_2\text{O}$ ex: $\text{Li} + \text{H}_2\text{O} \rightarrow \text{Li}^+ + \text{OH}^- + \text{H}_2$
all others	Non-oxidizing Acid, ex: $\text{HCl}$ $\text{Zn} + 2\text{HCl} \rightarrow \text{H}_2 + \text{ZnCl}_2$
$\text{Cu}, \text{Ag}, \text{Hg}$	Oxidizing Acid, $\text{HNO}_3$ or $\text{H}_2\text{SO}_4$ (conc.) $\text{Cu} + \text{HNO}_3 \rightarrow \text{NO}_2 + \text{H}_2\text{O} + \text{Cu}^{2+}$
$\text{Au}, \text{Pt}, \text{Ir}$	Aqua Regia ( $\text{HNO}_3 + \text{HCl}$ )