

## AP Chemistry – Summer Assignment

Mr. Seniuk

### **Instructions:**

Read each chapter below and answer all assigned end of chapter questions. Clearly label each problem, show all work, and circle your final answer. Be sure to follow rules for significant figures, and do not forget units when reporting final answers. PowerPoint notes for each Chapter are made available to you on my website. I do not suggest you print these as that would require a lot of ink as well as paper, but you should read through them. Also, start memorizing early in the summer...the more you can commit to memory more successful you will be in this course. I look forward to seeing all of you at the start of the school year!

### **Chapter 1 – Matter and Measurements**

- Read all of Chapter 1
- Review Chapter 1 PowerPoint Notes on my Website
- Do the following end of chapter problems: #'s 1, 3, 5, 9, 17, 21, 27, 33, 39, 47, and 51

### **Chapter 2 – Atoms, Molecules, and Ions**

- Read all of Chapter 2
- Review Chapter 2 PowerPoint Notes on my Website
- Do the following end of chapter problems: #'s 5, 13, 23, 39, 40, 45, 51, 57, and 61

### **Chapter 3 – Mass Relations in Chemistry; Stoichiometry**

- Read all of Chapter 3
- Review Chapter 3 PowerPoint Notes on my Website
- Do the following end of chapter problems: #'s 3, 13, 19, 27, 37, 47, and 55

### **Chapter 5 – Gases**

- Read all of Chapter 5
- Review Chapter 5 PowerPoint notes on my Website
- Do the following end of chapter problems: #'s 3, 19, 31, and 47

### **Additional Items:**

- ✓ Review & Memorize Common Elements and Symbols
- ✓ Review & Memorize Reaction Types
- ✓ Review & Memorize Polyatomic Ions
- ✓ Review & Memorize Strong Acids and Bases

# 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	$\text{Fe}^{3+}$ (yellow)	oxalate	$\text{C}_2\text{O}_4^{2-}$
aluminum	$\text{Al}^{3+}$	ferrous	$\text{Fe}^{2+}$ (green)	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	$\text{MnO}_4^-$ ( <i>purple</i> )
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	$\text{CrO}_4^{2-}$ (yellow)	mercuric	$\text{Hg}^{2+}$	sulfate	$\text{SO}_4^{2-}$
chromium	$\text{Cr}^{3+}$	mercurous	$\text{Hg}_2^{2+}$	sulfide	$\text{S}^{2-}$
cupric	$\text{Cu}^{2+}$ (blue)	nickel	$\text{Ni}^{2+}$ (green)	sulfite	$\text{SO}_3^{2-}$
cuprous	$\text{Cu}^+$ (green)	nitrate	$\text{NO}_3^-$	thiocyanate	$\text{SCN}^-$
cyanide	$\text{CN}^-$	nitride	$\text{N}^{3-}$	thiosulfate	$\text{S}_2\text{O}_3^{2-}$
dichromate	$\text{Cr}_2\text{O}_7^{2-}$ (orange)	nitrite	$\text{NO}_2^-$	zinc	$\text{Zn}^{2+}$

## SOLUBILITY RULES

*Always soluble:*

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

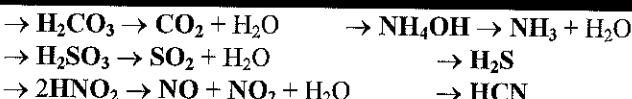
*Generally soluble:*

(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 alkali metal ions 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)

### 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) $\text{C}_6\text{H}_6$
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 $\text{R} - \text{O} - \text{R}$
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 $\begin{array}{c} \text{O} \\    \\ \text{R} - \text{C} - \text{NH}_2 \end{array}$
Substituted benzene:	ortho = 1,2	meta = 1,3	para = 1,4

### nuclear chem

alpha  
 ${}^4_2 \text{He}$

beta/electron  
 ${}^0_{-1} \text{e}$

neutron  
 ${}^1_0 \text{n}$

positron  
 ${}^0_{+1} \text{e}$

$\Delta H \Delta S$  Spont.?

- + at all temps

+ + high temps

- - low temps

+ - no temps

Note:  $\Delta S$  in J  
 $\Delta G$  &  $\Delta H$  in kJ

$K_{sp}$  & Solubility, s

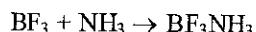
1:1  $K_{sp} = s^2$

1:2  $K_{sp} = 4s^3$

1:3  $K_{sp} = 27s^4$

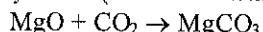
2:3  $K_{sp} = 108s^5$

### Lewis Acids & Bases



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

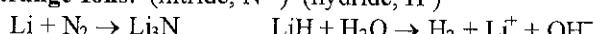
basic anhydrides (oxides of metals,  $\text{MgO}$ )



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,  $\text{H}^-$ )



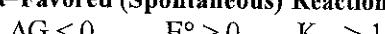
### Flame Test Colors

Quantum Numbers	
$n$	1, 2, 3, ...
$\ell$	0 ... ( $n-1$ )
$m_\ell$	$-\ell \dots +\ell$
$m_s$	$+\frac{1}{2}, -\frac{1}{2}$
$\ell$	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 (Spontaneous) Reactions



Properties Indicate Strength of Intermolecular Forces (IMF's)

IMF	BP	FP	$H_{vap}$	$H_{fus}$	VP
IMF	BP	FP	$H_{vap}$	$H_{fus}$	VP

### 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	$sp^2$	$\Delta$ planar
4	$sp^3$	tetrahedral
5	$sp^3d$	$\Delta$ 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 ( $\text{HNO}_3 + \text{HCl}$ )

### Orders of Reactions & Graphs That Give Straight Lines

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

## Common Elements and Their Symbols

aluminum	Al	lithium	Li
antimony	Sb	magnesium	Mg
argon	Ar	manganese	Mn
arsenic	As	mercury	Hg
barium	Ba	neon	Ne
beryllium	Be	nickel	Ni
boron	B	nitrogen	N
bromine	Br	oxygen	O
calcium	Ca	phosphorus	P
carbon	C	platinum	Pt
cesium	Cs	potassium	K
chlorine	Cl	radium	Ra
chromium	Cr	radon	Rn
cobalt	Co	rubidium	Rb
copper	Cu	selenium	Se
fluorine	F	silicon	Si
gallium	Ga	silver	Ag
germanium	Ge	sodium	Na
gold	Au	strontium	Sr
helium	He	sulfur	S
hydrogen	H	tin	Sn
iodine	I	tungsten	W
iron	Fe	uranium	U
krypton	Kr	xenon	Xe
lead	Pb	zinc	Zn