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

IONS LIST

acetate	$C_2H_3O_2^-$	ferr**ic**	Fe^{3+} (Orange – red)	oxalate	$C_2O_4^{2-}$
aluminum	Al^{3+}	ferr**ous**	Fe^{2+} (Yellow - *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-}	Plumb**ous**	Pb^{2+}	sodium	Na^+
chlorate	ClO_3^-	lithium	Li^+	stann**ic**	Sn^{4+}
chloride	Cl^-	magnesium	Mg^{2+}	stann**ous**	Sn^{2+}
chlorite	ClO_2^-	manganese	Mn^{2+} (*Pink*)	strontium	Sr^{2+}
chromate	CrO_4^{2-} (yellow)	mercur**ic**	Hg^{2+}	sulfate	SO_4^{2-}
chromium	Cr^{3+} (Violet ($Cr(NO_3)_3$ to Green ($CoCl_3$)	mercur**ous**	Hg_2^{2+}	sulfide	S^{2-}
cobalt	Co^{3+} (*pink)*	nickel	Ni^{2+} (*green*)	sulfite	SO_3^{2-}
cupr**ic**	Cu^{2+} (*blue*)	nitrate	NO_3^-	thiocyanate	SCN^-
cupr**ous**	Cu^+ (*green*)	nitride	N^{3-}	thiosulfate	$S_2O_3^{2-}$
cyanide	CN^-	nitrite	NO_2^-	zinc	Zn^{2+}
dichromate	$Cr_2O_7^{2-}$ (orange)				

SOLUBILITY RULES

Always soluble:

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

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 and alkali metals, 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

→ **H_2CO_3** → **CO_2** + H_2O → **NH_4OH** → **NH_3** + H_2O

→ **H_2SO_3** → **SO_2** + H_2O → **H_2S**

→ **HNO_2** → **NO** + **NO_2** + H_2O → **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	→ Mn^{2+} + H_2O
MnO_2 in acid solution	→ Mn^{2+} + H_2O
MnO_4^- in neutral or basic sol'n	→ MnO_2
$Cr_2O_7^{2-}$ in acid solution	→ Cr^{3+} + H_2O
$Cr_2O_7^{2-}$ with a base	→ CrO_4^{2-} + H_2O
CrO_4^{2-} in basic solution	→ CrO_2^- + H_2O
HNO_3, concentrated	→ NO_2 + H_2O
HNO_3, dilute (e.g. 6 M)	→ NO + H_2O
H_2SO_4, hot, concentrated	→ SO_2 + H_2O
Free halogens (e.g. Cl_2)	→ halide ions (Cl^-)
H_2O_2 in acid solution	→ H_2O
Note: H_2O_2 decomposes	→ H_2O + O_2
Na_2O_2	→ NaOH
$HClO_4$	→ Cl^- + H_2O

Other Oxidizers

Metal-"ic" ions (e.g. Sn^{4+}, Fe^{3+})	→ "-ous" ions (Sn^{2+}, Fe^{2+})
H_2O	→ H_2 + OH^-

STRONG REDUCERS (Reducing Agents)

Halide ions (e.g. Cl^-)	→ Free halogen (Cl_2)
Free metals	→ metal ions
"ites" SO_3^{2-} or SO_2, NO_2^-	→ "ates" SO_4^{2-}, NO_3^-
Free halogens, dil. basic sol'n	→ hypohalite ions (ClO^-)
Free halogens, conc. basic sol'n	→ halate ions (ClO_3^-)
$S_2O_3^{2-}$	→ $S_4O_6^{2-}$

Other Reducers

Metal-"ous" ions (e.g. Sn^{2+})	→ "-ic" ions (Sn^{4+})
H_2O	→ O_2 + H^+

Universal Gas Law Constants

$\frac{L \cdot mm\ Hg}{mol \cdot K}$ = **62.4** $\frac{L \cdot atm}{mol \cdot K}$ = **0.0821** $\frac{L \cdot kPa}{mol \cdot K}$ = **8.314**

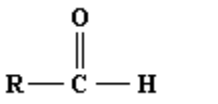
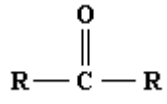
Stuff I Should Know (Page 2)

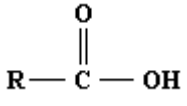
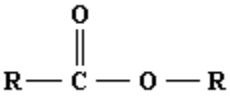
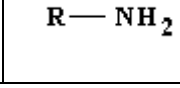
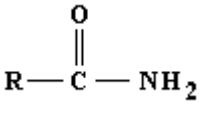
Complex Ions & Common Ligands

Ligands	polar molecules & anions	NH_3, H_2O, OH^-, CN^-, Cl^-	**Odd example:** $Fe^{3+} + SCN^- \rightleftharpoons FeSCN^{2+}$
Central Ions	transition metals and Al^{3+}	Ag^+, Cu^{2+}, Ni^{2+}, Zn^{2+}, etc. & Al^{3+}	
Examples	Usually twice the number of ligands as the charge on the central ion. **Key Words**: "excess, concentrated"	$Ag(CN)_2^-$, $Cu(NH_3)_4^{2+}$, $Ni(OH)_4^{2-}$, $Zn(NH_3)_4^{2+}$, $Al(OH)_6^{3-}$	**Reaction with Acid:** $Cu(NH_3)_4^{2+} + H^+ \rightarrow Cu^{2+} + NH_4^+$

Organic Chemistry & Functional Groups

alkanes	alkenes	alkynes	aromatics (benzene)
C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}	C_6H_6

alcohol	aldehyde	ketone	ether
R — OH			R — O — R

carboxylic acid	ester	amine	amide
			

Substituted benzene:	ortho = 1,2	meta = 1,3	para = 1,4

nuclear chem

alpha ^4_2He

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

neutron ^1_0n

positron $^0_{+1}e$

ΔH	ΔS	Spont.?
–	+	at all temps
+	+	high temps
–	–	low temps
+	–	no temps

Note: ΔS in J
ΔG & ΔH 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

$BF_3 + NH_3 \rightarrow BF_3NH_3$

acid anhydrides (oxides of nonmetals, CO_2)

basic anhydrides (oxides of metals, MgO)

$MgO + CO_2 \rightarrow MgCO_3$

decomposition reactions: $MgCO_3 \rightarrow MgO + CO_2$

Strange Examples: $P_4O_{10} + H_2O \rightarrow H_3PO_4$

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

$Li + N_2 \rightarrow Li_3N$ $\quad$ $LiH + H_2O \rightarrow H_2 + Li^+ + OH^-$

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	$-\ell$ … $+\ell$
m_s	+½, –½

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_4)

Product–Favored (Spontaneous) Reactions

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

Properties Indicate Strength of Intermolecular Forces (IMF's)

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

Orders of Reactions & Graphs That Give Straight Lines

0 Order	1st Order	2nd 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^- leave	e^- 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^2	△ planar
4	sp^3	tetrahedral
5	sp^3d	△ bipyramidal
6	sp^3d^2	octahedral

IMF's

London	nonpolar molecules, ex: CH_4, He
dipole–dipole	polar molecules, ex: H_2S, SO_2
hydrogen bonding	H–F, H–O–, H–N–, NH_3, H_2O amines and alcohols
metallic	metals, Ag, Pb
ionic	salts, NaCl, $CaCO_3$ (Note: "ates" contain covalent bonds)
covalent network	C(graphite), C(diamond), SiO_2, WC, Si, SiC (Note: graphite = London, too)

Activity of Metals (Four Groups)

Metals	React with…
Groups I & II	H_2O ex: $Li + H_2O \rightarrow Li^+ + OH^- + H_2$
all others	Non-oxidizing Acid, ex: HCl $Zn + 2HCl \rightarrow H_2 + ZnCl_2$
Cu, Ag, Hg	Oxidizing Acid, HNO_3 or H_2SO_4 (conc.) $Cu + HNO_3 \rightarrow NO_2 + H_2O + Cu^{2+}$
Au, Pt, Ir	Aqua Regia (HNO_3 + HCl)

Adapted from Paul Groves