

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^- , $C_2H_3O_2^-$

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 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

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

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

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

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 ₃ , H ₂ O, OH ⁻ , CN ⁻ , Cl ⁻	Odd example: Fe ³⁺ + SCN ⁻ ⇌ 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 ⁺ → Cu ²⁺ + NH ₄ ⁺

Organic Chemistry & Functional Groups

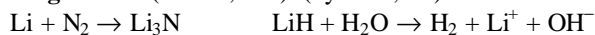
alkanes C _n H _{2n+2}	alkenes C _n H _{2n}	alkynes C _n H _{2n-2}	aromatics (benzene) C ₆ H ₆
alcohol R—OH	aldehyde R—C(=O)—H	ketone R—C(=O)—R	ether R—O—R
carboxylic acid R—C(=O)—OH	ester R—C(=O)—O—R	amine R—NH ₂	amide R—C(=O)—NH ₂
Substituted benzene:	ortho = 1,2	meta = 1,3	para = 1,4

nuclear chem	DH DS Spont.?
alpha ⁴ He ₂	- + at all temps + + high temps - - low temps + - no temps Note: DS in J DG & DH in kJ
beta/electron ⁰ e ₋₁	
neutron ¹ n ₀	K _{sp} & Solubility, s
positron ⁰ e ₊₁	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

BF₃ + NH₃ → BF₃NH₃
 acid anhydrides (oxides of nonmetals, CO₂)
 basic anhydrides (oxides of metals, MgO)
 MgO + CO₂ → MgCO₃
 decomposition reactions: MgCO₃ → MgO + CO₂
 Strange Examples: P₄O₁₀ + H₂O → H₃PO₄

Strange Ions: (nitride, N³⁻) (hydride, 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 ... +l
m _s	+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: XeF₄)

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 _{vap}	H _{fus}	VP
IMF	BP	FP	H _{vap}	H _{fus}	VP

Orders of Reactions & Graphs That Give Straight Lines

0 Order	1 st Order	2 nd 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	Δ planar
4	sp ³	tetrahedral
5	sp ³ d	Δ bipyramidal
6	sp ³ d ²	octahedral

IMF's

London	nonpolar molecules, ex: CH ₄ , He
dipole-dipole	polar molecules, ex: H ₂ S, SO ₂
hydrogen bonding	H-F, H-O-, H-N-, NH ₃ , H ₂ O 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 ₂ O ex: Li + H ₂ O → Li ⁺ + OH ⁻ + H ₂
all others	Non-oxidizing Acid, ex: HCl Zn + 2HCl → H ₂ + ZnCl ₂
Cu, Ag, Hg	Oxidizing Acid, HNO ₃ or H ₂ SO ₄ (conc.) Cu + HNO ₃ → NO ₂ + H ₂ O + Cu ²⁺
Au, Pt, Ir	Aqua Regia (HNO ₃ + HCl)