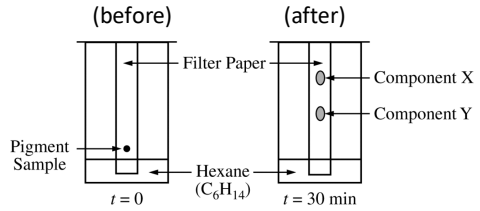
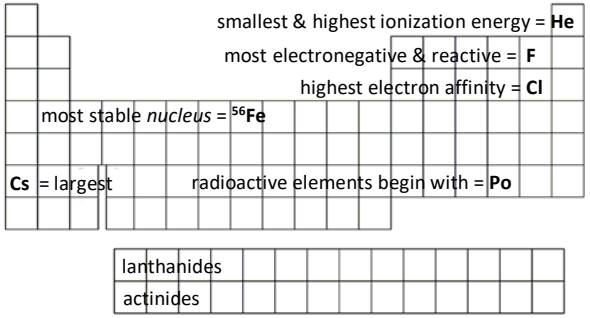
AP CHEM "NEED TO KNOW" REVIEW SHEET

1. CHROMATOGRAPHY



- *more polar* (Y) sticks to *polar* paper
- *less polar* (X) moves with *nonpolar* solvent

2. PERIODIC TABLE



- Know names and symbols of first ~40 elements and others (Pd, Ag, Sn, I, Xe, Cs, Ba, Au, Hg, Pb)
- Transition metals, semi-metals, *s*, *p*, *d*, *f* blocks.
- 1=alkali, 2=alkaline earth, 17=halogens, 18=noble
- Common ions (Na^+, Mg^{2+}, Al^{3+}, O^{2-}, Cl^-, etc)

3. EQUATIONS

$moles\ (n) = \frac{m}{MM}$ $\quad PV = nRT \quad and \quad d = \frac{P \bullet MM}{R \bullet T}$

$M_1V_1 = M_2V_2$ $\quad \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\Delta T = i \bullet K \bullet m$ $\quad pH = pK_a + \log \frac{[A^-]}{[HA]}$

$q = m \bullet c \bullet \Delta T$ $\quad E = E^o - \frac{RT}{nF} \ln Q$

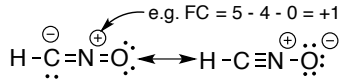
4. BOND ORDER

single	bond order = 1	σ
double	bond order = 2	σ, π
triple	bond order = 3	σ, π, π

5. HYBRIDIZATIONS, SHAPES, FORMAL CHARGES

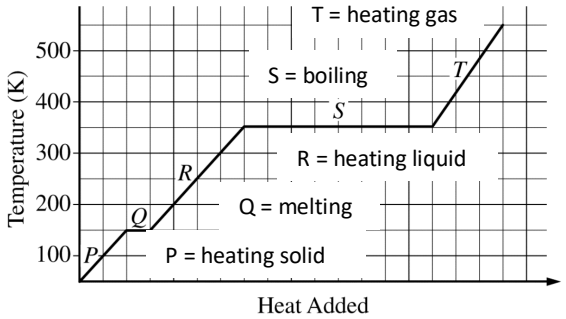
domains	*hybrid*	*shape*	*angle*
1	*s*	--	--
2	*sp*	linear	180
3	*sp²*	Δ planar	120
4	*sp³*	tetrahedral	109.5

Formal Chage = **V**alence - **B**onds - **D**ots



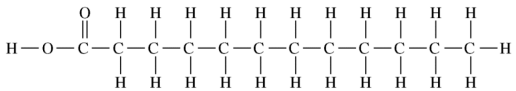
Better resonance contributors have the negative charge on more electronegative atoms.

6. HEATING CURVES

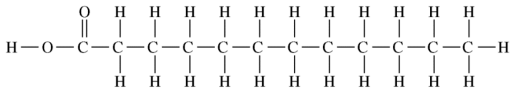


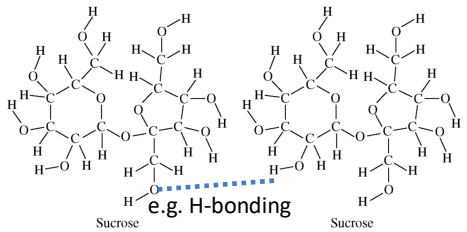
7. INTERMOLECULAR FORCES (between molecules)

- Dispersion (non-polar, e.g. C_nH_{2n+2} ---C_nH_{2n+2})
- Dipole-dipole (polar, e.g. HCl---HCl)
- H-bonding (e.g. HF---HF---HF)



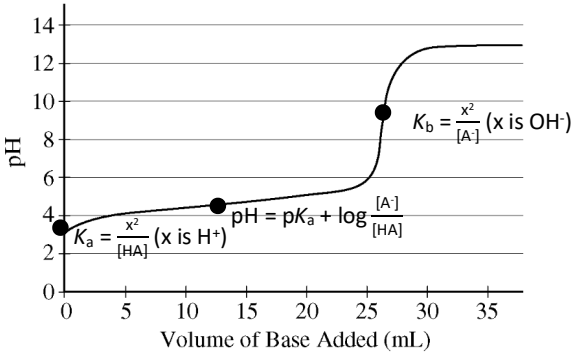
e.g. dispersion forces





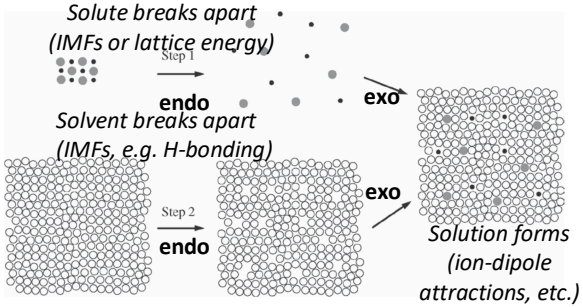
e.g. H-bonding

8. ACIDS, BASES, BUFFERS, & TITRATIONS

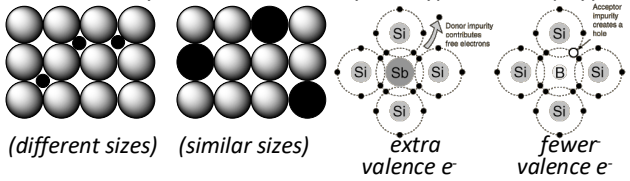


strong = HCl, HBr, HI, H_2SO_4, HNO_3, $HClO_3$, $HClO_4$

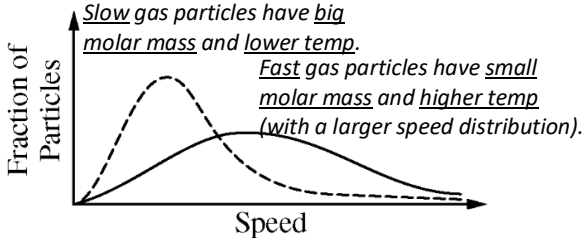
9. SOLUTION FORMATION



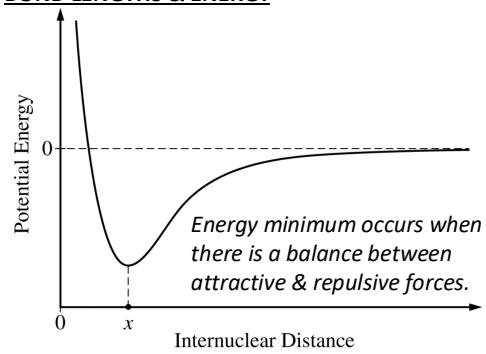
10. ALLOYS & SEMICONDUCTORS



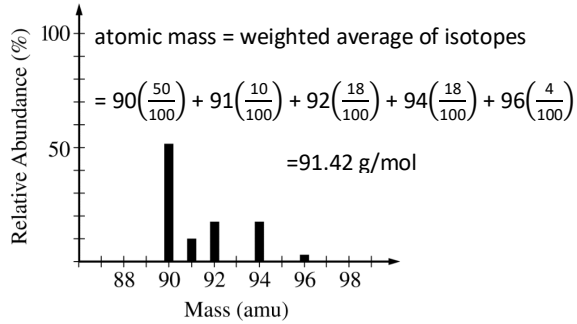
11. GAS SPEEDS



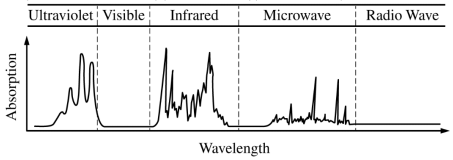
12. BOND LENGTHS & ENERGY



13. MASS SPECTROMETRY

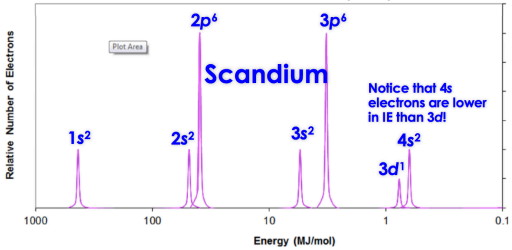


14. ABSORPTION SPECTROSCOPY



- Ultraviolet (UV)… e^- transition
- Infrared (IR)… molecular vibration
- Microwave (μ)… molecular rotation

15. PHOTOELECTRON SPECTROSCOPY (PES)



Inner electrons have a higher binding energy. Outer electrons are shielded and have lower BE.

16. K_{sp} & SOLUBILITY:

- 1:1 $K_{sp} = x^2$ $MX \rightleftharpoons M^+ + X^-$
- 1:2 $K_{sp} = 4x^3$ $MX_2 \rightleftharpoons M^{2+} + 2\,X^-$
- 1:3 $K_{sp} = 27x^4$ $MX_3 \rightleftharpoons M^{3+} + 3\,X^-$
- Group 1, NH_4^+, NO_3^-, $C_2H_3O_2^-$ salts are soluble
- Cl^-, Br^-, I^- are soluble, *except* with Ag, Hg, Pb

17. SPONTANEITY ("thermodynamically favorable")

ΔH	ΔS	$\Delta G = \Delta H - T\Delta S < 0$ at…
(–)	(+)	all temps (best scenario)
(+)	(–)	no temps (worst scenario)
(+)	(+)	high temps
(–)	(–)	low temps

18. GALVANIC / VOLTAIC CELLS (spontaneous)

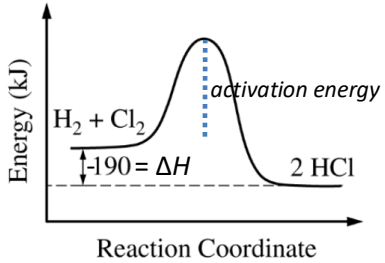
anode	***cathode***
oxidation	reduction
(–) side	(+) side
less positive E_{red}^o	more positive E_{red}^o
e^- leave	e^- enter

19. COMPLEX IONS & LIGANDS

- Key words: "excess, concentrated"
- usually 2x # ligands as charge on metal ion
- ligands = H_2O, NH_3, OH^-, CN^-, Cl^-, etc.
- metals = Al^{3+}, Zn^{2+}, Cu^{2+}, Ni^{2+}, Ag^+, etc.

EX: $Cu^{2+} + 4\ NH_3 \rightarrow Cu(NH_3)_4^{2+}$

20. REACTION ENERGY DIAGRAMS



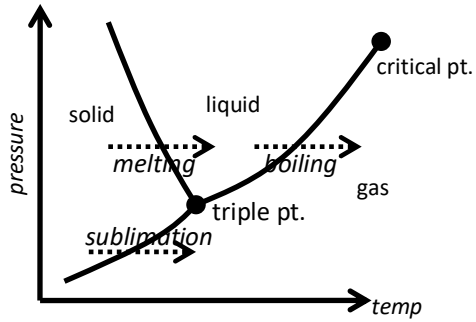
21. COLLISION THEORY

- Higher temperature = collisions with more KE
- More surface area = more frequent collisions
- Higher concentration = more frequent collisions

22. RATE LAWS

zero order	1st order	2nd order
$rate = k$	$rate = k[A]$	$rate = k[A]^2$
$[A] = [A]_o - kt$	$\ln[A] = \ln[A]_o - kt$	$\frac{1}{[A]} = \frac{1}{[A]_o} + kt$
$t_{½} = \frac{[A]_o}{2k}$	$t_{½} = \frac{\ln 2}{k}$	$t_{½} = \frac{1}{k[A]_o}$
[A] vs time	ln[A] vs time	1/[A] vs time

23. PHASE DIAGRAMS (not on AP)



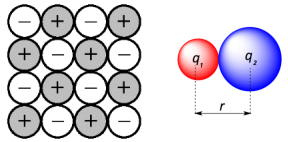
24. ORGANIC FUNCTIONAL GROUPS (not on AP)

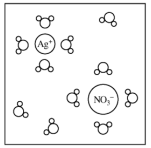
alkane C–C	alkene C=C	alkyne C≡C
amine —N—	aldehyde O C–C–H	amide O C–C–N
halide C–X	alcohol C–OH	ether C–O–C
acid O C–C–OH	ketone O C–C–C	ester O C–C–O–C

25. COULOMBIC FORCES OF ATTRACTION (for ions!)

Strong forces occur when ions are small and have more charge.

lattice energy = $E = \frac{kQ_1Q_2}{r}$





In ionic solids, there exists more lattice energy when the ions are closer together and or have greater charge magnitude. This leads to higher melting points, etc.

In aqueous salt solutions, there are stronger ion-dipole interactions when the ions are smaller and have greater charge magnitude.

26. REACTION TYPES (not on AP)

Type:	Example:
precipitation	$Ag^+ + Cl^- \rightarrow AgCl$
acid-base	$HC_2H_3O_2 + OH^- \rightarrow C_2H_3O_2^- + H_2O$
redox	$5\ Fe^{2+} + MnO_4^- + 8\ H^+ \rightarrow 5\ Fe^{3+} + Mn^{2+} + 4\ H_2O$
acid + metal	$Zn + H^+ \rightarrow Zn^{2+} + H_2$
acid + carbonate	$MgCO_3 + 2\ H^+ \rightarrow Mg^{2+} + H_2O + CO_2$
H_2O_2 decomp	$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

Reactants:	synthesize to form…	Example:	Product:
pure elements	a binary compound	$Mg + O_2 \rightarrow$	MgO_2
CO_2 + metal oxide	a carbonate (CO_3^{2-})	$CO_2 + K_2O \rightarrow$	K_2CO_3
O_2 + chloride	a chlorate (ClO_3^-)	$O_2 + KCl \rightarrow$	$KClO_3$
H_2O + metal oxide	a base (OH^-)	$H_2O + Na_2O \rightarrow$	NaOH
H_2O + nonmetal oxide	an acid (HX)	$H_2O + SO_2 \rightarrow$	H_2SO_3

Reactant:	decomposes into…	Example:	Products:
binary (**XY**)	elements	$MgCl_2 \rightarrow$	$Mg + Cl_2$
carbonate (X**CO_3**)	CO_2 + metal oxide	$CaCO_3 \rightarrow$	$CO_2 + CaO$
chlorate (X**ClO_3**)	O_2 + metal chloride	$Ba(ClO_3)_2 \rightarrow$	$O_2 + BaCl_2$
base (X**OH**)	H_2O + metal oxide	$Ca(OH)_2 \rightarrow$	$H_2O + CaO$
acid (**H**X)	H_2O + nonmetal oxide	$H_3PO_4 \rightarrow$	$H_2O + P_2O_5$

27. QUANTUM NUMBERS (not on AP)

- n = 1, 2, 3, … energy level
- l = 0…(n – 1)… (*0 = s, 1 = p, 2 = d, 3 = f*)
- m_l = - l … + l
- m_s = +½, -½

Ion	Name	Ion	Name
Hg_2^{2+}	Mercury(I)	NCS^-	Thiocyanate
NH_4^+	Ammonium	CO_3^{2-}	Carbonate
NO_2^-	Nitrite	HCO_3^-	Hydrogen carbonate (bicarbonate is a widely used common name)
NO_3^-	Nitrate		
SO_3^{2-}	Sulfite		
SO_4^{2-}	Sulfate	ClO^-	Hypochlorite
HSO_4^-	Hydrogen sulfate (bisulfate is a widely used common name)	ClO_2^-	Chlorite
		ClO_3^-	Chlorate
		ClO_4^-	Perchlorate
OH^-	Hydroxide	$C_2H_3O_2^-$	Acetate
CN^-	Cyanide	MnO_4^-	Permanganate
PO_4^{3-}	Phosphate	$Cr_2O_7^{2-}$	Dichromate
HPO_4^{2-}	Hydrogen phosphate	CrO_4^{2-}	Chromate
$H_2PO_4^-$	Dihydrogen phosphate	O_2^{2-}	Peroxide
		$C_2O_4^{2-}$	Oxalate

28. NUCLEAR CHEMISTRY (not on AP)

- alpha = ^4_2He or $^4_2\alpha$
- beta/electron = $^0_{-1}e$ or $ß^-$
- neutron = ^1_0n
- positron = $^0_{+1}e$ or $ß^+$

29. COLORS (not on AP)

$MnO_4^-(aq)$	dark purple	$Na^+(flame)$	yellow
$Cu^{2+}(aq)$	blue	$Ba^{2+}(flame)$	green
$Cr^{2+}(aq)$	blue	$Cu^{2+}(flame)$	green
$Mn^{2+}(aq)$	faint pink	$K^+(flame)$	violet
$Ni^{2+}(aq)$	green	$Sr^{2+}(flame)$	red
$Co^{2+}(aq)$	pink	$Li^+(flame)$	red
$CrO_4^{2-}(aq)$	yellow	$Ca^{2+}(flame)$	orange
$Cr_2O_7^{2-}(aq)$	orange	$Cl_2(g)$	green gas
$Br_2(l)$	red liquid	$I_2(s)$	purple solid

30. SOLUBILITY RULES (not on AP)

- nitrate, group 1, ammonium, and acetate salts are <u>soluble</u>..... KNO_3(aq)
- Cl^-, Br^- and I^- salts are <u>soluble</u> *except* with Ag^+, Pb^{2+}, Hg_2^{2+}..... AgCl(s)
- sulfate salts are <u>soluble</u> *except* with Ba^{2+}, Pb^{2+}, Hg_2^{2+}, Ca^{2+}..... $BaSO_4$(s)
- fluoride salts are <u>soluble</u> *except* with group 2, Pb^{2+}, Zn^{2+}..... MgF_2(s)
- S^{2-}, CO_3^{2-}, & OH^- salts are <u>insoluble</u> *except* w/ group 1 ..... $Pb(OH)_2$(s)
- CrO_4^{2-} and PO_4^{3-} salts are <u>insoluble</u> *except* with group 1..... HgS(s)

31. TIPS FOR WRITING FREE RESPONSE ANSWERS - Be sure to *explain* when it asks for a *justification*! Show all work! Use correct sig figs, units, and signs!

- Say "thermodynamically favorable" instead of "spontaneous."
- Say "reaction proceeds" instead of "shifts" when explaining with Le Chatelier's principle.
- Say "more polarizable electrons" when discussing a molecule that has stronger dispersion forces.
- Say "effective nuclear charge" when explaining that an atom has more protons.
- Say "Coulombic attraction" when explaining an ionic compound's greater lattice energy.