Chapter 15: Acids & Bases
Arrhenius: Acid increases H^+, Base increases OH^-
Bronsted: Acid donates proton, Base accepts
Lewis: Acid accepts e- pair, base donates
Acid Strength influenced by: bond polarity & bond strength
-increases going down a column, across a row, w/ # of O's
-decreases w/ increasing electronegativity
$K_w = 1.0 \times 10^{-14} = [H^+][OH^-]$ $K_w = K_a \times K_b$
If K is small, preference for reactants
Strong Acids: $HClO_4$, H_2SO_4, HI, HBr, HCl, HNO_3
Strong Bases: LiOH, NaOH, KOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$
$pH = -\log[H_3O^+]$ $[H_3O^+] = 10^{-pH}$ pH + pOH = 14

Chapter 16: Acid-Base Equilibrium, Buffers
$K_a = [H_3O^+][A^-]/[HA]$ $K_b = [HB^+][OH^-]/[B]$
° of ionization = x/original conc.
Small K_a -> weak acid; large K_a -> strong acid
Properties of salt solutions:
-strong acid + strong base: neutral sltn (NaCl)
-weak acid + strong base: basic sltn (NaCN)
-strong acid + weak base: acidic sltn (NH_4Cl)
-weak acid + weak base: depends on K_a vs. K_b
Buffers: resist changes in pH
Adding HCl to pure water: $[H_3O^+]$ = amount H^+ added/total volume
Henderson-Hasselbach Eqtn: $pH = pK_a + \log(B/A)$
$pK_a = -\log(K_a)$
Acid/Base Titration Curve: plot of pH vs. amount acid/base added
Equivalence point: # mols acid = # mols base
After equiv. point: VA > total volume; before: VA < total volume
After EP: $-\log(cA \times vA - cB \times vB)/V_{total}$

Chapter 18: Thermodynamics & Equilibrium
Entropy (S) Enthalpy (H) Free Energy (G)
$\Delta S = q/T$, @ eqlbm; $\Delta S > q/T$, rxn spontaneous
$\Delta S = \Delta H_{vap}/T$ $\Delta G^\circ_T = \Delta H^\circ - T\Delta S^\circ$
3rd law: a perfect crystalline @ 0K has entropy of 0
Entropy increases when...
-rxn in which a molecule is broken down into 2+
-rxn in which there is an increase in mols of gas
-a process in which solid -> gas/liquid or liquid -> gas
$\Delta S^\circ = \sum nS^\circ(\text{products}) - \sum mS^\circ(\text{reactants})$
$\Delta G^\circ = \sum nG^\circ_f(\text{products}) - \sum mG^\circ_f(\text{reactants})$
$\Delta G = \Delta H - T\Delta S$ $W_{max} = \Delta G$
When... ΔG° is large (-), rxn is spontaneous and proceeds
ΔG° is large (+), rxn is nonspontaneous
ΔG° is small (- or +), rxn is @ eqlbm
$\Delta G = \Delta G^\circ + RT \ln Q$ $\Delta G^\circ = -RT \ln K$ (R = 8.31 J/mol K)
Effect of Temp. on Rxn Spontaneity:

ΔH°	ΔH°	ΔH°	Description
-	+	-	Spont. @ all temps
+	-	+	Non @ all temps
-	-	+/-	Spont @ low, non @ high
+	+	+/-	Non @ lol, spont. @ high

*to find temp. at qhich a rxn becomes spontaneous:
- ΔG°, solve for $T = \Delta H^\circ / \Delta S^\circ$

Chapter 14: Chemical Equilibrium
$Kp = Kc\,(RT)^{\Delta n}$ ... Δn = change in # mols of gas
R = gas constant (.08206 Latm/molK)
When... Kc >> 1, nearly all products @ eqlbm
Kc = 1, mixture of both
Kc << 1, nearly all reactants @ eqlbm
Q vs. K...
Qc > Kc, the rxn goes to left (more reactants)
Qc = Kc, the rxn @ eqlbm
Qc < Kc, the rxn goes to right (more products)
*do not omit $[H_2O]$ for Kc, only Ka or Kb
*don't forget about coefficients as exponents in K's

Chapter 14: Chemical Equilibrium (cont.)
3 ways to alter eqlbm: 1.) change conc. by removing products or adding reactants
2.) change the partial pressures by changing volume 3.) change the temp
*if P is increased (by decreasing V), rxn shifts in direction of fewer gas molecules
*for endo rxn, incr. temp -> incr. of Products; exo rxn, decr. temp -> incr. react.
*a catalyst has no effect on eqlbm, only increases speed of rxn
*heterogeneous eqlbm: omit solids

Chapter 19: Electrochemistry
Faraday's Constant: 1F = 96485 C / 1 mol e-
1AS = 1C/1s
W = (-F)(potential difference) units: J = C·V
Red Cat: reduction occurs at cathode
$W_{max} = -nFE_{cell}$ .....where n = # moles of e-, F = Faraday's constant
$E_{cell} = E_{cathode} - E_{anode}$ $E_{cell} = RT \ln K/nF$ $E_{cell} = .0592/n \log K$
$\Delta G = -nFE_{cell}$ $\Delta G^\circ = -nFE_{cell}^\circ$ $E_{cell} = E_{cell}^\circ - (.0592/n \log K)$
Voltaic Cells: spontaneous, + E_{cell}
*e- flow toward cathode; cations flow toward cathode, anions flow toward anode
*to determine initial voltage: solve for E_{cell}
*to determine voltage after X amps for Y hours:
-change Y to seconds, then convert to C to mol e- to mol ions consumed (D)
-then find new conc. [reactant ion consumed] = original – D
-then find new conc. [product ion produced] = original + D
*to determine how long battery can deliver Z amps before going dead:
-change original mol ion consumed to mol e- to (Z)C to seconds
*to determine the cell potential when the conc. of X ion falls to Y amount:
-determine new Q, but make sure you add the difference of the change from the original top conc. (ex: 1.5 M Cu^{2+} & .05 M Pb^{2+};Cu^{2+} falls to .2 M)
-difference: 1.5 – x = .2, so x = 1.3
-new Q: [.05 + 1.3]/[.2] = [1.35]/[.2]
*aqueous electrolysis: what might occur @ anode/what might occur @ cathode?

Chapter 17: Solubility & Complex Ion Equilibrium
Molar solubility: mols of ionic compound that dissolve to give 1L of saturated sltn
*X from ICE tables tells you molar solubility
*to calc. molar solubility in a different ion: (ex: calc. MS of CuSO4 in NaCN)
-determine overall eqtn & break it up into 2 steps (Kf x Ksp)
Kc = Ksp x Kf
*the smaller the Ksp, the more insoluble
Criterion for Precipitation...
-if Qc > Kc, a precipitate forms
-if Qc = Kc, rxn is @ eqlbm
-if Qc < Kc, no precipitate forms
Fractional Precipitation:
-product w/ larger Ksp will precipitate first
-min conc. to trigger precipitation: solve for Q = Ksp
Complex Ion Equilibria:
Kf (formation constant); Kd (dissociation constant) Kd = 1/Kf
*to determine if a precip will form in a complex ion:
-rearrange to Kd format, the init. conc. on the right will be given amount – (2x the final amount) ex: will precip form from .010 M $AgNO_3$ & .1 M NH_3?
$Ag(NH_3)_2$ -> Ag+ + 2NH_3
.01 0 (.1 – 2x.01) = .98
Amphoteric hydroxides: metal hydroxide that reacts w/ both acids and bases
Ex: Zn^{2+}, Al^{3+}, Cr^{3+}, Pb^{2+}, Sn^{2+}, Sn^{4+}
*to determine if a precip will form when 2 volumes & molarities are given:
-find new conc. of both ions by dividing by total volume, then solve for Q
Separation of Metal Ions by Sulfide Precipitation:
-determine which precipitates first (larger Ksp)
-determine sulfide conc. which will trigger 1st precipitate (Q = Ksp)

Chapter 20: Nuclear Chemistry
Methods of Radioactive Decay:
-Alpha Emission: a ^4_2He nucleus is ejected
-Beta Emission: an electron is ejected
-Positron Emission: a proton is ejected
-Electron Capture
-Gamma Emission: release of energy
Spontaneous Fission: an unstable nucleus splits into 2 separate ones

Chapter 20: Nuclear Chemistry (cont.)
Special stabilities for nucleons:
-protons: 2,8,20,28,50,82
-neutrons: 2,8,20,28,50,82,126
Electron Volt (eV): 1 eV = 1.602×10^{-19} J
$Rate_{decay} = k\ N_t$ ...where K = radioactive decay constant
N_t = # of radioactive nuclei remain @ time T
Curie (Ci): unites for Rate of decay (1 Ci = 3.7×10^{-10} dis/sec
*if given amount remaining in grams: convert to mol to nuclei
6.02×10^{23} nuclei per mole (Avogadro's #)
Half Life: amount of time it takes for half of the nuclei to decay
$t_{1/2} = .693 / k$
Radioactive Dating: 1s = the duration of 9,192,631,770 periods of Radiation corresponding to transitions of a Cesium-133 nucleus
$\ln (N_t/N_0) = -kt$ ...where N_0 = # nuclei @ time 0
*always use these equations in the units of seconds
*to determine amount of Beta emissions that occur in X days:
-solve for k, convert days to seconds & solve for N_t
-then take difference ($N_0 - N_t$) & convert g to mols and then to decays using Avogadro's #
*to determine mass of nuclide that remain after X days:
-convert time to seconds, solve for k, then solve for N_t

Chapter 13: Kinetics
Factors that affect how long a rxn will take:
-as conc. of reactants increases, rate increases
-as conc. of catalyst increases, rate increases
-as temp/surface area increases, rate increases
-does not depend on total quantity consumed
*conc. matters more
Rate of formation: $\Delta[C]/\Delta t$
Rate of consumption: $-\Delta[A]/\Delta t$
*when equating 2 rates, coefficients become fractions
Determining Rate Laws: if init. conc. of react. is doubled/tripled...

Order:	rate multiplied by:
-1	½ / ⅓
0	1 / 1
1	2 / 3
2	4 / 9

Integrated Rate Laws:

Order	Integrated Rate Law	Units of K	Half-life
0	$[A]_t = -kt + [A]_0$	$M \cdot s^{-1}$	$t_{1/2} = [A]_0 / 2k$
1	$\ln[A]_t = -kt + \ln[A]_0$	s^{-1}	$t_{1/2} = 0.693/k$
2	$1/[A]_t = -kt + 1/[A]_0$	$M^{-1} \cdot s^{-1}$	$t_{1/2} = 1/k[A]_0$

*if k is large, the rxn is fast
Temperature vs. Rxn Rate:
-activation energy (Ea)
-if Ea is low, the rxn is fast
-if temp. increases, k increases
....where A = Arrhenius constant
Ea = activation energy
R = gas constant (8.31)
T = temp
k = rate constant

Elementary Reactions:
-the simpler steps that + together to give a more complex rxn
-intermediates are crosses off
-slowest step determines overall speed of rxn
Molecularity Rates:
-unimolecular rate = k[A]
-bimolecular rate = k[A][B]
-terimolecular rate = k[A][B][C]
*to determine how fast a reactant is disappearing:
-if given other reactant, set them equal to each other
-if given product, set them equal to each other
-remember coefficients become fractions

Chapter 13: Kinetics (cont.)
*to determine how long until [A] decays to 12.5%: (3 half-lives)
-solve for half-life and multiply by 3 (for 1st order rxns)
-for other orders: calc. regular half-lives, then the next one using new $[A]_0$
*if given $[A]_0$ = .2M, how long until the conc. reaches .015M? ($[A]_t$ = .015M)
-use integrated rate law and solve for t
*don't write rate laws in terms of intermediates
-choose one intermediate to solve for and substitute
-combine all k's together
Effect of Catalysts:
-don't change overall ΔH, only lowers Ea
*to determine rate law from initial rates of trials:
-compare exp 1 to 2, exp 1 to 3, and exp 1 to 4
-solve for each exponent (m,n,p)

Chapter 23: Organic Chemistry
*carbon makes 4 bonds, but only if sp, sp^2, or sp^3
*if structure is unique, molecule is unique
Methyl: carbon at end
Methylene: carbon in middle w/ 2 H
Methyne: carbon in middle w/ 1 H
Constitutional isomers: same molecular formula, different structure
Saturated: all single bonds (C_nH_{2+2n})
Unsaturated: double bonds (pi bonds), triple bonds, or rings
*to make a ring, you must remove 2 H atoms
Aromaticity: being in a ring w/ max double bonds
Carbon Roots: (meth, eth, prop, but, pent, hex, hept, oct, non, dec)
Naming Hydrocarbons (C & H only)
1. 1. Find longest carbon chain
2. 2. Any branches are named as allcul groups
3. 3. # the chain so substituents are at smallest #s
4. 4. When more than 1 branch: use di,tri,tera prefix
-commas btwn #s, - btwn #s and letters
-substituents are in abc order

Alkanes: all single bonds
Alkenes: double bonds
Alkynes: triple bonds
E (trans): opposite constituents
Z (cis): same side constituents
Amide: N atom connected to a carbonyl