

CH1a Final Review Sheet, 2009

This review sheet should help you study for the final exam. If you can go through each topic on this list and say a few sentences about it, you should be in good shape. Be aware that there may be things on the exam which are not on this sheet.

TOPICS

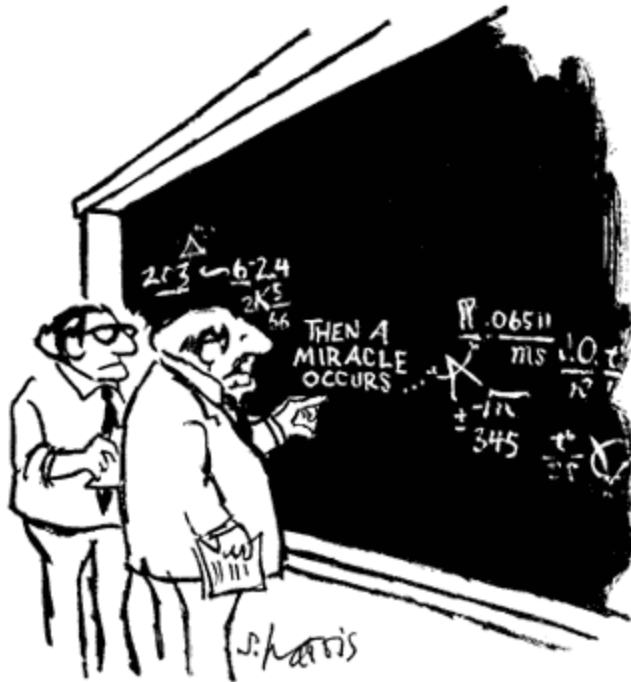
- 1) EVERYTHING FROM THE FIRST HALF OF THE COURSE! (The exam will focus on concepts from the second half, but concepts from the first half are still fair game.)
- 2) Atmospheric Chemistry
 - a) Temperature profile of the atmosphere
 - b) Free radicals
 - c) Radical chain reactions
 - i) Initiation
 - ii) Propagation
 - iii) Termination
 - d) Chlorine-catalyzed ozone destruction mechanism
 - e) Chlorofluorocarbons: structure, uses, why they are harmful
- 3) VSEPR (Valence Shell Electron Pair Repulsion Theory)
 - a) Steric number
 - b) Know all possible molecular geometries
 - c) VSEPR is only effective for molecules made of 1st and 2nd row atoms
 - d) Effect of lone pairs on geometry and bond angles
 - e) Effect of atom properties (electronegativity, etc.) on bond angles
- 4) Molecular Orbital Theory
 - a) What is meant by “linear combination of atomic orbitals (LCAO)”
 - b) What determines equilibrium bond length
 - c) Z axis is defined as internuclear axis
 - d) Atoms with wave functions of opposite polarity give antibonding orbitals with antibonding nodal planes
 - e) The number of M.O.s obtained is equal to the number of A.O.s used
 - f) Relative energies of bonding and antibonding orbitals
 - g) Names of M.O.s (sigma, pi, etc.)
 - h) Electron filling into M.O.s
 - i) Calculating bond order
 - j) Meaning of paramagnetic and diamagnetic
 - k) Drawing M.O.s for ions
 - l) Overlap Rule: Atomic orbitals which have better spatial overlap between their orbitals...
 - i) ... are closer in energy
 - ii) ...have bigger splitting between the bonding and the antibonding orbital energies
 - iii) ...have shorter bond lengths
 - m) How p orbitals form pi orbitals; which p orbitals can't form pi orbitals and why
 - n) The energy diagram for homonuclear diatomics

- o) The energy diagram for heteronuclear diatomics, esp. HF
 - p) When is the $2\sigma_b$ orbital higher in energy than the $2\pi_b$ orbitals and why?
 - q) How to tell whether a M.O. is σ or π
- 5) Hybridization
- a) The possible types of hybrid orbitals (sp , sp^2 , sp^3 , dsp^3 , d^2sp^3 ; see Gray pg. 122)
 - b) Rules for hybridization (slides X-15 and X-16)
 - i) Assign geometry using VSEPR theory
 - ii) Write electronic configuration of the atom to be hybridized
 - iii) Draw energy diagram for said atom and “decouple” paired electrons
 - iv) Take linear combinations of the atomic orbitals participating in the bond to make hybrid orbitals
 - v) Combine hybrid orbitals with other atom’s orbitals using diatomic M.O. theory
 - c) How to build up large molecules using hybridization
 - d) π bond networks from unhybridized p orbitals
 - e) Double bonds are formed by one σ and one π bond
 - f) Triple bonds are formed by one σ and two π bonds
 - g) How double bonds and triple bonds affect bond rotation
 - h) M.O.s of benzene
 - i) Extended delocalized pi networks such as graphite
 - j) Band structure in conduction polymers such as polyethylene
- 6) 18 Electron Rule (see notes for structures) (electron counts below are for neutral method)
- a) Common 1-electron donors: H, F, Cl, CH_3
 - b) Common 2-electron donors: CO, NH_3 , anything with a lone pair
 - c) Common 3-electron donors: allyl radical, cyclopentadienyl ($\eta = 3$)
 - d) Common 4-electron donors: butadiene, cyclobutadiene, things with two lone pairs
 - e) Common 5-electron donors: cyclopentadienyl ($\eta = 5$)
 - f) Hapticity, η
 - g) Allyl radical can donate 1 or 3 electrons
 - h) Cyclopentadienyl can donate 1, 3, or 5 electrons
 - i) Benzene can donate 2, 4, or 6 electrons
 - j) 3D structures are possible
 - k) Metals can form dimers to get to 18 electrons
- 7) Transition Metal Complexes
- a) Most common geometries (octahedral, tetrahedral, square planar)
 - b) Different isomers yield different properties (color, etc.)
 - c) Definition of cis and trans (Slide XIII-5)
 - d) How to determine oxidation number of central metal
 - e) Definition of the following terms:
 - i) Oxidation number (oxidation state)
 - ii) Coordination number
 - iii) Ligand
 - iv) Complex ion
 - v) Counter ion

- vi) Outer sphere
- vii) Chelate effect
- viii) Chelation
- f) How to write formulas for complexes
- g) Exceptions to electron filling order in metals
- h) Writing electron configurations for metals in various oxidation states
- i) Crystal field splitting
 - i) Why splitting occurs
 - ii) How the levels split for octahedral complexes (d_{z^2} and $d_{x^2-y^2}$ on top and d_{xy} , d_{yz} , and d_{zx} on the bottom) and for tetrahedral complexes (the opposite)
 - iii) Filling electrons in d orbitals of liganded metals
 - iv) Definitions of:
 - (1) High spin
 - (2) Low spin
 - (3) Strong-field ligand
 - (4) Weak-field ligand
 - v) Spectrochemical series
 - vi) How magnetic properties arise in metal complexes
 - vii) There are no low spin tetrahedral complexes; the splitting is too small
 - viii) How to calculate ligand field stabilization energy
 - ix) Trend in ligand field stabilization energy
- j) Common multidentate ligands (ethylenediamine, EDTA)
- k) Crown ethers
- l) Ignore everything in notes about electron exchange

8) Crystals

- a) Know the unit cells for:
 - i) Simple cubic lattice
 - ii) Face-centered cubic
 - iii) Rock salt structure
 - iv) Zinc blende structure
 - v) Body-centered cubic structure
 - vi) Fluorite
 - vii) Anti-fluorite
 - viii) Li_3B
- b) Stoichiometry of lattices (fractional atoms)
- c) Geometry of cubic lattices (and when one type of lattice changes to another, limits of ratio of cation radius to anionic radius)
- d) Lattice stabilization, how to calculate Madelung constants
- e) Doping
 - i) p-type (extra hole introduced to lattice)
 - ii) n-type (extra electron introduced to lattice)
 - iii) What would you use to dope silicon? Germanium? Gallium arsenide?



"I think you should be more explicit here in step two."