Math and Measurement

Sig digs

- 0 sig figs means data is not precise enough
- when dealing with logs/ln, all sig digs are only in the decimal places
  - seems like logs/ln are gaining sig digs
- when taking antilogs/anti-lns the number of sig digs after the decimal place represent the total # of sig digs in the calculated result
  - seems like its loosing sig digs

Exact numbers

- By definition
  - # that are counted
  - # that are math operators
  - # that are defined
  - Unit prefix conversions
- The sig digs for exact numbers is infinity

The Atom

(Sept 14th, 16)
Studying e- using EMR

- Photons: particles of light
- E and wavelength have an inversely related
- theres only one wavelength for each energy
- plank's constant is a measured value
- "quantized"

(Sept 19th, 16)
Rydberg Equation

- Certain specific allowed e states
  - if e is +ve, the photon is absorbed by the atom (up)
  - if e is -ve the photon is released by the atom (down)
- R.E. describes the e gap between the e levels in H+ atom
- once the e is known, use physics e formulas to find wavelength

R.E. for atoms other than H+

- no relationship to describe gap
- every atom has a unique em/abs spectrum

Photoelectric effect

- intensity is not the same thing as frequency
- photon striking an atom an e- being ejected off (1photon = 1e-)
- Ionization e (gas-phase) is the e required to remove one e- from an atom. Useful things:
  - Ionization e
  - sense of tendency to form covalent bonds (how tightly the e- are being held on by the

atoms)
- solubility of ionic compounds (in order to dissolve they must be separated)
- crystal lattice e

- when solving a ionization e problem: Don't answer in exponential form when it isn't scientific & express answer in KJ/mol
- Work function: the min e requires to remove an e- from a solid surface
  - incident photons e > than the work function of the material
  - excess e is converted into ke
  - work function is a version of conservation of e

(Sept 21st, 16)
Multi-electron atoms

- Looking at the H+ atom, one description is enough to describe the electrons position and behaviour
- with multi-electron atoms, we use the n value to describe the avg size of the space the electron occupies
- Also need:
  - 3 descriptors to describe the space in which the e is most likely to be found
    - size of the area
    - shape " "
    - tilt " "
  - 1 more descriptor to describe the behaviour in that space
    - spin of electron (relative to the nucleus)
- Quantum numbers

symbol	name	describes	a
n	Principal	Avg. distance from nucleus	
l	Angular	Shape of area where the electron is most probably found	
m_l	Magnetic	Tilt of the area, relative to the areas where other electrons are most probably found	
m_s	Spin	Direction of spin of the electron relative to the spin of the nucleus	Sp

- shell and sub-shell are enough nfo without B

spfghij..

- Pauli Exclusion Principle - no 2 e- in the same atom may have the same set of 4 quantum #s
- ground state- when all e- are in the lowest possible e level
- EMPE is energy relative to the nucleus
  - depends on distance from nu & electrical/mag interactions with other e-

(Sept 28th)
- Exceptions
  - one not completely filled level, but another higher on the list is occupied. There's more stability in
    - fully filled subshells
    - exactly 1/2 filled subtle
  - a level that is normally lower in e is actually higher in some configurations
    - Rows of La>> and Ac>> when the f only has 1 e- it prefers the d subshel

Atomic Size (aka space taken up)
- based on bonding
- based on couplet spacing
- nucleus pulls atoms inwards
- other e- pushes outwards
  - the ones in the same shells push the other ones around
  - the e- in the smaller shells push them outwards
- from left to right, atomic size is smaller because of the increasing amount of e- doing the inward pushing
- ionization energy is inversely proportional to atomic size (atomic number)
- another property that can intervene is the special stability
- diff. btw extra stability before vs extra stability after (graph diff)
- Be B N O
- General trend: IE lower in bottom left part of PTE and higher in top right PTE [/]

Higher order ionizations
- ionization is always the removal of ONE e

Electron affinity
- aka energy
- it is the e- required to add ONE e- to a gas phase particle
- not the reverse reaction of the ionization

[big difference btw ionization and electron affinity is that any element can be ionized but electron affinity cannot (lithium) therefore usually for EA you will be given elements that spont. react]

Electronegativity
- the tendency for an atom to pull e- in a chemical (in a covalent bond) bonds towards itself. I

The molecule

Ions vs cations
Cations

- must memorize molecular cation of ammonium

Anions
- “ide"
- the charge on an inion is never specified (no element can form more than one type of anion.

Correcting formal charge
- mol has a memory of its last charge
- F.C. = group # -(#Le- + #bonds)
- charges add up to total charge

Resonance
- wn Lewis structure has equivalent bonds > multiple bonds: multiple bonds are shared amg the equiv. positions
- show every possible position
- Bond order = total indiv. them bonds @ c position / # of structures
- resonance structures are NOT Lws

Bond Dipoles
- e- are not shared equally = partial charges (+/-)
- + en- = pull e- closer to itself
- shown as a vector (pointing towards the density shift. aka most en-)
- net dipole: overall shift (vector sum)

VSEPR
- deals with the geometry/shape of bonds
- Draw Lw
- look at Central atom to decide shape
- lone pairs (part of the shape not the naming process)
- bonds & outer atoms
- name & draw shape
- Lone pairs are always equatorial on the trigonal pyramid

Valence bond theory
- pi > sigma
- double bond > single bond
- double = sigma + pi

Molecule Bonding

Molecular bonding theory
- when we want to know the molecular orbitals
- mo theory says that atomic orbitals don’t just overlap-they blend

- only deal with diatomic

Single
- single - sigma (one and only one molecular orbital)
- lower e = e- going down = stabilizing energy (aka bonding)
- orbital at higher e than the original atomic orbital = destabilizing e when occupied (anti bonding)
- orbitals are conserved
- increase in e is shown from bottom to top

N type
- pi-p and sigma-p
- n looks like a fish

O-type
- diff between o and n is that the orbitals in the regions are flipped. pi-p is higher than the sigma-p
- o looks like an o
- avg atomic

Bond orders
- (#bonding e- #anti bonding e-)/2

Magnetism
- Diamagnetic: all e- are paired. The mol is not attracted to a B
- Paramagnetic: at least one unpaired e-. mol is attracted to a B

Mo theory Band Diagrams
- metals, carbon, silicon
- 4Li vs 4H.

Gases

Pv=nrt
- works because at relatively low pressures, errors cancel
- errors depend on concentration of gas (n/v)

Correction
- size (V=nb)
  b being Vander Wals constant which is different dependant on the size of particles
- IMF “stickiness/non-elasticiy"

Notes: a negative pressure derived from the ideal gas law, means that the gas overcomes intermolecular forces and therefore liquifies

Percent error:

- "wrong value" - true value / wrong

Gas Mixtures
- mole fraction: #mols of 1 component/total # of mols
- Fractional pressure

Liquids

- Fluid
- Condensed
- Mercury, bromine, noble gases water, acetic acid, acetone, gasoline

Intermolecular forces
- dipole-dipole forces: present in polar molecules but supaaa small
- Hydrogen Bonding - FON (Fluorine, Oxygen, Nitrogen) these are not chemical bond. weaker than a covalent bond but x3 stronger than these 3
- LDF- only sig for atoms & non-polar molecules and large molecules

Physical Properties
- Cohesion: IM attraction btw like mols
- Adhesion: IM attraction between unlike mols

Solutions

Solvent -Most abundant component (usually liquid)
solute- component that is dispersed

For covalent compounds..
- 1 mol of solid > 1 mol of solute in the solvent

For ionic compounds
- 1 mol of solid > 2 total mols of solute in solvent

Categories of concentration unit
- relate amount of <u>1 component vs the total amount</u> of all other components including itself (ex molarity, mole fraction, mass %)
- relate the amount of <u>1 component to the amount of some other component</u> (molality)

<u>NOTE: ending M is not the concentration of the elements. It is the concentration of the formula</u>

Molarity:

mols 1 component / total #L of solution
= mol/L or M

* Mole Fraction:
# mols os 1 component / total # of all components
= mols/mols (unitless)

Mass percentage
mass of 1 component / total mass of all components *100
=g/g (unitless)

Molality (m)
mols of 1 component / # of kilograms of solvent
=mol/kg = m

Colligative Properties: prop that depend on # of particles in solution. NOT the nature of the particles

Boiling point elevation/freezing point depression
- dissolved material interferes with ability of solvent mols to either
  - leave the liquid and enter the gas phase
  - crystallize into a solid
- Harder to boil = bp goes up
- harder to freeze= fp goes down

The change of temp is dependant of:
- the nature of the solvent (pure???)
- # of dissolved particles per kg of solvent (molality)