Wed 6th 1st class

- Office hours: Monday 9:45 - 11 Tuesday 11:45 - 1
- Mid term 1: Wed 18 Oct, Mid term 2: Mon 20 Nov
    - No office hours in mid term days.
- Final exam date announced at 8 Oct, somwhere Dec 10-22.
- Assignments can be submitted by paper, only marking by inclass copies
    - Can backup with scan/picture

Topic 1. Math and Measurement

Definitions:

- Significand(mantissa): The nonzero part of the number.
- Exponent: The multiple of 10.
- Scientific notation: Significand + Exponent
- Standard notation: Just numbers
- Exact Numbers:(numbers that is exactly correct thus has infinite sigfigs.)
    - Counted: e.g. the number of students in the room.
    - As mathematical operators: numbers in a mathematical equation
    - Defined: e.g. it is exactly 2.54 cm per inch.

Scientific Notation:

- Between 1 - 9.9999…
- No 0.x, you need **one** non zero before any decimals.
    - In numbers that are smaller than 1, you put a negative exponent instead.

Sigfigs(Significant Figures)

- Sig figs tell you that they know that the value is ±2 of the last significant digit.
    - Ex. 58926.325 means that they know it's somewhere between 58926.323 - 58926.327(what about during multiplication process)
- Rules:
    - All nonzero digits are significant
    - Any zeros between two digits are significant
    - The zeros on the right of the digit **are only** significant when there is a decimal.
    - Zeros in the left hand is **never** significant.
    - Don't round it up during calculations

    - **The sig fig rule does not apply to 10^x numbers because it could destroy the sigfig numbers of scientific notation. (and all cases)**
    - **1/x is just an inverse(x^{-1}) so sigfig is determined by the x.**

- Multiplication/Subtraction:
    - The final answer should be the input's fewest sigfig.

- Addition/Subtraction:
    - The final answer should be the input's least precise number, if the exponent of all input values are equal.
    - If we use the mult/div rule, it doesn't fall under uncertainty range. So fuck it.
    - **Keep the answers same exponent too. Then convert into scientific notation.**
    - **Don't give a shit about sigifigs when you add/subtract. Just give a shit about precision.**

- Logarithms
    - The number of sigfigs in the output is equal to the number of decimal places of the output.
    - $\log(2.73\times10^{-5}) = \log(2.73) + \log(10^{-5}) = 0.436 + (-5.00000000\ldots) = -4.\underline{564}$

    - Anti-logs are just opposite of logs, it's the sigfig after the decimal point.

Topic 2: matomato

Definition:

- Atomic number: Symbol Z: number of protons in the nucleus
    - All you need to identify an element.

- Mass number: Symbol A: number of protons and neutrons in the nucleus

- Isotope: Some atomic number, different mass number.

- EMR: Electromagnetic Radiation: Light, higher energy than the visible spectrum, and lower energy than the visible spectrum.

- Photons: “Particles” of light, whose energy depends on the frequency or wavelength of the radiation.

- Photoelectric effect: When a beam of photons with certain amount of energy is striked to the electron from any element, the electrons is emitted.

- Ionization Energy: Energy needed to take one electron out of an atom of an element.

- Work function: The minimum energy needed to take one electron out in a **solid** surface.

- Ground state - When all the electrons are in the lowest possible state.

- Quantum Numbers:
    - n : principal - avg. size of area where the electron is most probably found
    - 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 electron relative to nucleus.

- Atomic size: space occupied in a solid or a compound, determined by the attraction between the electrons and the nucleus.

- Electron Affinity : Energy released when electron is added.

- Electronegativity : Tendency to steal electrons from other chemicals.

- Ion Formation : Moves electron on or off to fill or empty the entire s and p shell.

- Valence shell: The shell that’s the furthest from the nucleus, and also the highest energy **LEVEL.**

- Valence subshell: any and all subshells inside the valence shell which has at least one electron.

EMR and Energy levels of hydrogen atom:

- Let's just say that EMR is made of photons; It's oversimplification, but explains quite well.

- EMR teaches us that if there is only one energy level, there should be only type of wavelength present.
- But spectrometer fucked that so proves that electrons has specific energy levels and absorb energy to move up and release energy to move down the energy level. The electrons would always want to go back to lower energy level and thus it creates an equilibrium.

- Electrons constantly move up and down the energy levels.

- Only hydrogen can be mathematically explained, any other atoms don't give a shit.(More exactly, it's because the equation only works for 1 electron system)

Photoelectric effect:

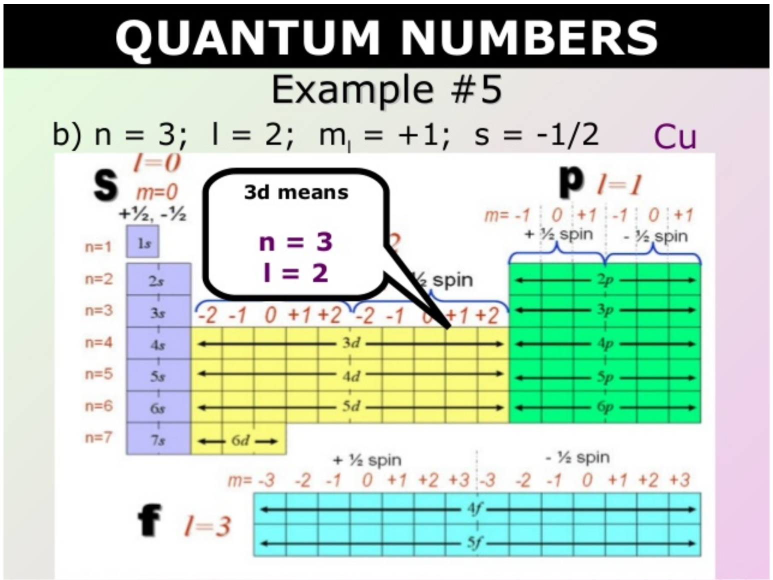
To experiment:
1. Take a gas phase of a sample of an element
2. Shine EMR(photons) to the element in relatively low energy.
3. Slowly increase the energy
4. Find a point where the electrons just start to appear.

- **Photoelectric effect involves the collision between 1:1 ratio of an electron and a photon.**

- If the photons have more energy than work function, then the energy gets converted to kinetic energy, and the electrons will move out faster.

- **Multi-electron Atoms:**
    - For hydrogen, one descriptor is enough to describe the electron's position and behavior.
    - For anything other than that, you need more than that.
    - **Quantum number:**
        - Principal(n) -shell- pretty much energy level, usually equivalent to the row of periodic table, ex. 1,2,3,4…

        - Angular(l) - subshell-, s, p, d, f. Ex. 0,1,2,3, 0 = s-orbital and so on.
        - Magnetic(m_l) - orbital - range = -l ~ l
            - -1 in p orbital means has one electron in p orbital, -1,0 means 2 electron, and -1,0,1 means
        - Spin(m_s) - -½, and ½ . If there is two electrons in any specific shell, then it's -½. If it's there is maximum of one electron, then the spin is ½.
- Ex.



QUANTUM NUMBERS

Example #5

b) $n = 3$; $l = 2$; $m_l = +1$; $s = -1/2$ Cu

- Pauli Exclusion Principle: No two electrons in the same atom should have the same set of four quantum numbers.
    - This means that electrons can't be in the same place with the same spin, which is why there is two spins to fill two electrons per shell.

- Electrons **TEND** to occupy the lowest level.
- Hund's rule: Electron will always spin parallel to the nucleus if they can.(+ ½)

Electron Configuration

- Only s and p shell can be valence subshell

- The latest shell is the shell with the highest energy level.

- **Mention ALL the quantum numbers of that particular shell when being asked.**

- If a specific atom/ion has both s subshell and p subshell, they are both valence subshell.

- **DON'T CONFUSE BETWEEN HIGHEST ENERGY LEVEL AND HIGHEST ENERGY SUBSHELL. HIGHEST ENERGY LEVEL IS VALENCE ELECTRON AND HIGHEST ENERGY SUBSHELL IS JUST THE MOST FRONT PART OF THE ELECTRON CONFIGURATION.**

- There are exceptions to this electron configuration system.
    - Cr, Mo, Cu, Ag, Au

Periodic properties:

- Atomic size: the attraction between electron and the nucleus
    - Inwards pull: protons in the nucleus
    - Outwards push: core(non-valence) electrons
        - As we go across the periodic table, the number protons in the nucleus increases while the number of core electrons(non-valence) electrons stays the same. Thus, it decreases horizontally.
    - Periodic trend: decreasing down-left diagonal to up-right.
    - Units for atomic radii: Angstroms(10^{-10}m)
    - You consider similar when you compare atoms in down-right diagonal.

- Ionization energy: Energy needed to take one electron out of an atom of an element.
    - Increases as it removes more and more electrons
    - **It always requires and ABSORBS energy.**
    - However it tops in the noble gas, so decreases a bit.
    - Periodic trend: decreasing up-right diagonal to down-left.
    - The smaller the atom, the closer to the nucleus, thus requiring more energy.

- If you break the half-fill/full-fill shell, you need more IE.
- If you create the half-fill/full-fill shell by taking electrons away, you need less IE.

- Full-fill > half-fill

- IE smaller than expected:
    - Li, B, O
- IE larger than expected:
    - Be, N, Ne

- Thus, IE: Li<B<Be<C<O<N<F<Ne

- The atomic radius would only change when you empty out the subshell through ionization.

- Electron affinity: Energy released when electron is added
    - Generally increases as you add more, however significantly drops when you try to add an electron to a noble gas.
    - **IT releases or absorbs energy depending on the atom.**
    - Periodic trend: Decreasing up-right to down-left.

- Electronegativity: Tendency to steal electrons from other chemicals
    - Periodic trend: Decreasing up-right to down-left.

- All periodic trends(atomic size, electronegativity, electron affinity, ionization energy) has a tendency to decrease up-right to down-left **EXCEPT** atomic size.

- Ion Formation: Moves electron on or off to fill or empty the entire s and p shell.
    - You **CAN** empty p (and d) shell when $n \geq 4$.
        - So gallium can form Ga^{1+} **AND** Ga^{3+}.
    - You empty all p and s subshell when $n < 4$. **why?**
    - Rules:
        - Never add more than 3 electrons
        - Never remove more than 3 electrons from small atoms and 4 electrons from big atoms.
            - So when $n \geq 4$.
        - If it's a metal, they are big losers. Always remove their shit.
    - So carbon can't do shit.

    - Transition metals don't always follow predictably. They don't give a shit.

Calculations:

- To calculate the energy of the photon, use formula : $E = \frac{hc}{\lambda}$, where E = energy, h = plank's constant, c = speed of light, lambda = wavelength.
    - Technically, $E = hv$, where v is **NOT VELOCITY,** but frequency.
    - Since Velocity = Frequency x Wavelength, and since we know the speed of light, we can replace frequency with
    - Speed of light/wavelength when you calculate the energy of photon.
    - The unit of energy is **ONE PHOTON collided with ONE ELECTRON**. Therefore take in account when the problem mentions 'mole'.
    - Also KJ. The unit is **joules**.

- **Rydberg Equation:** $E_{Gap} = R_H(1/n_i^2 - 1/n_f^2)$: The energy gap between energy levels in **hydrogen atom**.
    - R_H = Rydberg constant (We use 2.18×10^{-18} J/mol)
    - n_i = electron's initial level
    - n_f = electron's final level
    - Because the electrons constantly move up and down the energy level, you can say that the energy gap between the energy levels is equal to the energy of the photon in that instantaneous moment.

- **Work Function:** $W = E_{photon} - KE$
    - Energy of Photon is **DIFFERENT** from Work function. Don't be a retard.

Topic 3: Molecule

- Cations: Positive ions
    - At the end has the word “ion”.
    - Molecular cations: NH_4^+

- Anions: Negative ions

    - Drop the two last syllables and add -ide.

    - Molecular anions: OH^-, CH_3COO^- (acetate), NO_3^- (nitrate ion), CO_3^{2-} (carbonate ion), SO_4^{2-}(sulfate ion), PO_4^{3-}(phosphate ion)
        - Notice it doesn’t end with -ide.

- **Ionic compound** = Metal + nonmetal or **molecular ion and any other ions**

    - Those molecular ions can form together or with metal/nonmetal ions and can be said as “Ionic compound”

- **Binary Covalent Compound**
    - There is no charges so you have to add some prefixes and shit.
    - You mention the less electronegative first.
        - Take out the last two syllables of the more electronegative that comes second and add -ide.
    - Prefixes
        - Mono/mon
        - Di
        - Tri
        - Tetra/tetr
        - Penta/pent
        - Hexa/hex
        - Hepta/hept
        - Octa/oct
        - Nona/non
        - Deca/dec

- **Lewis Structure**
    - O atoms can often form double bonds
    - C atoms can often form double bond, quite often form triple bond
    - N atoms can quite often from double bonds, often form triple bond
    - Rarely to halogen and never to F atom
    - Never more than 4 bonds to second row atom.

    - Bonding is like sharing 1 electron to other atoms and having access to 1 electron.
    - The number of valence electrons is the amount of electrons you use for lewis structure.
    - If acid, then add the shit out O to H.

    - Calculate the formal charge by calculating each element after bonding.