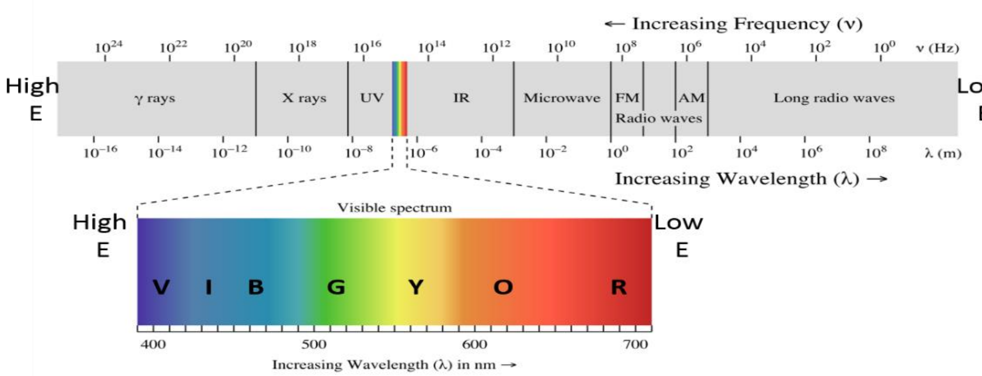
AP Chemistry – Atomic Structure and Periodicity

EM Radiation Spectrum



- Visible Light produced when excited state electrons return back to ground state by releasing energy in the form of a photon
- Radiation in IR region produced from molecular motion

EM Spectrum Calculations

Frequency (f or v)

Wavelength (λ)

Energy (E)

Planck's Constant (h)

Speed of light (c)

$c = \lambda f$ $E = hf$

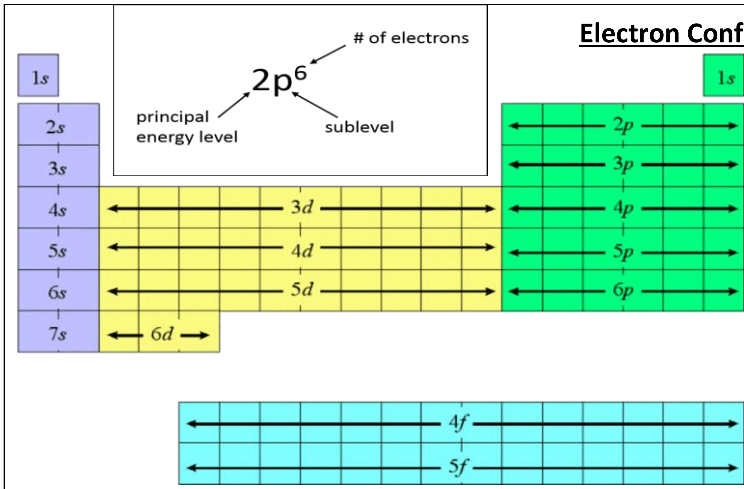
Combine the two…

$$E = \frac{hc}{\lambda}$$

h = 6.63 E -34 J sec

c = 3.00 E 8 m/sec

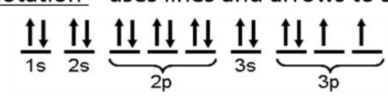
Electron Configurations



Electron configuration – starts with 1s and shows location of ALL electrons within an atom

Noble gas configuration – starts with [Noble gas] and shows location of outermost electrons (VE and d sublevel)

Orbital notation – uses lines and arrows to show electron



(s has 1 orbital) : (p has 3orbitals) : (d has 5 orbitals)

- s will hold max of 2 electrons
- p will hold max of 6 electrons
- d will hold max of 10 electrons

orbitals x 2 e^- per orbital = max # e^-

Rules for electron configs: electrons will fill lowest energy level 1st (aufbau principle)
orbitals can hold a max of 2 electrons (pauli exclusion principle)
e^- will remain unpaired in orbitals, if possible, to reduce e^-/e^- repulsion (Hunds rule)

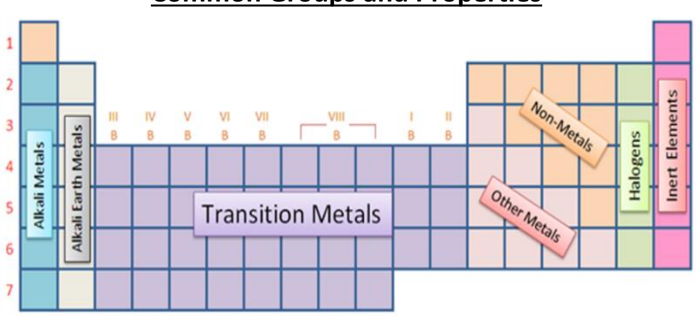
Magnetism (based on unpaired electrons)

Dimagnetic – NO UNPAIRED electrons (not magnetic)

Paramagnetic – HAS UNPAIRED electrons (attracted to magnets)

Ferromagnetic – will retain magnetism when magnetic field applied (has unpaired electrons!)

Common Groups and Properties



Alkali metals (G1A) – very reactive metals, explosive in water

Earth metals (G2A) – soft, silvery metals, pastes used in batteries

Halogens (G7A) – very reactive nonmetals, gas at room temp.

Noble gases (G8A) – inert gases, full valence shell ($8e^-$)

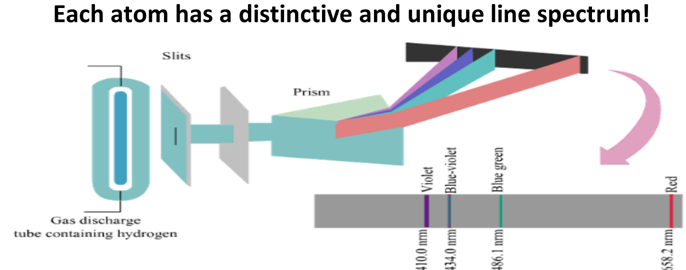
Transition metals (B group) – metals, multiple ox. states

Atomic Line Spectra

Atoms have more than 1 e^- that can be excited, and each e^- can be excited to different energy levels

➔ The emission spectrum is a line spectrum that shows all colors of light produced by an "excited" atom

Each atom has a distinctive and unique line spectrum!



Effective Nuclear Charge

Effective nuclear charge – describes attraction between the nucleus (positive protons) and the Valence electrons (neg.)

There are only 3 things to discuss when explaining ENC (Z_{eff})

1.) Number of protons – based on atomic number, the higher the atomic number the more protons present in the nucleus

2.) Shielding – shielding occurs when core electrons block the valence electrons from the nucleus (the more core e^-, the more shielding!)

3.) Energy level of VEs – the energy level describes the relative distance of the VE from the nucleus, the higher the energy level the farther the VE is from nucleus

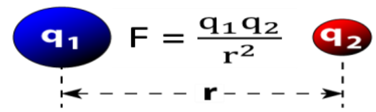
Number of protons only matters if moving horizontally within a period (b/c shielding and energy level of VE is constant)

Shielding LOWERS ENC…
So the more core e^-, the lower the ENC

Quick way to calculate # of core e^-

Total e^- - # VE = # core e^-

The higher the energy level the LOWER the ENC…
(because it is farther from nucleus and based on Coulombs law



Larger (r) reduces attractive force

Atomic Radius (size of atom)

AR is distance from nucleus to outer VE

Atomic Radius is OPPOSITE of ENC
High ENC means small atomic radius

- ➔ e^- are more attracted to nucleus and pulled closer so the overall atom is smaller

EXPLAIN ENC THEN RELATE TO ATOMIC RADIUS!

Electronegativity

Attraction of nucleus to ANOTHER ATOMS electrons

Since this is an attractive force between nucleus and electrons ALL ENC arguments will explain electronegativity!

Electron Affinity

Attraction of nucleus to its OWN electrons

Since this is an attractive force between nucleus and electrons ALL ENC arguments will explain affinity!

Ionic Radius (size of ion)

Positive ions – lost outer VE (loses energy level) so ions are SMALLER than their neutral counterpart

Negative ions – gain electrons, have increased e^-/e^- repulsion and electrons spread out so ion is BIGGER

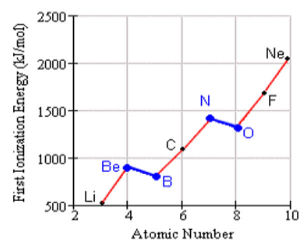
Ionization energy

Energy required to remove an electron

** The closer the electron is to the nucleus (lower the energy level, the more energy is required to remove it

Overall trend is explained by using ENC

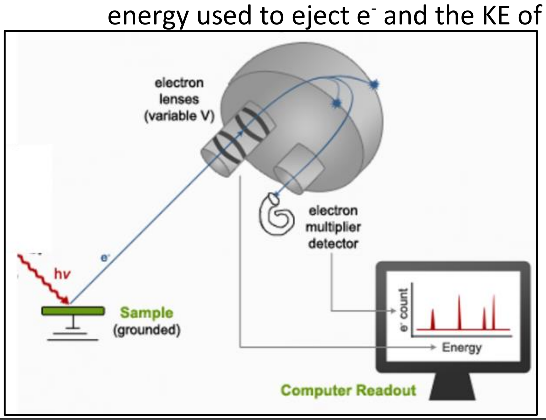
Be able to explain The exceptions to the overall trend that occur going from Be to B and N to O

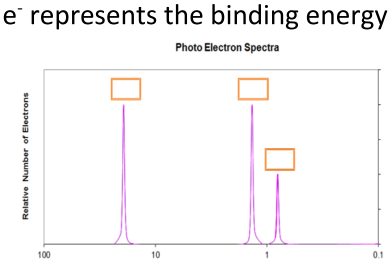


Photon-Electron Spectroscopy (PES)

PES is a technique used to determine the energy of each electron within an atom

- ➔ Shine high energy radiation at the surface and measure KE of ejected e^- (the difference between the amount of energy used to eject e^- and the KE of e^- represents the binding energy of the e^- in its ground state)





Peak height = # electrons
Peaks related to electron configurations (1s, 2s, 2p, 3s, 3p, 4s, etc…)
1s will be highest energy (closest to nucleus)

If comparing different PES spectrum Remember that ENC explains differences in energies… the higher the ENC, the more energy is required to remove electrons

General trick: since 1s will hold 2 electrons, it generally is a reference point to how high a peak will be with 2 electrons!