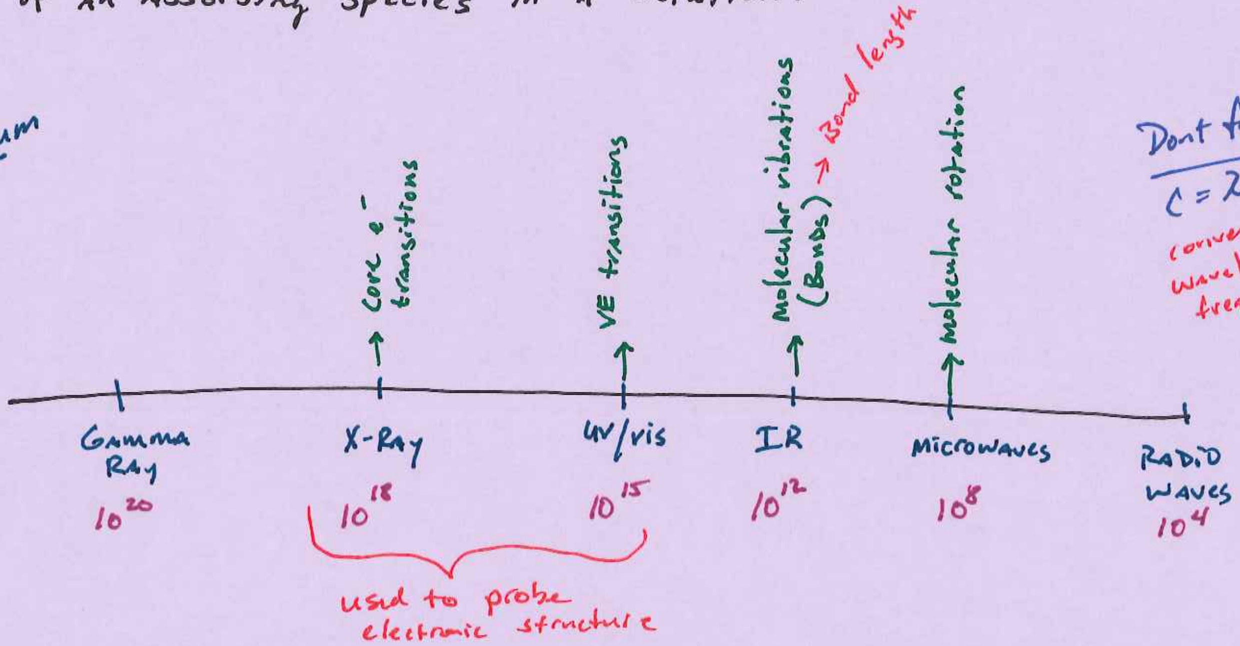
Spectroscopy (Light Spectroscopy)

Intro: We have already seen that matter will interact with photons in the electromagnetic spectrum. there are unique interactions within different regions that allow us to ~~probe~~ probe the structure of atoms and molecules as well as to determine the concentration of an absorbing species in a solution.

EM Spectrum



Don't forget:

$c = \lambda \nu$

convert B/W wavelength and frequency

Remember: we relate the amount of Energy in a single photon via Planck's equation

used to calculate Energy of photons in EM Spectrum $\rightarrow$ $$E = h\nu$$

h = Plancks Constant
$h = 6.626 \times 10^{-34}$ J·s

⊛ photons in EM spectrum are discrete packets of energy that we can use to study interactions

↳ infer this from what we know about e⁻ absorption, emmission

⊛ Direct relationship b/w E and ν

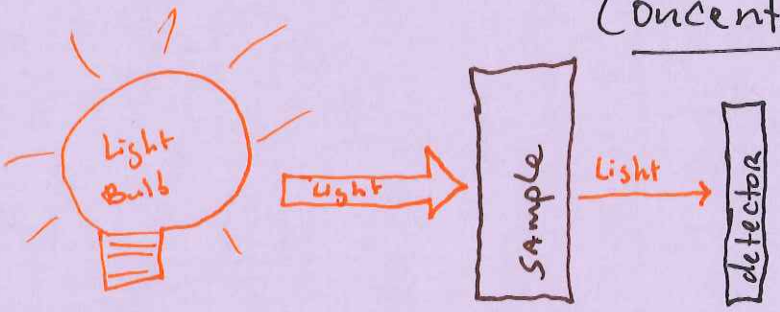
↳ If we know the energy of a photon being absorbed or emitted we know the energy of the molecule is changing

So why does this Matter?

⊛ We will use light and portions of the EM spectrum to probe or "see" matter and study its properties

- one of the main properties we will probe with light is:

Concentration



⊛ In general: more concentrated $\left(\frac{mol}{L}\right)$ = more Absorbance

100% Light → Sample absorbs some light → 50% Light transmitted

Absorbance = how much light was absorbed by analyte of interest

% transmittance = how much light made it through sample to detector

To convert transmittance to Absorbance

$$Abs = -\log(T)$$

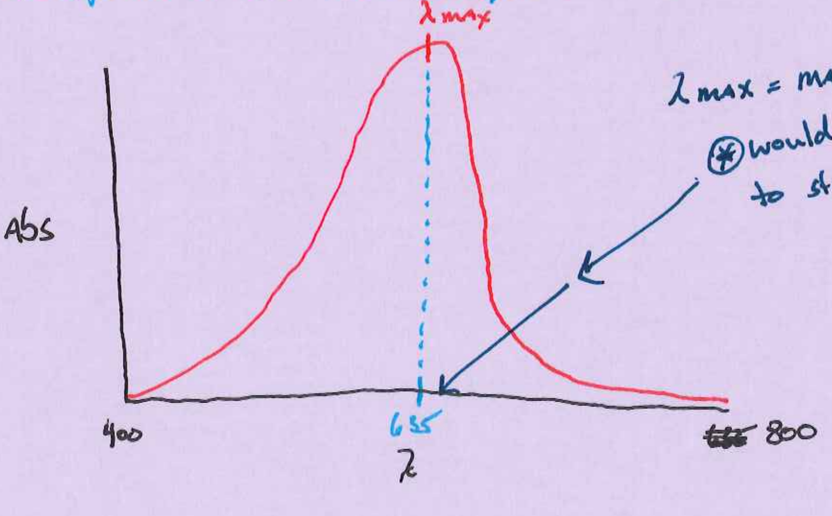
must be decimal form of percentage

⊛ We know elements/molecules have unique electronic structures

- Diff molecules "Better" at absorbing different frequencies of light
  - ↳ we can use this fact and probe for a Maximum Absorption λ for our analyte of interest

Notice:

* Abs -vs- All wavelengths



λ MAX = maximum Abs

⊛ would use this to study the analyte

λ MAX = wavelength of light that our molecule of interest is most efficient at absorbing

Beer - Lambert Law (AKA Beers Law) $\boxed{A = abc}$

↳ states their is a linear relationship between absorbance and concentration

$$A = abc$$

A = absorbance

holding these constant ... say call it m we get

- a = molar absorptivity - constant for solution
- b = path length - width of cuvette

c = concentration

$A = mc$ ⟹ think about $y = mx + b$ (linear relationships can be graphed!)

Standard curve

- used to determine linear relationship b/w A & c

⇓

MUST use λ max as wavelength here!

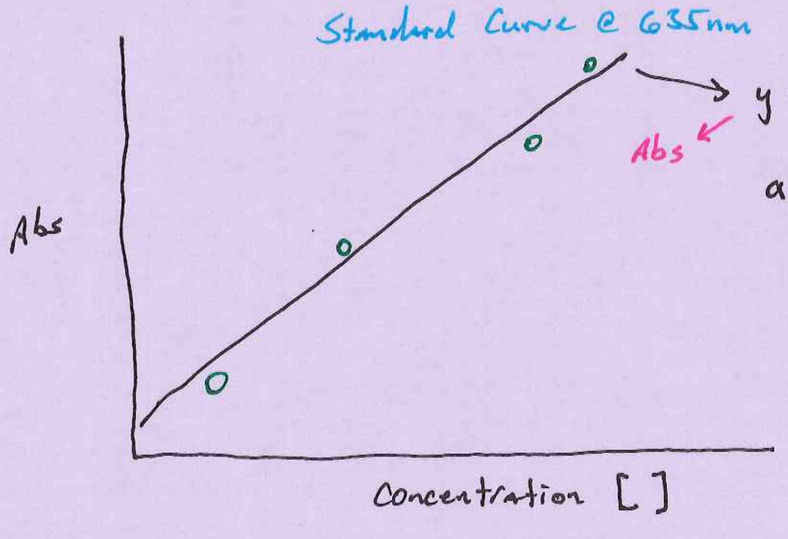
1M stock solution

Dilutions of stock
- 0.5M
- 0.25M
- 0.125M

↓

$M_1V_1 = M_2V_2$

Standard Curve @ 635nm



$$\underset{\text{Abs}}{y} = \underset{ab}{m}\overset{c}{x} + b$$

ab → if b=1 then slope equals a

⊛ get absorbance values for all dilutions

⊛ can use linear regression equation $y = mx + b$ to determine unknown [ ] from absorbance value.