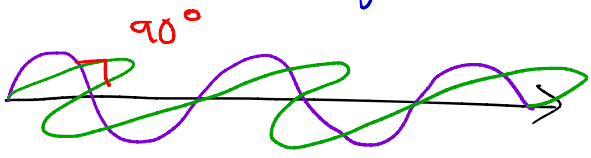
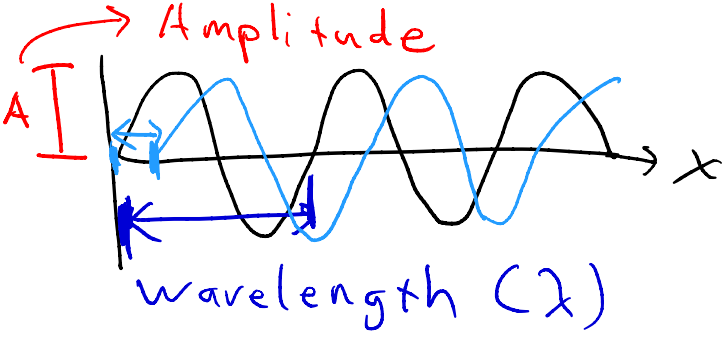
Spectroscopy

Electromagnetic radiation (light)



Light is a combination of oscillating electric & magnetic fields,



frequency - f or ν → $\frac{1}{s}$ Hertz (Hz)

$$\nu \cdot \lambda = \frac{1}{s} \cdot m = m/s = c$$

c = speed of light

In light, wavelength and frequency are always inversely proportional

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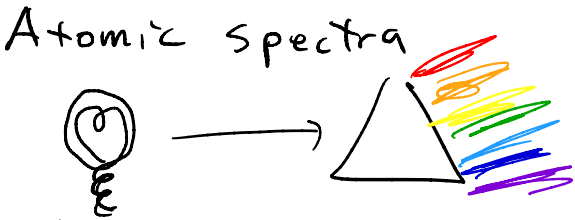
Photons - particles of light

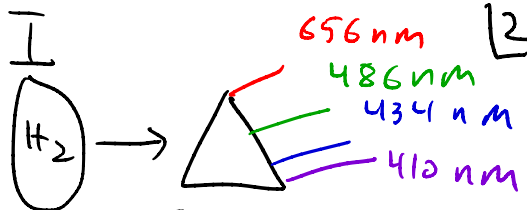
$$\Delta E = h\nu$$

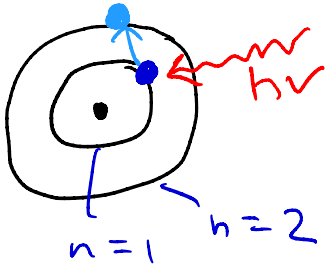
- ΔE: energy per photon
- h: Planck's constant
- ν: frequency

$\pm\frac{1}{2}\frac{h}{2\pi}$
$\pm\frac{1}{2}\hbar$

Atomic spectra





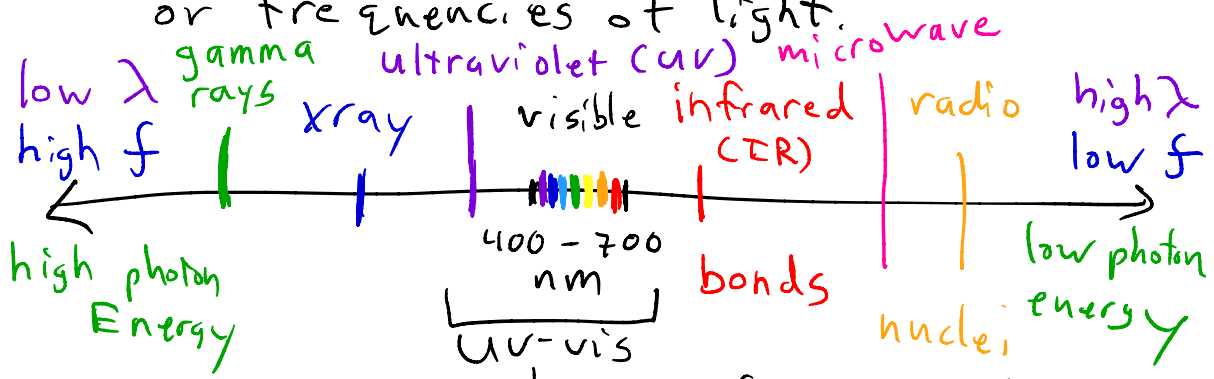


When light strikes an electron, if the light is the correct frequency, it can be absorbed, causing the electron to move to a higher energy level.

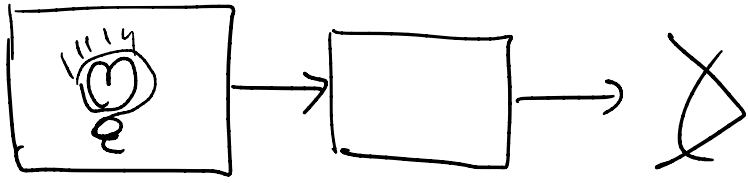
Electrons are not just particles, they act like standing waves, which means electrons can only have very specific values of energy. When electrons move between energy levels, they can only absorb or release specific energies, which correspond to specific wavelengths (or colors) of light.

If light with the right frequency that corresponds to a photon with an energy that matches the gap between two energy levels hits an electron, that light can be absorbed.

EM Spectrum — A range of wavelengths or frequencies of light.



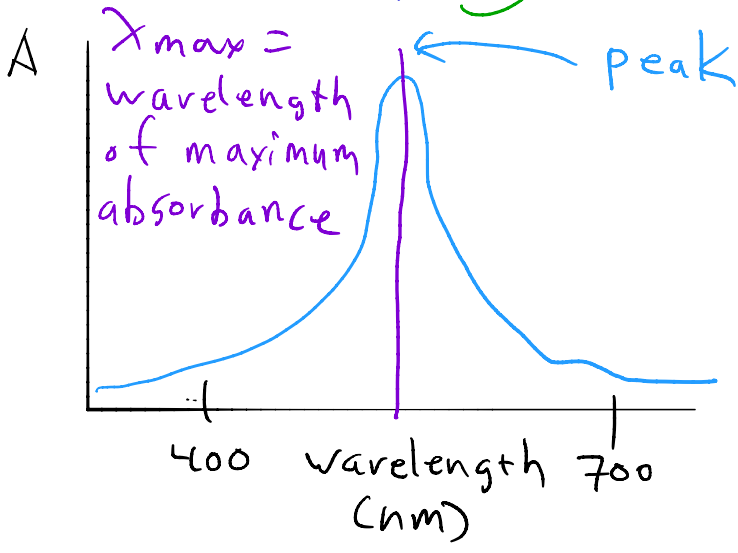
Spectroscopy - analysis of a sample using a range of wavelengths or frequencies of light

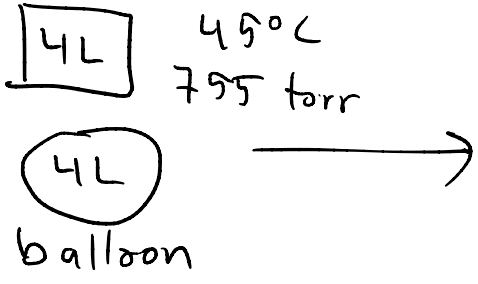


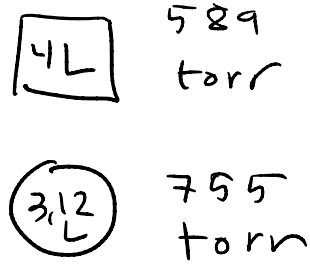
In spectroscopy, a sample is irradiated with a range of frequencies of light. Those frequencies that match energy gaps in the sample will be absorbed. By analyzing which frequencies of light are absorbed, some aspect of the structure of the substance can be determined

Transmittance – % of light that passes through the sample (max 100% or 1)

Absorbance $= -\log_{10} T$ ← decimal, not %







balloon

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{4L}{318K} = \frac{V_2}{248K}$ $\quad V_2 = 3.12$

box

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{P_1}{T_1} = \frac{P_2}{V_2}$ $\quad \frac{755}{318K} = \frac{P_2}{248K}$ $\quad P_2 = 589$ torr

0.25 mol H_2

$PV = nRT$

$V = \frac{nRT}{P}$

1) 293K, 745 torr

$$V = \frac{(0.25)(0.0821)(293\,K)}{(745/760)} = 6.13\ L$$

2) STP → 273K, 760 torr (1 atm)

$$V = \frac{(0.25)(0.0821)(273\,K)}{1} = 5.60\ L$$