Chem 111

Lecture 18

Announcements

- Breanne has a recitation session HASA 126 – 10/27 (5-6pm)

Homework

- Continue Reading Chapter 6
- OWL online homework

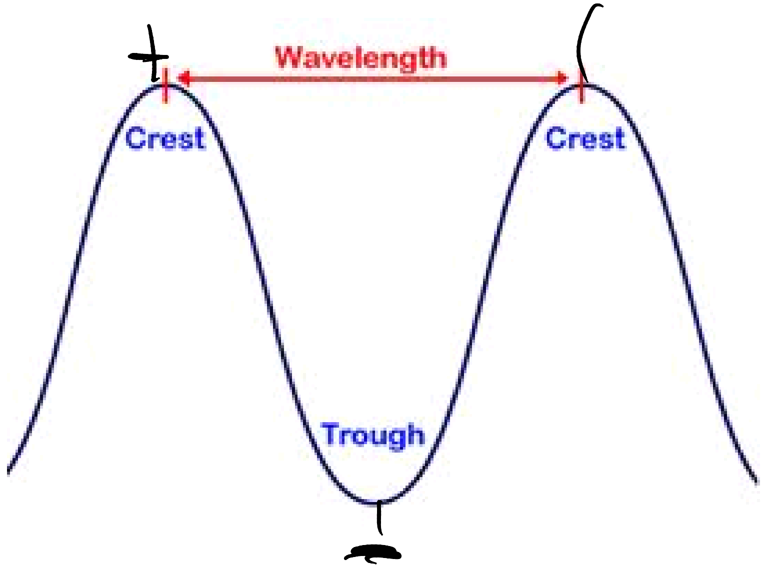
Recap

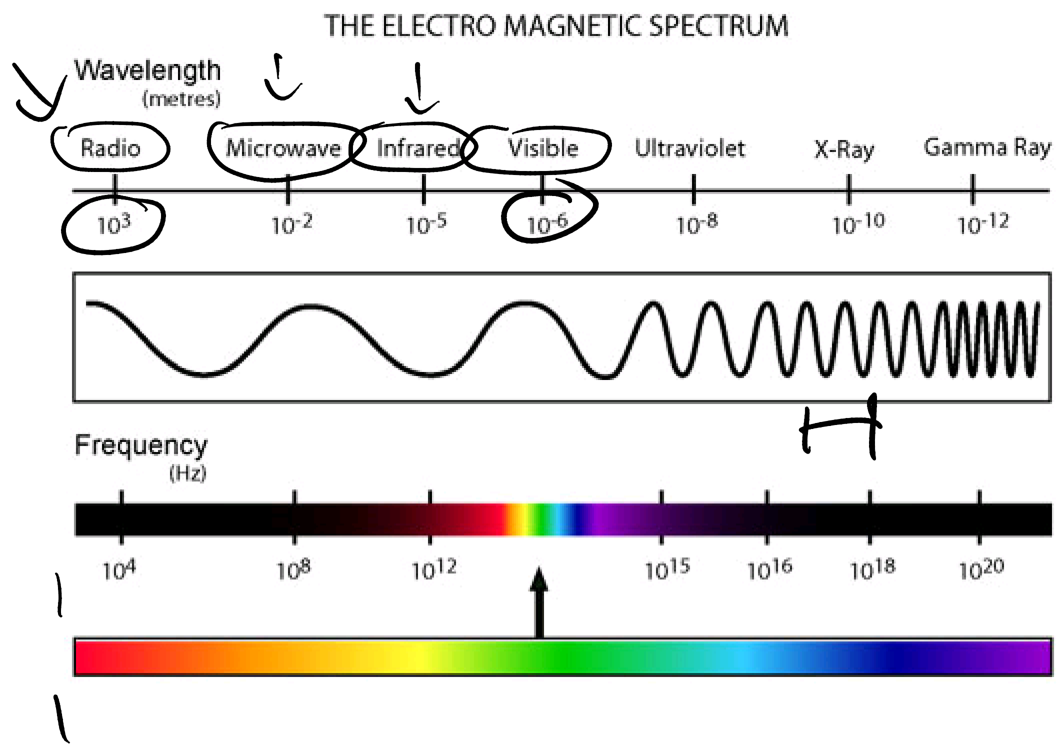
- Enthalpies of formation

Electronic Structure of Atoms

Electromagnetic radiation: Electromagnetic energy is a term used to describe all the different kinds of energies released **.**

Moves in waves





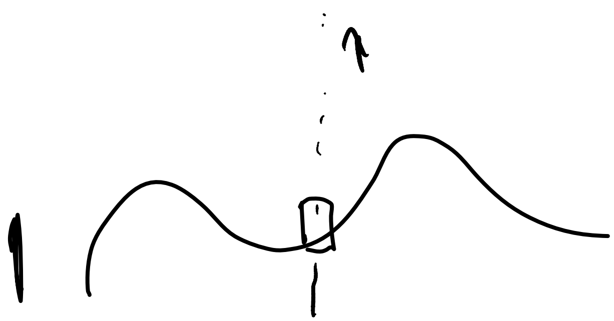
Electronic Structure of Atoms

Wavelength: peak to peak. Symbol = λ. Measured in meters

Frequency: is the number of waves that pass a fixed place in a given amount of time. Symbol = ν. Measured in s^{-1} or 1/s or hertz (Hz)

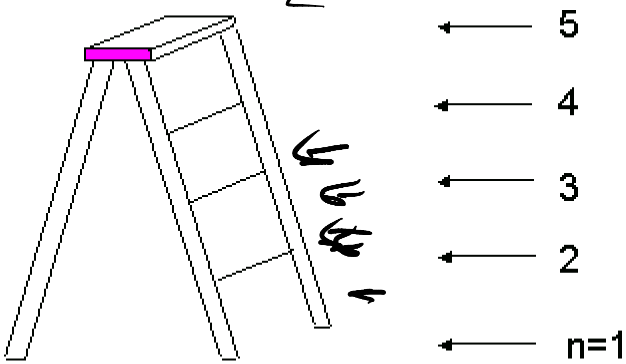
The speed of light through a vacuum, c, is 3.00×10^8 m/s.

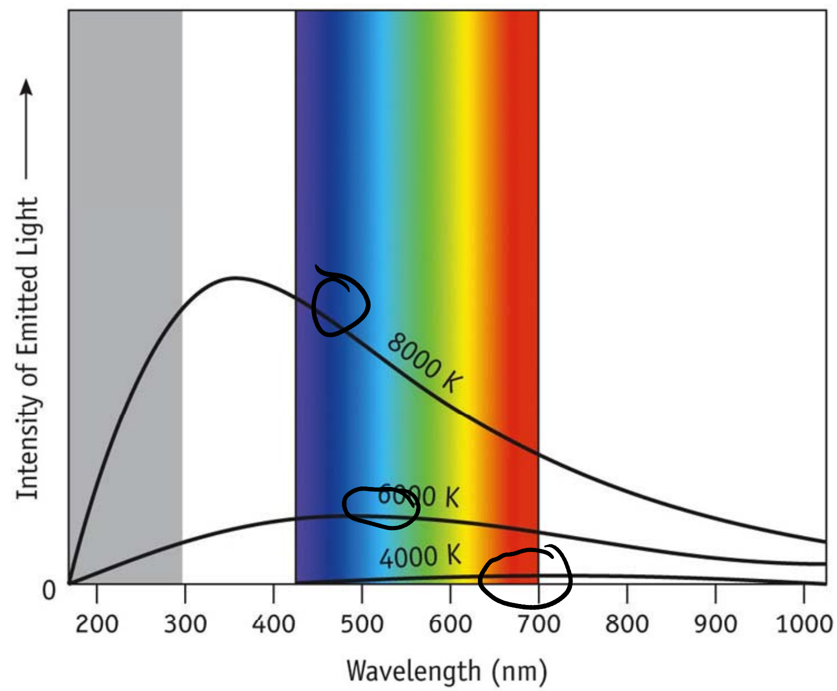
$$\mathbf{c} = \lambda\nu$$



Blackbody Radiation

Heating up a piece of metal. Physics could not explain this.
Planck → Energy can be released (or absorbed) by atoms only in "chunks" of some minimum size. The chunks are called quantums.





Electromagnetic Radiation

$$E = h\nu$$

h, Planck's constant = 6.63 x 10^{-34} (Js)

Atoms will absorb/release:

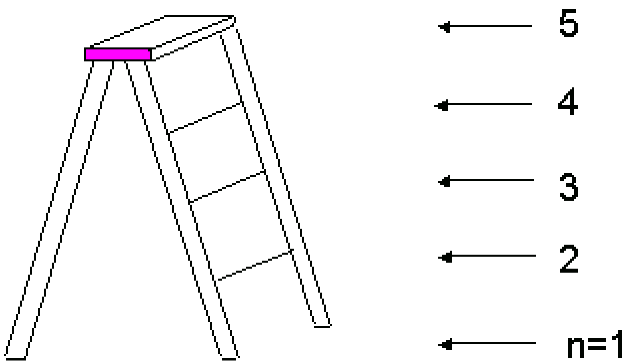
$$E = nh\nu$$

n is a whole number

hν

2hν 0.5hν

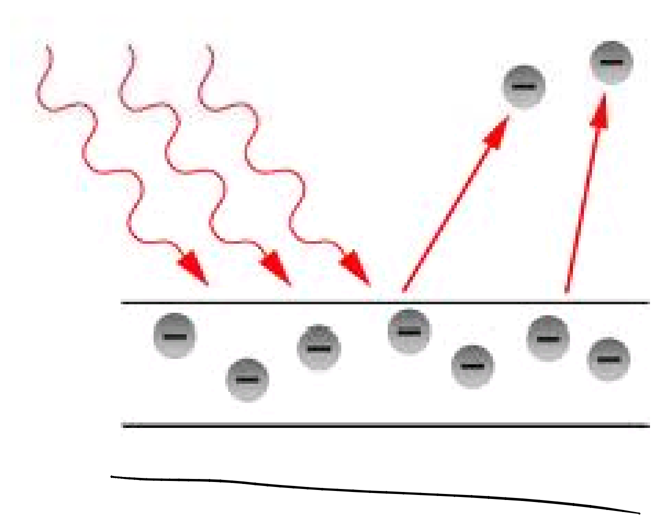
3hν 2.03h



The Photoelectric Effect

Einstein used Planck's quantum theory to explain the photoelectric effect.

Each energy packet behaves like a tiny packet of light and is called a **photon.**



Let's Practice

What wavelength of radiation has photons of energy 8.23×10^{-19} J?

$\nu \lambda = c \rightarrow \nu = \frac{c}{\lambda}$

ν = panda

$E = h\nu$

$\frac{E}{h} = \nu$

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

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

$2.41 \times 10^{-7}\ m = \frac{(6.63 \times 10^{-34}\ Js)(3 \times 10^{8}\ \frac{m}{s})}{8.23 \times 10^{-19}\ J}$

241 nm

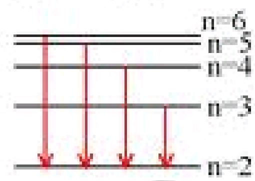
Emission

Radiation composed of 1 wavelength = *monochromatic*
Radiation can be composed of many wavelengths
When separated a **spectrum** is produced:

Continuous Spectrum

Neon

Sodium Vapor

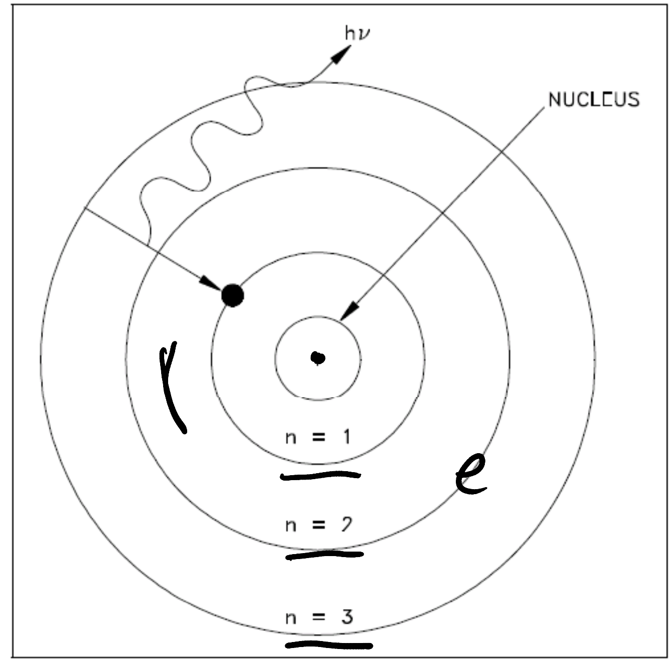


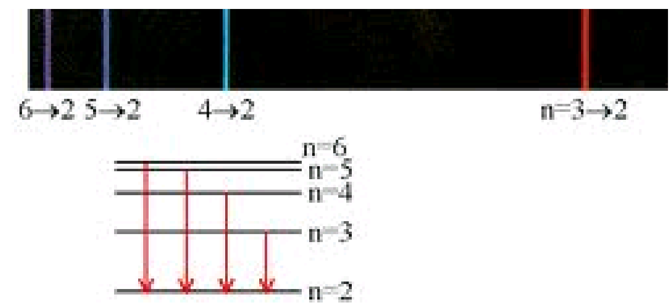
$$\frac{1}{\lambda} = (R_H)\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$$

$R_h = 1.0974 \times 10^7\ m^{-1}$

Bohr Model

- "Microscopic solar system"
- Lower the energy (more negative) the more
- The lowest energy state, n = 1, is called the **ground state.**
- When the electron is in a higher state (n=2,3…) the atom is said to be in an **excited state.**





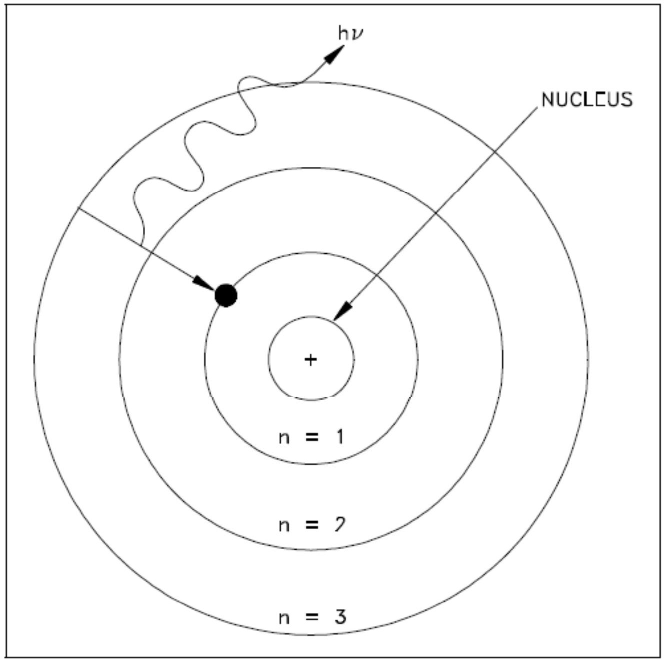
$$E_n = -\frac{R_H hc}{n^2}$$

Bohr Model

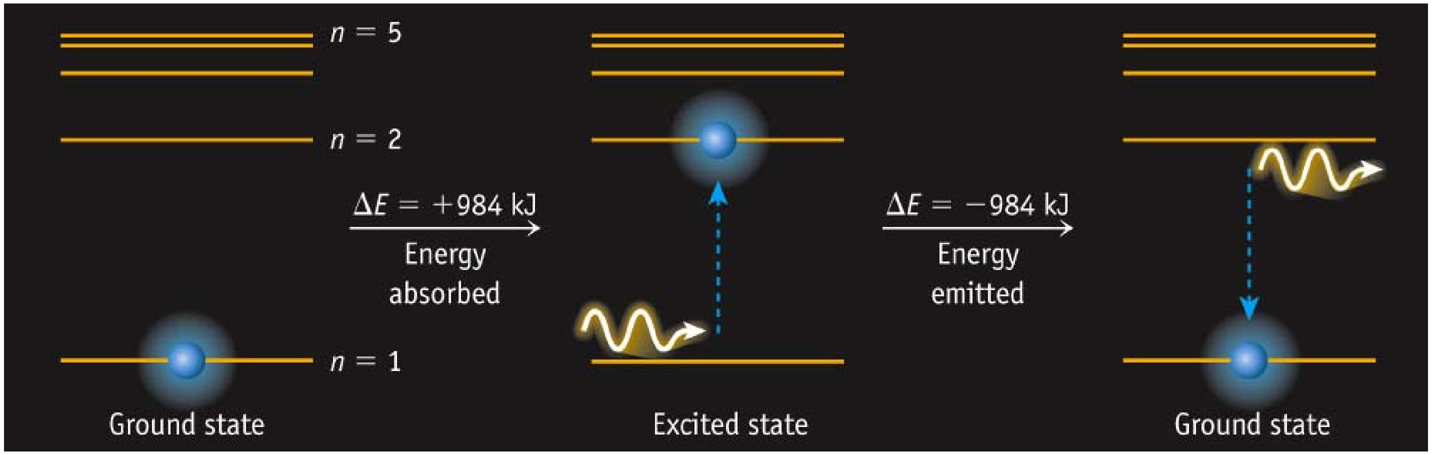
- Electrons can “jump” from one
- allowed energy level by

emitting/absorbing a photon of light.

$\Delta E = E_f - E_i = h\nu$



Only specific frequencies of light can satisfy that equation.



Bohr Model

$$h\nu = \Delta E = R_H hc\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

- Positive value ν results when $n_f > n_i$, which means that radiant energy of $\nu = \Delta E/h$ is absorbed.

- $n_i > n_f$ (electron jumps from higher state to a lower state), you'll calculate a negative ν, light is being emitted.

Let's Practice

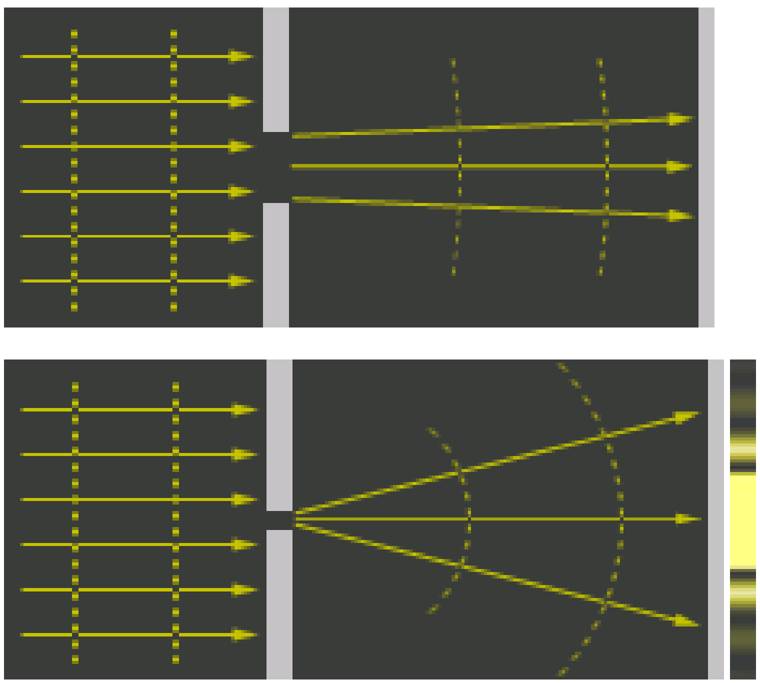
$$\frac{hc}{\lambda} = h\nu = \Delta E = R_H hc\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

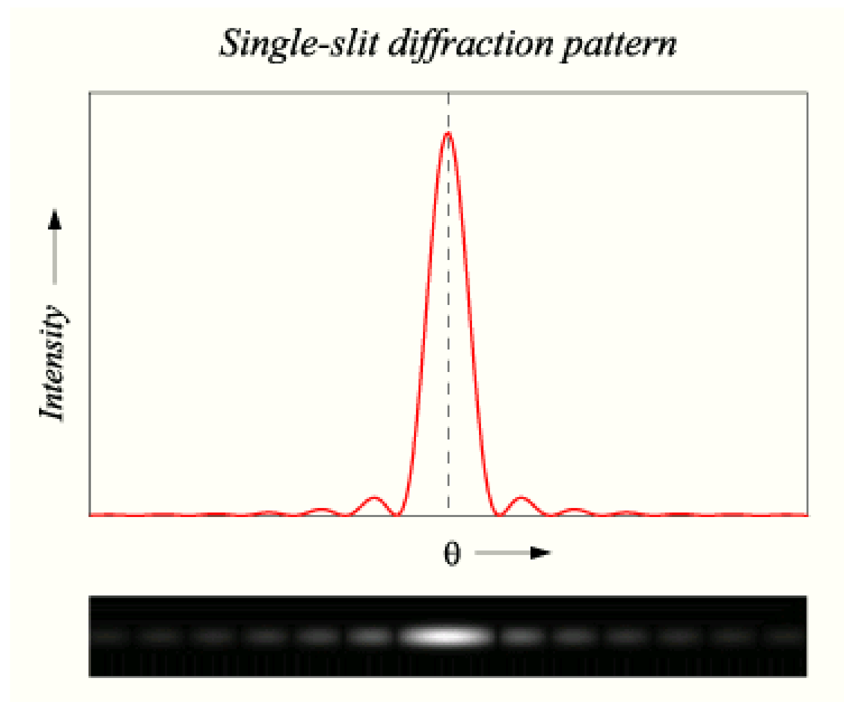
Calculate the wavelength of light that corresponds to the transition of the electron form the n=4 to the n=2 state of the hydrogen atom. Is the light absorbed or emitted?

Wave-Particle Duality

Light has wave and particle like characteristics.
What about something that mass.

$$\lambda = \frac{h}{mv}$$





Quantum Mechanics

Uncertainty Principle: It is impossible for us to simultaneously both the exact momentum of the electron and its exact location in space.

Schrödinger's equation: Incorporates wave like and particle behavior. Through these we are able to calculate probabilities of where the electron location.