9/24/13

Light, electrons, quantum model
Why are there no blue fire works?
LM 14, 15, 16

The simplest atom- Hydrogen
-use light as a tool to probe electrons
-$e^-$ have discrete energy levels

clicker 550nm

$E = h\nu$ $\nu = \frac{c}{\lambda}$
$= (6.626E-34)(5.44E14)$ $= \frac{3E8}{5.5E-7}$
$= 3.6E-19$ $= 5.44E14$

Absorption Light IN → low E → high E
Emission Light OUT → high E → low E

Exciting electrons demo
Add electrical energy to various elements:
Noble gases. Each gas → discrete lines
different gas → different colors
Each atom has its own pattern
Each element - distinct pattern of lines

Exciting electrons
H··H → H· H· H atom + energy
Ne Ne → Ne· Ne· "excited"
Energy going into $e^-$
Light $E = h\nu$
discrete lines ≡ fixed $\nu$ → $e^-$ have discrete energy

If you put a grating between you & the light source - emission spectrum

H: shortest $\lambda$, highest $\nu$ - high E

$E \propto \frac{1}{n^2}$

☆ Lowest energy state - most stable

$E=0$ when the electron is far away
$E<0$ $e^-$ closer to nucleus
$n=1$ ground state - lowest E possible.
$n>2$ excited state

Red: $n=3 \rightarrow n=2$
blue: $n=4 \rightarrow n=2$

Rydberg formula
Emperical model from data

$$\Delta E = -2.18 \times 10^{-18} J \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

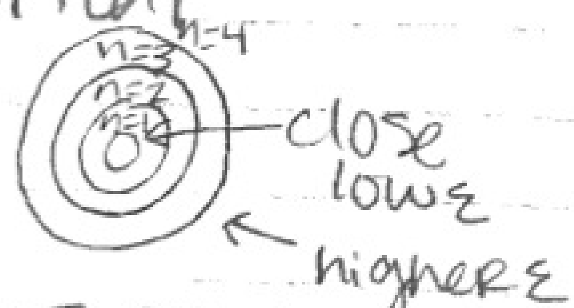
Be careful w/units

↑ $\frac{1}{\lambda}$

discrete lines = discrete energies
☆ not all energies are possible! ☆

Energies of electrons must be quantized! (discrete units)

Bohr's model - solar system - emperical
allowed for calculation of energy level




☆ Bohr model - problem: treated $e^-$ as a particle. Electrons have wave properties (Schrödinger)

Wave-particle duality
- Small (low mass) "particles" have wave like properties.
- Neither particles or waves - they have

characteristics of each.
- same issue for "light"
- Seems like a wave but the $\varepsilon$ (photon) appears particle like

Quantum Mechanics
doesn't make sense! $e^-$ → wavelike, NOT particle
It is what it is.

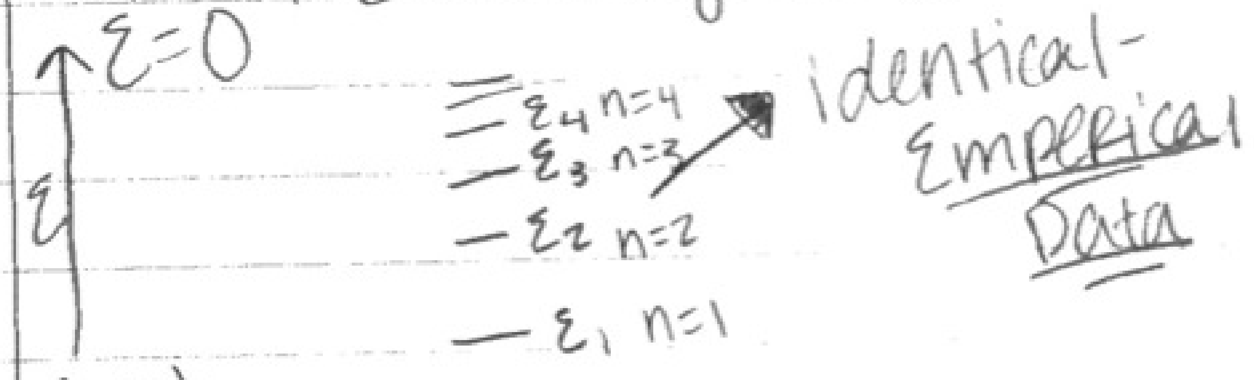
Schrödinger equation allows us to solve for all possible wavefunctions & energies.

"where" (sol'n)

Each wave function is paired w/ $\varepsilon$.

Lowest possible $\varepsilon$ → ground state

Lowest $\varepsilon$ to highest $\varepsilon$.



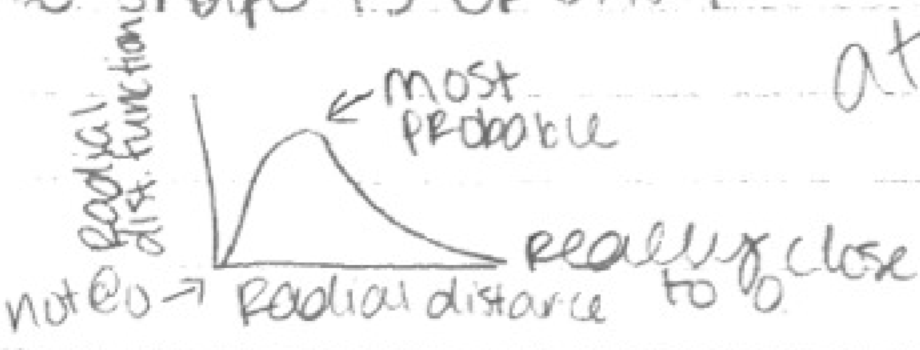

$\varepsilon \propto \frac{1}{n^2}$

Energies are negative.

Where is the particle?
- wave functions
- energies

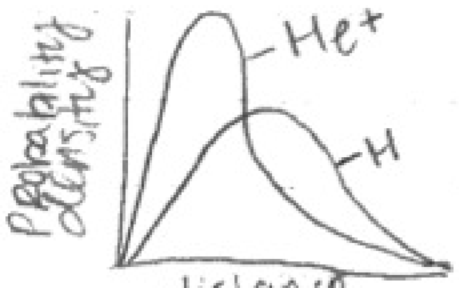
Wave function (3D)
- $\Psi$ (psi)
- we look at $(\Psi)^2$ a probability density

Solutions: Atomic orbitals
- link online to the orbitron
- n - size & energy
  l - shape
  $m_l$ - orientation
- sphere - the shape is orbital


atomic radius

Clicker




$He^+$ has 2 protons, so the electron will be even closer to the proton

Atomic orbitals - defined by quantum #'s
n = energy
l = "shape" - angular momentum

 l=0  l=1

l=0 is s orbital.
l=1 is p orbital
l=2 d
l=3 f

September 24th, 2013

Why are there no blue fireworks? – Initial question

LM 14, 15 and 16 + Exam Wrapper LM Due Thursday @ 9am

$\lambda = 550nm$ $E = h\nu$

$c = \lambda\nu$

The energy in electrons are at fixed, discrete levels. Discrete lines = Discrete Energies – Quantized.

E is proportional to $1/n^2$. The most stable energy level is the lowest energy level.

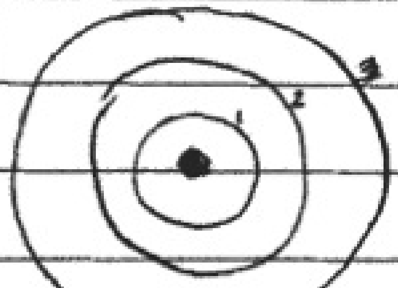
lowest energy possible – ground state

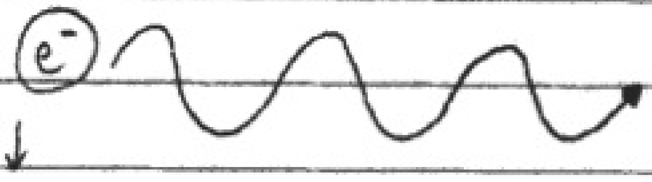
The light we see is just electrons jumping from one energy level to another.

$$\Delta E = -2.18 \times 10^{-18} J \left( \frac{1}{n^2_f} - \frac{1}{n_i^2} \right)$$

Bohr's model – downside → electrons are not like particles.

It has wave-like nature.




Neither a wave nor particle.

Quantum numbers – code for math functions

- n = size and energy
- l = shape
- m = orientation

No elements Royal spectrum → blue