Chem 111

Lecture 19

Announcements

- Exam 2, Nov 1

→ Pencils, Erasers, Calculator, ID card

- Disabilities services
- Note Taker: Talk with Ginger Dudkiewicz or AnneMarie Duchon

→ Whitmore Rm 161 or 413.545.0892

→1 academic pass/fail credit or 45 h volunteer service

Spark Dis. ex credit.

Homework

- Continue Reading Chapter 6

- OWL online homework

$27.68 - 98$

$q = -$

$q_m + q_{cal} + q_{water} = 0$

$\uparrow T \rightarrow \downarrow T$ = losing heat = $-q$

$\downarrow T \rightarrow \uparrow T$ = gaining heat = $+q$

$\Delta T = T_f - T_i$

$\boxed{25°C \rightarrow 27.68°C}$

$m\ 98 \rightarrow 27.68°C$

$q = m C_{sp} \Delta T$

$q = C_{cal} \Delta T$

$(T_f - T_i)$

Recap

- Electromagnetic Radiation
- Wavelength
- Frequency

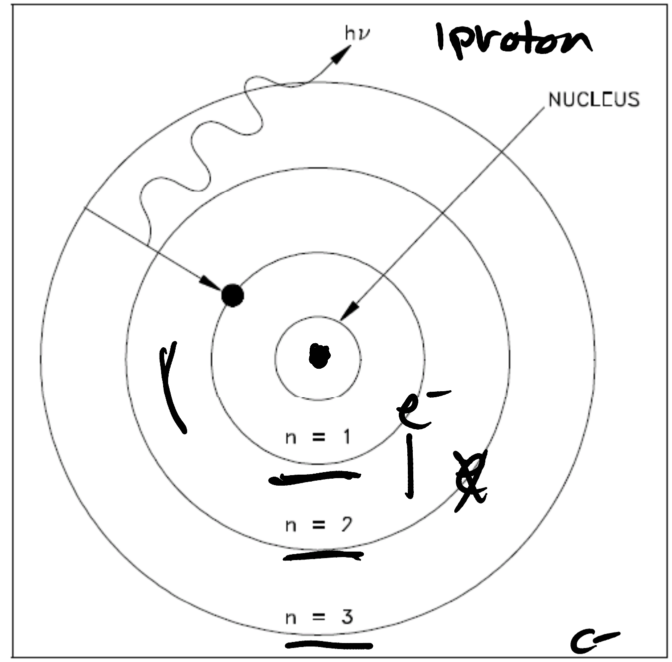
$c = \nu\lambda$

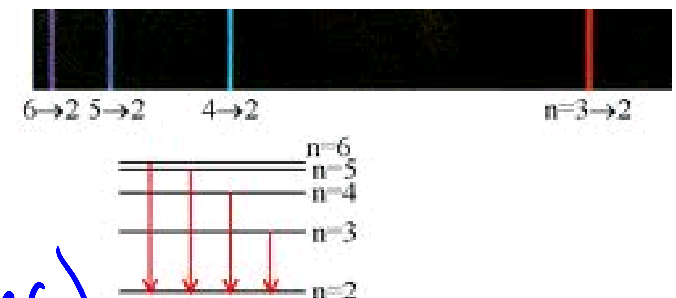
s^{-1} / 1/s / Hz

- Blackbody Radiation
- Quantization
- Photoelectrical Effect
- Emission

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.**





$$\frac{R_H hc}{n_i^2} - \frac{R_H hc}{n_f^2}$$

$$-\frac{R_H hc}{n_f^2} - \left(-\frac{R_H hc}{n_i^2}\right)$$

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

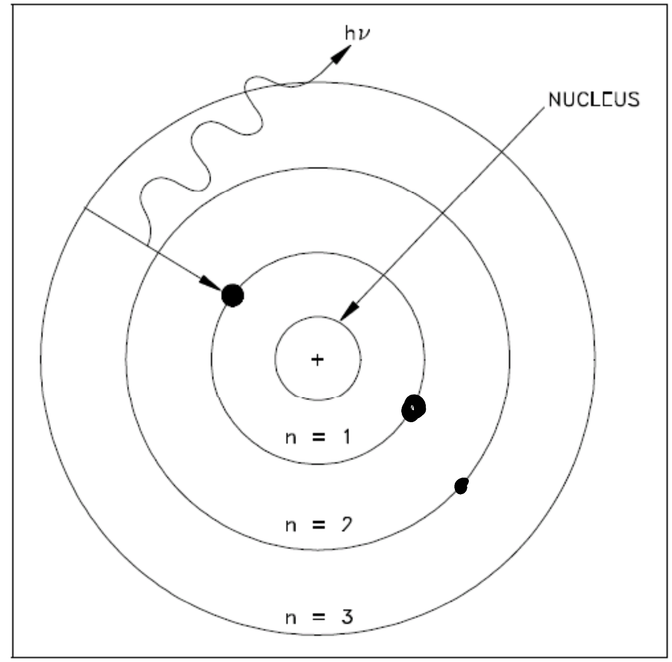
$$= R_H hc\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

Bohr Model

U = q + w

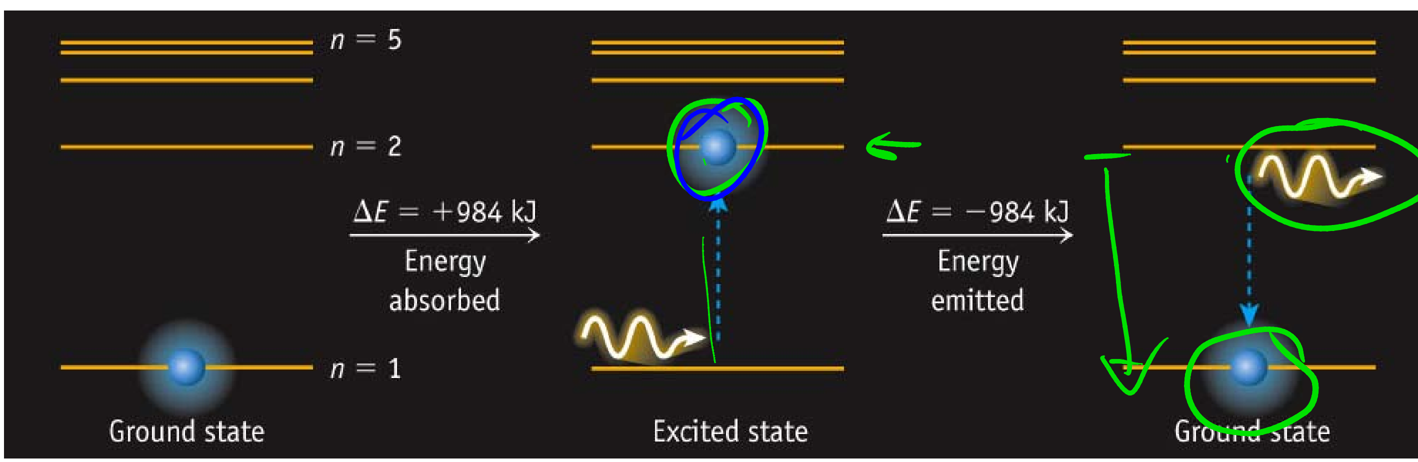
- Electrons can "jump" from one
- allowed energy level by

emitting/absorbing a photon of light.



$$\boxed{\Delta E = E_f - E_i = h\nu}$$

Only specific frequencies of light can satisfy that equation.



ex

gs

Bohr Model

$n = 1$

$n = 3$

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

• Positive value ν results when $n_f > n_i$, which means that radiant energy of ν = ΔE/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

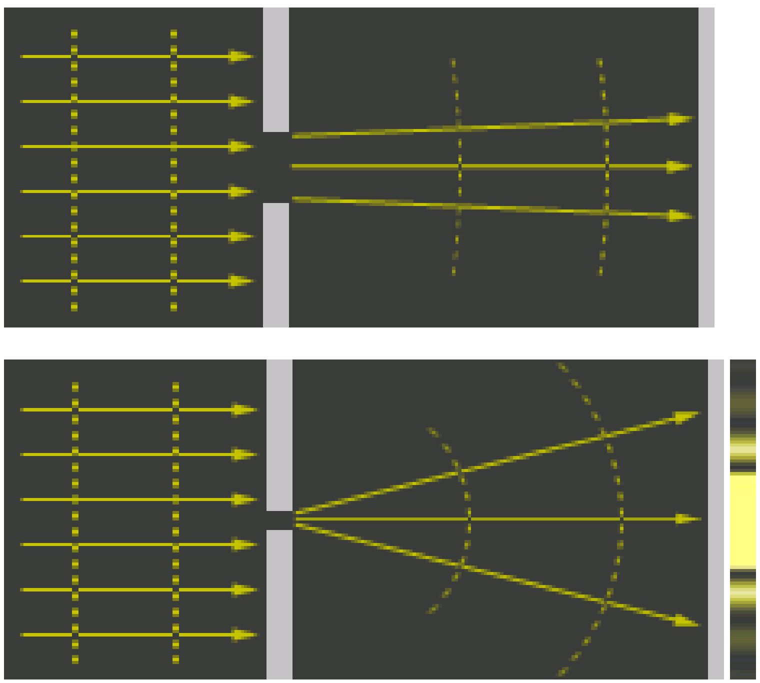
$$\frac{hc}{\lambda} = h\nu = \Delta E = R_H hc\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

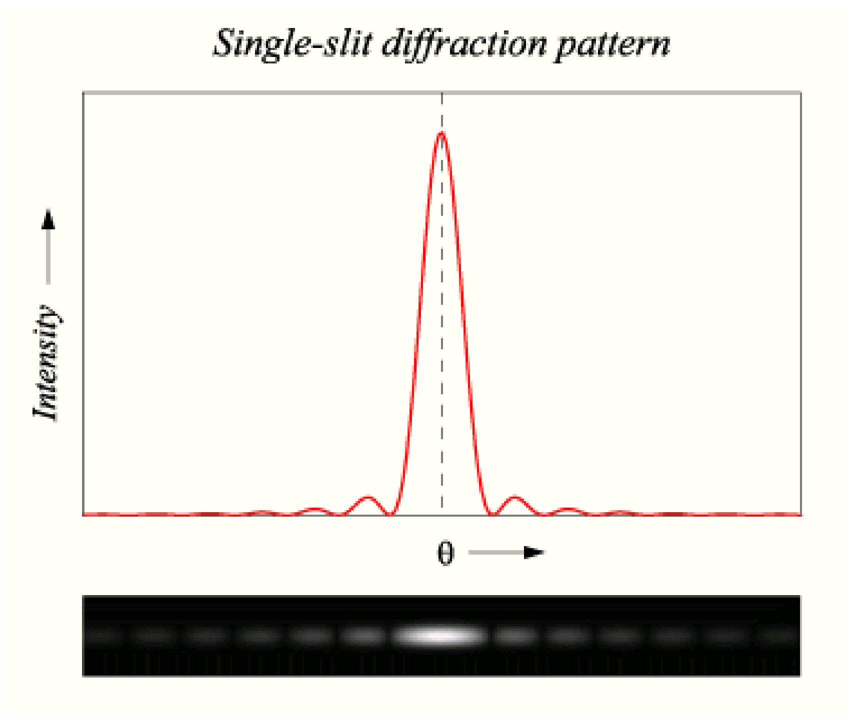
Calculate the wavelength of light that corresponds to the transition of the electron form the n=4 to the n=2 state of the hydrogen atom. Is the light absorbed or emitted?

Wave-Particle Duality

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

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

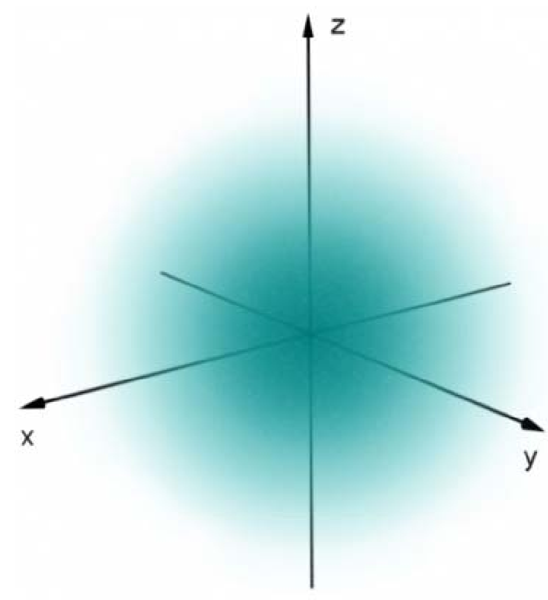




Quantum Mechanics

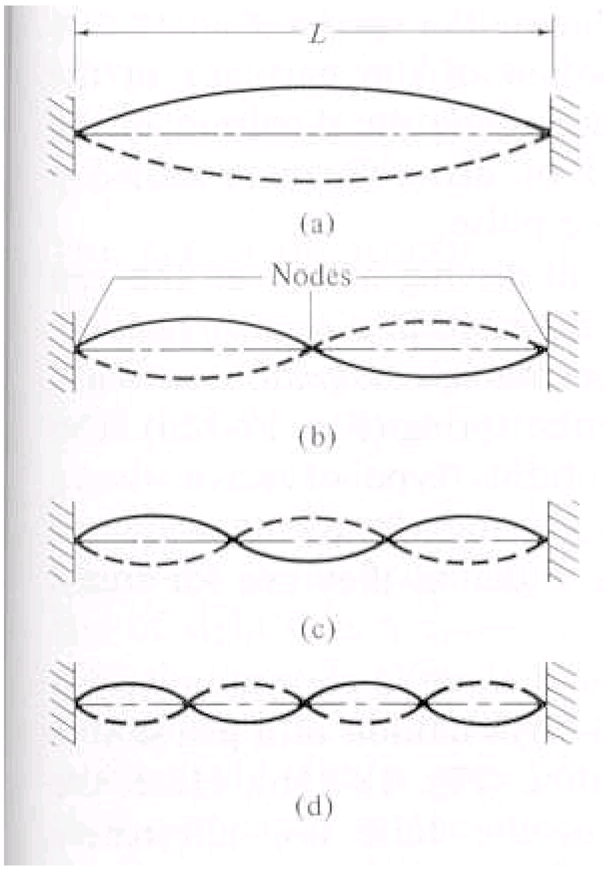
Uncertainty Principle: It is impossible for us to simultaneously both the exact momentum of the electron and its exact location in space.

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

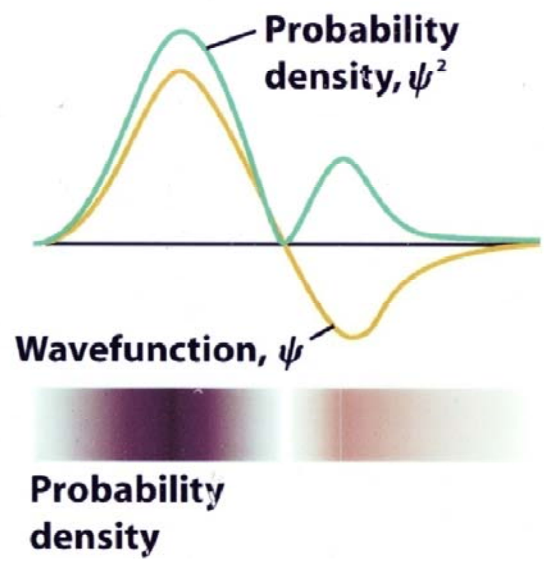


Schrödinger's Equation

- Treat the electron as a standing wave.



When the amplitude passes zero, we call that a **node**.



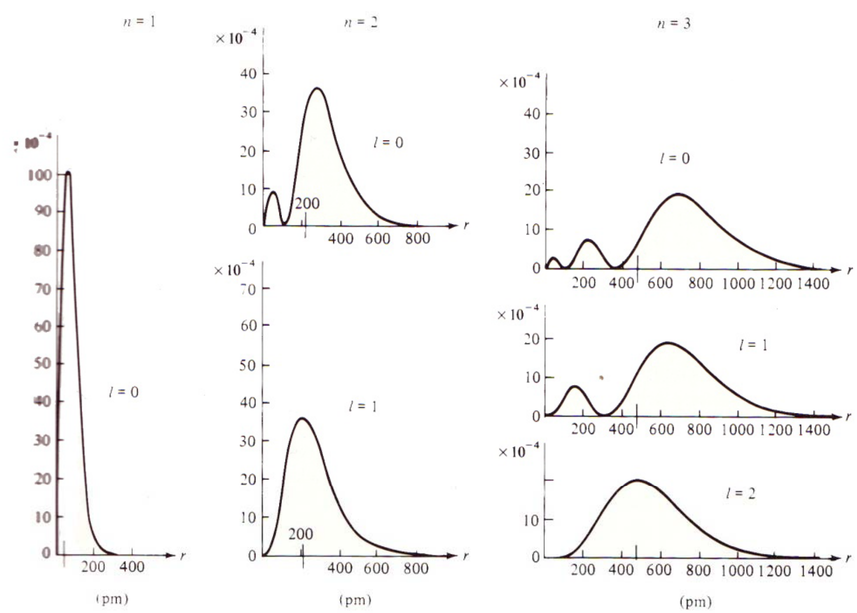
High probabilities makes orbitals

Quantum Numbers

- Each **orbital** describes a specific distribution of electron density in space, given by its probability density.

- The principle quantum number, n, can have integral value of 1, 2, 3 and so forth.

- As n increases the electron spends more time away from the nucleus (has a higher energy).



- Electron shell

Quantum Numbers

- The Azimuthal quantum number, ℓ, can be integral values of 1 to n-1.
- This describes the shape of the orbital.
- Sometimes letter are used instead of numbers. 0=s; 1=p; 2=d; 3=f
- Subshell

Quantum Numbers

- The magnetic quantum number, m_ℓ, can have intergral values between $-\ell$ and ℓ, including zero

- The quantum number describes the orientation of the orbital in space.

Quantum Numbers

TABLE 6.1 Summary of the Quantum Numbers, Their Interrelationships, and the Orbital Information Conveyed

Principal Quantum Number	Azimuthal Quantum Number	Magnetic Quantum Number	Number and Type of Orbitals in the Subshell
Symbol = n Values = 1, 2, 3, . . . n = number of subshells	Symbol = ℓ Values = 0 . . . $n-1$	Symbol = m_ℓ Values = $+\ell$ . . . 0 . . . $-\ell$	Number of orbitals in shell = n^2 and number of orbitals in subshell = $2\ell + 1$
1	0	0	one 1s orbital (one orbital of one type in the $n = 1$ shell)
2	0 1	0 +1, 0, −1	one 2s orbital three 2p orbitals (four orbitals of two types in the $n = 2$ shell)
3	0 1 2	0 +1, 0, −1 +2, +1, 0, −1, −2	one 3s orbital three 3p orbitals five 3d orbitals (nine orbitals of three types in the $n = 3$ shell)
4	0 1 2 3	0 +1, 0, −1 +2, +1, 0, −1, −2 +3, +2, +1, 0, −1, −2, −3	one 4s orbital three 4p orbitals five 4d orbitals seven 4f orbitals (16 orbitals of four types in the $n = 4$ shell)

Quantum Numbers

- The shell with principle quantum number n will consist of exactly n subshells.

- For a given value of ℓ, there are $2\ell + 1$ values of m_ℓ.

- The total number of orbitals in a shell is n^2