CHM1011

Lecture 1 – Atomic Structure

Discovery of the Atom

- Dalton (discovered atom)
- J.J Thomson (discovered electron through cathode rays)
- Millikan (measured the electron's charge)
- Becquerel and Curies (discovered radiation)
- Rutherford (discovered nucleus)
- Mass Spec. (discovered isotopes)

Lecture 2 – Light and Matter

Spectrum of Light

- All electromagnetic radiation travels at the same velocity
- Speed of light is 3.00×10^8 m/s
- λ = Wave length of light
- Relationship between frequency and wavelength is $v\lambda=c$
- Wavelength (m), frequency (Hz or s^{-1}) and amplitude (intensity)

"Quanta" and The Photoelectric Effect

- Planck assumed that energy comes in packets called quanta
- Einstein concluded that "photons" have energy proportional to frequency → $E=hv$ (h is Planck's constant; 6.63×10^{-34} J s)
- Einstein proved that light had properties of quanta, they weren't just waves
- Atomic emission (where energy is released), a specific sequence of colours is emitted for each individual element

Quantum Mechanics

- Wave Particle Duality → Light possesses both wave-like properties as well as particle-like properties
- De Broglie proposed that matter should exhibit WPD properties given by $\lambda = h/p$; where $p = mv$
- Electrons have wavelength motions that are restricted to an orbit of fixed energy called resonant waves
- Schrödinger's "wave equation", using ψ to determine the probability of the location of an electron

Lecture 3 – Atomic Orbitals

Orbits

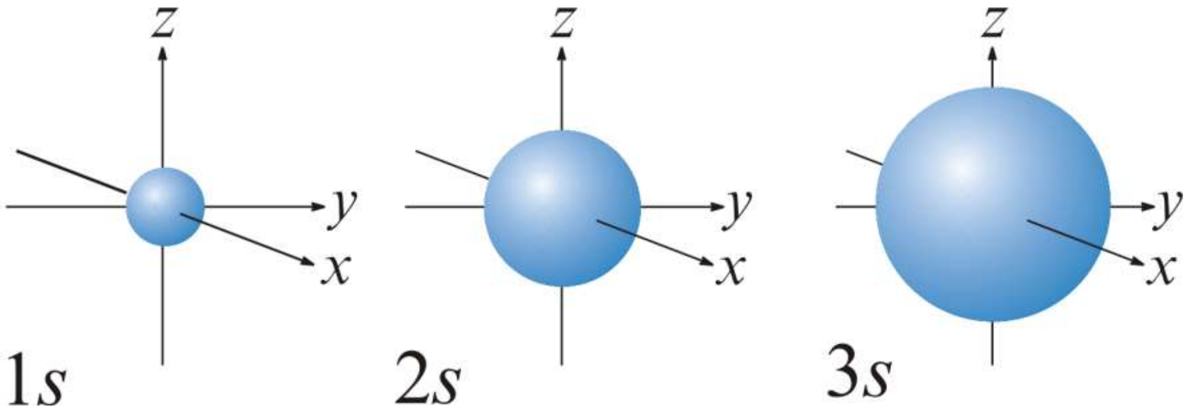
- Probability Density: Ψ^2 & $R(r)^2$
- The probability density describes the probability of finding an electron at a point in space with respect to the nucleus (r)
- Radial Distribution Function/Electron Density: $4\pi r^2 R(r)^2$
- The probability of an electron being found in an outer shell is greater than the shells before it due to increasing volume

Quantum Numbers

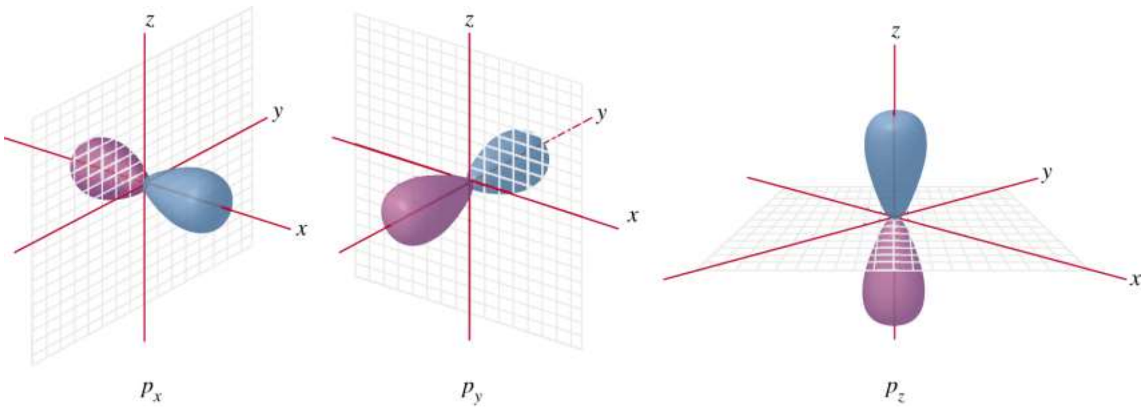
- Every electron will have a unique set of quantum numbers
- Principal: n, takes positive integers, represents orbital energy (size)
- Angular Momentum: l, takes integers from 0 to n-1, represents orbital shape
- Magnetic: m_l, takes integers from $-l$ to 0 to $+l$, represents orbital orientation
- Spin Number: m_s, takes either $+\frac{1}{2}$ or $-\frac{1}{2}$, represents the spin of the electron (up or down)
- A set of quantum numbers describes the possible locations for each individual electron
  - When $l = 0$, the orbital is s
  - When $l = 1$, the orbital is p
  - When $l = 2$, the orbital is d
  - When $l = 3$, the orbital is f

Atomic Orbitals

- The shape of an orbital by where an electron is likely to be found 95% of the time (region of space)
- Drawn on a x,y,z axis
- s orbitals have a spherical shape (when l=0)



- p orbitals have a 'dumbbell' shape and can have three orientations (when l=1). Known as p_x, p_y, p_z as there are three values for m_l



- d orbitals can have five orientations (when l = 2). Known as $d_{xy}, d_{yz}, d_{xz}, d_{x^2-y^2}, d_{z^2}$ as there are five values for m_l