LIGHT AND THE ELECTROMAGNETIC SPECTRUM

- Electromagnetic energy (light) is characterized by WAVELENGTH, FREQUENCY, and AMPLITUDE
- Wavelength (symbol is upside-down y; called lambda) is the distance between successive wave peaks
- Frequency (v) is the number of wave peaks that pass a given point per unit time
- Amplitude is the height of the wave maximum from the center
- HIGHER frequency = LOWER wavelength

Wavelength (lambda) x Frequency (v) = Speed (c)

- Speed of light (c)= 3.00 x 10^8 m/s

- Line Spectrum: A series of discrete lines on an otherwise dark background as a result of light emitted by an excited atom
- Johann Balmer in 1885 discovered a mathematical relationship for the four visible lines in the atomic line spectra for hydrogen

    1 / (lambda) = R (1/2^2 - 1/n^2)

- Johannes Rydberg later modified the equation to fit every line in the spectrum of hydrogen

    1 / (lambda) = R (1/m^2 - 1?n^2)

Rydberg constant (R) = 1.097 x 10^-2 nm^-1

- Photoelectric Effect: Irradiation of clean metal surface with light causes electrons to be ejected from the metal. Furthermore, the frequency of the light used for the irradiation must be above some threshold value, which is different for every metal.

E = hv

h (Planck's constant) = 6.626 x 10^-34 Joules x seconds

- Electromagnetic energy (light) is quantized

PARTICLE PROPERTIES OF ELECTROMAGNETIC ENERGY

- Niels Bohr purposed in 1914 a model of the hydrogen atom as a nucleus with an electron circling around it
- In the model, the energy levels of the orbits are quantized so that only certain specific orbits corresponding to certain specific energies for the electron are available
- Louie de Broglie in 1924 suggested that, if LIGHT can behave in some respects like matter, then perhaps matter can behave in some respects like light
- In other words, perhaps matter is wavelike as well as particle like

(lambda) = h / mv

- The de Broglie equation allows the calculation of a "wavelength" of an electron or of any particle or object of mass, m, and velocity, v
- In 1926, Erwin Schrodinger proposed the quantum mechanical model of the atom which focuses on the wavelength of the particle
- In 1927, Werner Heisenberg stated that is is impossible to know where an electron is and its path- a statement called the Heisenberg uncertainty principle

(change in X) (change in Mass x Velocity) less than or equal to (h / 4pi)

- A wave function is characterized by three parameters called quantum numbers, n, l, m

Note: wave equation describes the motion of electrons as waves. Solution of this equation for particular atom are wave functions or orbitals.

- The exact electron position is not known (Heisenberg Uncertainty Principle) but wave functions (orbital) specifies where it is most probably known.

PRINCIPLE QUANTUM NUMBER

- Describes the size and energy level of the orbital
- Commonly called a shell
- Positive integer number
- As the value of n increases:
    - The energy increases
    - The average distance of the e- from the nucleus increases

ANGULAR MOMENTUM QUANTUM NUMBER

- Defines the 3-D shape of the orbital
- Commonly called a subshell
- There are n different shapes for orbitals
    - If n = 1 then l = 0
    - If n = 2 then l = 0 or 1
    - If n = 3 then l = 0, 1 or 2
- Commonly referred to by letter (subshell notation)
    - l = 0 s (sharp)
    - l = 1 p (principal)
    - l = 2 d (diffuses)
    - l =3 f (fundamental)

MAGNETIC QUANTUM NUMBER

- Defines the spatial orientation of the orbital

- There are 2l + 1 values of ml and they can have any integral value from -l to +l
    - If l = 0 then ml = 0
    - If l = 1 then ml = -1, 0, or 1
    - If l = 2 then ml = -2, -1, 0, -1, or -2

SHAPES OF ORBITALS

- Node: a surface of zero probability for finding the electron