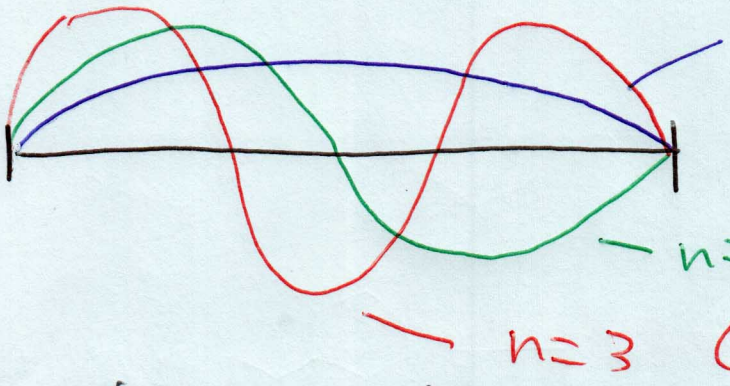
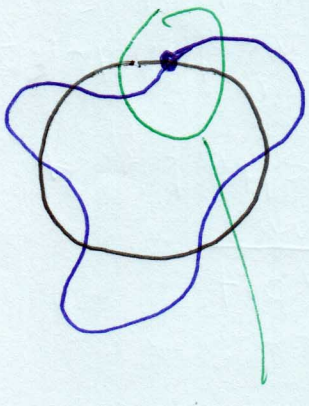
9/29/11 standing waves
quantization of energy
atomic orbitals (shapes + nodes)
filling rules
electron configurations
valence electrons
isotopes

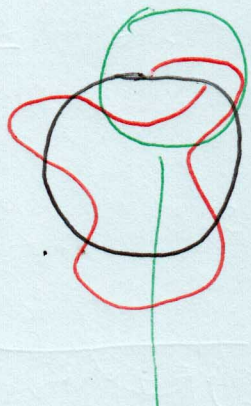


standing wave - a non-propagating wave with one or more boundary conditions

node - a place on a wave that has a value of 0.

quantization of energy - in a standing wave, there are only certain waves that can exist based on the boundary conditions. these waves will only have particular energy levels associated with them → energy is quantized.





Because this wave exactly overlaps itself, it is compatible with the boundary conditions of the system and will reinforce itself.

Because this wave does not overlap with itself, it will deconstructively interfer with itself and dissipate.

Electrons are described by wavefunctions (Ψ) which are mathmatical representations of the wave behavior of an electron. The wavefunctions are standing waves with the nucleus as a boundary condition. All of the unique shapes of the wavefunctions are caused by the presence of exactly and only one nucleus.

Because wavefunctions act like standing waves, only certain wavefunctions can exist.

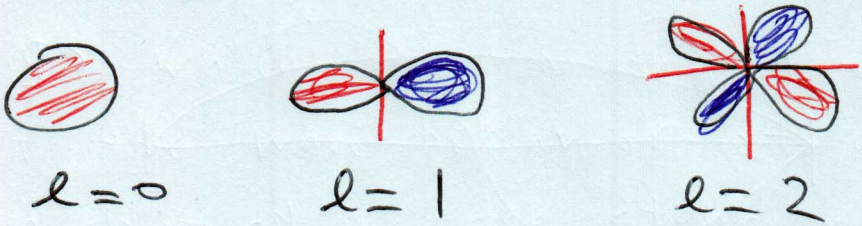
orbital - a region in space described by a wavefunction.

$$\Psi(r, \theta, \phi) = \underbrace{R(r)}_{\text{radial}} \underbrace{Y(\theta, \phi)}_{\text{spherical}}$$

Quantum numbers - used to represent the possible wavefunctions in an atom. Three of the numbers are used to describe a specific orbital.

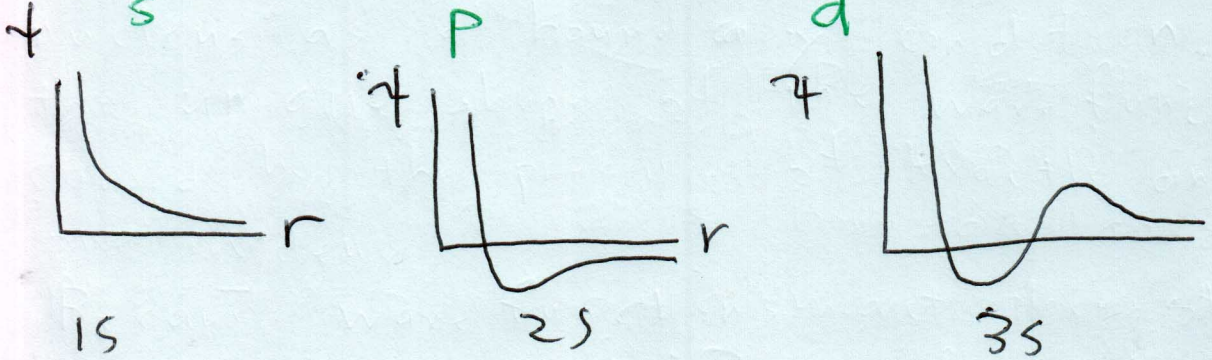
n = principal quantum number — represents the total # of packets in energy in an electron ⟶ $n \geq 1$

ℓ = orbital angular momentum — can be interpreted as how much energy is directed around the nucleus ⟶ maximum is $n-1$

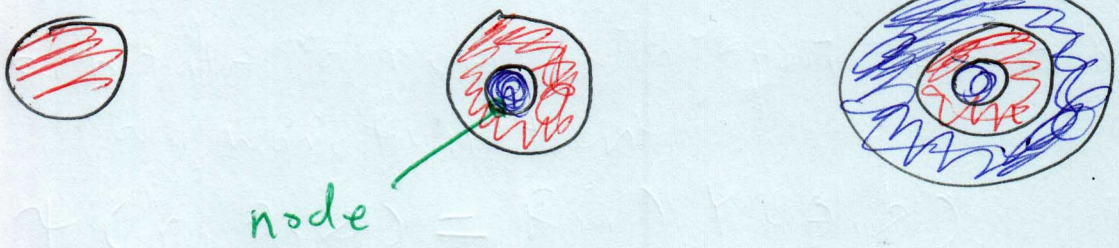


$\ell = 0$ $\ell = 1$ $\ell = 2$

s p d



1s 2s 3s



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electron configuration

octet rule - atoms are unusually stable when the s+p subshells are filled

shell - energy level ⟶ specific value of n

subshell - specific value of ℓ inside a shell

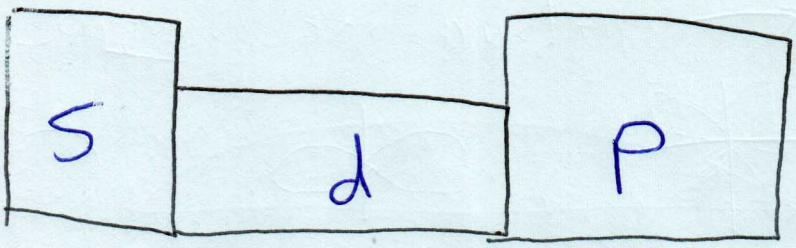
valence electons - the most energetic electrons in the outermost shell that participate in bonding.

F: $1s^2 2s^2 2p^5$

Cl: $1s^2 2s^2 2p^6 3s^2 3p^5$

Br: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

Elements in the same group act similarly because they have the same # of valence electrons.



Electron filling rules

Hund's rule - If there are multiple equal-energy orbitals (degenerate orbitals), each orbital is filled with one electron first before pairing occurs,

Pauli exclusion principle - An orbital can have a maximum of two electrons (only if they have opposite spin)

Aufbau principle - "building up" - electrons fill from lowest to highest energy.

Isotopes - atoms that have the same # of protons (same element) but different # of neutrons,

$^{1}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$

H D T

protium deuterium tritium