The Atom

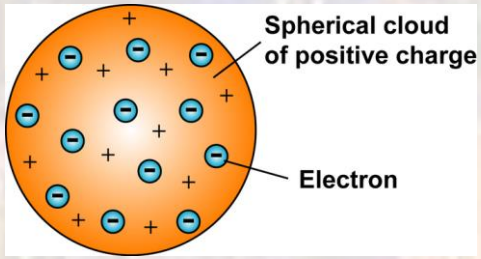
Last updated 2/4/22

These concepts have been greatly simplified

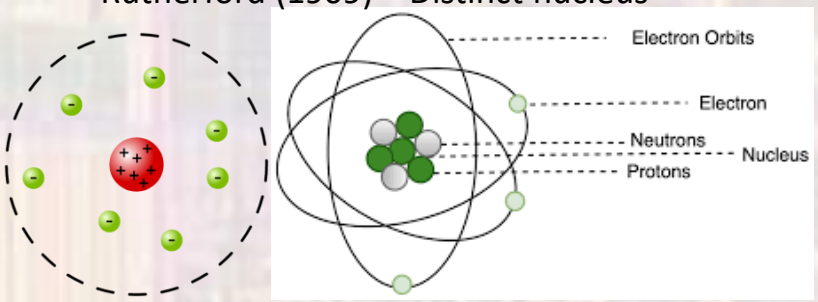
The Atom

- Our understanding of atomic structure has changed over time

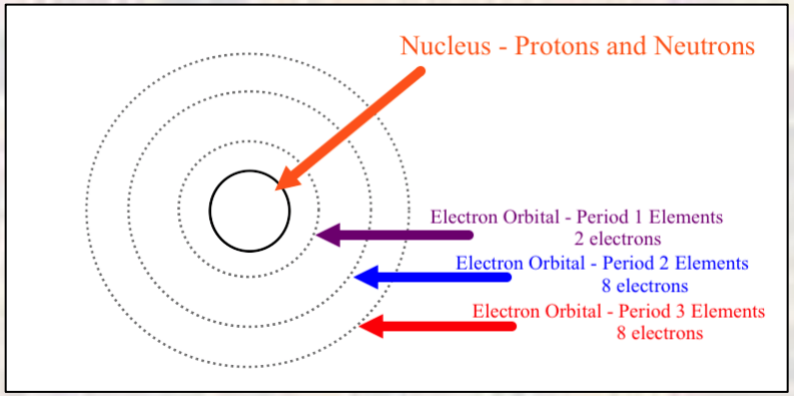
Thomson (1897) – Plum Pudding



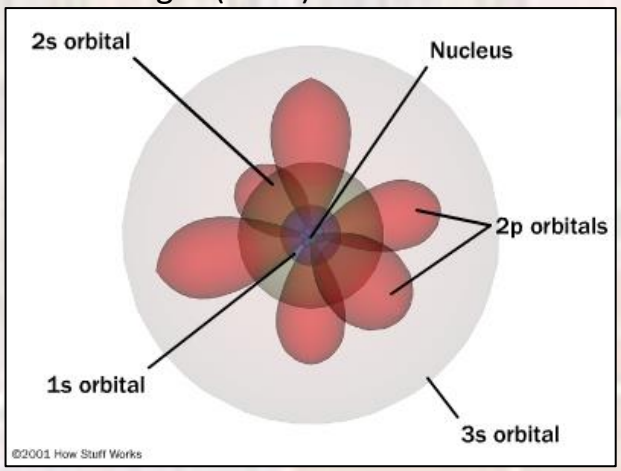
Rutherford (1909) – Distinct nucleus



Bohr (1913) – Electron Orbitals



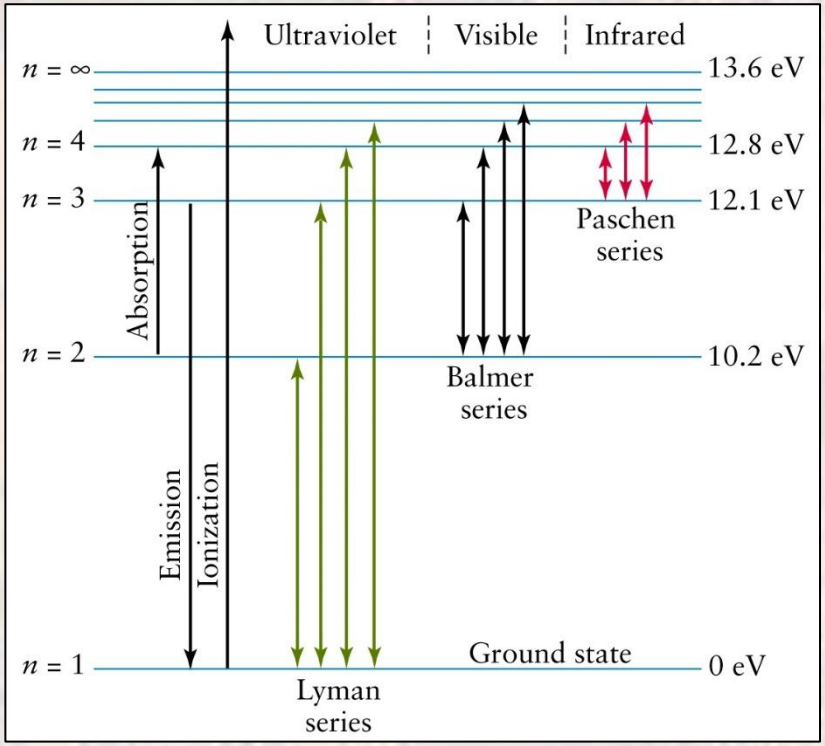
Schrödinger (1926) – Electron Clouds

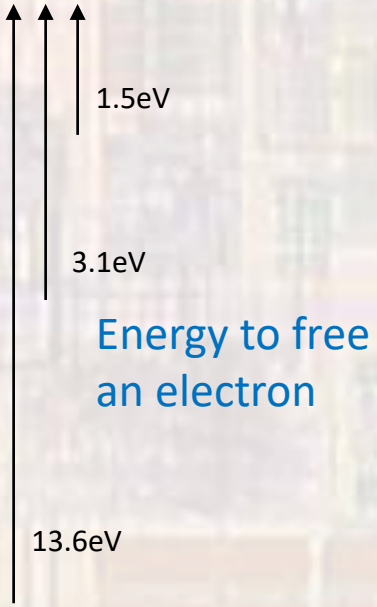


The Atom

- Electrons are only allowed to occupy specific energy levels (states)

Hydrogen Electron Energy States and Transitions





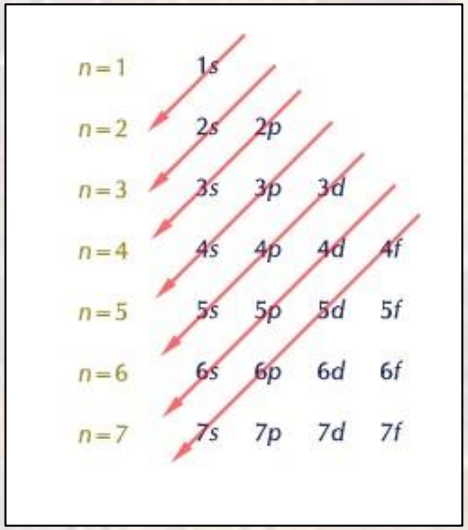
The Atom

- Electron configurations
  - As the atomic number increases, more electrons are associated with the atom
  - These electrons occupy specific energy levels

Energy levels and # of electrons / level

Energy Level (n)	Sublevels in main energy level (n sublevels)	Number of orbitals per sublevel	Number of Electrons per sublevel	Number of electrons per main energy level ($2n^2$)
1	s	1	2	2
2	s p	1 3	2 6	8
3	s p d	1 3 5	2 6 10	18
4	s p d f	1 3 5 7	2 6 10 14	32

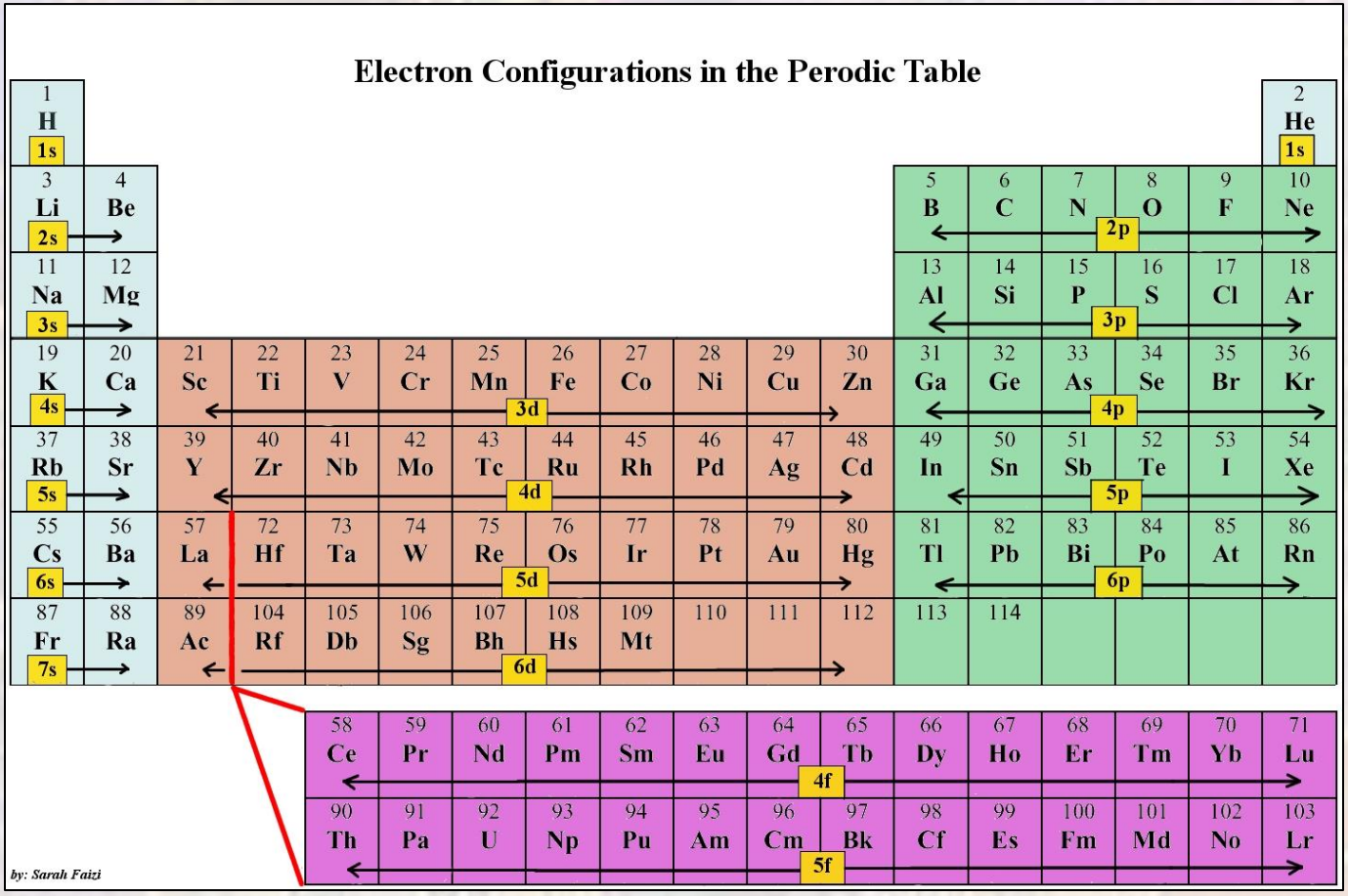
Energy level fill order



All electrons at a given level are filled before filling the next level

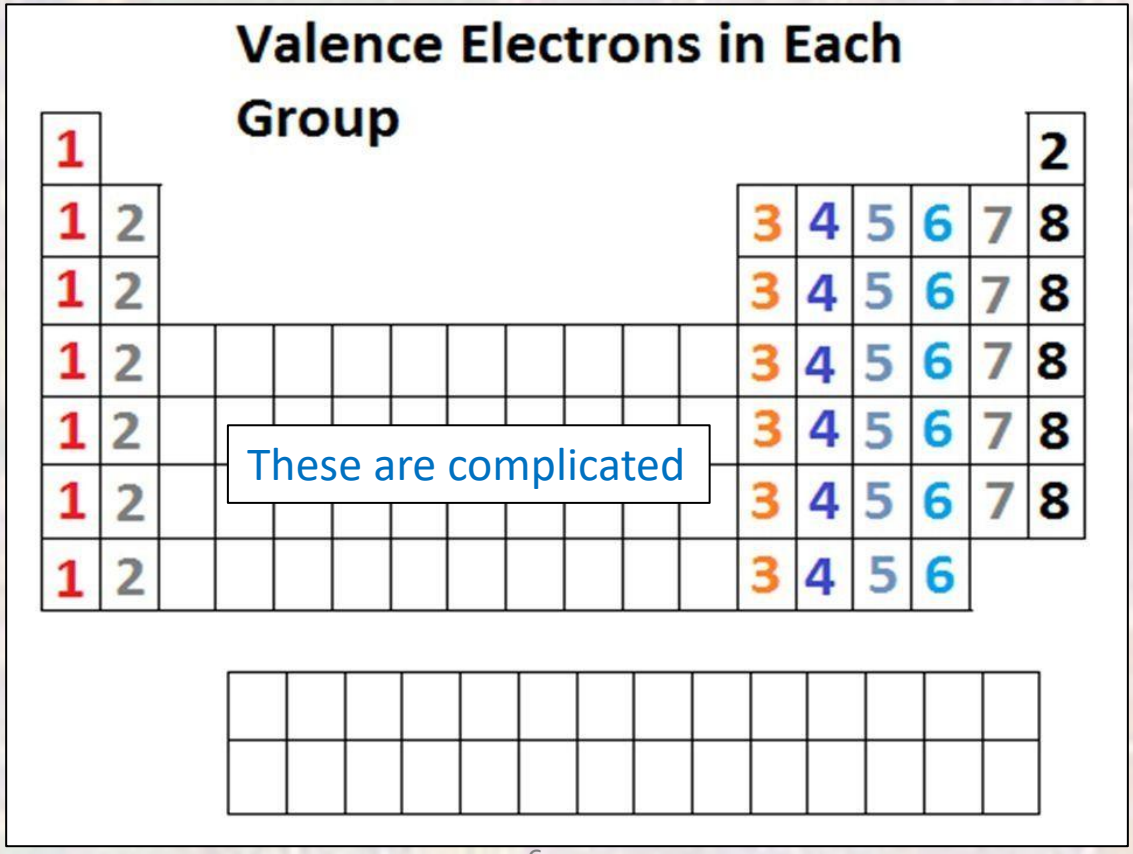
The Atom

- Electron configurations



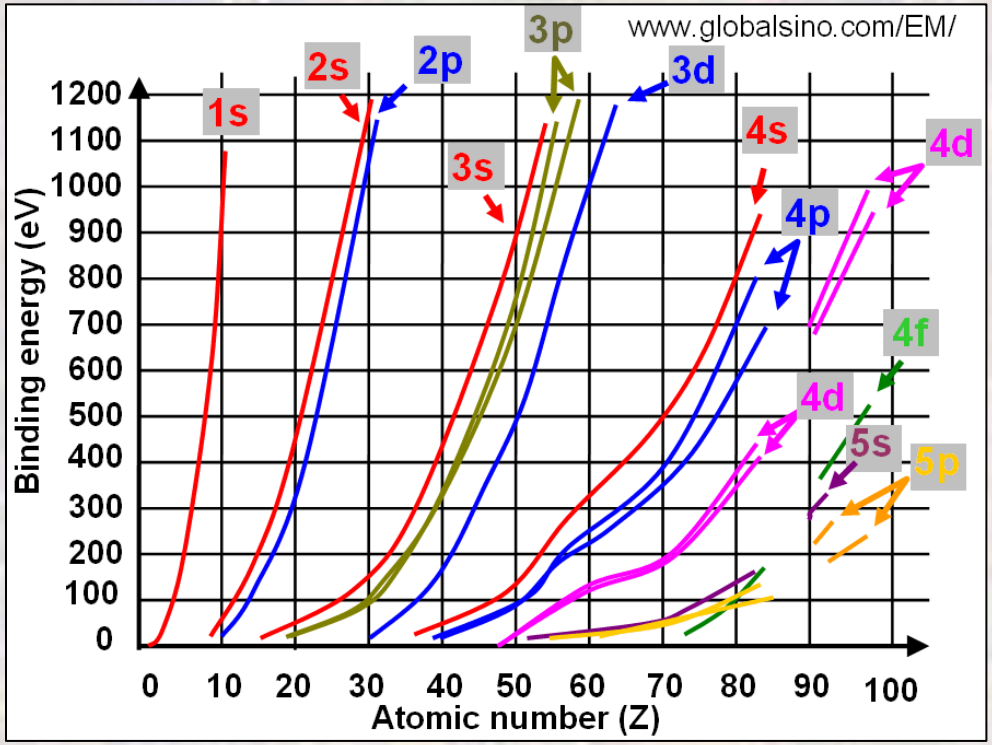
The Atom

- Valance Electrons
  - Electrons in the outer “shell” of the atom
    - Easiest electrons to free from the atom



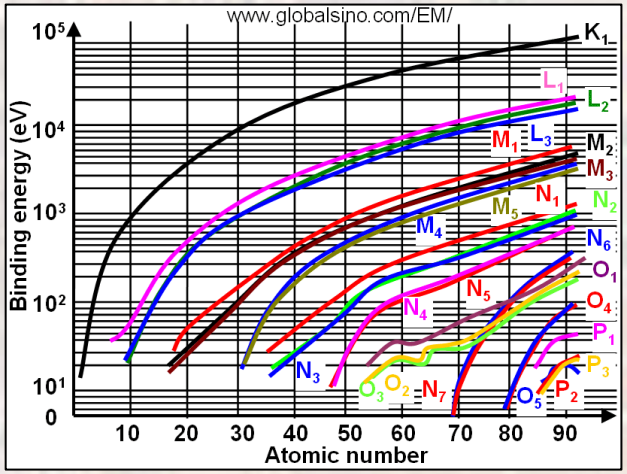
The Atom

- Binding Energy
  - Energy required to free an electron from an atom
    - Once a shell is “protected” the binding energy goes up fast



Conversion[2][3]

Quantum numbers				Atomic notation	X-ray notation
n	ℓ	s	j		
1	0	1/2	1/2	$1S_{1/2}$	K_1
2	0	1/2	1/2	$2S_{1/2}$	L_1
2	1	1/2	1/2	$2P_{1/2}$	L_2
2	1	1/2	3/2	$2P_{3/2}$	L_3
3	0	1/2	1/2	$3S_{1/2}$	M_1
3	1	1/2	1/2	$3P_{1/2}$	M_2
3	1	1/2	3/2	$3P_{3/2}$	M_3
3	2	1/2	3/2	$3D_{3/2}$	M_4
3	2	1/2	5/2	$3D_{5/2}$	M_5



The Atom

- A few atoms of interest

Silicon

Symbol:	Si	
Atomic number:	14	
Atomic mass:	28.0855 au	
Electron Config:	$1s^2 2s^2 2p^6 3s^2 3p^2$	[Ne] $3s^2 3p^2$
Valance Electrons:	4, (4 empty spots)	

8 possible states / atom

Boron

Symbol:	B	
Atomic number:	5	
Atomic mass:	10.811 au	
Electron Config:	$1s^2 2s^2 2p^1$	[He] $2s^2 2p^1$
Valance Electrons:	3, (1 empty spot)	

Phosphorus

Symbol:	P	
Atomic number:	15	
Atomic mass:	30.974 au	
Electron Config:	$1s^2 2s^2 2p^6 3s^2 3p^3$	[Ne] $3s^2 3p^3$
Valance Electrons:	5, (3 empty spots)	