

# Chapter 7: Electromagnetic Radiation (Light Energy)

---

November 15, 2022

Chemistry Department, Cypress College

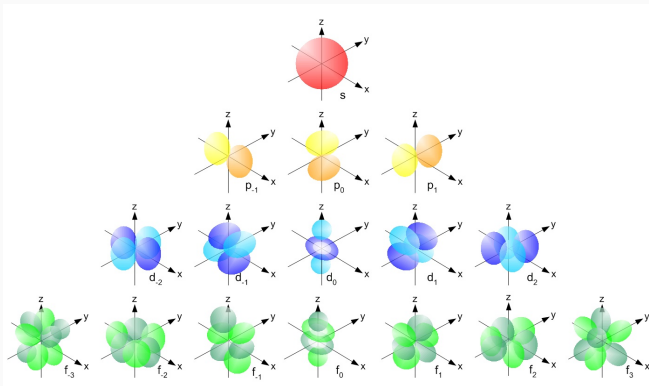
## Lecture

- Finish Ch 7 and begin Ch 8
- Quiz and Homework assignment released Fri, Nov 18th at 3pm
- Exam 3 on Nov 22nd; 10 questions covering Exam 2 and Chs 7-8

Review: Periodicity of Electron Configurations

Periodic Properties of Atoms

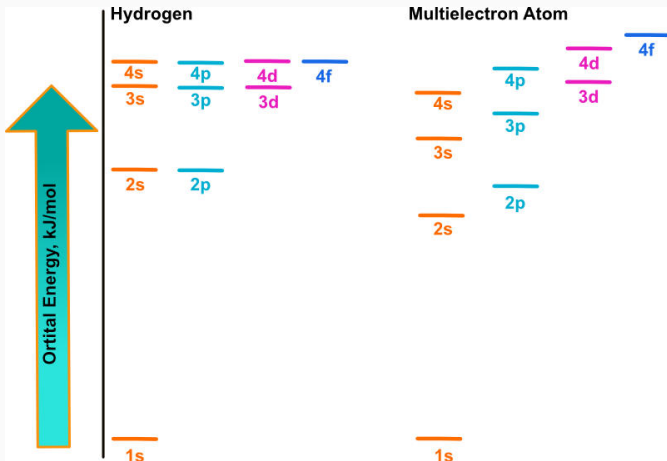
# Atomic Orbitals



- Specific orbitals occupy certain **principal energy level** e.g.  $n = 1, 2, 3, \dots$
- Basis in which atoms form bond; atomic orbitals combine to make molecular orbitals

# Orbital Diagram - Multielectron Element

**Q:** What do notice about the relative atomic orbital energies?



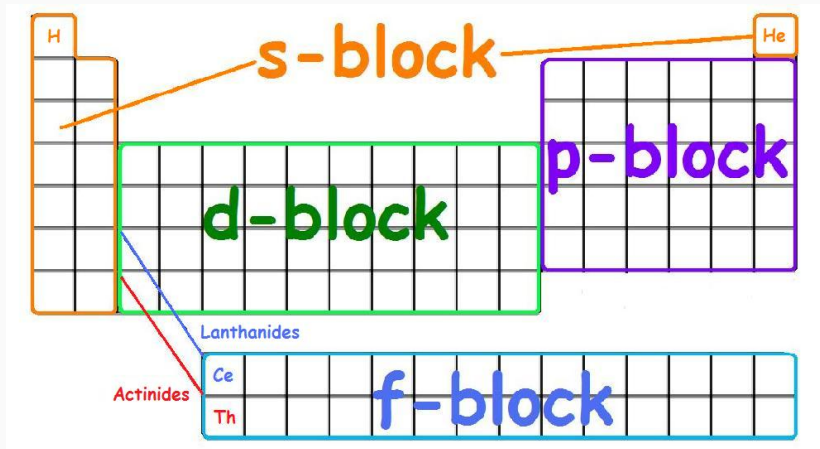
# Principles for Filling Atomic Orbitals

**Aufbau principle** - electrons fill an orbital starting with the lowest energy level

**Pauli exclusion principle** - No two electrons with the same spin can occupy the same orbital

**Hund's Rule** - Maximize the number of unpaired electrons

# Relating to Periodic Table



# Purpose of Electron Configurations

- Outermost shell is referred to as the valence electrons (**Q:** What is special about valence electrons?)
- Innermost shell is the core electrons
- Predicts stability of the atom e.g. unfilled orbitals indicate instability
- Make predictions how elements react forming new chemical compounds



# Core and Valence Electrons

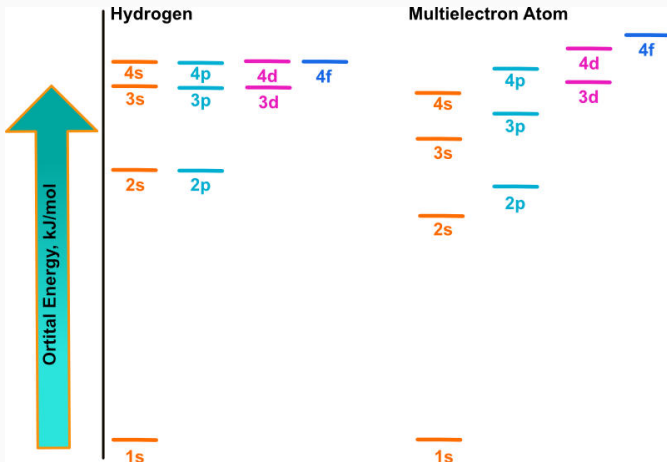
**Core Electrons** - Energy level  $n$  below the valence electrons and these are completely filled orbitals

**Valence Electrons** - Outermost electrons above the energy level  $n$  of the core electrons

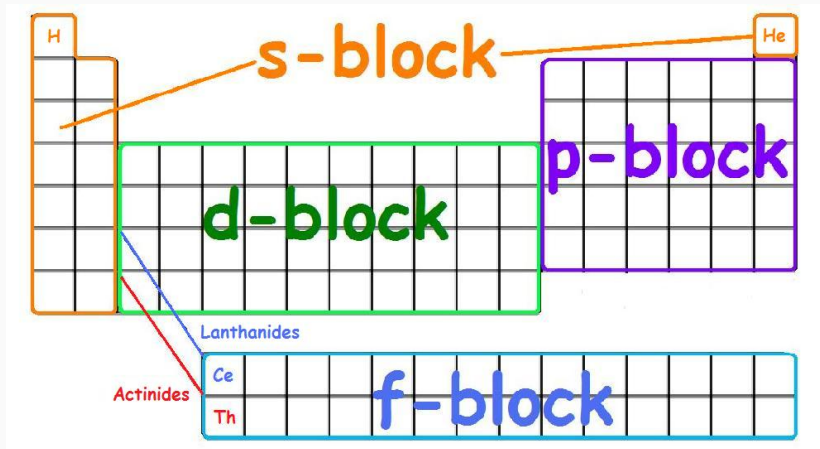
**Example:** Si -  $1s^2 2s^2 2p^6 3s^2 3p^2$

## Special Note about d-orbitals

Energy levels of 4s and 3d are close along with subsequent  $n$  levels  
e.g. 5s and 4d, 6s and 5d

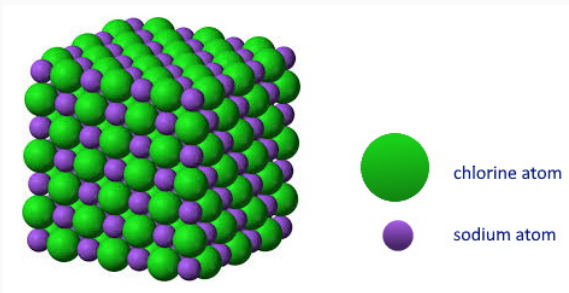


## Relating to Periodic Table



# Electron Configuration of Ions

**Q:** What is a cation? What is an anion?



**Cation:** Sodium ion ( $\text{Na}^+$ ) **Anion:** Chloride ion ( $\text{Cl}^-$ )

**Q:** For electron configuration, how do we add/remove electrons from atomic orbitals for anion/cation?

# Principles for Filling Atomic Orbitals

**Aufbau principle** - electrons fill an orbital starting with the lowest energy level

**Pauli exclusion principle** - No two electrons with the same spin can occupy the same orbital

**Hund's Rule** - Maximize the number of unpaired electrons

## Practice: Writing Electron Configurations

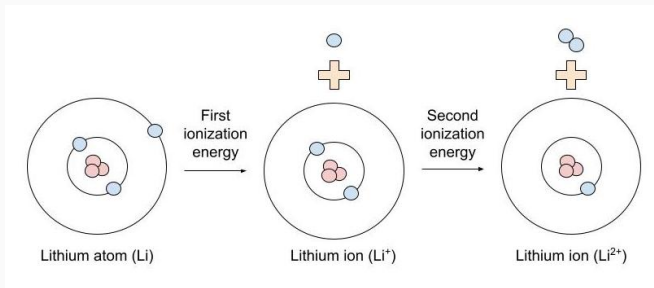


Review: Periodicity of Electron Configurations

Periodic Properties of Atoms

# Meaning of Ionization

**Ionization energy** - Energy required to eject an electron

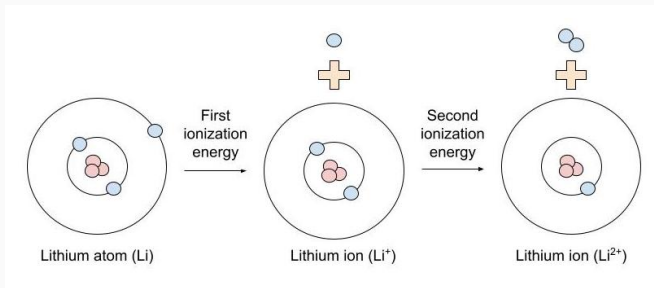


First ionization takes 520 kJ/mol and second ionization takes 7298 kJ/mol



# Meaning of Ionization

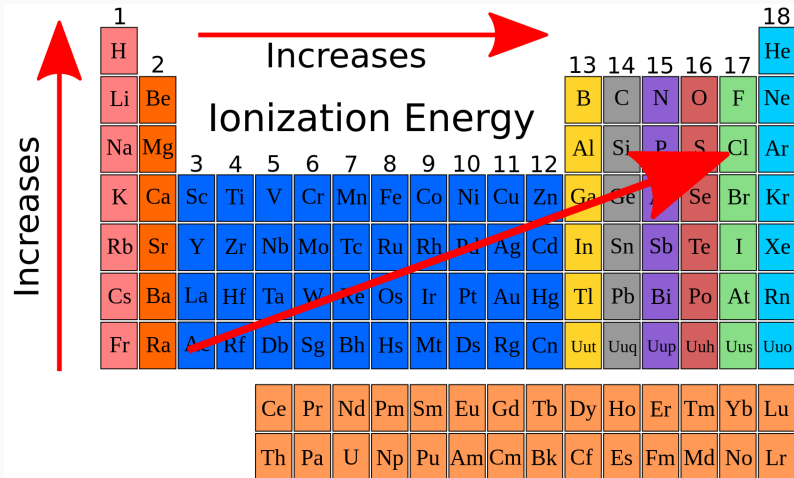
**Ionization energy** - Energy required to eject an electron



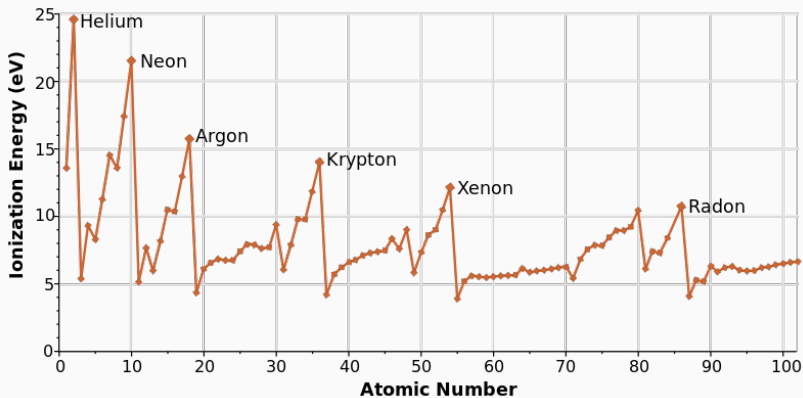
First ionization takes 520 kJ/mol and second ionization takes 7298 kJ/mol

**Q:** Why is the second ionization energy significantly higher?

# First Ionization Energy Trends



# First Ionization Energy Trends



## Atomic Sizes of Neutral Atoms

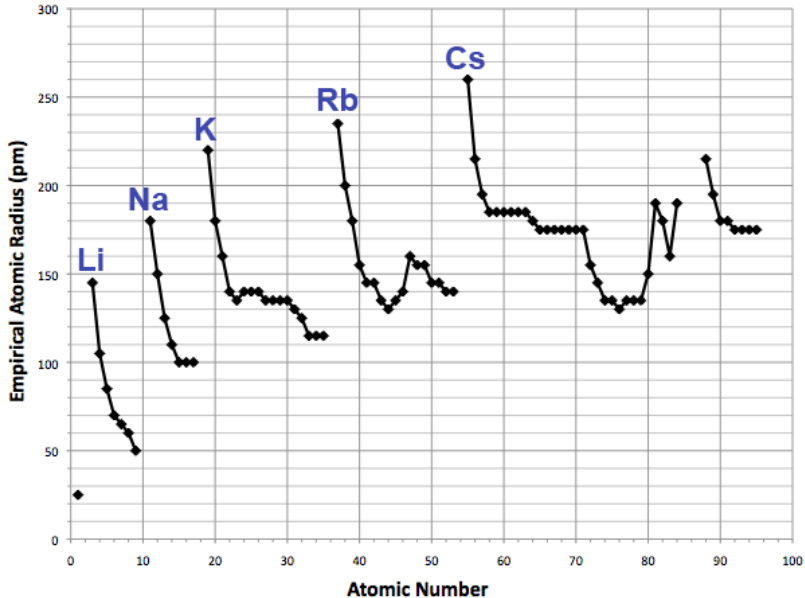
The diagram shows a periodic table with the following elements and their atomic numbers:

1 H																	18 He
2 Li	3 Be											13 B	14 C	15 N	16 O	17 F	18 Ne
11 Na	12 Mg											31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	











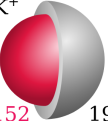


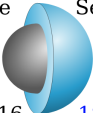
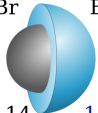



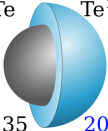
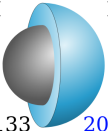
Below the main table, the lanthanide and actinide series are shown:

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

# Atomic Sizes of Neutral Atoms



# Atomic Sizes of Ions

Sizes of atoms and their ions in pm									
Group 1		Group 2		Group 13	Group 16	Group 17			
Li <sup>+</sup>	Li	Be <sup>2+</sup>	Be	B <sup>3+</sup>	B	O	O <sup>2-</sup>	F	F <sup>-</sup>
									
90	134	59	90	41	82	73	126	71	119
Na <sup>+</sup>	Na	Mg <sup>2+</sup>	Mg	Al <sup>3+</sup>	Al	S	S <sup>2-</sup>	Cl	Cl <sup>-</sup>
									
116	154	86	130	68	118	102	170	99	167
K <sup>+</sup>	K	Ca <sup>2+</sup>	Ca	Ga <sup>3+</sup>	Ga	Se	Se <sup>2-</sup>	Br	Br <sup>-</sup>
									
152	196	114	174	76	126	116	184	114	182
Rb <sup>+</sup>	Rb	Sr <sup>2+</sup>	Sr	In <sup>3+</sup>	In	Te	Te <sup>2-</sup>	I	I <sup>-</sup>
									
166	211	132	192	94	144	135	207	133	206