Unit2Day3-Crawford

Wednesday, September 25, 2013
4:08 PM

Vanden Bout/LaBrake/Crawford :)

CH301

ELECTRON CONFIGURATION and PERIODIC TABLE

Why is Sr so dangerous?

UNIT 2 Day 3

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Important Information

LM 14, 15 & 16 are all due today

HW05 POSTED DUE Tue 9AM
LM17 Posted DUE Tue 9AM
Review Periodic Table Basics and Nomenclature on Fundamental Section of Website

Laude LMs Lecture 4, 5 & 6

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What are we going to learn today?

–Apply the Theoretical Model (QM view)

- Relate empirical model to the theoretical model for atoms with more than one electron
- Understand the powerful, predictive nature of the model
- Relate the predicted ground state electron configurations with position on the periodic table
- Relate electron configuration with periodic trends

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QUIZ: CLICKER QUESTION 1

The solutions to the Schrodinger Equation yield solutions that provide information about:

a) Energy of electrons
b) Probability of finding electrons in certain regions in space
c) Both a and b
d) Neither a or b

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QUIZ: CLICKER QUESTION 2

Which of the following is not a valid set of quantum numbers for the wave function for an electron in a hydrogen atom?

A. n=1, l=0, m=0
B. n=2, l=2, m=1
C. n=2, l=1, m=-1
D. n=3, l=2, m=0

Atomic Orbitals- Defined by Quantum Numbers

n – principal quantum number-specifies the **energy** of the orbital,
All atomic orbitals with the same value of n have the same energy and belong to the same shell

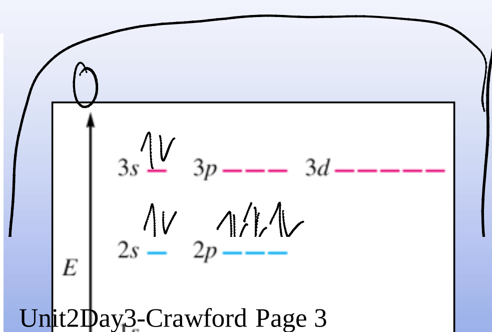
l – orbital angular momentum quantum number – measure of the **rate** at which the electron **circulates** around the nucleus, which defines the **shape** of the orbital

l = 0,1,2…n-1
n different values of l for any given n
orbitals of a shell fall into n groups called subshells
l=0 is called s-orbital
l=1 is called p-orbital
l=2 is called d-orbital
l=3 is called f-orbital

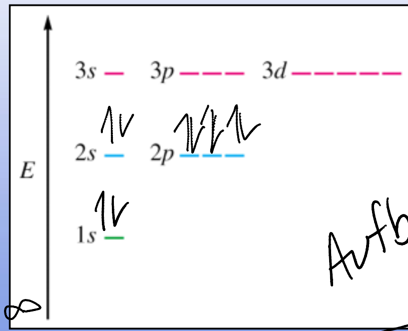
m_l – magnetic quantum number – indicates the **orientation** of the angular momentum around the nucleus
distinguishes the different orbitals within a subshell
$m_l = l, l-1…, -l$
there are $2l + 1$ values of m_l for a given value of l

DEFINITIONS:
quantum numbers – orbital notation

- The location of an electron in a H atom is described by a wave function known as an atomic orbital, each **orbital** is designated by a set of three quantum numbers and fall into

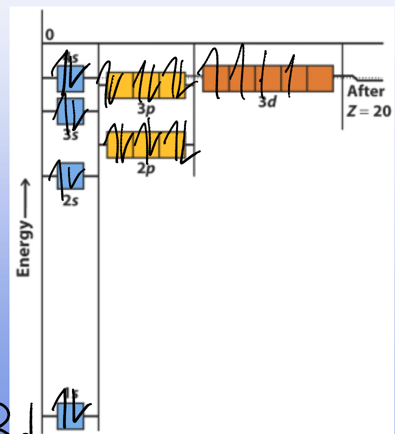


- The location of an electron in a H atom is described by a wave function known as an atomic orbital, each **orbital** is designated by a set of three quantum numbers and fall into **shells** and **subshells**



Electronic Configuration of many electron atom

- Z denotes the nuclear charge and hence the # of e- in an atom
- Potential energy of electrons in a many electron atom is more complex than the simple H atom
- Too difficult to solve exactly
- Loss of degeneracy in shells
- Outer electrons are shielded from nucleus
- Need to add 4th quantum number, m_s, spin quantum number



1s < 2s < 2p < 3s < 3p < 4s < 3d

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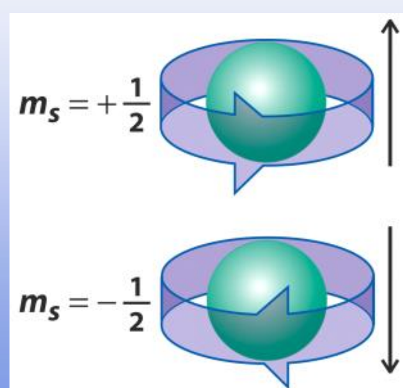
4th Quantum Number

- m_s - spin magnetic quantum number- indicates the spin on the electron, the electron can spin one of two directions up or down
- Pauli Exclusion Principle: In a given atom no two electrons can have the same set of four quantum numbers.
- An orbital can hold only two electrons, and they must have opposite spin.



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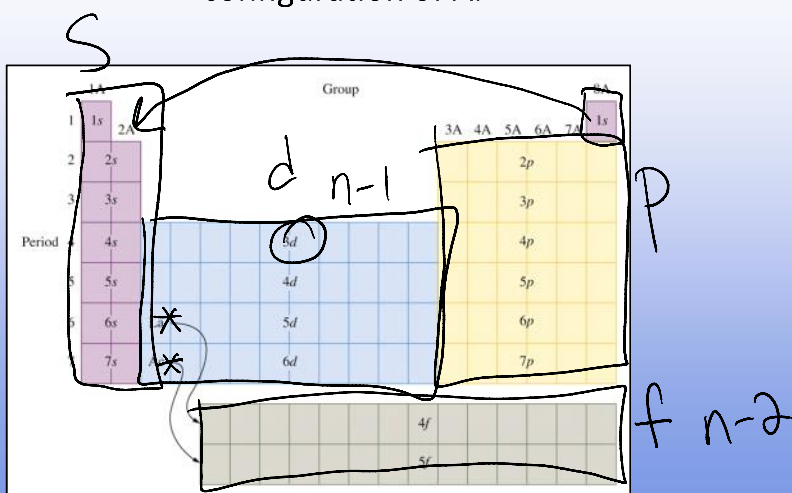
- An orbital can hold only two electrons, and they must have opposite spin.

Quick recap of key points.

Periodic Table helps to determine order of orbital filling for elements, use table to predict electron configuration of Al



PRACTICE IDENTIFYING QUANTUM NUMBERS AND ELECTRON CONFIGURATIONS

CLASS GROUP WORK

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POLL: CLICKER QUESTION 4

A FEW QUESTOINS RELATING TO THE WORKSHEET

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ARRANGEMENT OF ELEMENTS - PERIODIC TABLE

Take a few minutes to write down everything you know about the Periodic Table

While we are setting up a demo…

Na in water… K in water…..

What will happen? Should it be the same… should it be different?

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Periodic Table of the Elements

1A 1	2A 2	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)							

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

McCord (2006)

Aufbau Principle (building up)

Where are the electrons in Ne?

$1s^2 2s^2 2p^6$ very stable gas

Z=10

Where are the electrons in Ne?

$1s^2 2s^2 2p^6$ very stable gas

Z=10

Where are the electrons in Na?

$[Ne]3s^1$ not so stable metal

Z=11

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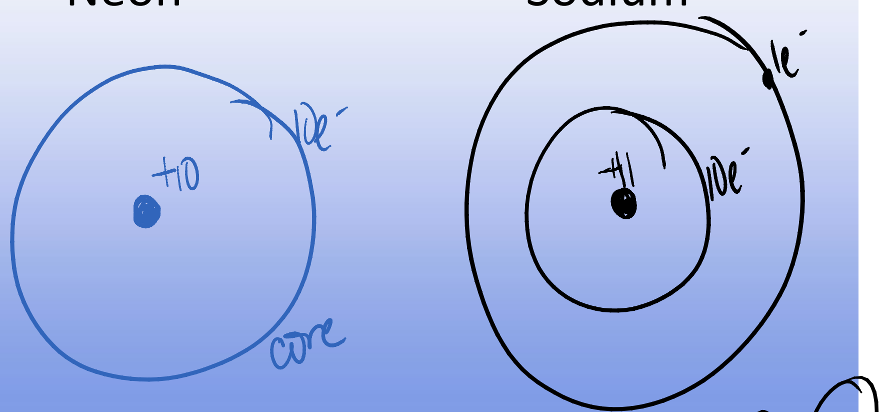
Shielding and effective nuclear charge

Neon Sodium



Z_{eff} = atomic # − core e⁻ = 10 − 10 = 0

Z_{eff} = 11 − 10 = 1

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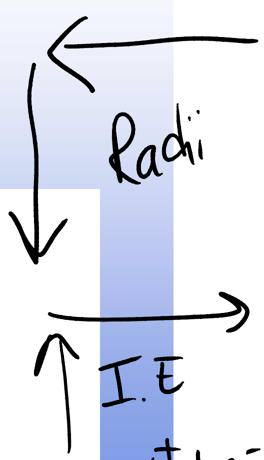
POLL: CLICKER QUESTION 5

Shielding and effective nuclear charge

Because of shielding
Sodium is more like H than Ne



As I go from left to right in a period
I add electrons: more shielding, and
I add more protons: bigger Z

Which has a larger effect?

A) Adding more electrons across period

B) Adding more protons across period

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I add electrons: more shielding, and
I add more protons: bigger Z

Which has a larger effect?
A) Adding more electrons across period
B) Adding more protons across period

I.E
$X \rightarrow X^+ + e^-$

Shielding and effective nuclear charge

As I go from left to right in a period I add electrons more shielding and I add more protons bigger Z
Which has a larger effect?

Left to Right Z_{eff} is increasing

Electrons are more stable. Lower Energy. Closer to the nucleus

Ionization energy increases
Size decreases

Shielding and effective nuclear charge

Sodium Potassium

Trends in
ATOMIC RADIUS and IONIZATIONS ENERGY

As I go from top to bottom in a family Z_{eff} is about the same. But the valence electrons are in higher and higher n orbitals (farther from the nucleus).

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Trends in size and IE

As I go from top to bottom in a family Z_{eff} about the same. But the valence electrons are in higher and higher n orbitals (farther from the nucleus).

Top to Bottom

Electrons are less stable. Higher in Energy. Farther from the nucleus

Ionization energy decreases
Size increases

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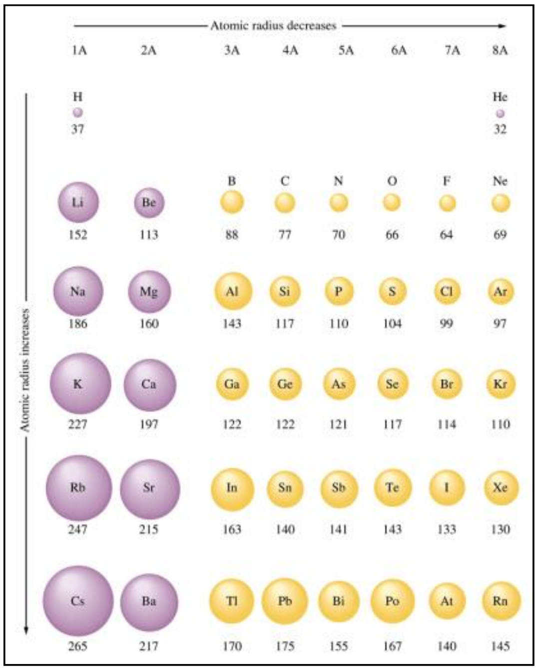
Trend: Atomic Radii



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What have we learned?

LIGHT CAN BE USED TO PROBE THE ENERGY OF ELECTRONS IN MATTER

ELECTRONS IN ATOMS HAVE DISCRETE ENERGIES

ELECTRONS CAN BE DESCRIBED BY WAVE FUNCTIONS THAT CAN BE CLASSIFIED BY QUANTUM NUMBERS

THE HYDROGEN WAVEFUNCTIONS CAN APPROXIMATE THE WAVEFUNCTIONS OF MULTIELECTRON ATOMS

THE ORDERING OF ENERGY LEVELS IS GENERALLY THE SAME FOR ATOMS FOR ALL ELEMENTS

NUCLEAR CHARGE FELT BY VALENCE ELECTRONS IS SHIELDED BY THE CORE ELECTRONS

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Learning Outcomes

Describe the difference between one electron systems and multi-electron systems.

Predict electron configurations based on position on periodic table.

Apply the Aufbau principle to determine the configuration for any atom or ion.

Use Hund's Rule to determine electron configuration using an orbital diagram (electrons in individual orbitals with spins.

Students will use the shell model of multi-electron atoms to describe the concept of core vs. valence electrons

Define ionization energy.

Describe the concept of electronic shielding and effective nuclear charge (Zeff) and their relationship to trends in ionization energy, atomic radii and ionic radii.

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WHAT DO YOU THINK?

When I'm studying chemistry, I spend my time learning the new material and…

A) That is it until the next exam comes along.
B) Reviewing what I already understand.
C) Focusing on what I do NOT understand.
D) Splitting up time between reviewing what I already understand and focusing on what I do NOT understand.

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* higher n, higher t

∴ **less** stable (bigger)