Chem 111

Lecture 21

Announcements

- Exam 2, Nov 1

→Pencils, Erasers, Calculator, ID card

- Practice Exams:

http://courses.umass.edu/chem111-bbotch/ExamInfo.html

- Breanne has a recitation session HASA 126 – 10/27 (5-6pm)

- SI session schedule is posted on website

- Sunday 4 – 6 PM, ISB 135, Prof. Tyson

Exam Equation Sheet

$q_1 + q_2 + q_3 \cdots = 0$

$N_A = 6.022 \times 10^{23}$

$q = mC_{sp}\Delta T \rightarrow q = C_{cal}\Delta T$

C_{sp} (water) = $4.184 \frac{J}{g\ ^oC}$

1 ml water weighs 1 g

$h = 6.626 \times 10^{-34}$ Js

$c = 2.998 \times 10^8 \frac{m}{s}$

$R_H = 1.097 \times 10^7\ m^{-1}$

1 Hz = $1\ s^{-1}$

1 cal = 4.184 J

$\Delta U = q + w$

$w = -P\Delta V$

$\Delta H = \Delta U + P\Delta V$ reactions at constant pressure

$\Delta H^0_{rxn} = \Sigma \Delta H^0_f$ (products) - $\Sigma \Delta H^0_f$ (reactants)

$$E_n = -\frac{R_H hc}{n^2}$$

$$\Delta E = -R_H hc\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$c = \lambda\nu$

$E = h\nu$

$E = \frac{hc}{\lambda}$

$$\lambda = \frac{h}{mv}$$

Exam

- Chapter 3: Redox Reaction and Oxidations States (3.9-end)
- Chapter 4: Limiting reactant problem
- Chapter 5: Everything
- Chapter 6: Everything except Dia/Paramagnetism

- Expected to manipulate them
- Know what the variable mean
- Calorimeter/Phase change
- Concept equations

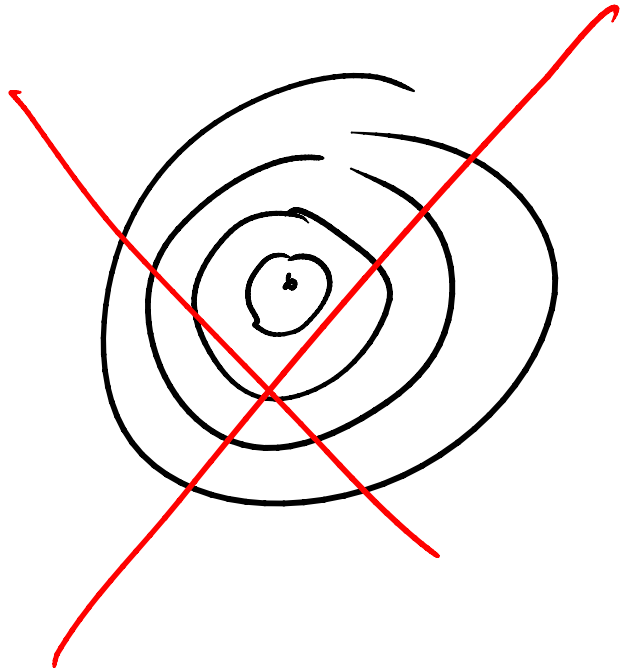
- Need to know concepts from earlier chapters (balance, prefixes – n, p, M, k… etC)

Homework

- Finish Reading Chapter 6
- Owl (homework that is due on Sunday you can do now and will be on the test)

Recap

- Wave-Particle Duality
- Uncertainly Principle
- Schrödinger equation
- Waves
- Quantum numbers
- Orbitals



Let's Practice

What are the possible values of ℓ if n = 3? What is the subshell designation (s,p,d,etc…) of each? What are the possible values of m_ℓ?

$n=2,\ \ell=1 \Rightarrow 2p$

$n=3,\ \ell=2 \Rightarrow 3d$

$m_\ell = -\ell \ldots 0 \ldots +\ell$

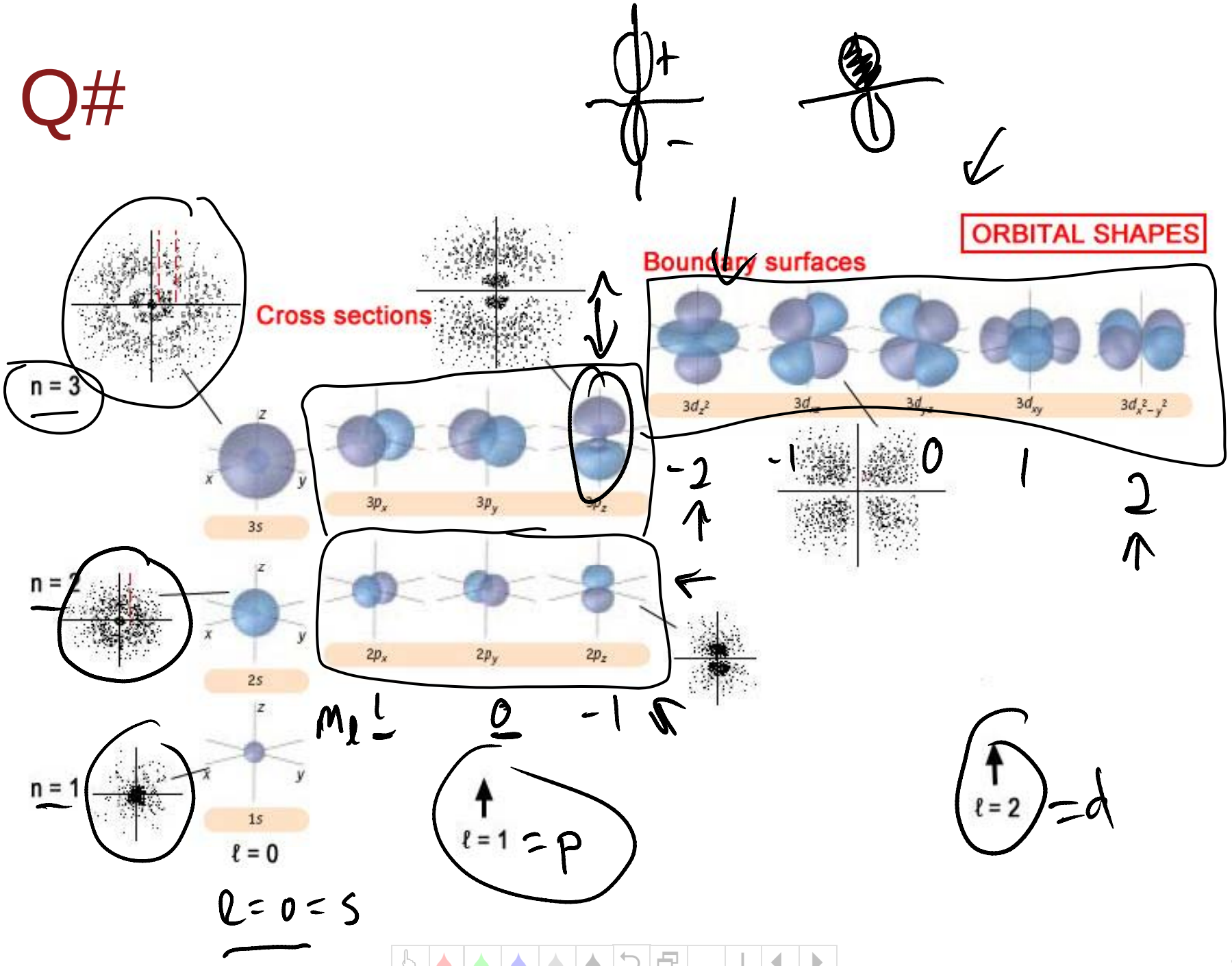
$\ell = 0, 1 \ldots n-1$

ℓ	ss	m_ℓ
0	S	0
1	p	-1, 0, 1
2	d	-2, -1, 0, 1, 2

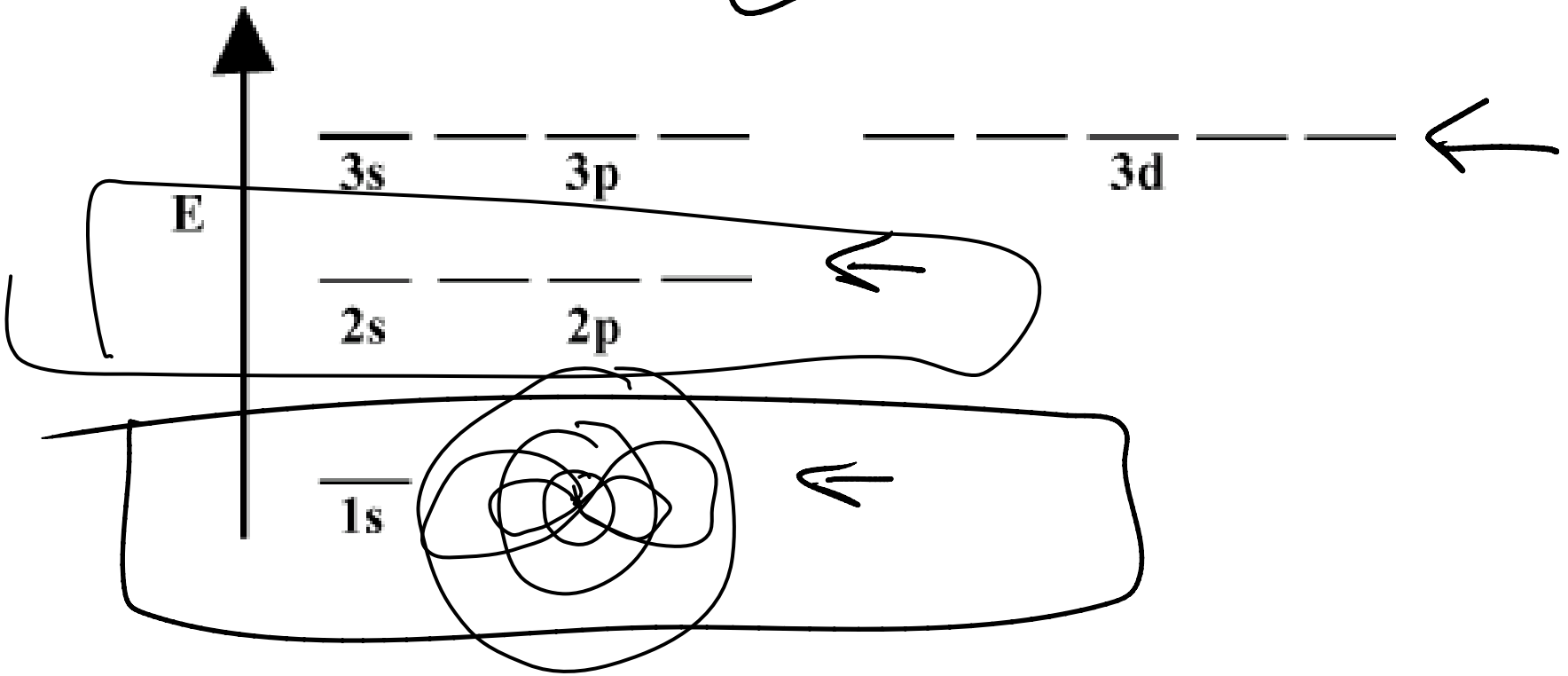
$n=3$, $\ell=0$ ← 3s

$n=3$, $m_\ell=-3$, $\ell=3$

Q#


ORBITAL SHAPES
Boundary surfaces
Cross sections
n = 3
n = 2
n = 1
3s
3p_x
3p_y
3p_z
2s
2p_x
2p_y
2p_z
1s
3d_z²
3d_xz
3d_yz
3d_xy
3d_x²-y²
ℓ = 0
ℓ = 1 = p
ℓ = 2 = d
m_ℓ
-2
-1
0
1
2
ℓ = 0 = s

Orbitals



Oribitals of same energy level are said to be **degenerate**.

Quantum Numbers

- The shell with principle quantum number n will consist of exactly n subshells. $n=3$ $l=0,1,2$ or s,p,d $n=4$ s,p,d,f $l=0,1,2,3$
- For a given value of ℓ, there are $2\ell + 1$ values of m_ℓ. $l=2$ $m_l=2,1,0,-1,-2$ 5 total $2(2)+1=5$
- The total number of orbitals in a shell is n^2

$n=1^2 \rightarrow 1$ orbital

$n=2^2 \rightarrow 4$ orbital

Spin

- s = intrinsic angular spin.
- For an electron s=1/2 always
- m_s = magnetic spin q#
- For and electron m_s = +1/2 or -1/2

The for q# n, l, m_l, m_s are used to characterize a electron in an atom

Let’s Practice Day

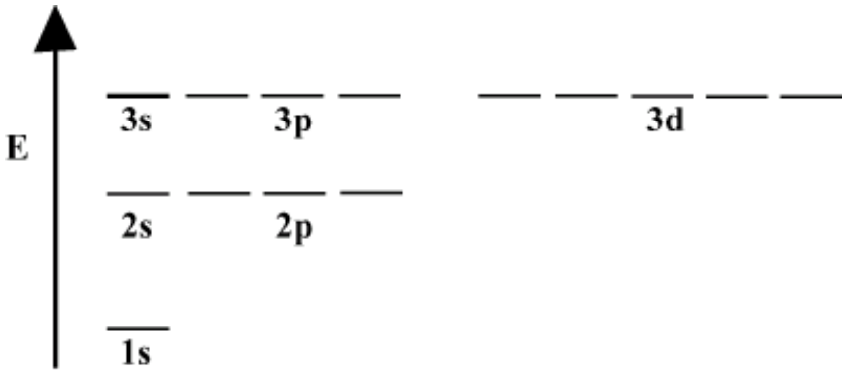
- Friday I am going to do a whole bunch of practice problems

- If there is something you want me to go over, email me

Electron Configuration

- The way in which electrons are distributed among the various orbitals of an atom is called its **electron configuration.**

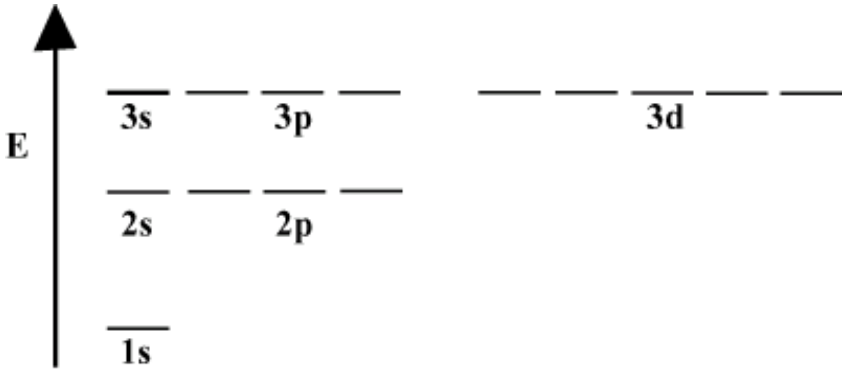
- The most stable, or ground state, electron configuration of an atom is that in which the electrons are in the lowest possible energy state.



Hydrogen

Helium

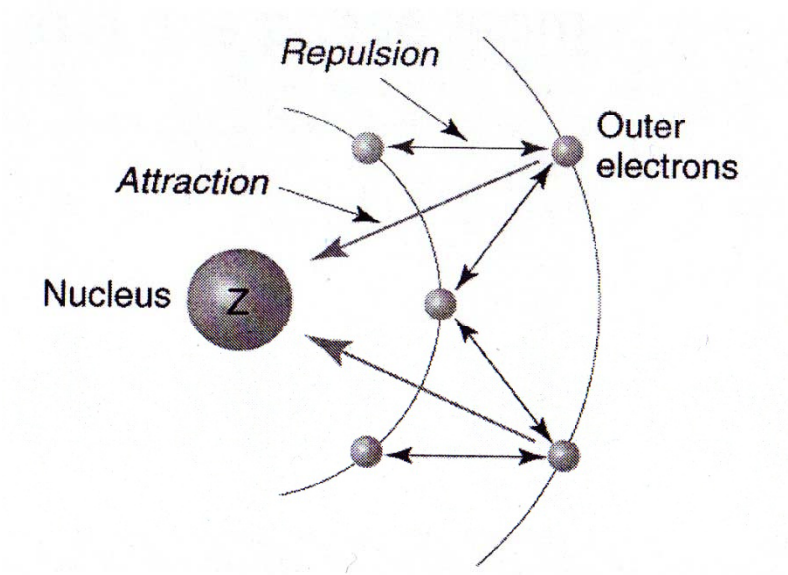
- **Pauli exclusion principle** states that no two electrons in an atom can have the same set of four qauntum numbers (n, ℓ, m_ℓ, m_s)



- An orbital can hold a maximum of two electrons and they must have opposite spins

Effective nuclear charge

- $Z_{eff} = Z - \sigma$
- σ : Is the shielding constant



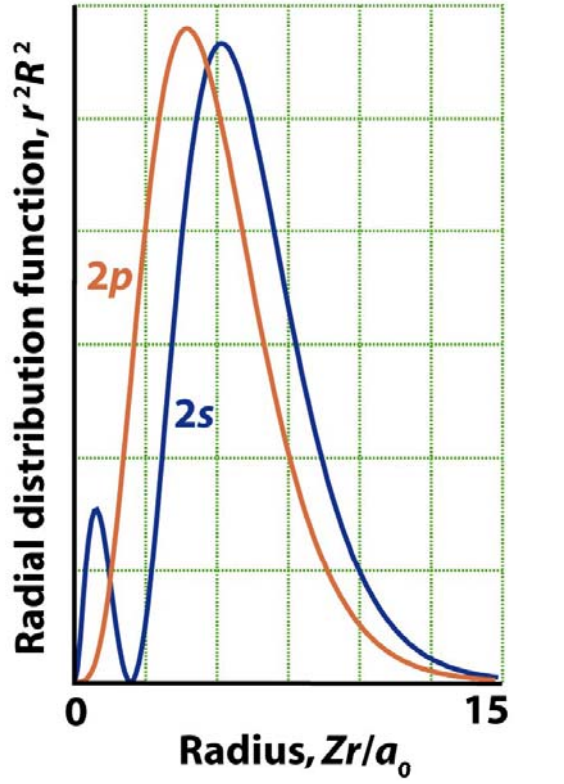
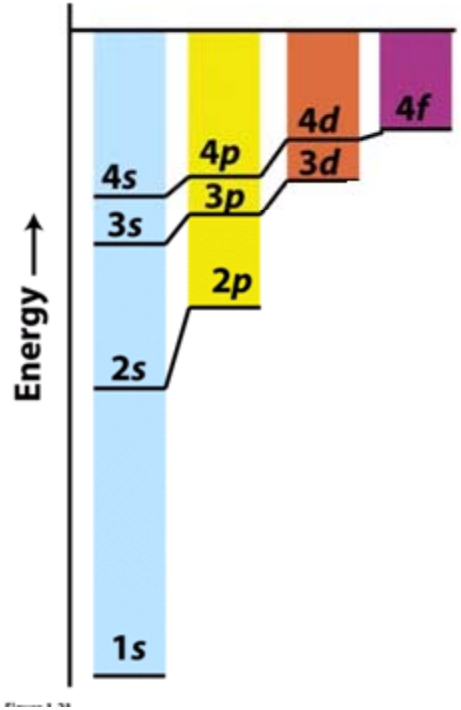
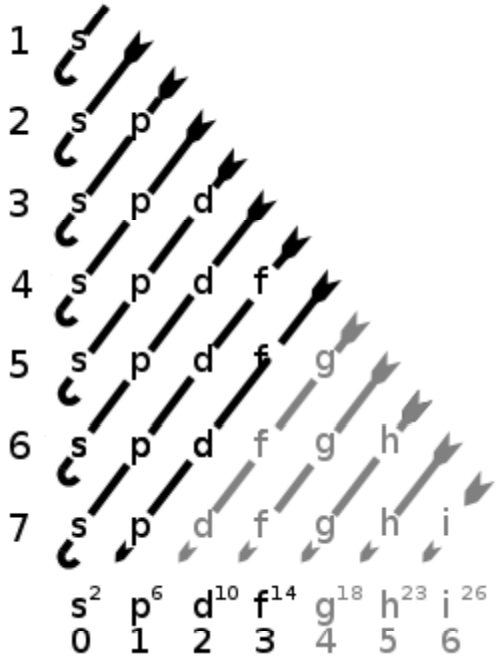


Figure 1-14
Shriver & Atkins Inorganic Chemistry, Fourth Edition
© 2006 by D. F. Shriver, P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller, and F. A. Armstrong

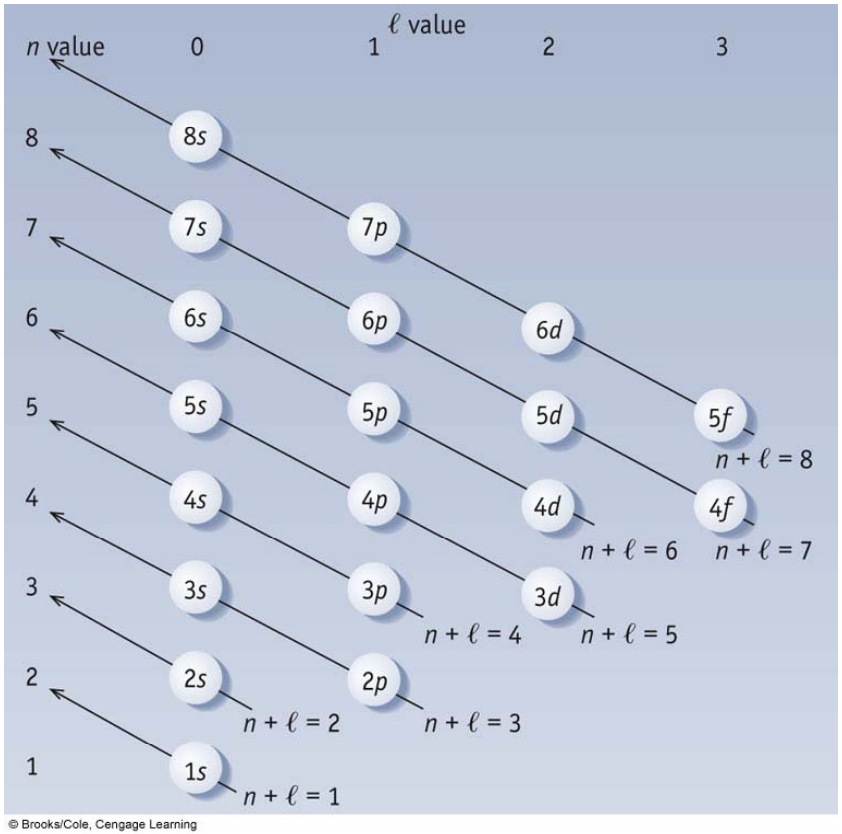
ns<np<nd<nf

Lithium


Energy
4s
4p
4d
4f
3s
3p
3d
2p
2s
1s


1 s
2 s p
3 s p d
4 s p d f
5 s p d f g
6 s p d f g h
7 s p d f g h i
s2 p6 d10 f14 g18 h23 i26
0 1 2 3 4 5 6

If you are more math inclined



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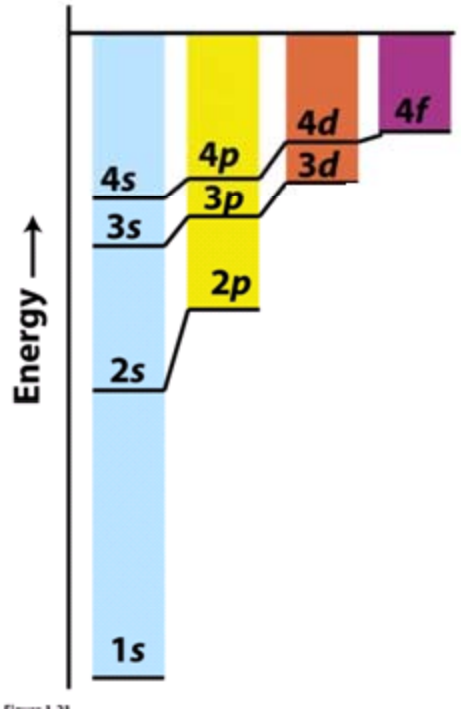
- Electrons are assigned to subshells in the order of increasing "n+ ℓ" value.

- If two subshells with same n+ ℓ" value electrons are assigned to the subshell of lower n.

Carbon



Hund's Rule: for degenerate orbitals, the lowest energy is attained when the number of electrons wit the same spin is maximized.

Let’s Practice

Draw the orbital diagram representation for the electron configuration of oxygen. What is its electron configuration?