In-Class Review (GRADED)

How will Reviews be graded?

1) Go through all the Review questions (you do not need to complete them before the review)

2) During the Review time, you will work on all the problems in a group.

3) You will receive a link from Crowdmark on the day of your tutorial (either Thursday at 11:30 am or Friday at 10:30 am). If you are attending a different tutorial section than the one you are registered in, it's okay, you will just need to let the instructor know during the tutorial.

4) During review you will work on the problems together with your peers.

To get full points for the review:

- Upload any one answer (it can be any question and it should be a credible attempt but does not need to be correct) to Crowdmark.
- Your instructor will also ask you to answer a "word of the day" question. I will show this on a slide during class.

Crowdmark submission must be done within 30 minutes of the tutorial.

Once you upload your answer, and answer the word of the day question, you are done!

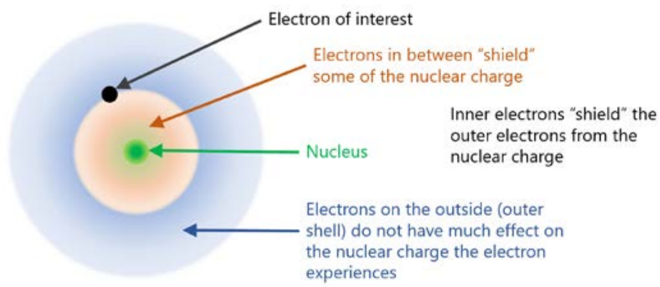
Major Concepts Covered

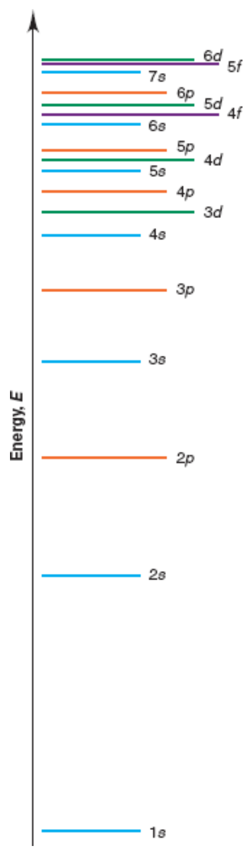
Many electron atoms

Fourth quantum number (describes electron)

1. Principal Quantum Number (n)
    1. Positive integer (1,2,3....)
    2. Indicates the relative size of the orbital – relative distance
    3. Specifies the energy level (higher n indicated higher energy)
2. Angular Quantum Number (l)
    1. Positive Integer (0 to n-1)
    2. Shape of the orbital
    3. The value of n limits l; if n=1, l can only have the value 0; if n=2, l can have the values 0 and 1
3. Magnetic Quantum Number (m_l)
    1. Integer ($-l$ to $+l$)
    2. Orientation of the orbital around the nucleus
    3. The value of l limits m_l; For l=1, values of m_l can be -1,0, and 1
4. Spin Quantum Number (m_s)
    1. -1/2 or +1/2
    2. Direction of electron's angular momentum

Effect of other electrons on orbital energy





Energy Level Diagram for different orbitals (many electron species)

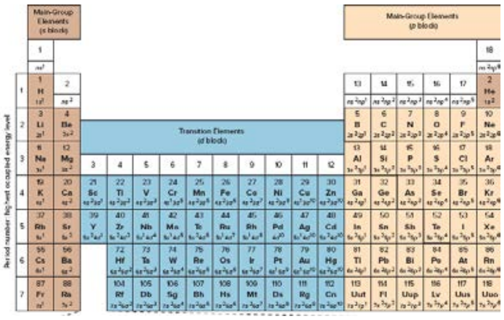
Periodic Table

1. Aufbau Principle

   Build up the periodic table (or atoms) by adding one proton at a time to the nucleus and one electron around the nucleus to get the *ground state* electronic configuration. The electrons sequentially fill the lowest energy orbital available.

2. Hund's Rule

   A principle stating that when orbitals of equal energy are available, the electron configuration of lowest energy has the maximum number of unpaired electrons with parallel spins

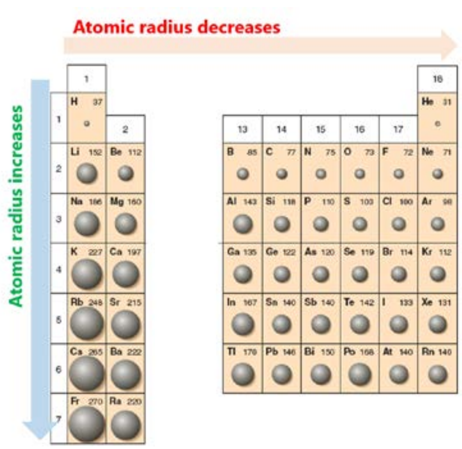


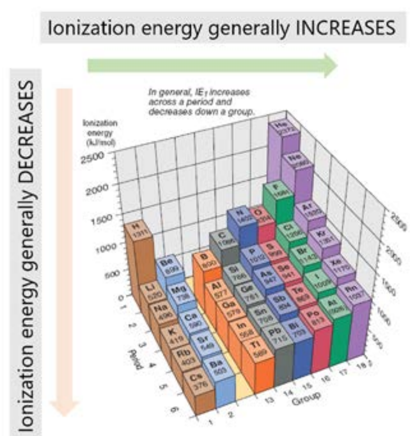
Follow Aufbau's principle and Hund's rule to fill electrons in atomic orbitals.

<u>Periodic Trends</u>

Explain the periodic trends of atomic size and ionization energy of atoms based on electronic configuration (also know the exceptions)

Explain the general trends for electron affinity and electronegatvity





<u>Concept Video 10: Atomic Properties</u>

Explain and describe the following atomic properties and their trends:

- Metallic Character
- Magnetism
- Ionic size (and comparison to atoms)

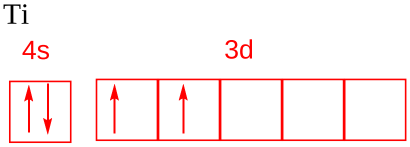
Tutorial Questions

1) Write the full set of quantum numbers for the following:
   (a) The outermost electron in a Ca atom
   (b) The electron gained when I becomes I- anion
   (c) The electron lost when an Ag atom ionizes
   (d) The electron gained when Na^+ becomes Na

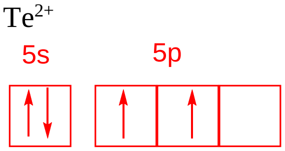
   The outermost electron in a Ca atom
   4s electron (n = 4; l = 0; m_l =0; m_s =+ or - 1/2)
   The electron gained when I becomes I- anion
   5p electron (n = 5; l = 1; m_l =0/1/-1; m_s =+ or - 1/2)
   The electron lost when an Ag atom ionizes
   5s electron (n = 5; l = 0; m_l =0; m_s =+ or - 1/2)
   The electron gained when Na^+ becomes Na
   3s electron (n = 3; l = 0; m_l =0; m_s =+ or - 1/2)

2) Draw (show orbitals as boxes) a partial orbital diagram (showing only valence shells) for the ground state electronic configuration for the following
   (a) Ti
   (b) Te^{2+}
   (c) Br^-
   (d) Ba^+

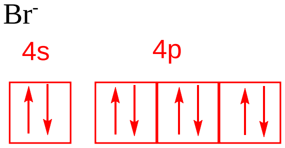
   Ti



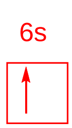
   Te^{2+}



   Br^-

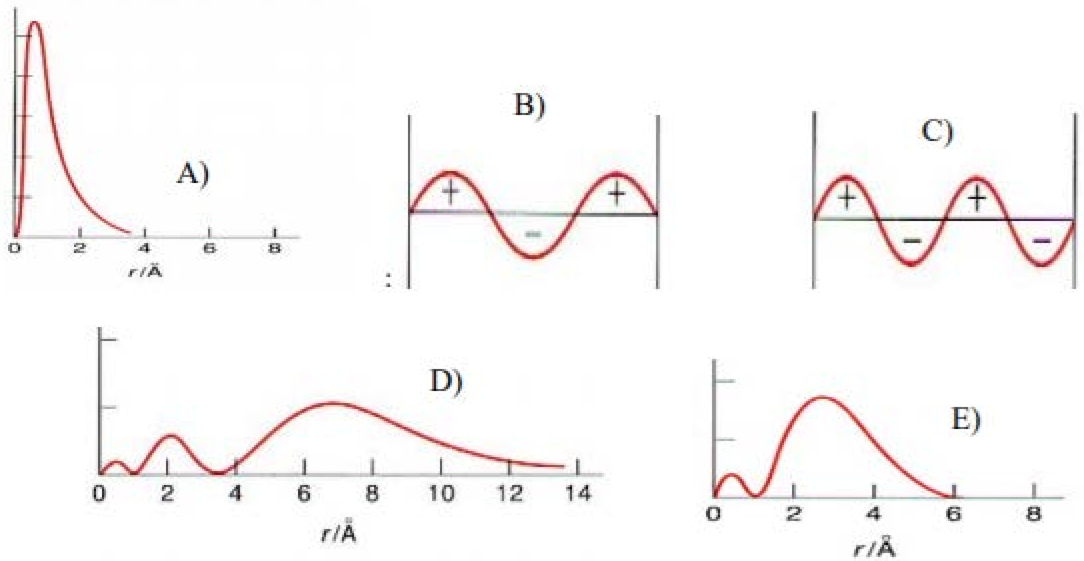


   Ba^+



3) A) Among the following plots, put an “X” across the plot that correctly represents the electron orbital radial distribution for the orbital containing the *valence electron* in Sodium (Na):

Choice D



B) Write down the 3 quantum numbers that describe the *orbital* from part A.

n= 3; l =0 ; m_l =0

C) Compare the size of Na atom to Na^+ cation. Which is larger? Why?

Na^+ is smaller in size. From atom to cation, size decreases – number of electrons are lesser but Z (number of protons) does not change.

D) Compare the metallic character of Na to Rb.

Rb is more metallic because it is to the left and below Na.
Rb has a larger atomic radius and lower IE

4) Identify the error in the statements below. Briefly explain the error and change the statements to reflect a correct statement.

a. In a single atom, the maximum number of electrons that can have quantum number n = 4, are 16

Identify Error:

Correction:

Correction: Maximum number of electrons with n = 4 are 32 electrons.

Explanation
The orbitals: 4s, 4p, 4d, and 4f.
The total orbitals in the shell = 16, so 32 electrons.

b. In period 3, there are 6 elements that have electrons in an orbital with l=1

Identify Error:

Correction:

Identify Error:
There are 6 elements in period 3 that have electrons in l=1 orbital

Correction and explanation:
There are 6 elements that have valence electrons in l=1 orbital. All 8 elements of period 3 have electrons in the core 2p orbital(l=1).

c. The maximum number of electrons in an atom that can have $n = 3$; $l = 2$; $m_l = -1$ is 10

Identify Error:

Correction:

The maximum number of electrons in an atom that can have $n = 3$; $l = 2$; $m_l = -1$ is 2

5) a. Write down the equation (showing configuration) for the first and second ionization energy for a Mg atom. Which of the two has a higher magnitude?

IE_1

$Mg(g)\ (1s^2 2s^2 2p^6 3s^2) \longrightarrow Mg^+(g)\ (1s^2 2s^2 2p^6 3s^1) + e^-$

IE_2

$Mg^+(g)\ (1s^2 2s^2 2p^6 3s^1) \longrightarrow Mg^{2+}(g)\ (1s^2 2s^2 2p^6) + e^-$

$IE_2 > IE_1$

b. Among the following which has the highest ionization energy. Explain your answer.

1. **IE_4 for B**
2. IE_3 for Be
3. IE_2 for Li

Answer: All are noble gas configuration and have the same number of inner electrons (same shielding) but B has the highest number of protons, so the electron to be removed will experience the highest Z_{eff}

6)

A. The following are the ionization energies (in kJ/mol) of an element belonging to period 2. Identify the element X. Provide a rationale for your choice.

	IE_1	IE_2	IE_3	IE_4	IE_5	IE_6
X	1086.5	2352.6	4620.5	6222.7	37831	47277

The following are the ionization energies (in kJ/mol) of an element belonging to period 2. Identify the element X. Provide a rationale for your choice.

	X^{+}	X^{+2}	X^{+3}	X^{+4}	X^{+5}	X^{+6}
	IE1	IE2	IE3	IE4	IE5	IE6
X	1086.5	2352.6	4620.5	6222.7	37831	47277

Biggest change in IE from IE_4 to IE_5

So X^{+4} must be noble gas configuration

Period 2 : Group 14 $\longrightarrow$ $\boxed{C}$ Ans

B. Write down the condensed ground state electronic configuration for X^{2+}

C^{2+} : $1s^2\ 2s^2$

7) Arrange the following

a) Na^+, Ne, Mg^{2+}, O^{2-} in *increasing* order of *size*

Na^+, Ne, Mg^{2+}, O^{2-} all have the same electron configuration of

[Ne] Therefore, the larger the Z_{eff}, the smaller the size.

$Mg^{2+} < Na^+ < Ne < O^{2-}$

b) 1s, 3s, 3p, 3d, 4s, 4p orbitals in increasing order of stability (for H atom)

4s = 4p < 3s = 3p = 3d < 1s

In H, only n determines the energy of the orbital. No electron-electron repulsion, so the subshells are all of the same energy. The lower n, the more stable the orbital. (Remember – ground state of H – most stable – n =1)

c. Orbital represented by the following quantum numbers in order of *decreasing* energy (for any multi electron species):

I. n = 4, l = 1, m_l = 1, m_s = +1/2

II. n = 3, l = 2, m_l = -1, m_s = +1/2

III. n = 4, l = 0, m_l = 0, m_s = +1/2

4s < 3d < 4p

d. In *increasing* atomic size: Cl, K, S

Increasing atomic size: **Cl < S < K**; chlorine and sulfur are in the same period so chlorine is smaller since it is further to the right in the period. Potassium is the first element in the next period so it is larger than either Cl or S.

8) Identify the following as paramagnetic or diamagnetic – explain your answer:
Ga: Paramagnetic
V: Paramagnetic
V^{3+}: Paramagentic
Cd^{2+}: Diamagnetic
Co^{3+}: Paramagnetic

Unpaired electron in valence orbitals– paramagnetic
Paired electron in valence orbitals – diamagnetic
(Elements in d orbitals – ns orbital electrons removed before n-1 d orbital)