Quantum Chemistry 1: EM Radiation, Bohr, Heisenberg

1. A dance radio station broadcasts at a frequency of 92.7 MHz. What is the wavelength associated with the radio waves?

2. What is the energy of a photon of EM radiation if its wavelength is 195 nm? What is the energy of a mole of these photons?

3. What is the maximum wavelength of EM radiation that can cause electrons to be ejected from the surface of lithium metal in a photoelectric cell? The ionization energy for lithium is 513.3 kJ/mol.

4. The threshold frequency that will allow electrons to be ejected from the surface of beryllium metal is 2.25×10^{15} Hz. What is the ionization energy (in kJ/mol) for Be?

5. What is the minimum uncertainty in the position of an electron traveling at $8.4 \times 10^4 \pm 0.6 \times 10^4$ km/s ?

Notes: 1 Joule (J) = 1 kg•m^2/s^2 $m_{electron} = 9.11 \times 10^{-31}$ kg

Quantum Chemistry 2: Electron Configurations & Quantum Numbers

1. Write full electron configurations for the following atoms in the ground state.

   Si

   Mo

   Kr

2. Write abbreviated electron configurations for the following atoms in the ground state.

   Mg Sn

   Cu U

   Re H

3. A) What is the last orbital term filled in the Hg atom?

   B) Write the full set of quantum numbers for the last electron to fill in the Hg atom's ground state

4. A) What is the last orbital term filled in the Ne atom?

   B) Write the full set of quantum numbers for the last electron to fill in the Ne atom's ground state

5. In each case, what atom's outermost electron would have the following set of four quantum numbers?

   A) $n = 3$, $l = 2$, $m_l = -1$, $m_s = +\frac{1}{2}$

   B) $n = 7$, $l = 0$, $m_l = 0$, $m_s = -\frac{1}{2}$

   C) $n = 4$, $l = 3$, $m_l = -2$, $m_s = +\frac{1}{2}$

   D) $n = 6$, $l = 1$, $m_l = +1$, $m_s = +\frac{1}{2}$

Quantum Chemistry 3: Electron Configurations & Quantum Numbers

1. A) What is the last orbital term filled in the Ba atom?

   B) Write the full set of quantum numbers for the last electron to fill in the Ba atom's ground state.

2. A) What is the last orbital term filled in the Cf atom?

   B) Write the full set of quantum numbers for the last electron to fill in the Cf atom's ground state.

3. In each case, what atom's outermost electron would have the following set of four quantum numbers?

   A) $n = 3$, $l = 1$, $m_l = -1$, $m_s = -\frac{1}{2}$

   B) $n = 5$, $l = 2$, $m_l = -2$, $m_s = +\frac{1}{2}$

   C) $n = 1$, $l = 0$, $m_l = 0$, $m_s = -\frac{1}{2}$

4. Write abbreviated electron configurations for the following atoms and ions in the ground state.

Ca Ca^{2+}

Ga Ga^{3+}

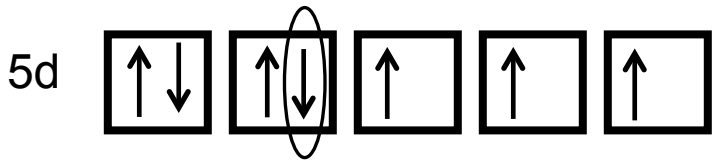
Cr Cr^{2+} Cr^{3+}

P P^{3-}

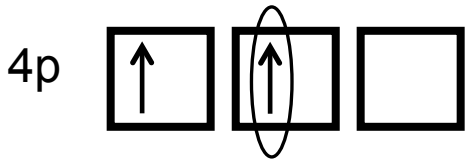
Sb Sb^{3+} Sb^{5+}

Quantum Chemistry 4: Quantum Numbers & Periodic Properties

1) Write the full set of quantum numbers for the electron circled in the diagram below:



2) Write the full set of quantum numbers for the electron circled in the diagram below:



3) Draw an orbital diagram (as in 1 & 2 above) if the last electron filling in a ground state atom has the following set of 4 quantum numbers:

n = 5, **l** = 3, $\mathbf{m_l}$ = +2, $\mathbf{m_s}$ = +½

4) Draw an orbital diagram (as in 1 & 2 above) if the last electron filling in a ground state atom has the following set of 4 quantum numbers:

n = 6, **l** = 0, $\mathbf{m_l}$ = 0, $\mathbf{m_s}$ = -½

5) Place the following in order of increasing (smallest to largest) particle size:

F He N O P

6) Place the following in order of increasing (smallest to largest) particle size:

K $\mathbf{K^+}$ **Se** $\mathbf{Se^{2-}}$

7) Put the following in order of increasing (smallest to largest 1st ionization energy:

Al K Mg Na

8) What atom in the third row of the periodic table will have the largest jump between its 5th and 6th ionization energies?

9) What does the following reaction correspond to? $\mathbf{S_{(g)} + e^- \rightarrow S^-}$

10) Write the reaction for the 2nd ionization of barium.

11) Using only an ordinary periodic table:

A) Put the following in order of INCREASING radius:

Al Al^{3+} P P^{3-}

B) Put the following in order of INCREASING 1st ionization energy:

Br Ca Na Mg

C) Put the following in order of INCREASING electronegativity:

Br Ca Na Mg

12) Which element in the 3rd period will have its most significant jump in ionization energies between its 5th and 6th?