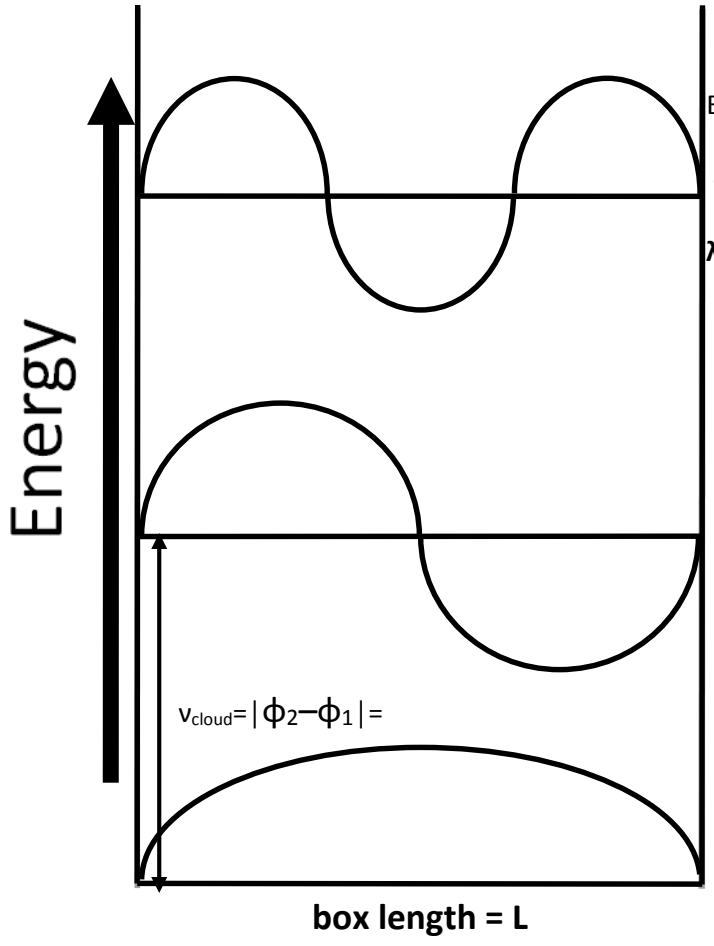
Practice sheet #3: Waves and quantum mechanics II.

1. Fill up the diagram below.



E_3=

ϕ_3=

λ_3=

E_2=

ϕ_2=

λ_2=

$v_{cloud} = |\phi_2 - \phi_1| =$

$E_1 = \frac{h^2}{8m_e L^2}$; $n^2=1$

$\phi_1 = \frac{E_1}{h} = \frac{h}{8m_e L^2}$;

$\lambda_1 = 2L$; $L = \frac{\lambda_1}{2}$

2. Using the one-dimensional particle in a box model calculate the wavelength of an electron wave that will have an energy 25x greater than that of the ground state energy; the size of the box equals 10 Å.

3. Neutron diffraction is used in determining the structure of molecules.
    a. Calculate the De Broglie wavelength of a neutron moving at 1.00% of the speed of light.

    b. Calculate the velocity of a neutron with a De Broglie wavelengths of 75pm.

4. Calculate the shortest and longest wavelength of light emitted by electrons in the hydrogen atoms falling to lower levels from n=6.

5. Using the Heisenberg principle…
    a. Calculate Δx for an electron having Δv=0.100 m/s

    b. Calculate Δx for a baseball (m=145g) having Δv=0.100m/s

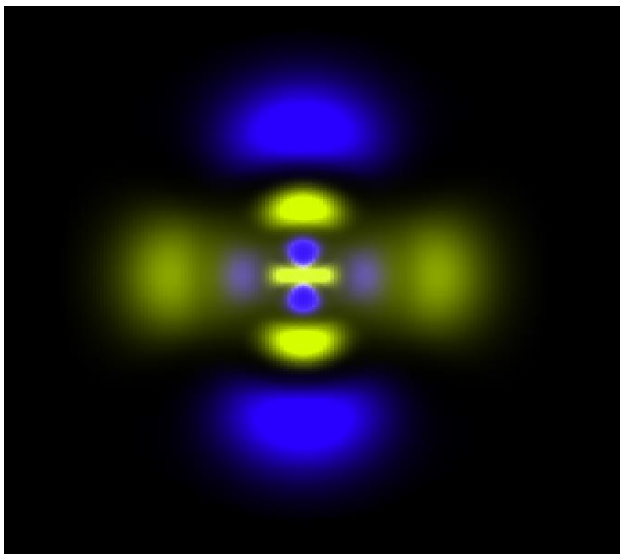
    c. How does the answer in part a compare with the size of a hydrogen atom?

    d. How does the answer in part b correspond to the size of a baseball?

6. What is the physical significance of Ψ^2 at a particular point in an atomic orbital?

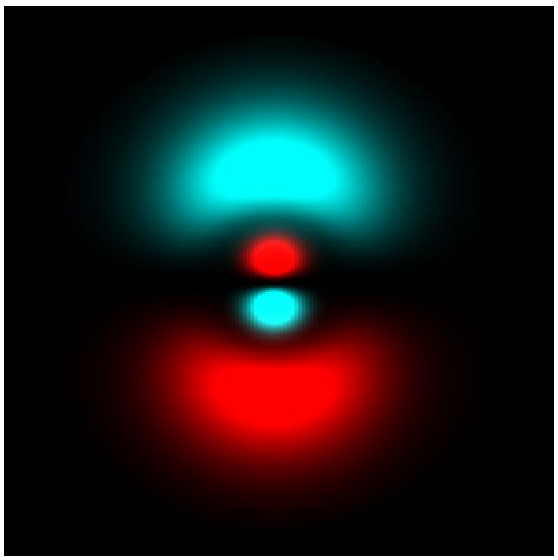
7. Which of the following sets of quantum numbers are NOT allowed?
    a. n=3, l=3, m_l=0, m_s=-1/2
    b. n=4, l=3, m_l=2, m_s=-1/2
    c. n=4, l=1, m_l=1, m_s=+1/2
    d. n=2, l=1, m_l=-1, m_s=-1
    e. n=5, l=-4, m_l=2, m_s=+1/2
    f. n=3, l=1, m_l=2, m_s=-1/2

8. Counting the number and type (angular v. radial) nodes, identify each of the following orbitals, and determine *n* and *l* values.



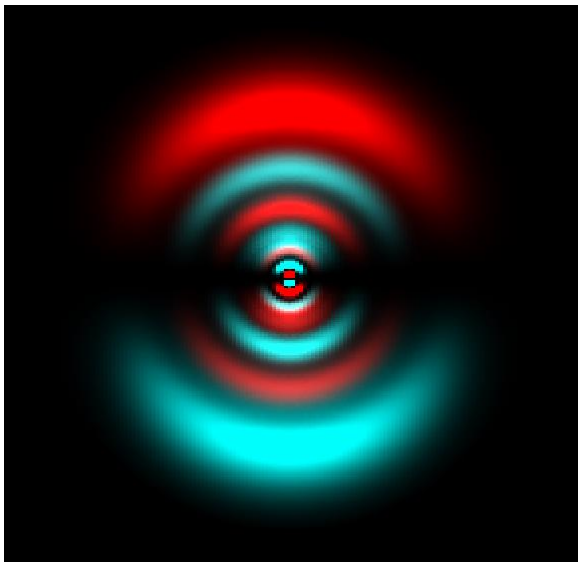
Orbital :

n = l =



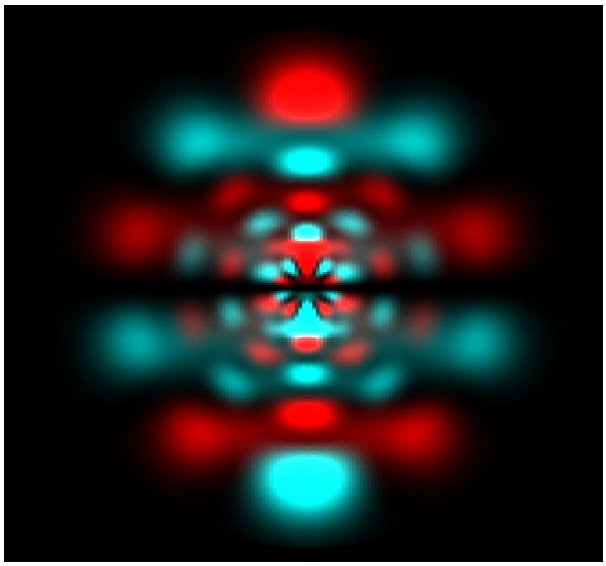
Orbital :

n = l =



Orbital :

n = l =



Orbital :

n = l =

You can keep playing with this simulation. It is free and open access on-line at http://www.falstad.com/qmmo/ , once on the page, click on Hydrogen atom applet. The applet itself is a Java pop-up window.

9. Draw the following orbitals and name them:

    a. n=2, l=0
    b. n=3, l=2
    c. n=2, l=1
    d. n=2,l=2
    e. l=2, j=1
    f. l=0, j=3
    g. l=1, j=2

10. Rank the orbitals from question 9 in increasing order of size.

11. Rank the orbitals from question 9 in increasing order of ionization energies.

12. Write the electron configuration of the atoms of the first 2 periods:

    H:

    He:

    Li:

    Be:

    B:

    C:

    N:

    O:

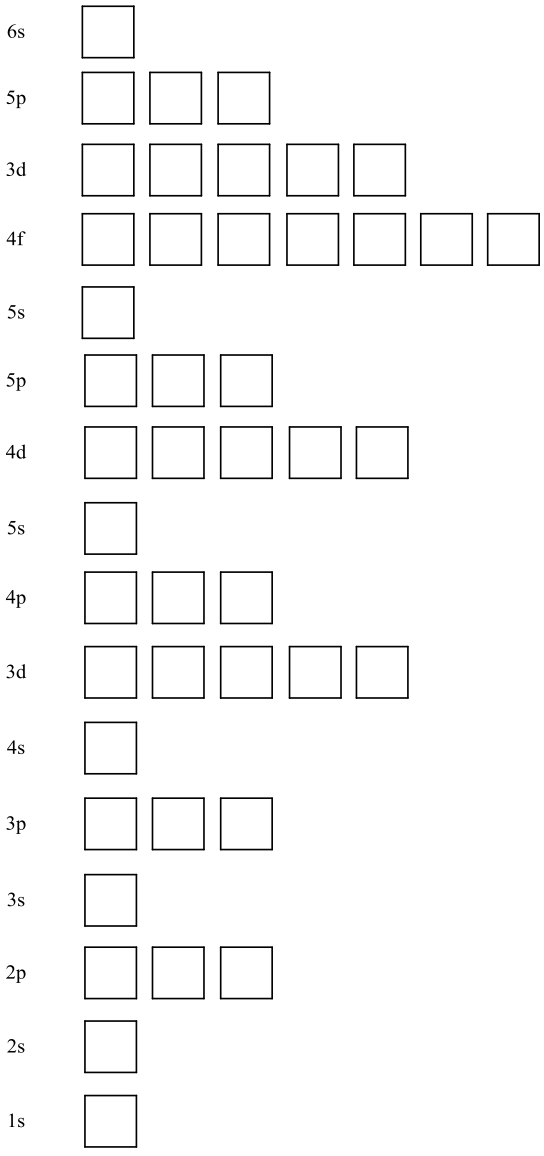
    F:

    Ne:

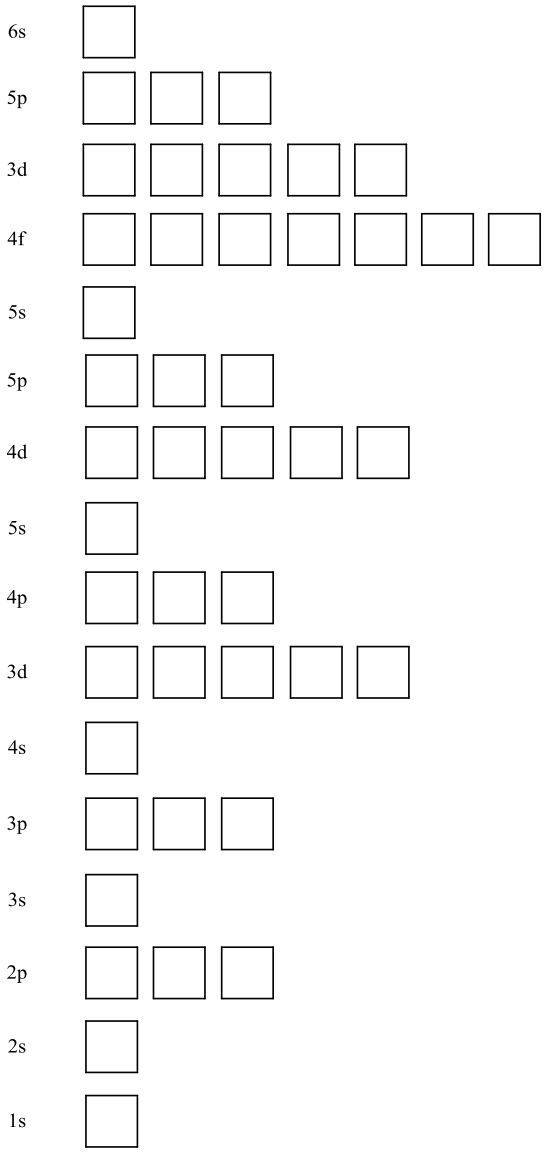
13. Building-up principle and electronic configuration.

a. Fill in the boxes with the electrons (arrows up = spin +1/2 ; arrows down = spin -1/2).

Sb^{3+}



Ar* (* means it is in its first excited state)



b. Write the electron configurations for the species in problem 13a.

Configuration Sb^{3+}: _____

Configuration Ar*: _____

c. In the diagrams in problem 13a, circle the following electrons (If it does not exist, say so):

Sb^{3+} (n, l, m_l, m_s) = (4, 3,-2, +1/2) and (2, 0, 0, -1/2)

Ar* (n, l, m_l, m_s) = (3, 2, -2, +1/2) and (3, 0, -1, -1/2)

14. Periodic table and periodic properties of elements:

a. Rank the following species according to their properties. (1 = highest, 4 lowest)

	Se^{2-}	H	Se	C
Radius				
Ionization Energy				
Electron Affinity				
Electonegativity				