Problem Set 5: Atomic Structure

1a) Identify the shell and subshell of an orbital with the quantum numbers n = 3 and l =2.

This is a 3d orbital, because n =3 and l = 2 which is a d-subshell. Thus, this orbital is of the 3rd shell, and the d-subshell.

b) How many different orbitals of this type are there?

Since the value of l is 2, the allowed values of ml = -2, -1, 0, 1, 2. Therefore, there are five spatial orbitals which can hold electrons in this subshell.

c) How many electrons could this set of orbitals hold?

Since each orbital can hold two electrons, the set of five orbitals could hold up to 10 electrons before it is full.

2) Give all possible sets of quantum numbers for an electron in a 4p orbital.

This orbital has n = 4, and since it is a p orbital, l = 1. Thus, all electrons corresponding to this orbital will have n and l defined as such.

Since l = 1, the allowed values of ml for any electron in the 4p orbital are: -1, 0, 1. Also, once ml is defined, each electron can have ms = + ½ or - ½. Therefore, the possible values are:

Value of n	**Value of l**	**Value of m_l**	**Value of m_s**
4	1	-1	+ ½
4	1	-1	- ½
4	1	0	+ ½
4	1	0	- ½
4	1	1	+ ½
4	1	1	- ½

3) Provide orbital notation for electrons in orbitals defined with the following quantum numbers:

a) n =2, l = 1, ml = 1, This is a 2p orbital

b) n = 4, l = 3, ml = -2, This is a 4f orbital

c) n =3, l = 2, ml = 0, This is a 3d orbital

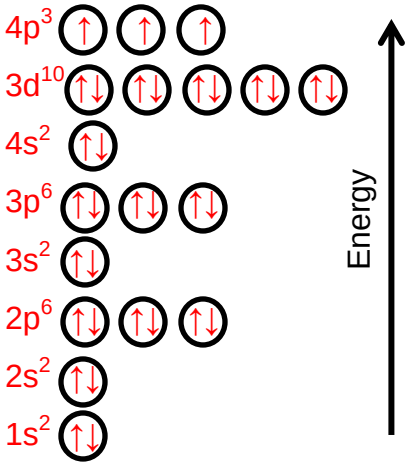
4) a) Give the ground-state electron configuration of arsenic, Z = 33.

The ground state neutral arsenic atom has 33 electrons, using the periodic table, the electronic configuration is:

As: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$

b) Draw an orbital filling diagram, indicating the electrons as up or down arrows.

The corresponding orbital diagram should look something like:



c) What is the shorthand electronic configuration of this atom?

The previous noble gas is Ar, therefore, the shorthand configuration is:
As: [Ar] $4s^2 3d^{10} 4p^3$.

5) Predict the main group ions that will form from the following atoms and write the shorthand electron configuration for the ion.

a) Mg, Mg^{2+} [He] $2s^2$ $2p^6$
b) S, S^{2-} [Ne] $3s^2$ $3p^6$
c) Al, Al^{3+} [He] $2s^2$ $2p^6$