

## Electron Configurations : Notes/W.S. - 50

The Bohr model of the atom is basically correct. Electrons are found in specific orbits called **energy levels** (or **shells**, symbol  $n$ ). But each energy level consists of sub-levels called orbitals (s,p,d,f,...). Electrons can move to a higher unfilled orbital when energy is absorbed, or they can move to a lower unfilled orbital when energy is emitted. Electrons want to be in the lowest energy level.

Level 1 ( $n = 1$ ) has one orbital (1s). There is a maximum of 2 electrons in this orbital. Level 2 ( $n = 2$ ) has 2 orbitals. They are named the 2s and 2p orbitals. The 2s orbital has a maximum of 2 electrons and the 2p orbital has a maximum of 6 electrons. Level 3 ( $n = 3$ ) has 3 orbitals, 3s, 3p, and 3d. The maximum number of electrons are 2, 6, and 10, respectively for these three orbitals.

The table below gives the electron configuration for neutral atoms in the "**ground state**" (lowest energy state) up to atomic number 21.

	n	1	2	2	3	3	3	4
	orb	1s	2s	2p	3s	3p	3d	4s
1	H	1						
2	He	2						
3	Li	2	1					
4	Be	2	2					
5	B	2	2	1				
6	C	2	2	2				
7	N	2	2	3				
8	O	2	2	4				
9	F	2	2	5				
10	Ne	2	2	6				
11	Na	2	2	6	1			
12	Mg	2	2	6	2			
13	Al	2	2	6	2	1		
14	Si	2	2	6	2	2		
15	P	2	2	6	2	3		
16	S	2	2	6	2	4		
17	Cl	2	2	6	2	5		
18	Ar	2	2	6	2	6		
19	K	2	2	6	2	6		1
20	Ca	2	2	6	2	6		2
21	Sc	2	2	6	2	6	1	2

The  $n$ th energy level contains  $n$  orbitals (sub levels).

All s orbitals have a maximum of 2 electrons. All p orbitals have a maximum of 6 electrons. All d orbitals have a maximum of 10 electrons. For energy level  $n$ , the maximum number of electrons is  $2n^2$ .

The electron configuration for H is  $1s^1$ . He is  $1s^2$ . Li is  $1s^2 2s^1$ . F is  $1s^2 2s^2 2p^5$  and so on. The superscript gives the number of electrons in the orbital.

The electrons in the outermost energy level (or shell) are called the **valence** electrons. (e.g. boron has three valence electrons)

All atoms want to have eight electrons in their outermost shell. This is called the **octet rule**.

Problems :

1)a) What is the maximum number of electrons in the fourth energy level of the atom?

b) Find the number of electrons in the 3p orbital of the sulfur atom.

c) How many valence electrons are in the atoms of group IA?

d) How many valence electrons are in the atoms of group IIA

e) How many valence electrons are in the noble gas atoms?

f) What is the maximum number of electrons in the f orbital?

2) Write down the electronic configurations for:

a) B

b) Mg

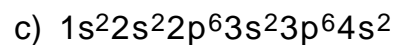
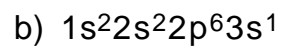
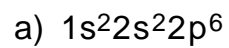
c)  $\text{Cl}^-$

d)  $\text{Ca}^{2+}$

3) List the following orbitals in terms of increasing energy:

2s, 3p, 4s, 3d, 2p. (hint: see the table)

4) Name the atoms with the following electronic structures:



Answers : 1)a) 32, b) 4, c) 1, d) 2, e) 8 (except He), f) 14, 2)a)  $1s^2 2s^2 2p^1$ , b)  $1s^2 2s^2 2p^6 3s^2$ , c)  $1s^2 2s^2 2p^6 3s^2 3p^6$ , d)  $1s^2 2s^2 2p^6 3s^2 3p^6$ , 3) 2s, 2p, 3p, 4s, 3d, 4)a) neon, b) sodium, c) calcium.