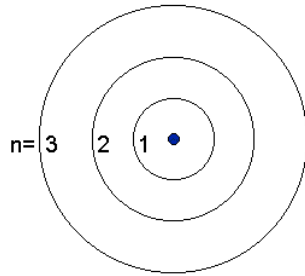


Electron Configuration & Dot Diagrams 6E

First some terms and more information about the structure of the atom:

1) Energy level is no longer an orbit but more like a boundary or maximum distance from the nucleus that electrons occupy. 1, 2, 3

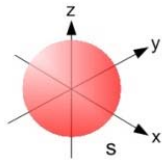


2) Within each energy level (boundary or maximum distance from the nucleus) there are sublevels that describe the shape of the orbital (region occupied by electrons are orbitals).

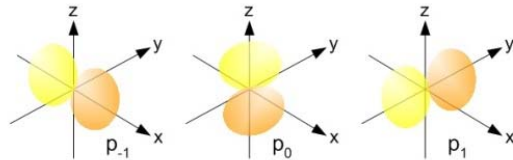
3) The s, p and d orbitals have the same shape but differ in their orientation (direction the orbitals are in space around an X, Y and Z axis).

Here are some orbital shapes and orientations for you to check out!

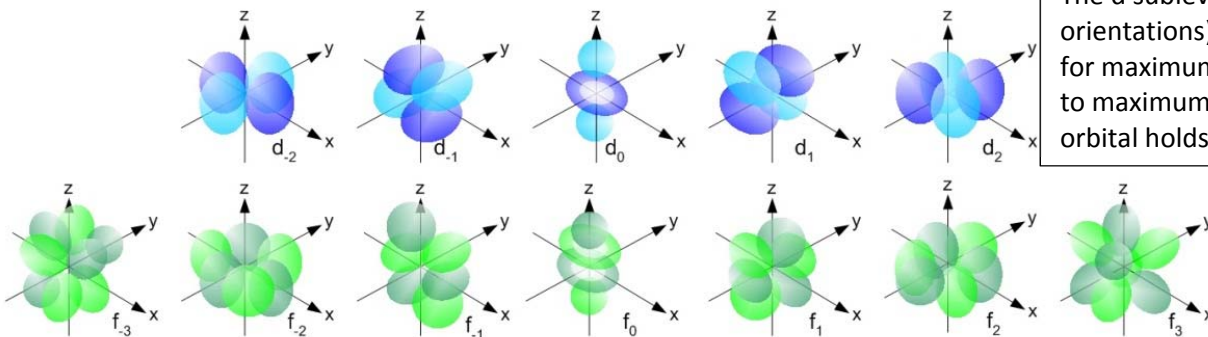
The s sublevel only has one orbital (possible orientation) for a total of 2 electrons [s holds 1 to maximum of 2 electrons]



The p sublevel has three orbitals (possible orientations) all same shape different orientations each holding 2 electrons for a maximum of 6 electrons to fill all 3 p sublevels [p hold 1 to maximum of 6 electrons]



The d sublevel has five orbitals (possible orientations) each holding 2 electrons for maximum of 10 electrons [d hold 1 to maximum of 10 electrons] (each orbital holds 1 to 2 electrons)



The f sublevel has seven orbitals (possible orientations) each holding 2 electrons for maximum of 14 electrons [f holds 1 to maximum of 14 electrons]. Each orbital holds 1 to 2 electrons or is unoccupied.

4) Each orbital can hold two electrons but the electrons in the same orbital have opposite magnetic fields called spin. The electron's like charges that repel are cancelled by their opposite spin which is an attractive force equal to the repulsion of like electric charges. The important consequence of spin is that each orbital can hold 2 electrons which have opposite spins.

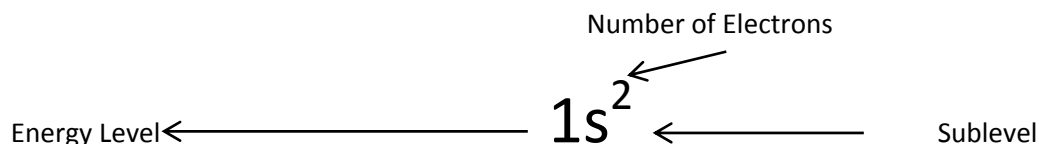
5) Electrons in a sublevel remain unpaired before the second electron is added to an orbital. (For example each of the 3 p orbitals will each contain one electron before the second electron will occupy the orbital)

6) The energy levels do not contain the same number of sublevels. This makes sense because the energy levels further from the nucleus are larger. You need to know the sublevels in each energy level, the number of orbitals each sublevel has and the maximum number of electrons a sublevel will contain when all the sublevel's orbitals contain 2 electrons.

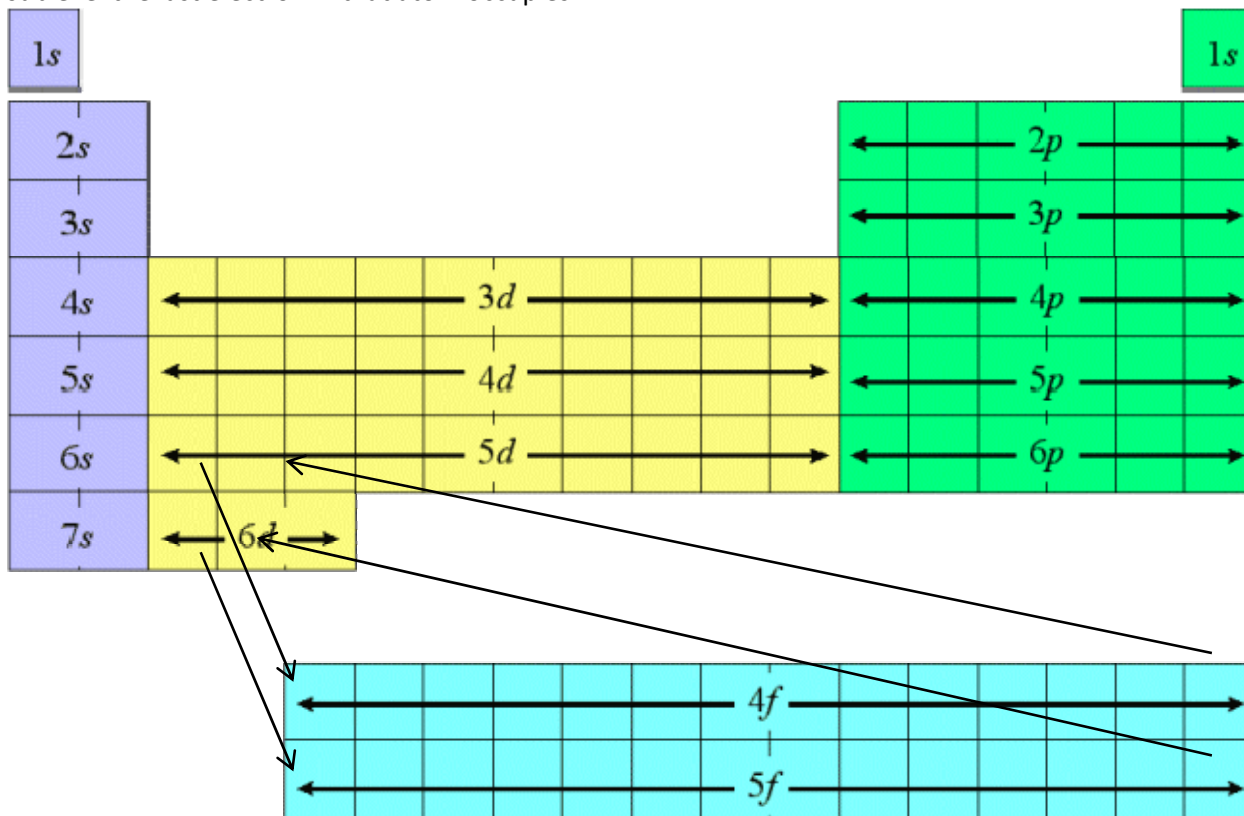
Energy level	Number of sublevels	Names of sublevels
1	1	s
2	2	s, p
3	3	s, p, d
4	4	s, p, d, f
5	5	s, p, d, f, g

Sublevel Name	s	p	d	f
Number of Orbitals	1	3	5	7
Maximum number of electrons	2	6	10	14

Electron Configurations: Assigning each electron in an atom to the energy level and sublevel it occupies in the atom.



Neutral atoms have equal number of protons and electrons. The number of protons is indicated by the atomic number on the periodic table if the atom does not have a charge it has the same number of protons as electrons. Electrons fill one sublevels orbitals before starting to fill another sublevel. The energy levels are not filled in numerical order. The periodic table tells you what energy level and sublevel the last electron in that atom occupies.

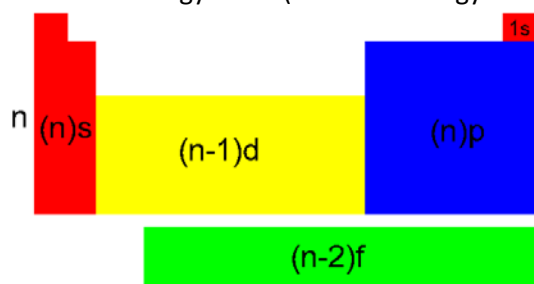


s block		d block										p block					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	3A	4A	5A	6A	7A	8A
3 2s	4	21 3d	22	23	24	25	26	27	28	29	30	5 2p	6	7	8	9	10
11 3s	12	39 4d	40	41	42	43	44	45	46	47	48	13 3p	14	15	16	17	18
19 4s	20	57 5d	58	59	60	61	62	63	64	65	66	31 4p	32	33	34	35	36
37 5s	38	71 6d	72	73	74	75	76	77	78	79	80	49 5p	50	51	52	53	54
55 6s	56	89 7d	90	91	92	93	94	95	96	97	98	81 6p	82	83	84	85	86
87 7s	88	103 8d	104	105	106	107	108	109	110	111	112	113 7p	114	115	116	117	118

This look at an electron configuration and determine what it tells us: $1s^2 2s^2 2p^5$ means "2 electrons in the 1s subshell, 2 electrons in the 2s subshell, and 5 electrons in the 2p subshell"

$1s^2 2s^2 2p^6 3s^2 3p^3$ is an electron configuration with 15 electrons total; 2 electrons are in the 1s subshell; 8 electrons are in the energy level 2 in the 2s subshell + 6 in the 2p subshell; and 5 electrons are in energy level 3=2 in the 3s subshell + 3 in the 3p subshell.

The d sublevels are filled one back from the outer energy level and the f sublevels are filled 2 back from the outer energy level. (n = outer energy level)



Writing electron configurations:

1) Each electron that is added to an atom is placed in the lowest-energy orbital that is available. The orbitals are filled in the order which is read off the periodic table when reading in order of atomic number:

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f

s block		d block										p block					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
3 2s	4	21 3d	22	23	24	25	26	27	28	29	30	5 2p	6	7	8	9	10
11 3s	12	39 4d	40	41	42	43	44	45	46	47	48	13 3p	14	15	16	17	18
19 4s	20	57 5d	58	59	60	61	62	63	64	65	66	31 4p	32	33	34	35	36
37 5s	38	71 6d	72	73	74	75	76	77	78	79	80	49 5p	50	51	52	53	54
55 6s	56	89 7d	90	91	92	93	94	95	96	97	98	81 6p	82	83	84	85	86
87 7s	88	103 8d	104	105	106	107	108	109	110	111	112	113 7p	114	115	116	117	118

f block	
4f	5f
57	89
58	90
59	91
60	92
61	93
62	94
63	95
64	96
65	97
66	98
67	99
68	100
69	101
70	102

Each orbital can hold no more than two electrons. Two electrons in the same orbital must have opposite spins (the Pauli exclusion principle).

If two or more orbitals are available at the same energy level and same sublevel (degenerate orbitals), one electron is placed in each orbital until the available orbitals are occupied by one electron. Remember one electron in each orbital before you double up.

Electron configurations are written as a list of sublevels which are occupied, followed by a superscript to indicate how many electrons are in those sublevel's orbitals.

Complete Electron Configurations:

Determine the number of electrons in the atom from its atomic number. (See Below.)

Add electrons to the sublevels in the correct order of filling.

Add two electrons to each s sublevel, 6 to each p sublevel, 10 to each d sublevel, and 14 to each f sublevel.

To check your complete electron configuration, look to see whether the location of the last electron added corresponds to the element's position on the periodic table.

Write the electron configuration for Zn:

1. Ni atomic number is 28 so it has 28 protons and 28 electrons because it does not have a charge.

The periodic table is color-coded by blocks: s block (pink), d block (yellow), p block (green), and f block (blue). Element 28 (Ni) is marked with a blue star in the 4d block.

2 and 3. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
 Electron 1 and 2 are in 1s, the 3rd and 4th electrons are in 2s, the next six electrons which are the 5th to the 10th are in the 2p, the 11th and 12th electron are in the 3s, the next six electrons which are 13th to the 18th are in the 3p sublevels orbitals, the 19th and 20th electron occupy the 4s orbital, the last 8 electrons will occupy the 3d orbitals but not fill all the orbitals in the 3d sublevel.

2 and 3. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$ in order of filling which usually is rearrange in numerical order of energy level $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$

4. Add the electrons (superscripts to check answer): $2+2+6+2+6+2+8=28$ If we add electrons to correct orbitals we are correct.

Here are a couple of electron configurations you can use to check your conversions from energy level diagrams:

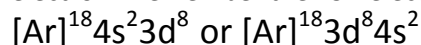


Yes there is a short cut: the short cut is sometimes called core notation:

Using Ni as an example

Use the nearest noble gas with a smaller atomic number than the element you are writing the electron core notation for: for Ni this would be Ar with the atomic number 18. Write the symbol of the noble gas in [] with the number of electron of the noble gas as a superscript. $[Ar]^{18}$ (this is saying the first 18 electrons in Ni are in the same orbitals as the 18 electrons in Ar.

Add the rest of the electrons reading from the periodic table. You will be assigning the 19th through 28th electron. Remember the 19th electron is in the same orbital for all atoms.



Lewis Dot Diagrams

- A Lewis dot structure is like a simplified electron energy level model.
- The Lewis structure contains the element symbol with dots representing electrons.
- The only electrons shown are those on the outer energy level or valence electrons.
- The electrons are placed around the element symbol, one at a time, clockwise or counterclockwise, and then grouped in pairs as more electrons are added.

PERIODIC TABLE ELEMENTS 1-20							
HYDROGEN 1 H·							HELIUM 2 He·
LITHIUM 3 Li·	BERYLLIUM 4 Be·	BORON 5 ·B·	CARBON 6 ·C·	NITROGEN 7 ·N·	OXYGEN 8 ·O·	FLOURINE 9 ·F·	NEON 10 ·Ne·
SODIUM 11 Na·	MAGNESIUM 12 Mg·	ALUMINUM 13 ·Al·	SILICON 14 ·Si·	PHOSPHORUS 15 ·P·	SULFUR 16 ·S·	CHLORINE 17 ·Cl·	ARGON 18 ·Ar·
POTASSIUM 19 K·	CALCIUM 20 Ca·						

Lewis Dot Diagrams:

Group							
1	2	13	14	15	16	17	18
Number valence electrons							
1	2	3	4	5	6	7	8
H·							He·
Li·	·Be·	·B·	·C·	·N·	·O·	·F·	·Ne·
Na·	·Mg·	·Al·	·Si·	·P·	·S·	·Cl·	·Ar·
K·	·Ca·	·Ga·	·Ge·	·As·	·Se·	·Br·	·Kr·
Rb·	·Sr·	·In·	·Sn·	·Sb·	·Te·	·I·	·Xe·
Cs·	·Ba·	·Tl·	·Pb·	·Bi·	·Po·	·At·	·Rn·

A **Lewis symbol (Lewis dot diagram)** is a symbol in which the electrons in the valence shell (outer energy level) of an atom or simple ion are represented by dots placed around the letter symbol of the element. Each dot represents one electron. Negative ions gain electrons and positive ions lose electrons.

Hydrogen $1s^1$ H·

Oxygen $1s^2 2s^2 2p^4$ · \ddot{O} ·

Chlorine $1s^2 2s^2 2p^6 3s^2 3p^5$ · \ddot{Cl} ·

Chloride ion Cl^{-1} $1s^2 2s^2 2p^6 3s^2 3p^6$ · \ddot{Cl} :

