Electron Configurations and Orbital diagrams

OK - Quantum mechanics is a lot to absorb from just one reading assignment so I'll try to simplify it for you.

You need to know:

1 2 3 4

$(2\ p\ x\ (+\tfrac{1}{2}))$

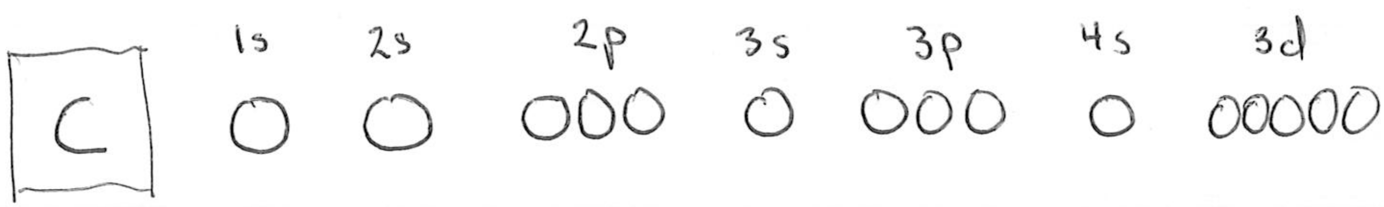
- the four Quantum numbers
- the Pauli exclusion principle
- the Aufbau principle
- Hund's rule
- Orbital diagrams
- Electron configurations

Example Write the electron configuration and draw the orbital diagram for neutral Carbon.

Carbon has 6 electrons

Quantum mechanics tells you where you would find these 6 electrons

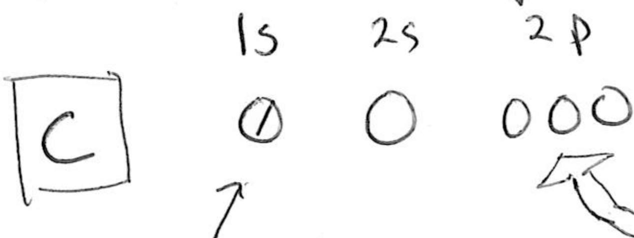
lets start with the Orbital diagram



- Each circle represents an orbital
- Each orbital can hold 2 electrons (provided they have opposite spin)
- The orbitals are placed from lowest energy (1s) on the left to higher energy levels as you move right.

Now, since Carbon has just 6 electrons, with 2 electrons in each orbital, the highest orbital energy we get to is 2p, therefore orbitals higher in energy than 2p are not required (they do however still exist)

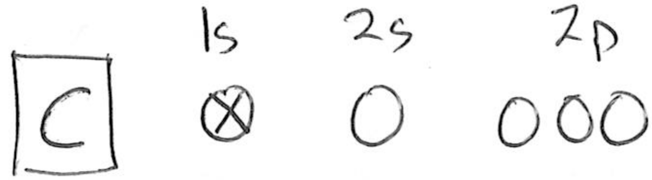
The first electron would go into the 1s orbital.



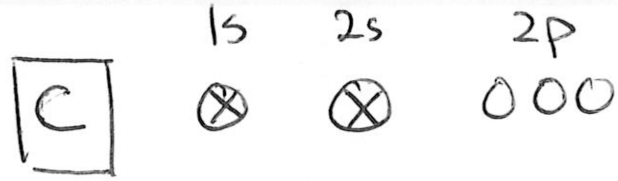
the dashed line represents an electron with spin

the 3, 2p orbitals are all equal in energy so we group them together (2px 2py, 2pz)

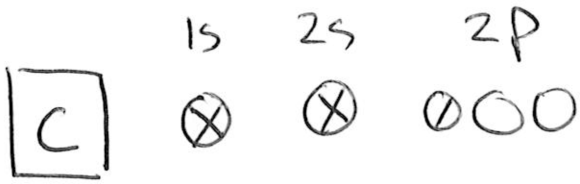
The second electron could go into the 2s orbital but that is too high in energy (also the next shell) so it goes into the 1s orbital but with the opposite spin



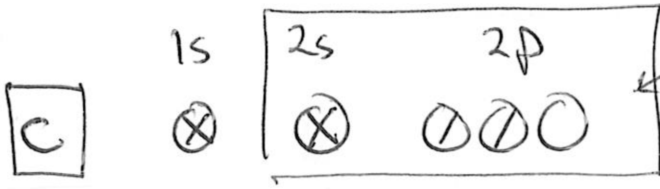
The next 2 electrons would fill the 2s orbital.



The 5th electron must go into a 2p orbital. They are all equal in energy so it does not matter which one it goes in. Lets put it in the first circle with either spin (\ or /)



The 6th electron has a choice of doubling up with the 5th electron or occupying one of the two empty orbitals (see Hund's rule). Since atoms prefer unpaired orbitals over empty orbitals we get

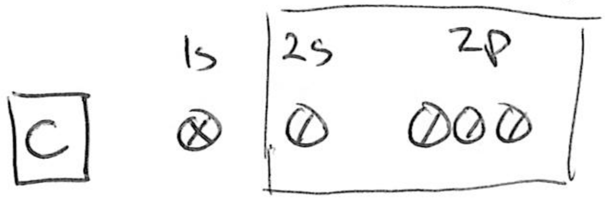


the highest principle quantum # s and p orbitals is the Outer-shell (valence shell)

Carbon has 4 electrons in its valence shell

→ used for bonding!

Carbon does a little trick to make its outershell a bit more stable. It promotes a 2s election into the empty 2p orbital (atoms don't like empty orbitals). This costs Carbon a little bit of energy but the rewards are immense as 4 unpaired orbitals is a very stable configuration.



Electron Configurations are similar to orbital diagrams but without the circles for orbitals.

$\boxed{C}$ $1s^2\ 2s^2\ 2p^2$

↑ this says it has 2 electrons in the 1s orbital

Lets look at Sulfur

Orbital diagram

← Valence shell (6 electrons)

Election Configuration $\boxed{S}$ $1s^2\ 2s^2\ 2p^6\ \boxed{3s^2\ 3p^4}$

Ions exist because atoms can lose, gain or share electrons in their outermost shell to form more stable configurations. Full outer-shells are very stable so sulfer can pick up 2 electrons to fill the two half-filled 3p orbitals to become S^{2-}

	1s	2s	2p	3s	3p
$\boxed{S^{2-}}$	⊗	⊗	⊗⊗⊗	⊗	⊗⊗⊗

$\rightarrow$ full outershell

For larger elements the electron configurations can get rather large and tedious to write down. <u>Core</u> notation shortens it down and shows only the really important electrons (the electrons furthest from the nucleus)

ex Rubidum Atomic # 37

Valence shell

$\boxed{Rb}$ $\boxed{1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 4s^2\, 3d^{10}\, 4p^6}$ $\boxed{5s^1}\; 4d^0\; \boxed{5p^0}$

the electron configuration of the Noble gas: Krypton

the 4d shells exist but contains no electrons and are not part of the valence shell

<u>Core notation</u>

$\boxed{Rb}$ $[Kr]\, 5s^1\, 4d^0\, 5p^0$