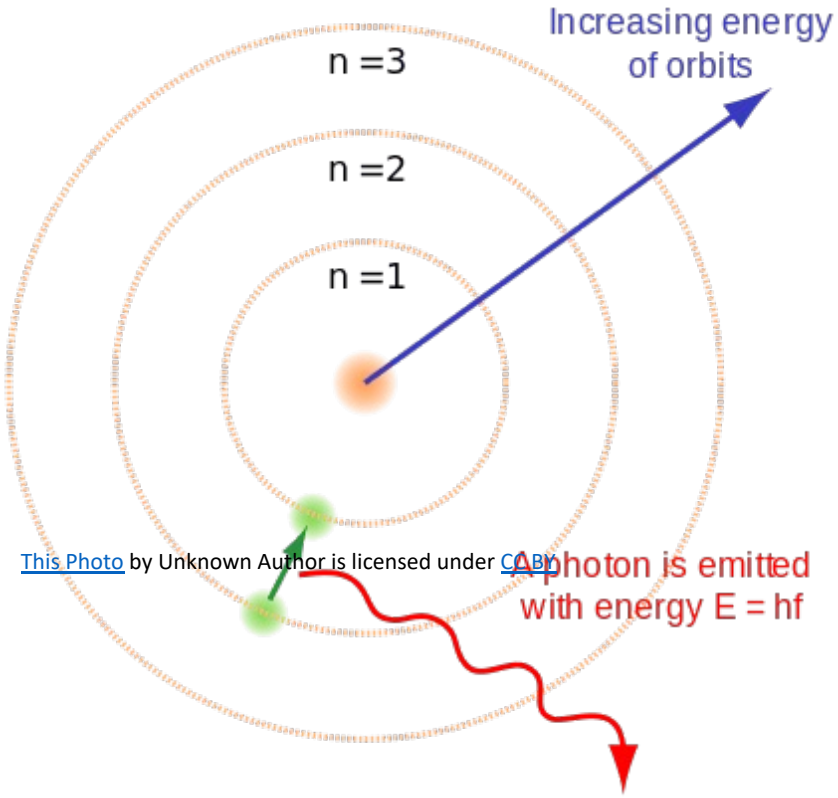
Main energy level number	1	2	3	4	5
Maximum number of electrons	2	8	18	32	50

The number of electrons is equal to the number of protons.
Electrons inhabit the closest to the nucleus shells and orbitals.
Each shell and each orbital can
hold just a certain number of
electrons.
The maximum number of electrons that each shell can have is
$2n^2$
n is the main energy level number (principal quantum number)
On n level we will have n^2 different orbitals.
Number n also can tell us how many sublevels the shell has
(Level 1 has 1 sublevel, Level 2 has two sublevels etc.

When an electrons fall from a higher to a lower energy level in an atom, a photon of light is emitted.



Evidence for discrete energy levels in atoms.

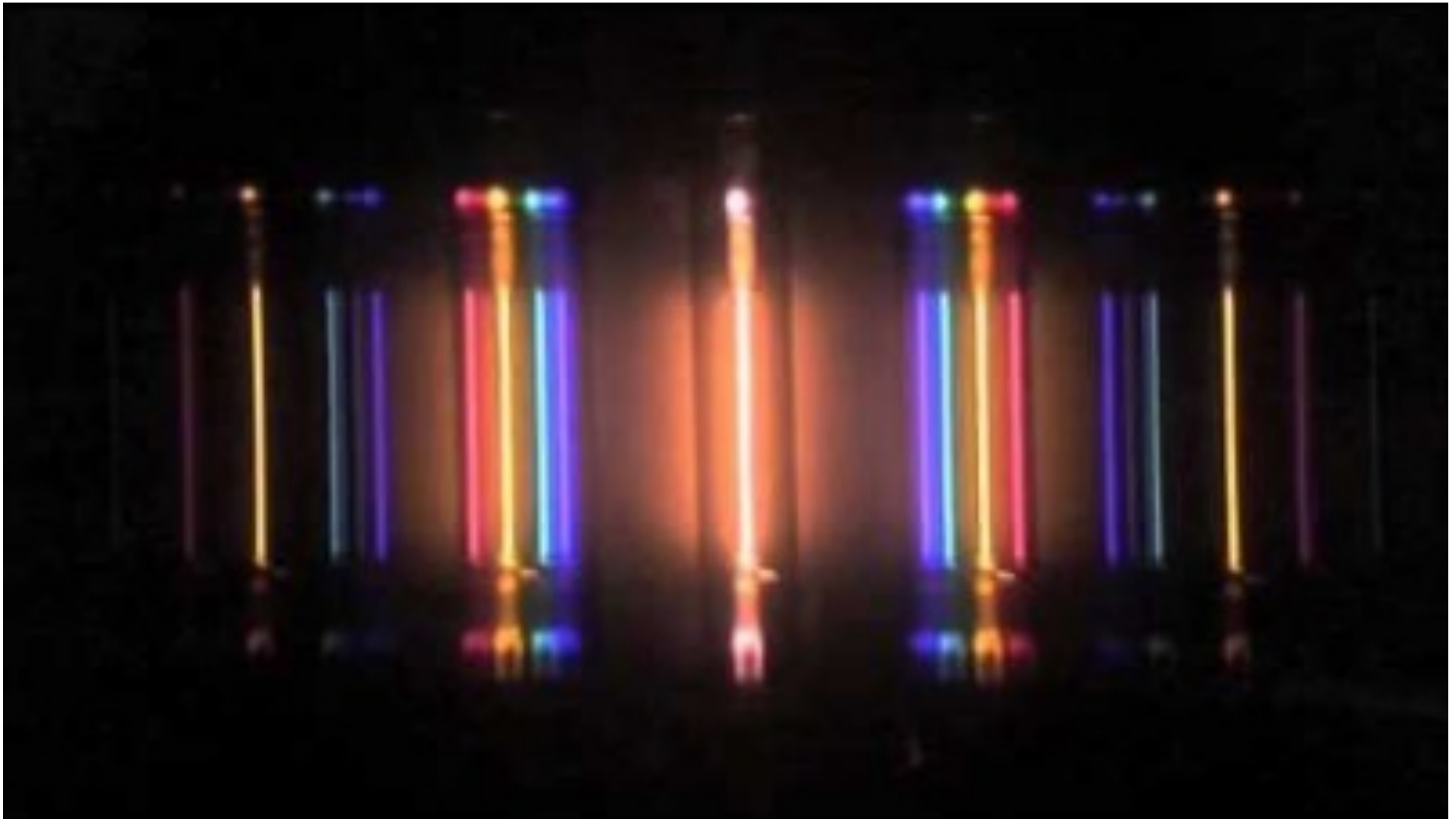
(a)

(b)

Passing an electric discharge through a gas causes an electron to go to a higher energy level. The electron does not stay for long there. It will go to a lower energy level, and extra energy is given out in the form of a photon (quantum of light). And we can see this as an emission spectrum of an element. The spectrum consists of a series of lines, because only transitions between two discrete energy levels are possible. If there were no discrete levels, we would see a continuous spectrum.

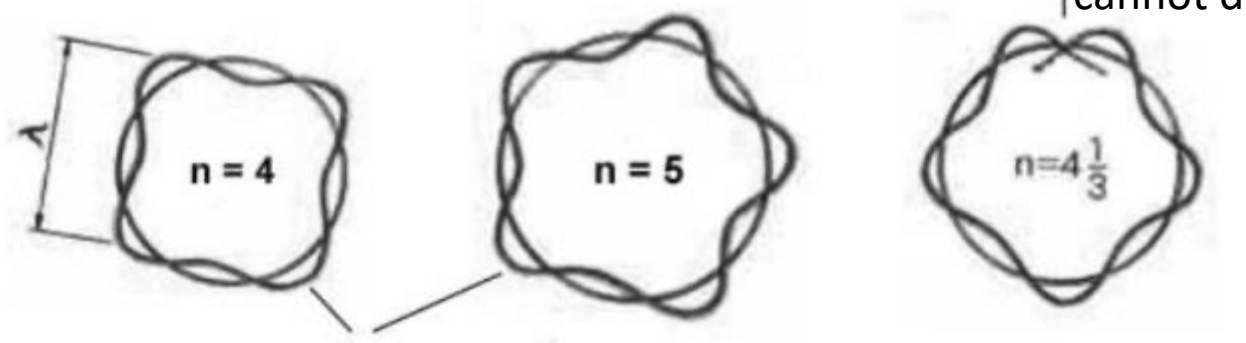
VIDEO

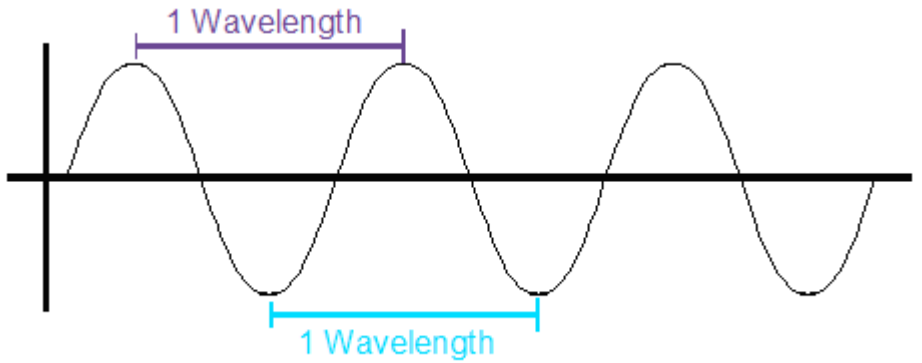
https://youtu.be/7_2Wi646M0o



We can also visualize electron as a wave, beaming around the nucleus. Quantum mechanics tells us that the electron is always a “standing wave” that is it “goes around” the nucleus a whole number of wavelength, but never a fractional value.

Electron cannot do that





An electron must occupy an orbit around the nucleus that is consistent with the whole number of wavelength – n is a whole number.

The numbering starts from the nucleus.

We will call these orbits “shells”. Each shell has a number starting from the nucleus 1, 2, 3…, n. This number is called principal quantum number.

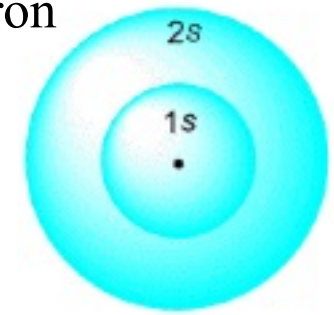
Electron as a wave – Schrödinger atomic model

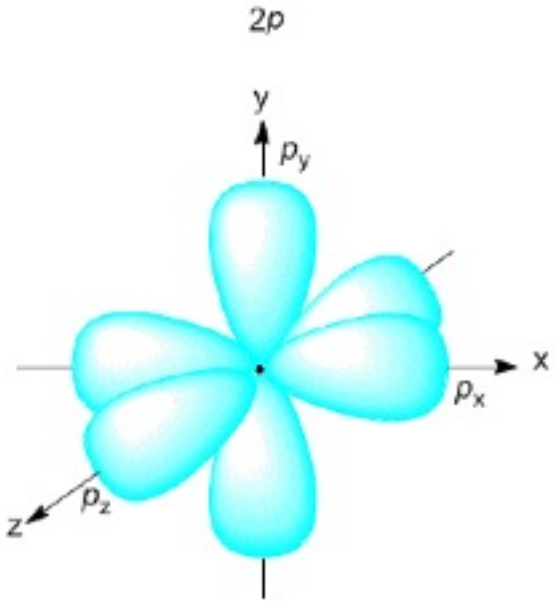
Schrodinger described electron movement in space using mathematical models for a wave

The model describes probability of finding an electron-wave in a certain point around the nucleus

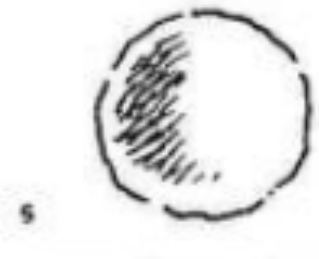
There are still orbitals in this model, they represent the space around a nucleus where an electron can be found with the probability of 95%

• All calculations were done for a single electron

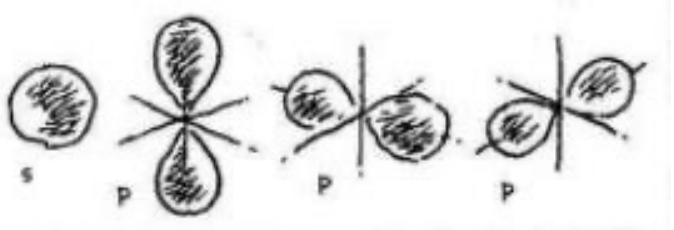




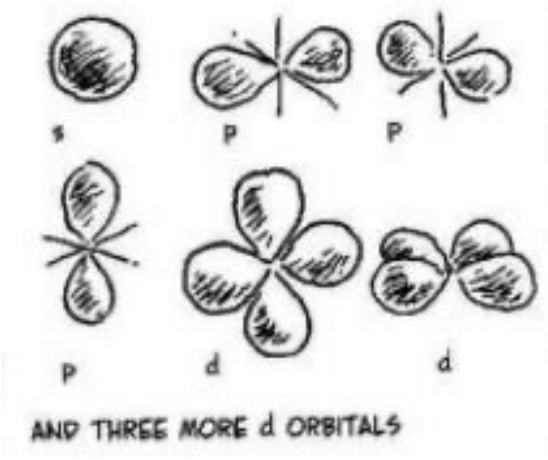
Shell 1



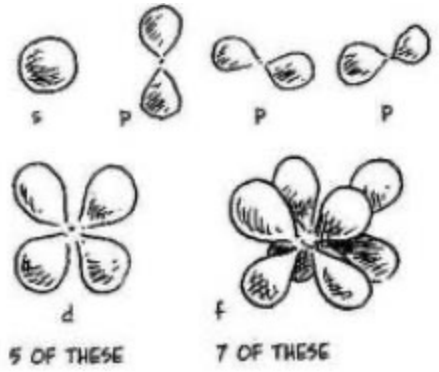
Shell 2



Shell 3



Shell 4



Within any sub-level all the orbitals have the same energy (degenerate), three p-orbitals are degenerate, five d-orbitals are degenerate.

Shells (levels)	Sub-levels			
	s	p	d	f
1	1			
2	1	3		
3	1	3	5	
4	1	3	5	7

The number of electrons is equal to the number of protons.
Electrons inhabit the closest to the nucleus shells and orbitals.
Each shell and each orbital can hold just a certain number of electrons.
On n level we will have n^2 different orbitals.
The maximum number of electrons that each shell can have is $2n^2$.
Each orbital can hold up to two electrons.

Rules of filling electrons' shells

1. Decide the total number of electrons to be placed (it should be equal to the number of protons, which is its atomic number)
2. Add electrons to each orbital starting with that of the lowest energy level and keeping in mind that we cannot place more than 2 electrons on each orbital

Energy level	Sublevels				Number of electrons			
					s	p	d	f
1	1s				2			
2	2s	2p			2	6		
3	3s	3p	3d		2	6	10	
4	4s	4p	4d	4f	2	6	10	14

First we fill the lowest energy levels. We completely fill level 1, then level 2. Then we jump to level 3 and fill it with 8 electrons, then the electrons go to the 4^{th} level. This scheme works smoothly up to element number 20 (Ca).

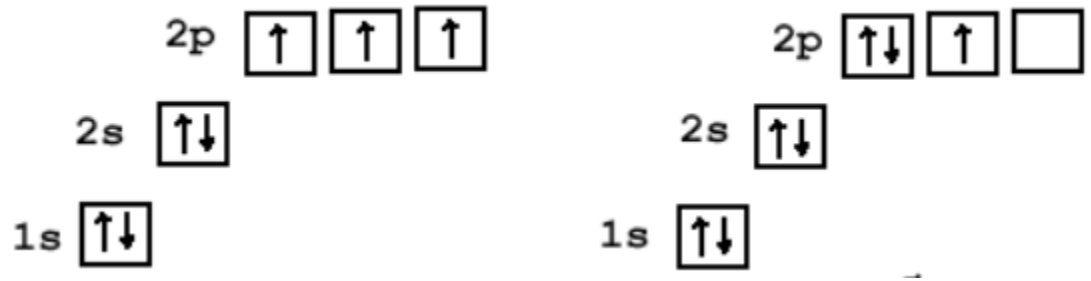
For majority of atoms the electrons will occupy levels and orbitals as following:
1s,2s,2p,3s,3p,4s,3d,4p,5s,4d,5p,6s,4f,5d,6p,7s,5f,6d…

Let’s build some atoms

What do we see here?
If you compare element 11-18 and 3-10, you will see that each atom has an outer shell identical to that of the atom eight elements behind it.

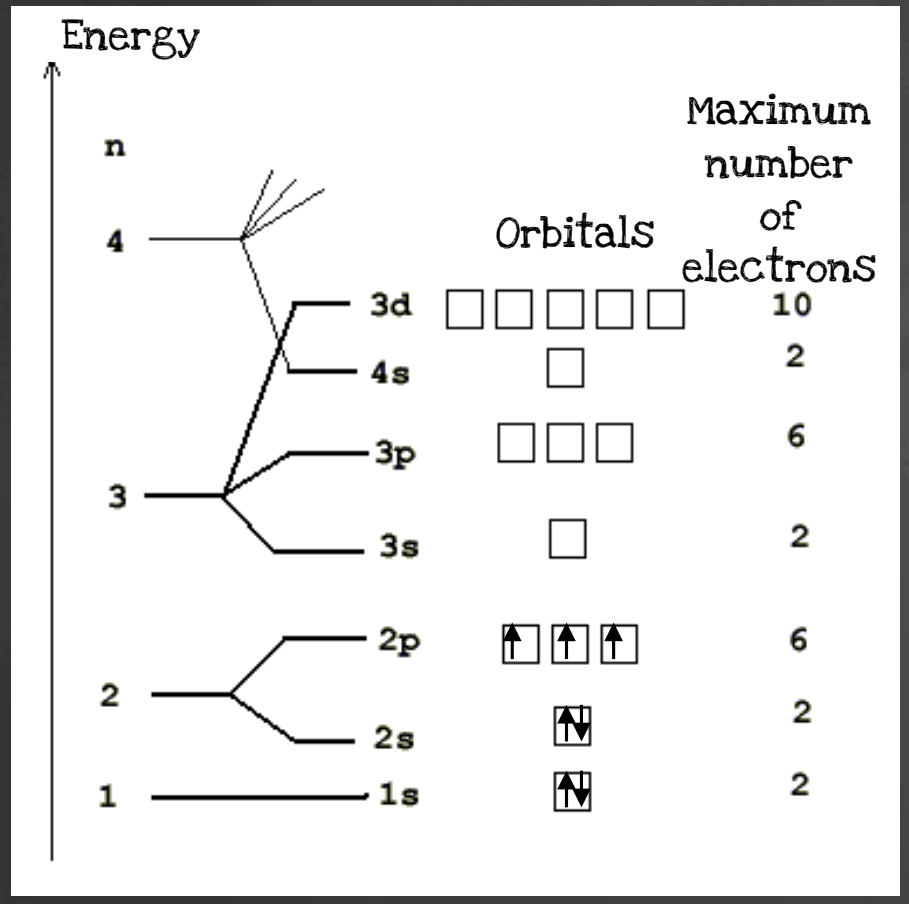
Orbital diagram

Hund's rule states that: Every orbital in a sublevel is singly occupied before any orbital is doubly occupied. All of the electrons in singly occupied orbitals have the same spin (to maximize total spin).

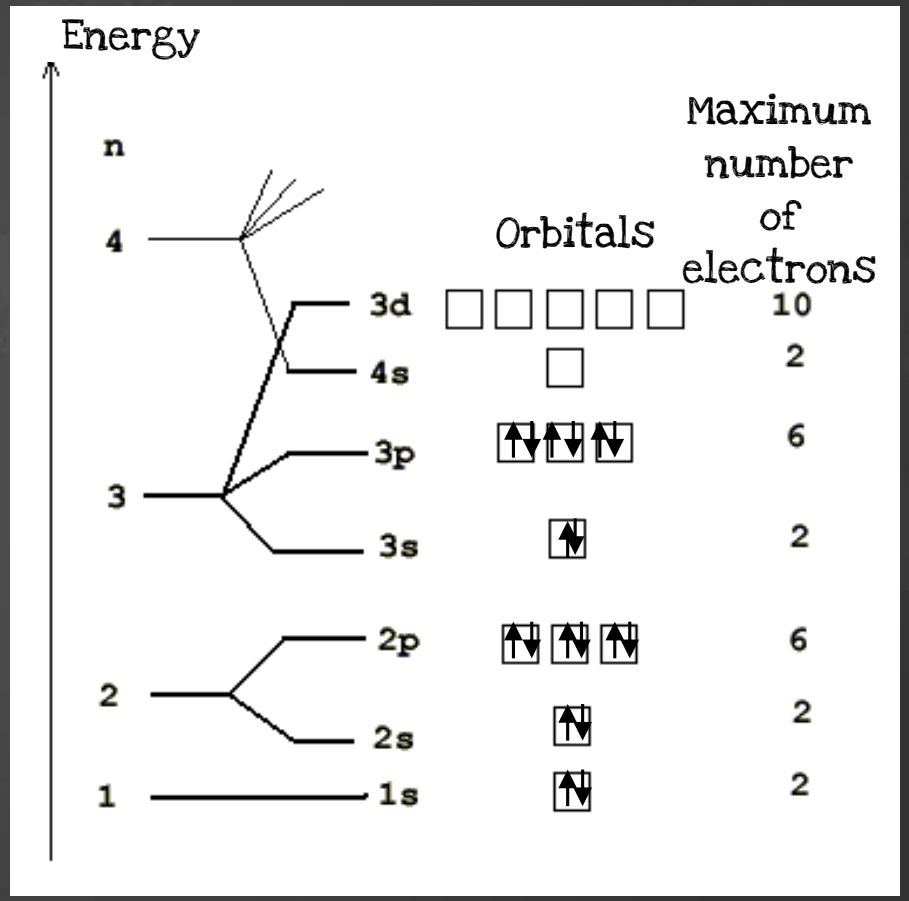


These are two versions of nitrogen electron orbital diagrams. Which one is correct?

$_{7}N$



$_{18}Ar$



The further we go from the nucleus the smaller distances between levels and sublevels, they start to “overlap” each other.

Putting electrons into orbitals

1. The Pauli exclusion principle: the maximum number of electrons in an orbit is two. If there are two electrons in an orbit, they must have opposite spin.
2. Hund's rule: electrons fill orbitals of the same energy so as to give the maximum number of electrons with the same spin.