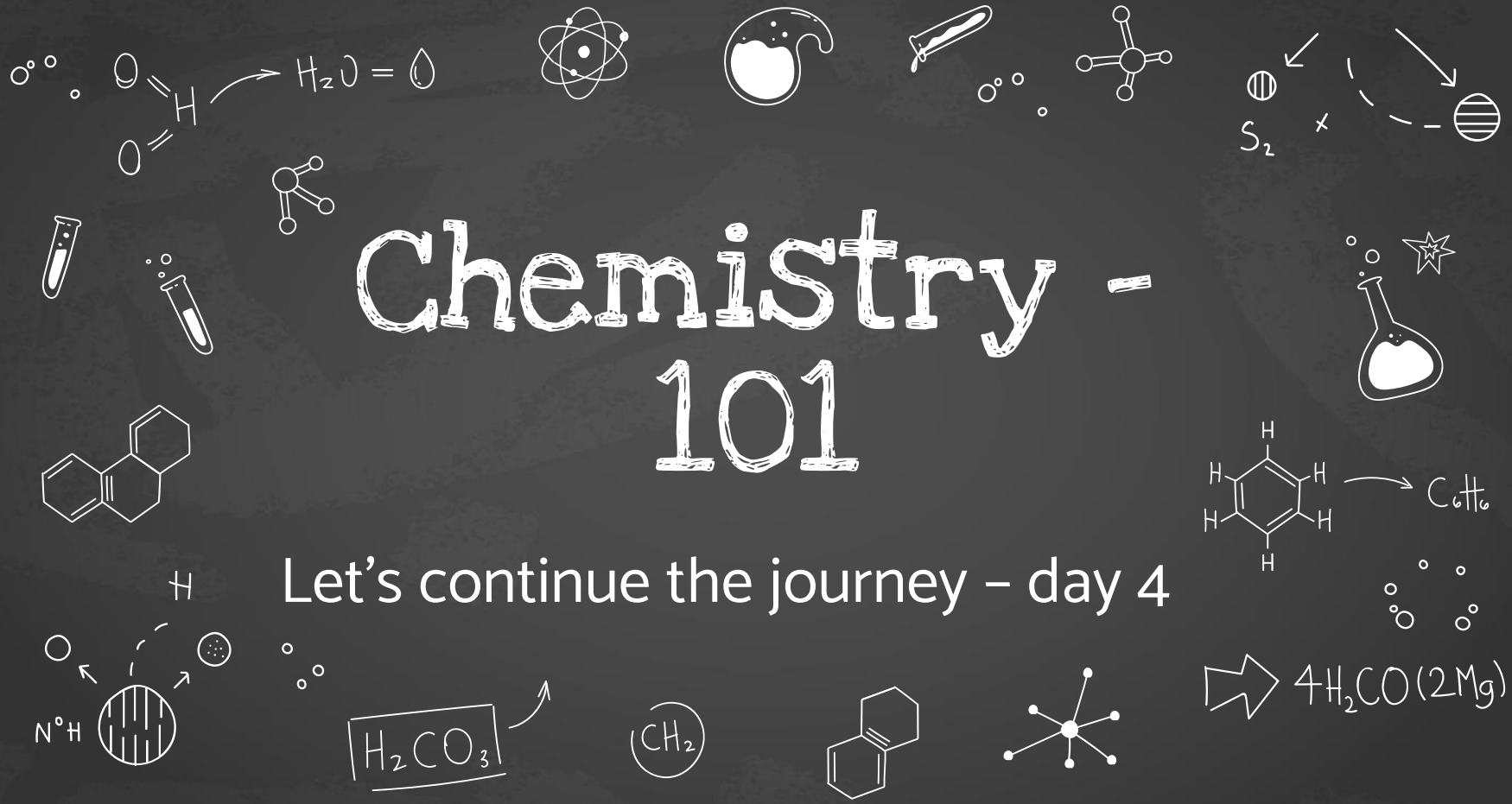
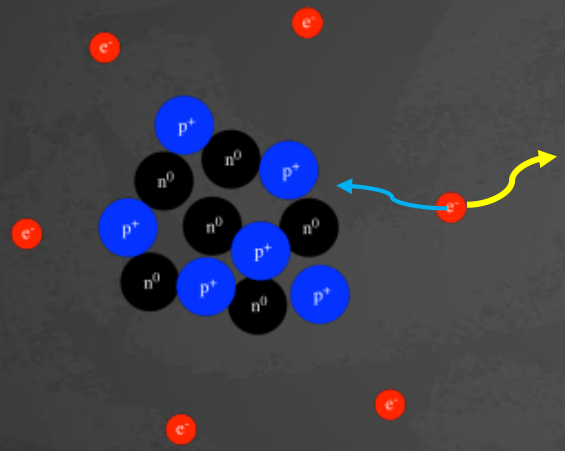

Chemistry - 101
Let's continue the journey – day 4
H_2O
S_2
C_6H_6
H_2CO_3
CH_2
$4H_2CO(2Mg)$

What do we know about an atom?



Protons have positive charge (+)
Electrons have negative charge (-)
Neutrons are not charged

An atom with an unbalanced charge is called an ION
An ion has more or less electrons than protons in an atom

Which of these are the same elements?

A:
- # of protons – 8
- # of neutrons – 9
- # of electrons - 10

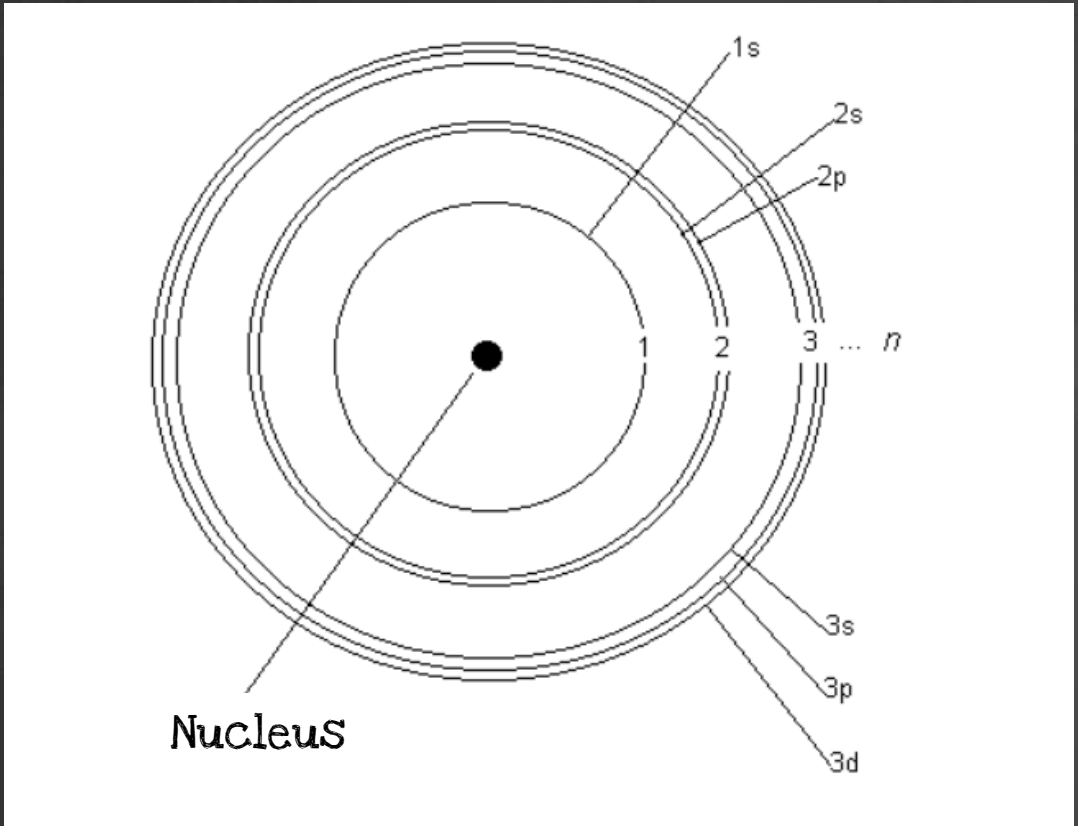
B:
- # of protons – 9
- # of neutrons – 9
- # of electrons - 10

C:
- # of protons – 9
- # of neutrons – 9
- # of electrons - 9

D:
- # of protons – 8
- # of neutrons – 8
- # of electrons - 8

E:
- # of protons – 8
- # of neutrons – 8
- # of electrons - 8

F:
- # of protons – 8
- # of neutrons – 10
- # of electrons - 10



Atom model by Niels Bohr

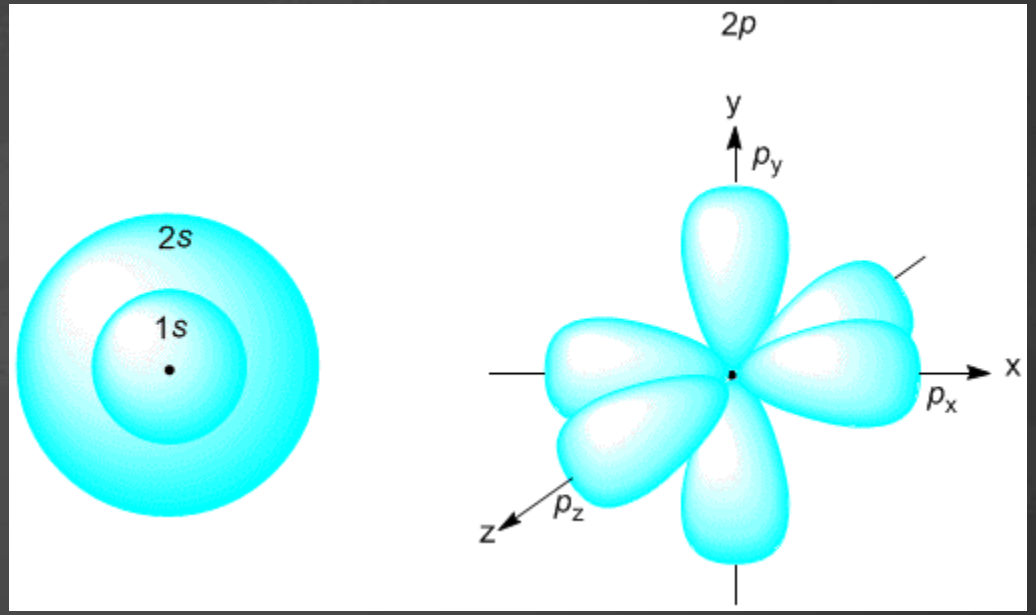
Shells consist of electron configurations that are close in energy and are called "orbitals". You can think of these orbitals as energy sublevels.

Different sublevels are called s, p, d, and f, and each orbital can hold **up to two electrons**

- 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 $2n^2$

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



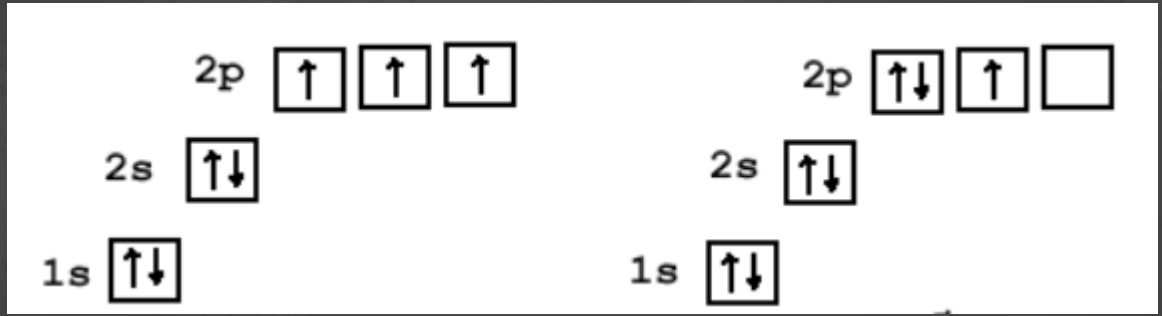
Rules of filling electrons' shells

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
3. According to Hund's rule, all orbitals will be singly occupied before any is doubly occupied.

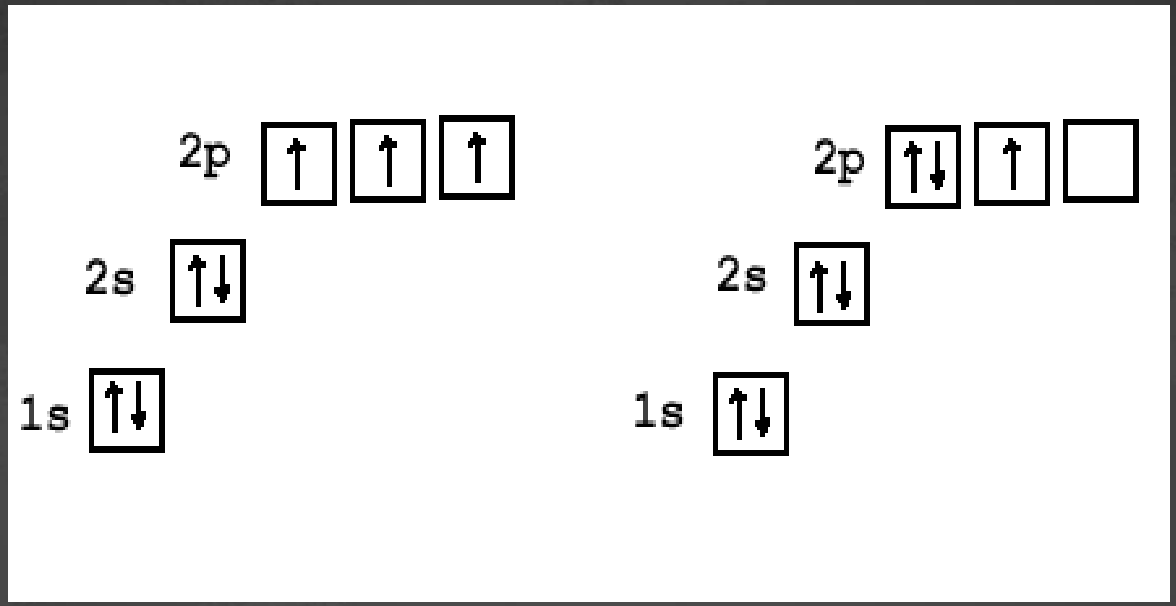
This will be an *atomic electron configuration*

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).



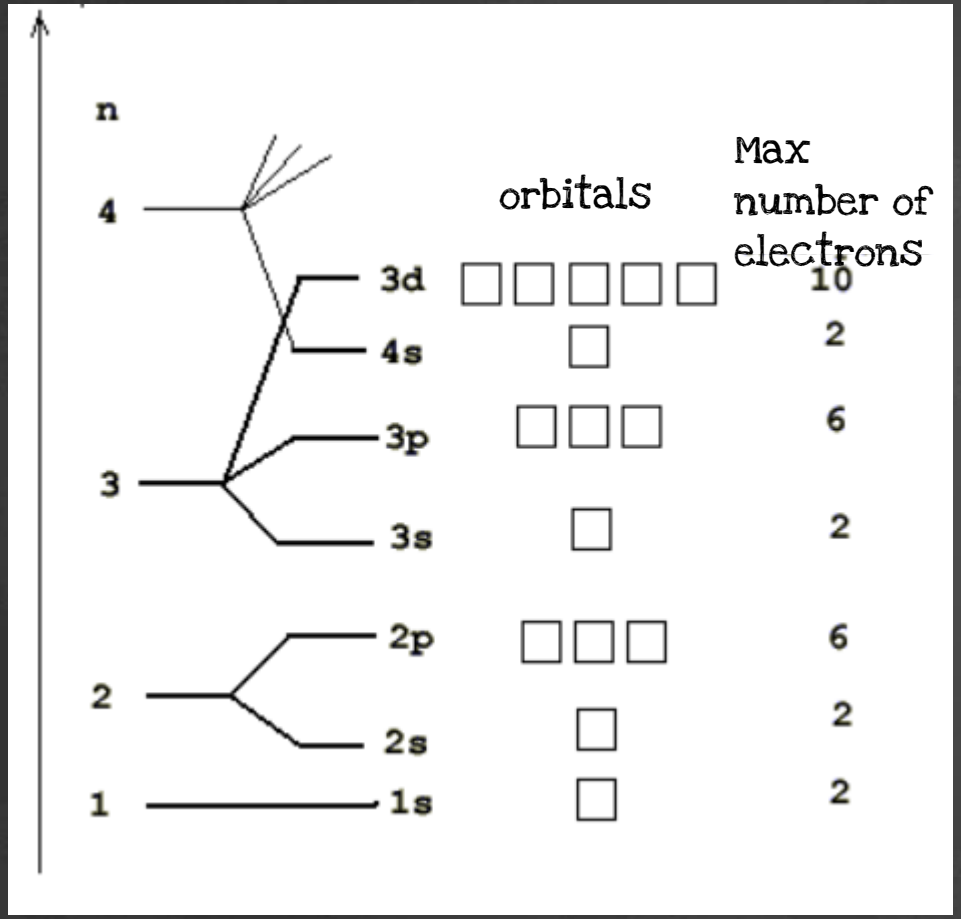
These are two versions of nitrogen electron orbital diagrams. Which one is correct?



Correct

Incorrect

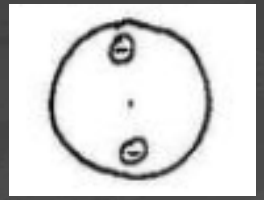
Orbital diagram



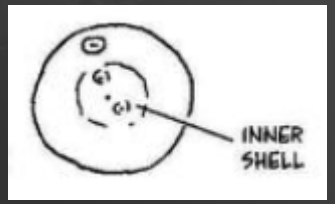
- The orbitals fill with electrons in the way that the total atom energy is at its minimum

1. Hydrogen, H

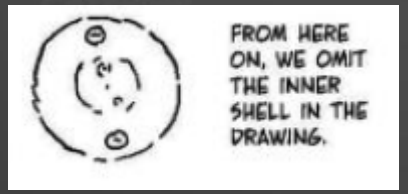
2. Helium, He

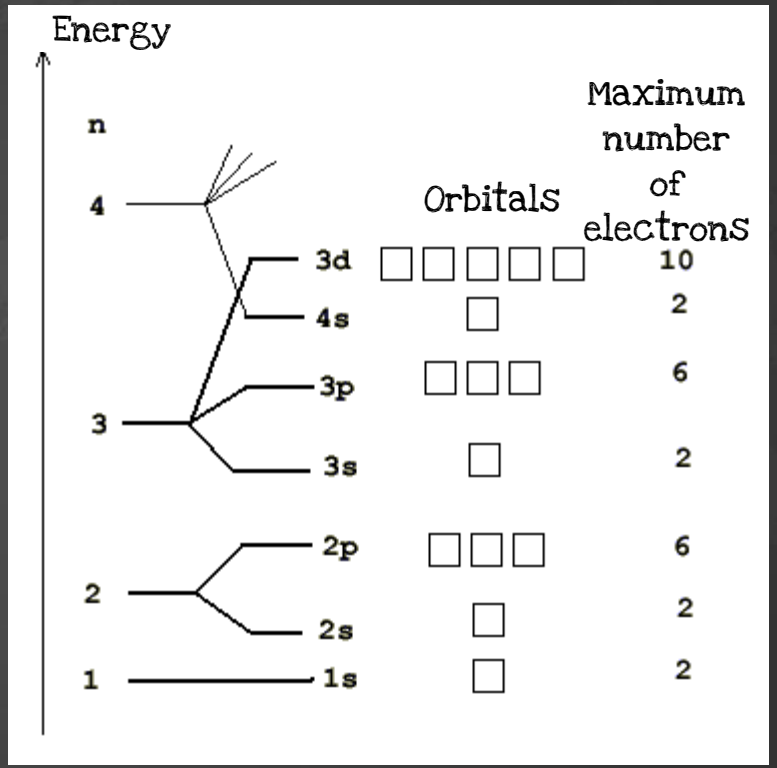


3. Lithium, Li

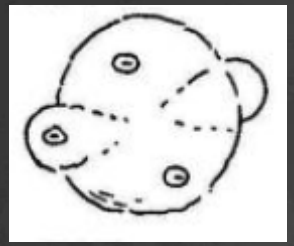


4. Beryllium, Be

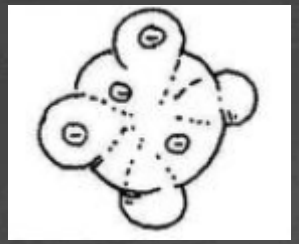




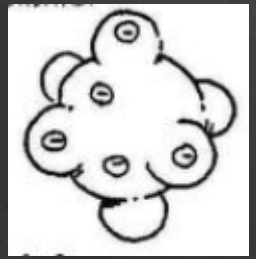
5. Boron, B



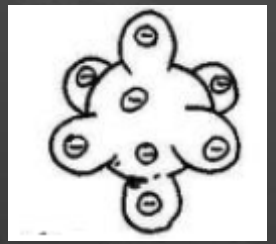
6. Carbon, C

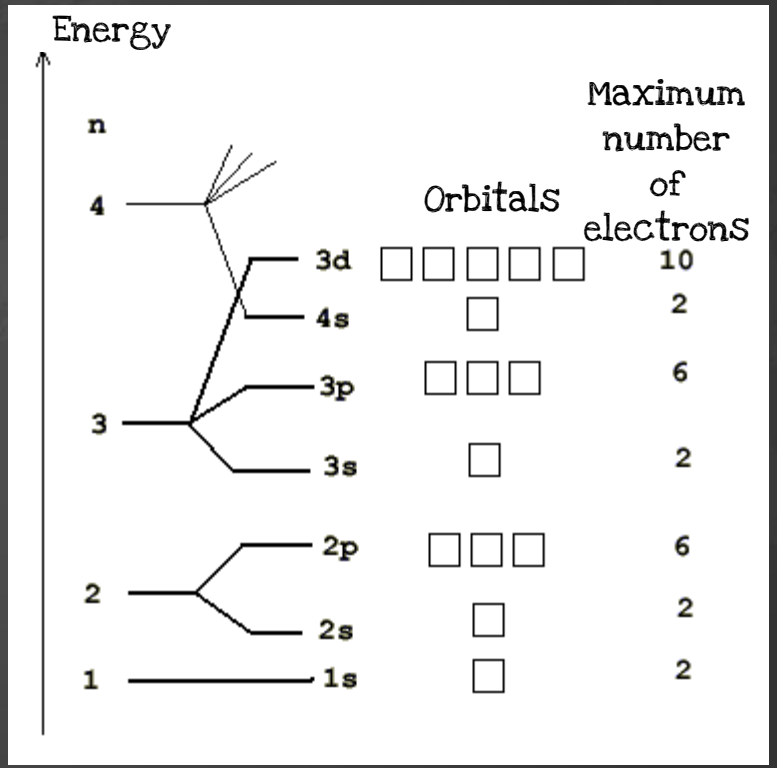


7. Nitrogen, N

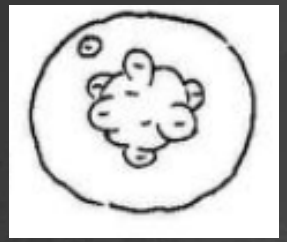


10. Neon, Ne

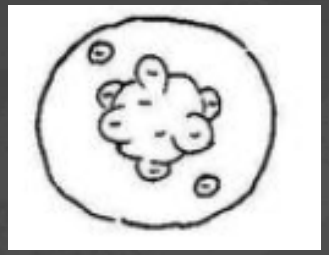




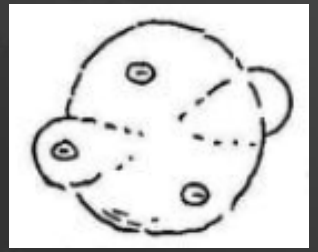
11. Sodium, Na



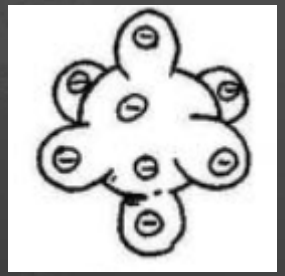
12. Magnesium, Mg

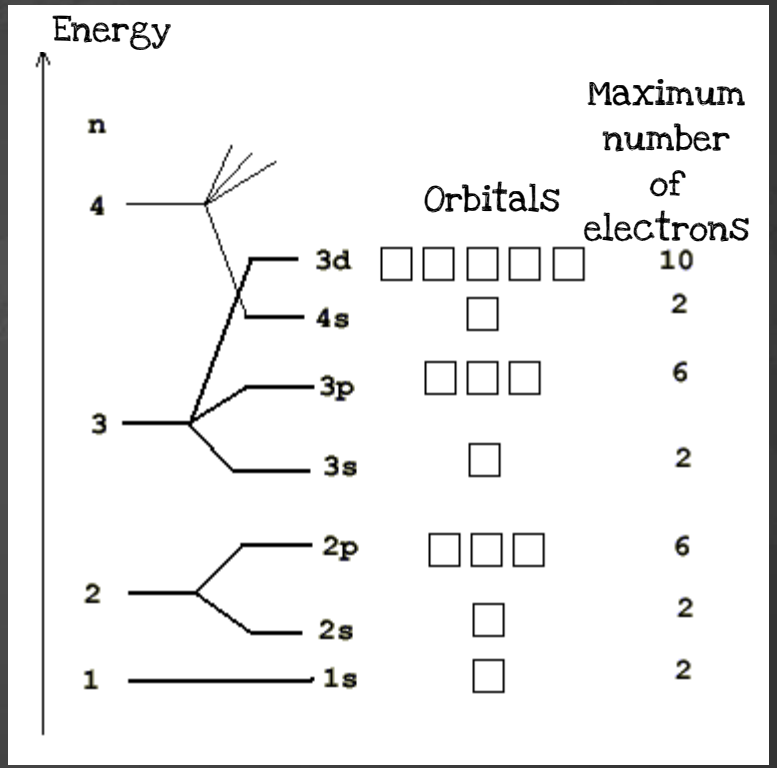


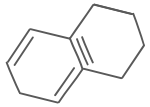
13. Aluminum, Al

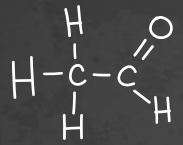


18. Argon, Ar





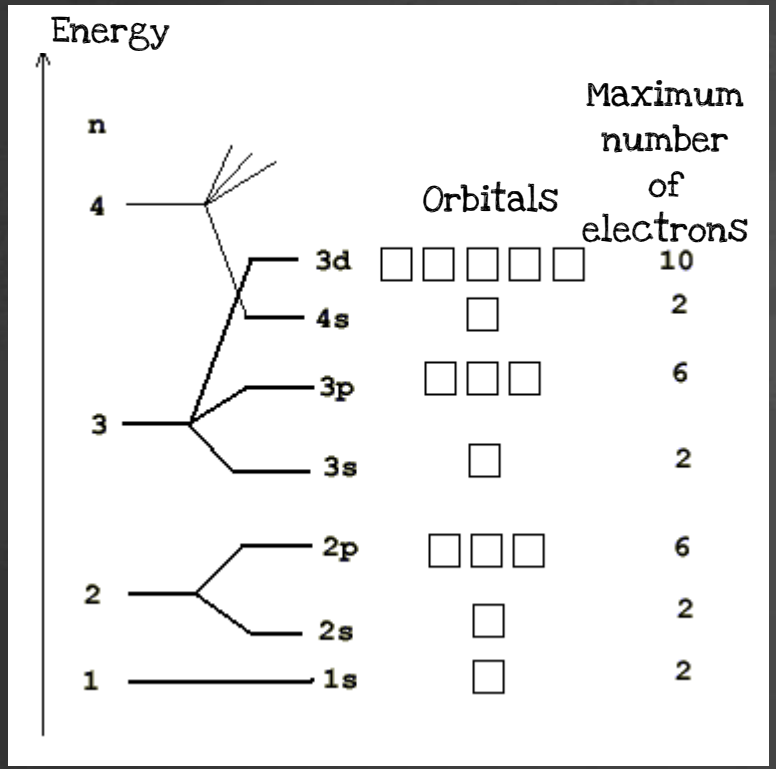




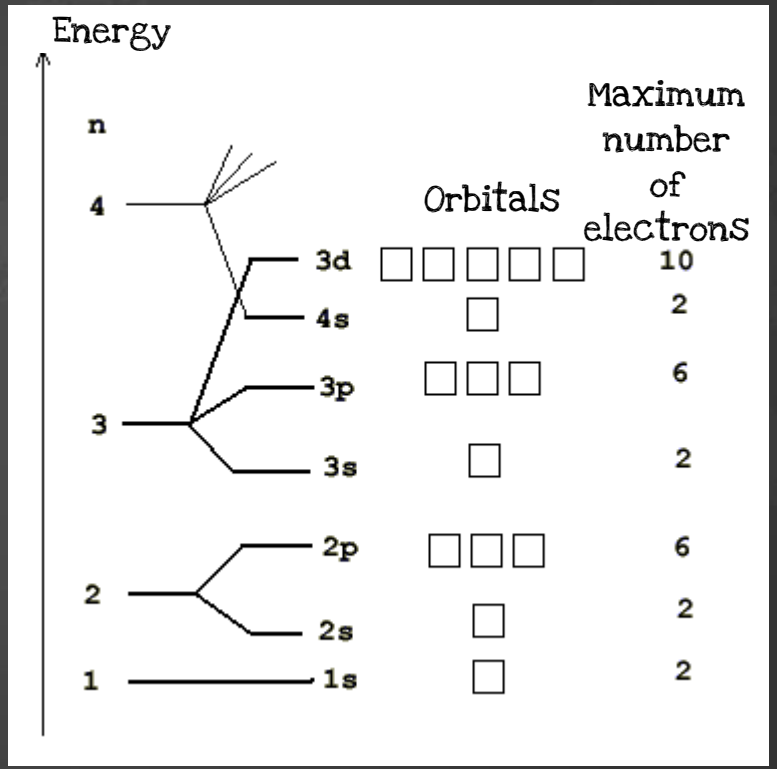
Electron configurations Togetherness

How can electron configurations explain behavior of elements?
How everything works together – elements interactions?

$_{7}N$


Energy
n
4
3
2
1
3d
4s
3p
3s
2p
2s
1s
Orbitals
Maximum number of electrons
10
2
6
2
6
2
2

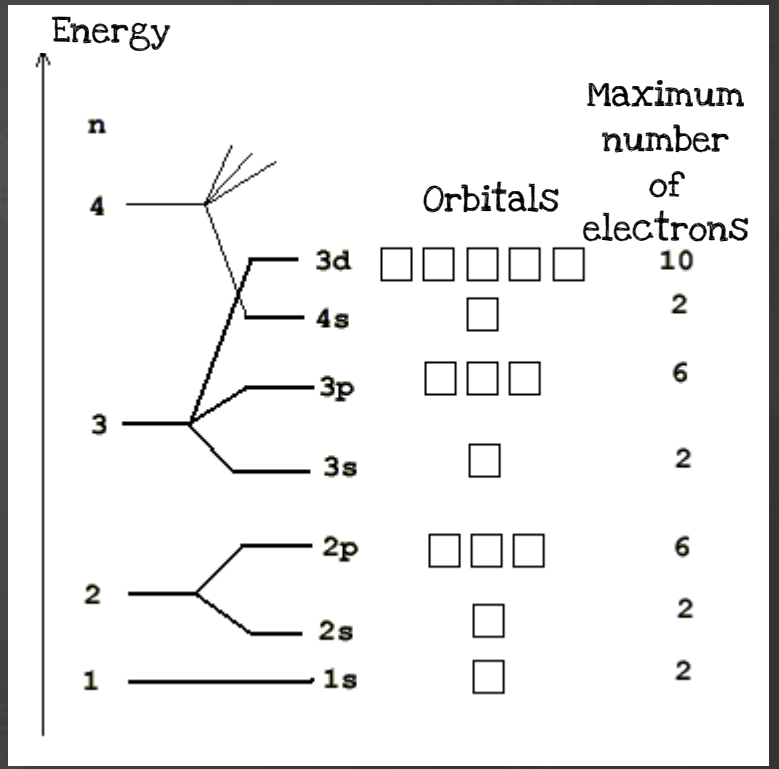
$_{18}Ar$


Energy
n
4
3
2
1
3d
4s
3p
3s
2p
2s
1s
Orbitals
Maximum number of electrons
10
2
6
2
6
2
2

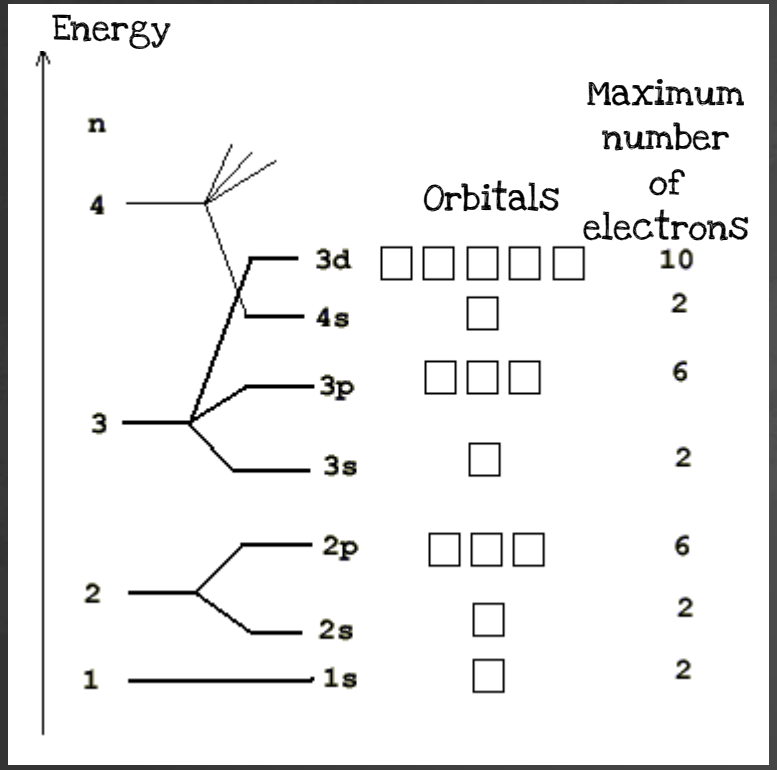
A complete outer shell, $\underline{ns^2np^6}$, is energetically more advantageous than an incomplete one.

$_7N$

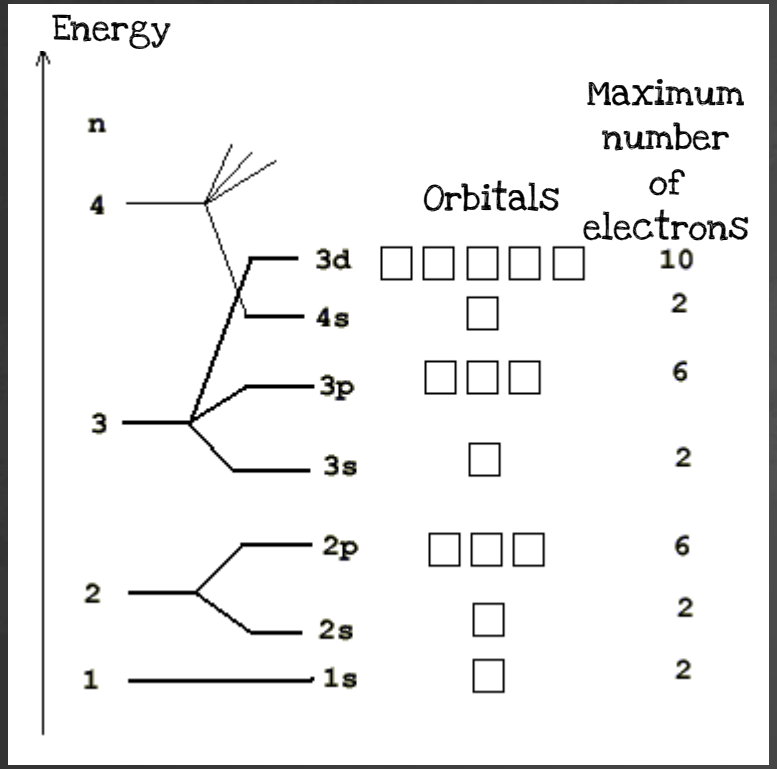
E.g. in its interactions with other atoms nitrogen can accept 3 electrons to complete its outer shell.



$_{18}Ar$



It has a complete outer shell and is called "non-active"
It is one of "noble" gases



10. Neon, Ne,

Similarly, Neon has an outer shell completed with the 8 electrons

Just like real nobility, the noble gases are the envy of the common elements. Everyone wants that full complement of 8 outer electrons.

We call it the **RULE OF EIGTH**: at atom tends to pick up or give away just enough electrons to make eight in its outer shell - AN **ELECTRON OCTET**.

This class uses the materials from the following books:
Larry Gonick and Graig Criddle “The cartoon guide to chemistry”
Manyuilov and Rodionov “Chemistry for children and adults”
Kuzmenko, Eremin, Popkov “Beginnings of chemistry”