Electron Configuration

Chemistry

Learning objectives

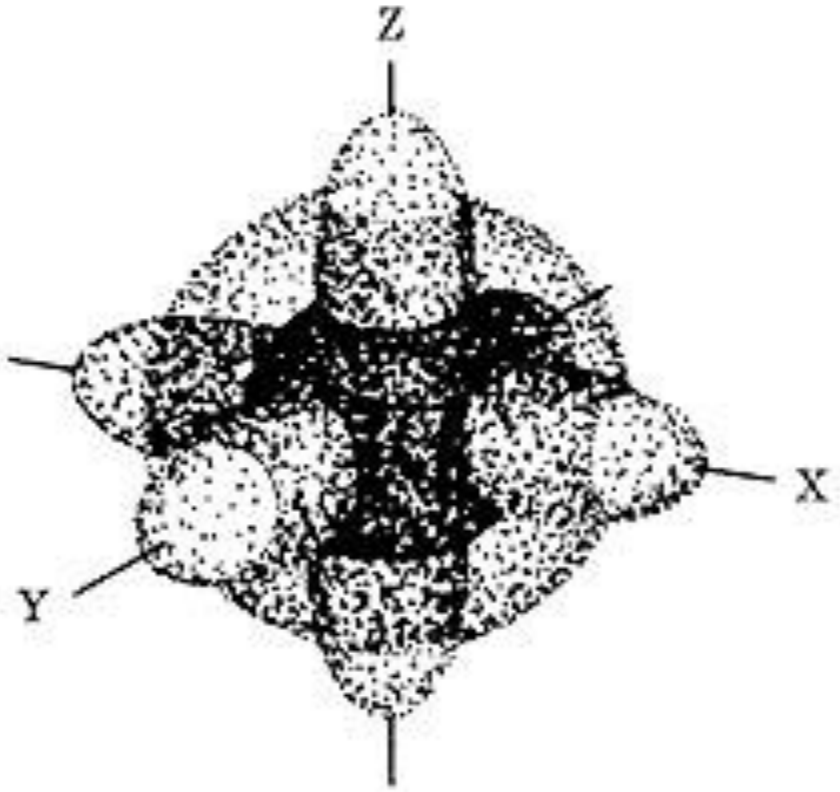
- 11.1.3.1 understand and be able to work with a shell model of the atom: shell, sub-shell, orbital
- 11.1.3.2 recall the shapes of s, p, d, and f orbital (sets)
- 11.1.3.3 understand the rules for the filling of shells and sub-shells
- 11.1.3.4 recall the Aufbau (Kletchkovsky) principle as a mnemonic for the arrangement of electrons
- 11.1.3.5 be able to draw the electronic configuration for the first 36 elements

Success criteria

- explain the shell - subshell - orbital structure of the atom and relate it to quantum numbers
- describe and sketch the shapes of s and p orbitals
- identify the main principles of atomic orbital filling with electrons
- state the electronic configuration of atoms and ions given the proton number and charge, using the convention $1s^2 2s^2 2p^6$, etc.
- construct the electronic configuration of atoms and ions in full and shorthand form

Electron Configuration

- The way electrons are arranged around the nucleus.



Quantum Mechanical Model

- 1920's
- Werner Heisenberg (Uncertainty Principle)
- Louis de Broglie (electron has wave properties)
- Erwin Schrodinger (mathematical equations using probability, quantum numbers)

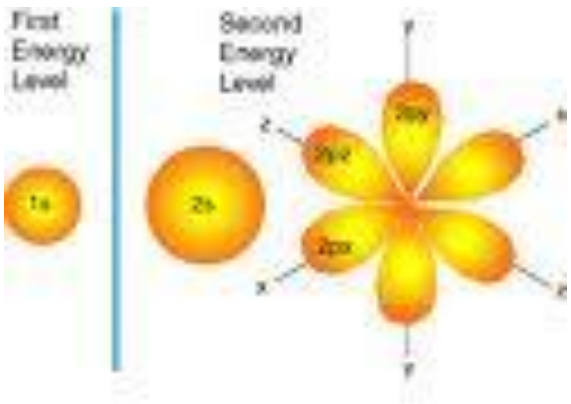
Energy Levels

- Indicates main energy levels

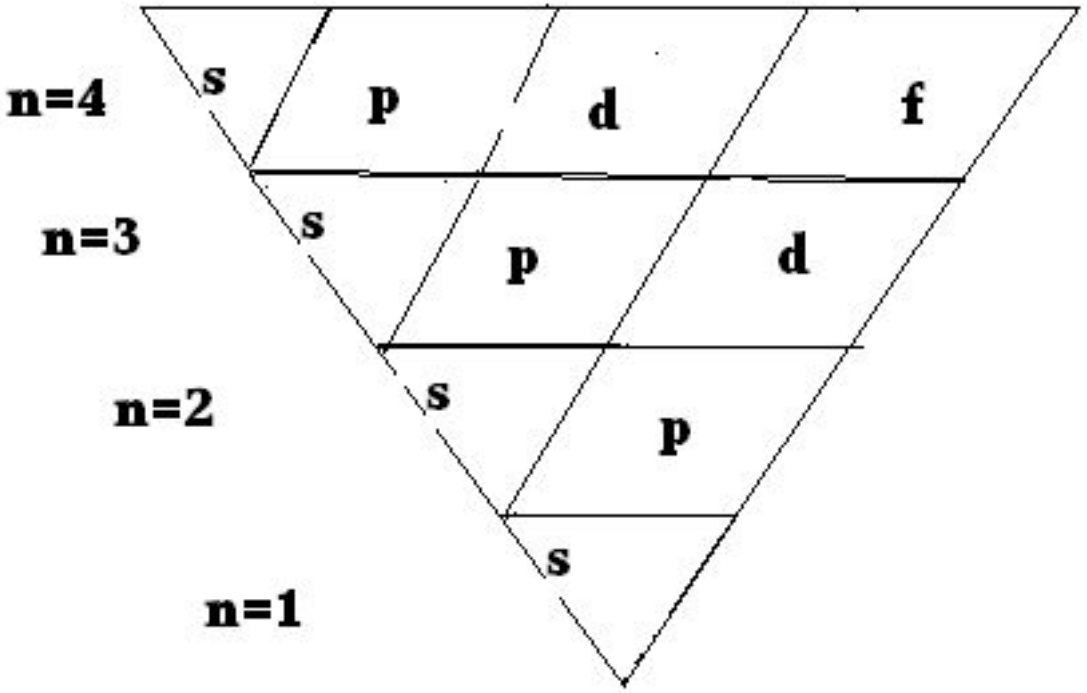
  n = 1, 2, 3, 4…

  Farther from nucleus = higher number

- Each main energy level has sub-levels
  - s p d f



- The Energy level number, n, determines the number of sublevels within the principle energy level.



Orbital Quantum Number, ℓ (Angular Momentum Quantum Number)

- Indicates shape of orbital sublevels
- $\ell = n-1$

ℓ	sublevel
0	s
1	p
2	d
3	f
4	g

Orbital

- The space where there is a high probability that it is occupied by a pair of electrons.
- Orbitals are solutions of Schrodinger's equations.

Orbitals in Sublevels

Sublevel	# Orbitals	# electrons
s	1	2
p	3	6
d	5	10
f	7	14
g	9	18

shapes

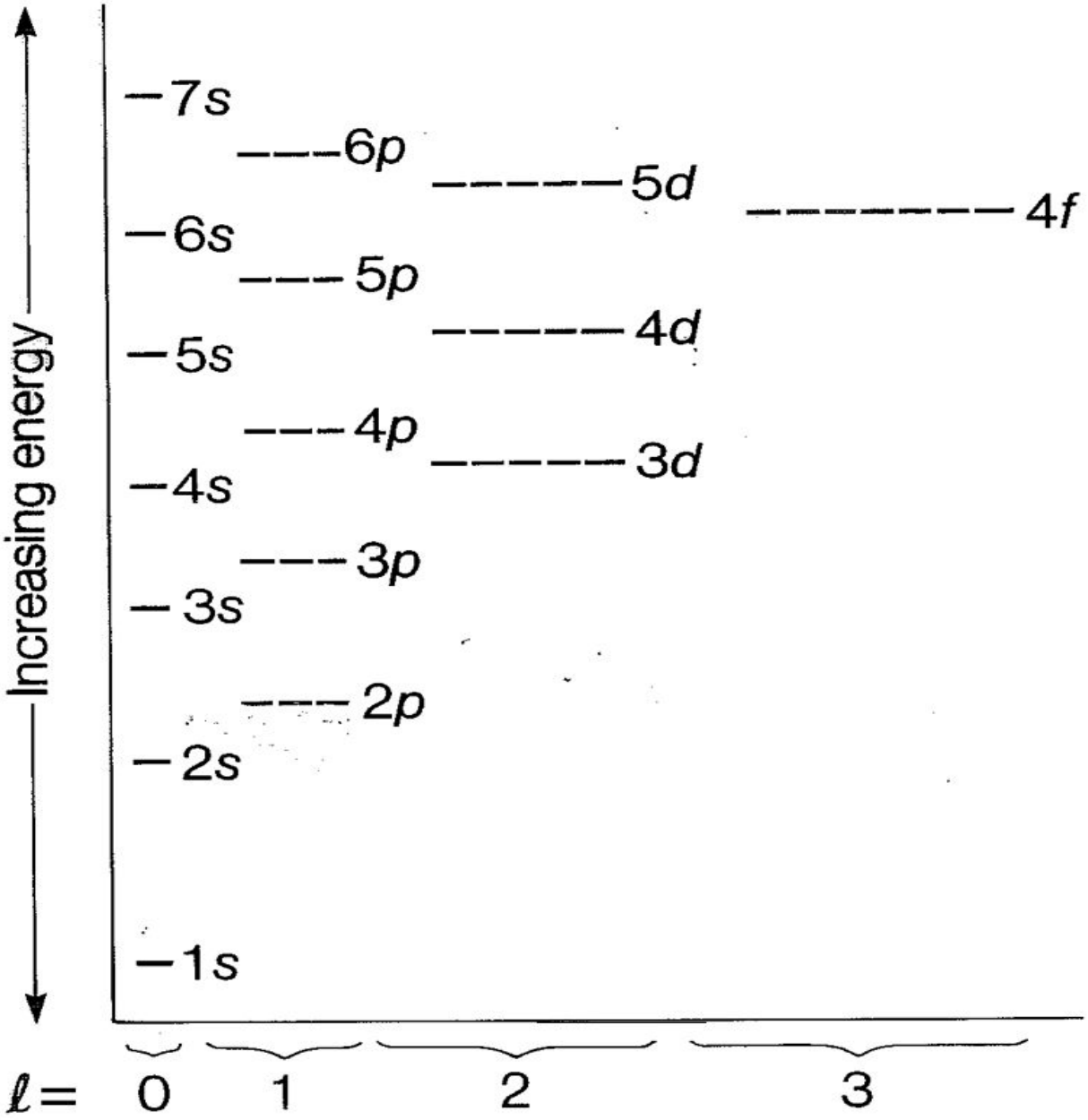
Three rules are used to build the electron configuration:

- Aufbau principle
- Pauli Exclusion Principle
- Hund's Rule

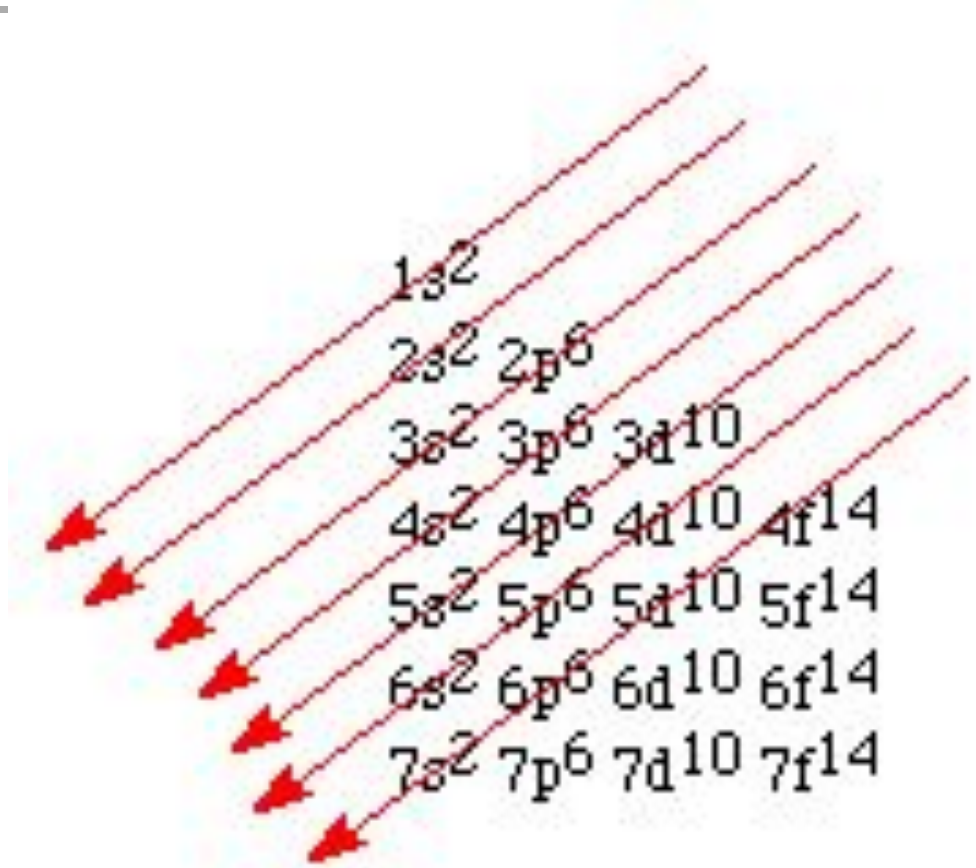
Aufbau Principle

- Electrons occupy orbitals of lower energy first.

Aufbau Diagram

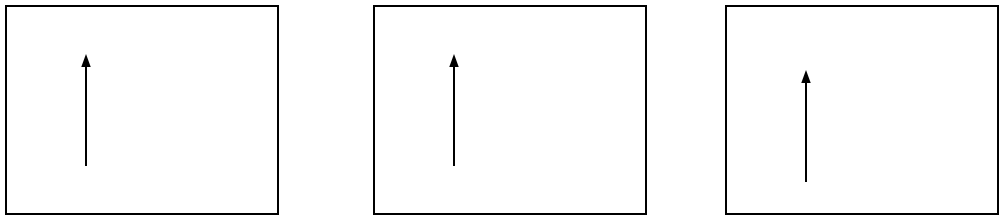


The diagonal rule



Hund's Rule

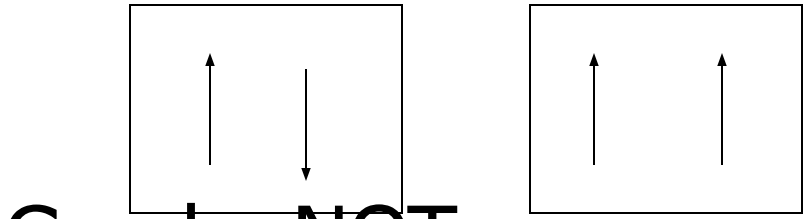
In a set of orbitals, the electrons will fill the orbitals in a way that would give the maximum number of parallel spins (maximum number of unpaired electrons).



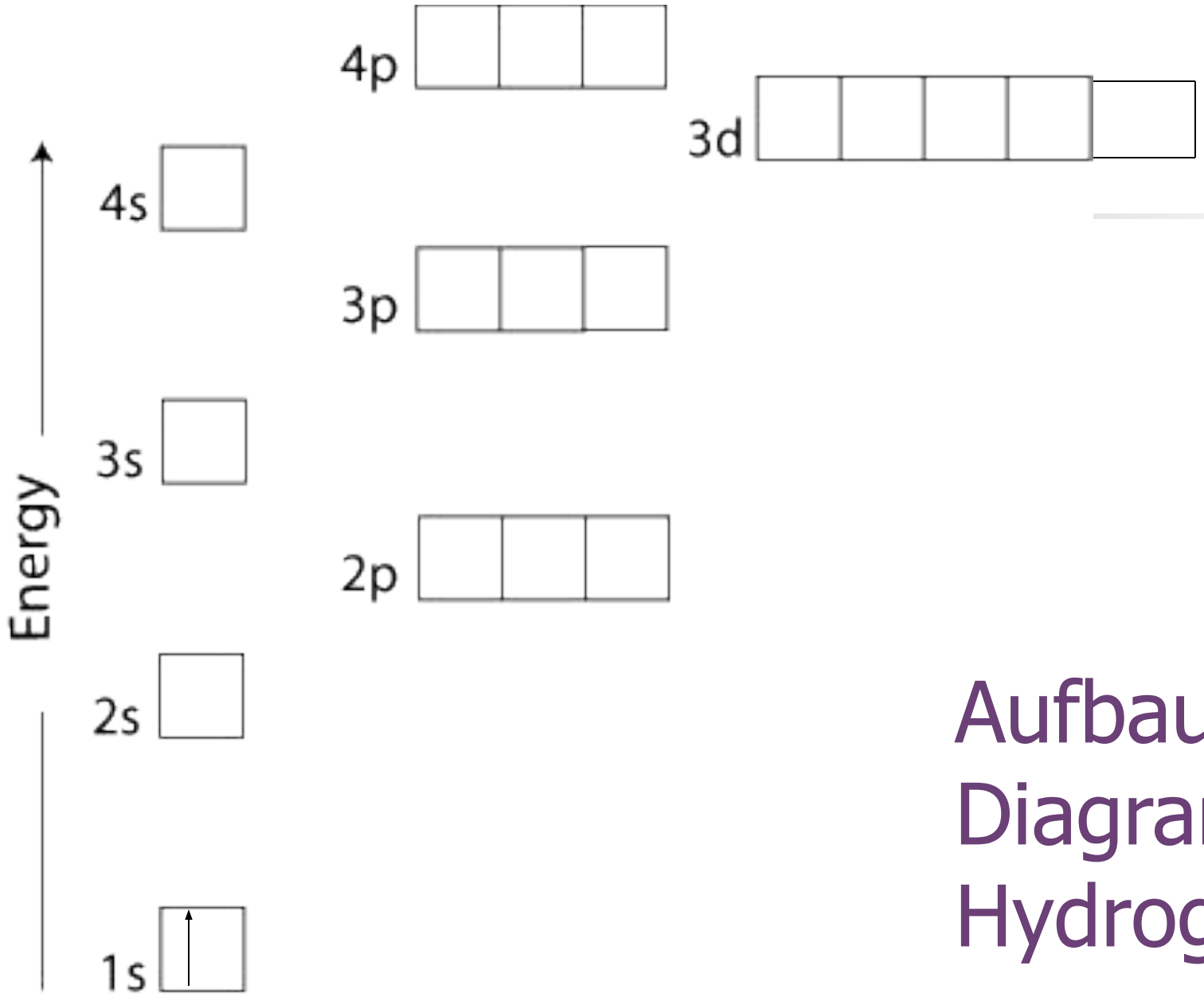
Analogy: Students could fill each seat of a school bus, one person at a time, before doubling up.

-Pauli Exclusion Principle (Wolfgang Pauli, Austria, 1900-1958)

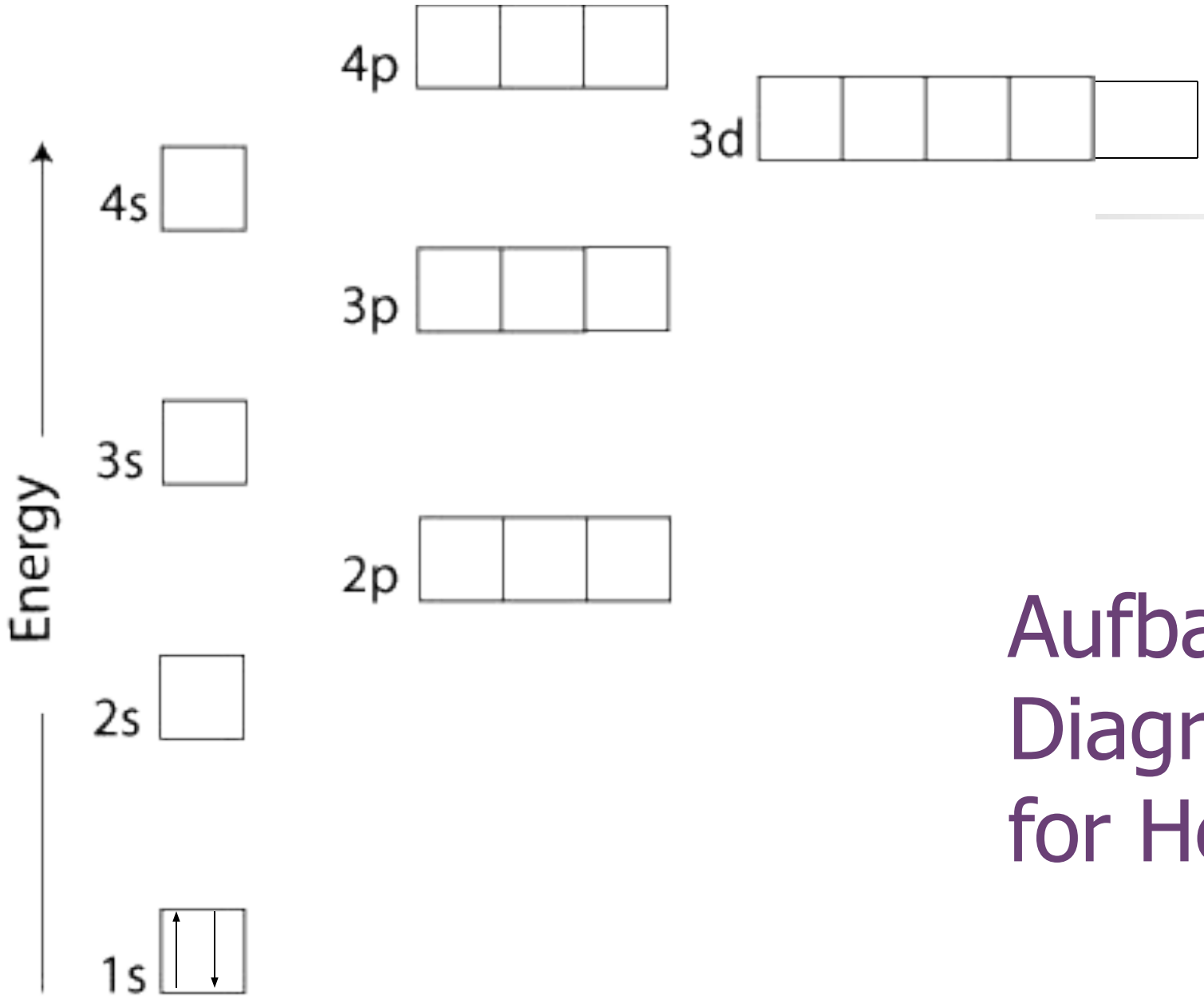
- An orbital can hold only two electrons and they must have opposite spin.



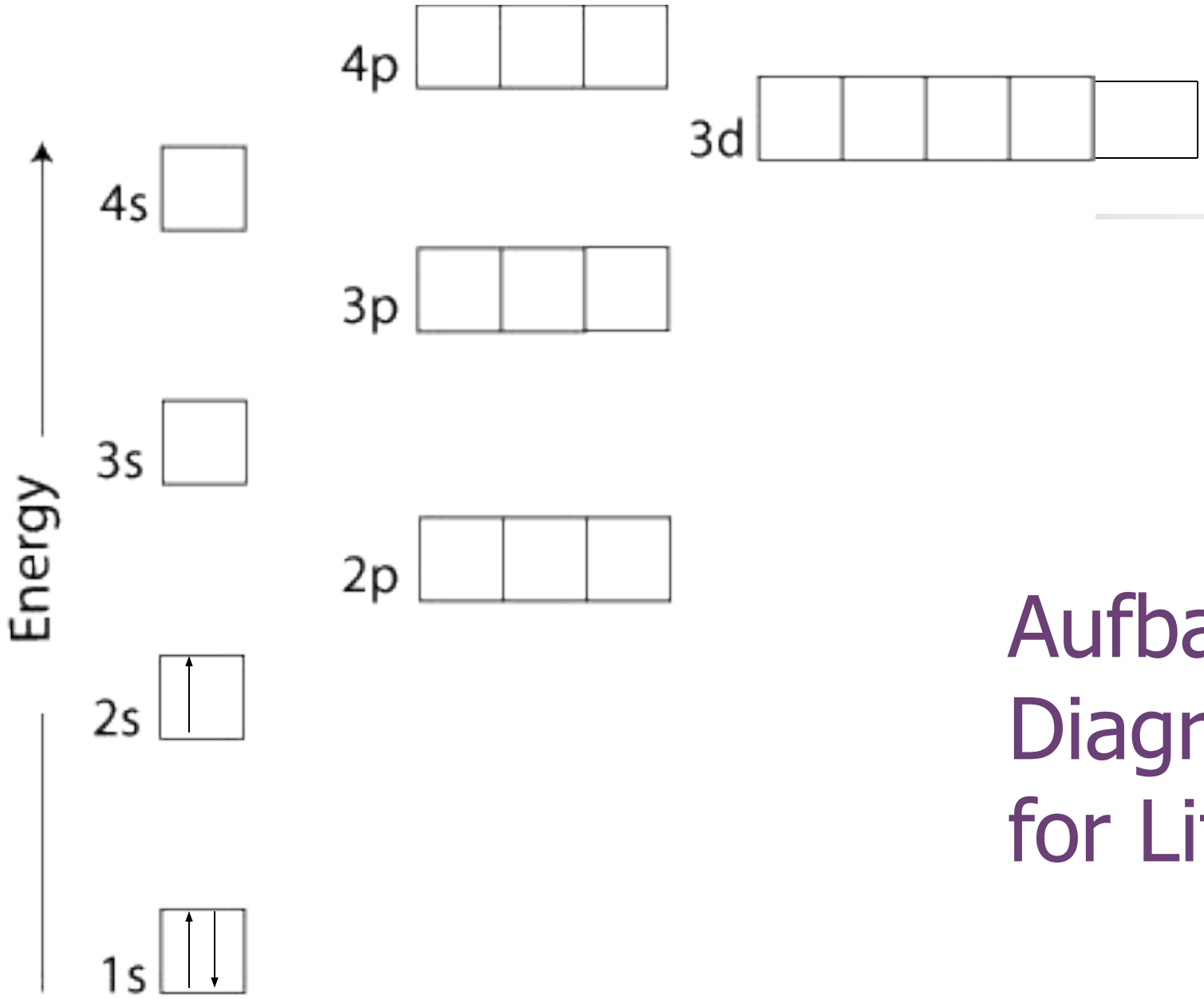
Good NOT



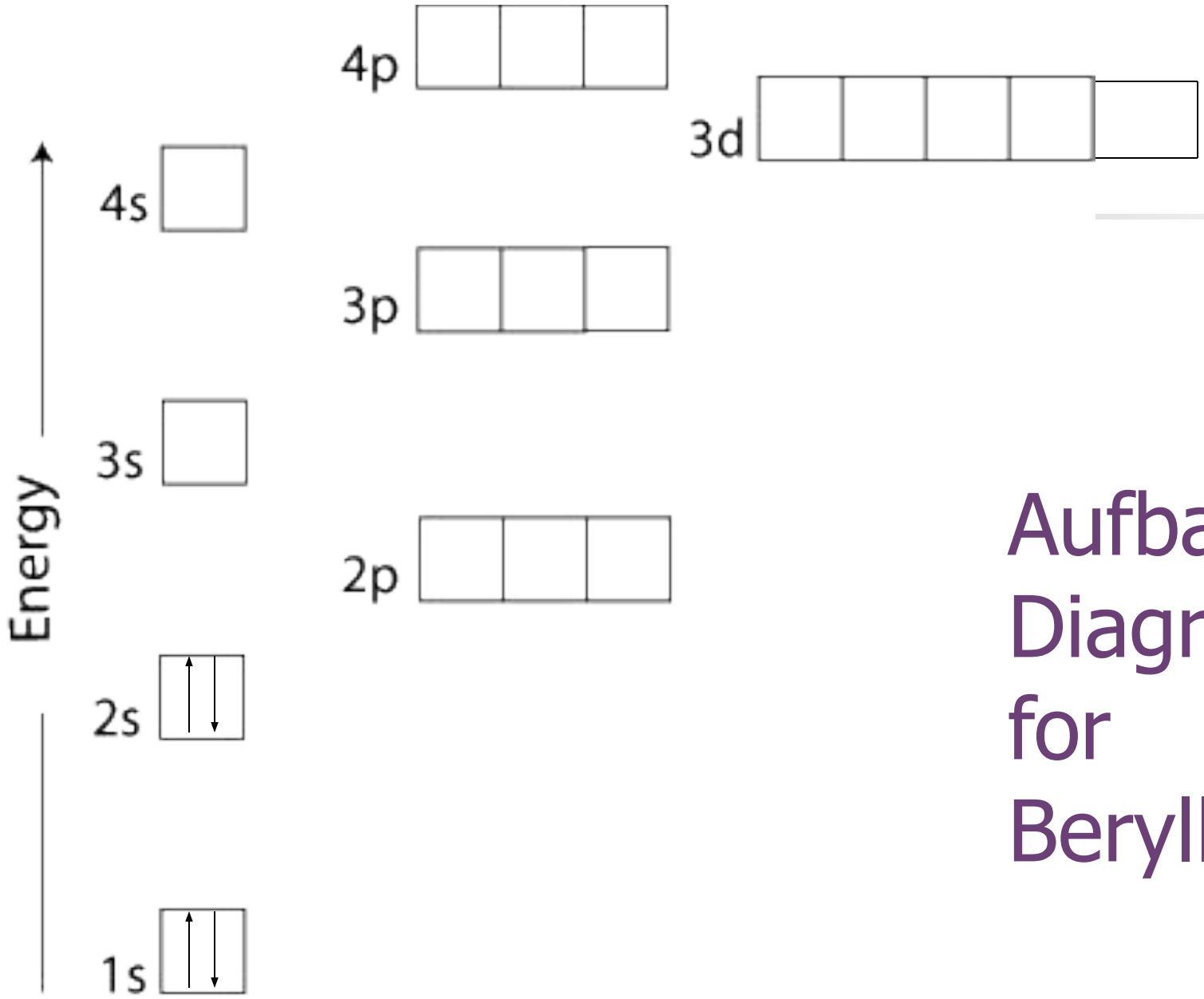
Aufbau Diagram for Hydrogen



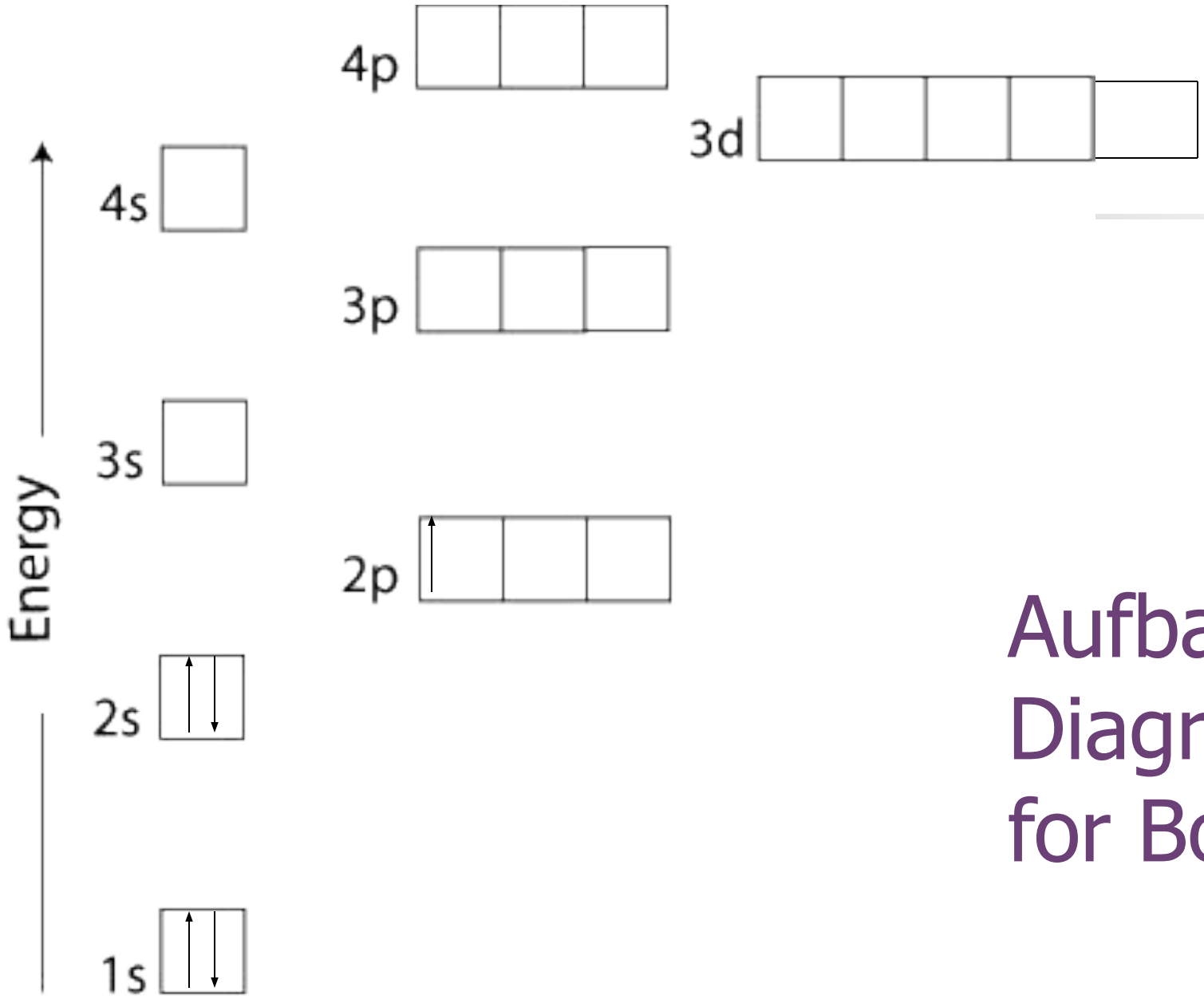
Aufbau Diagram for Helium



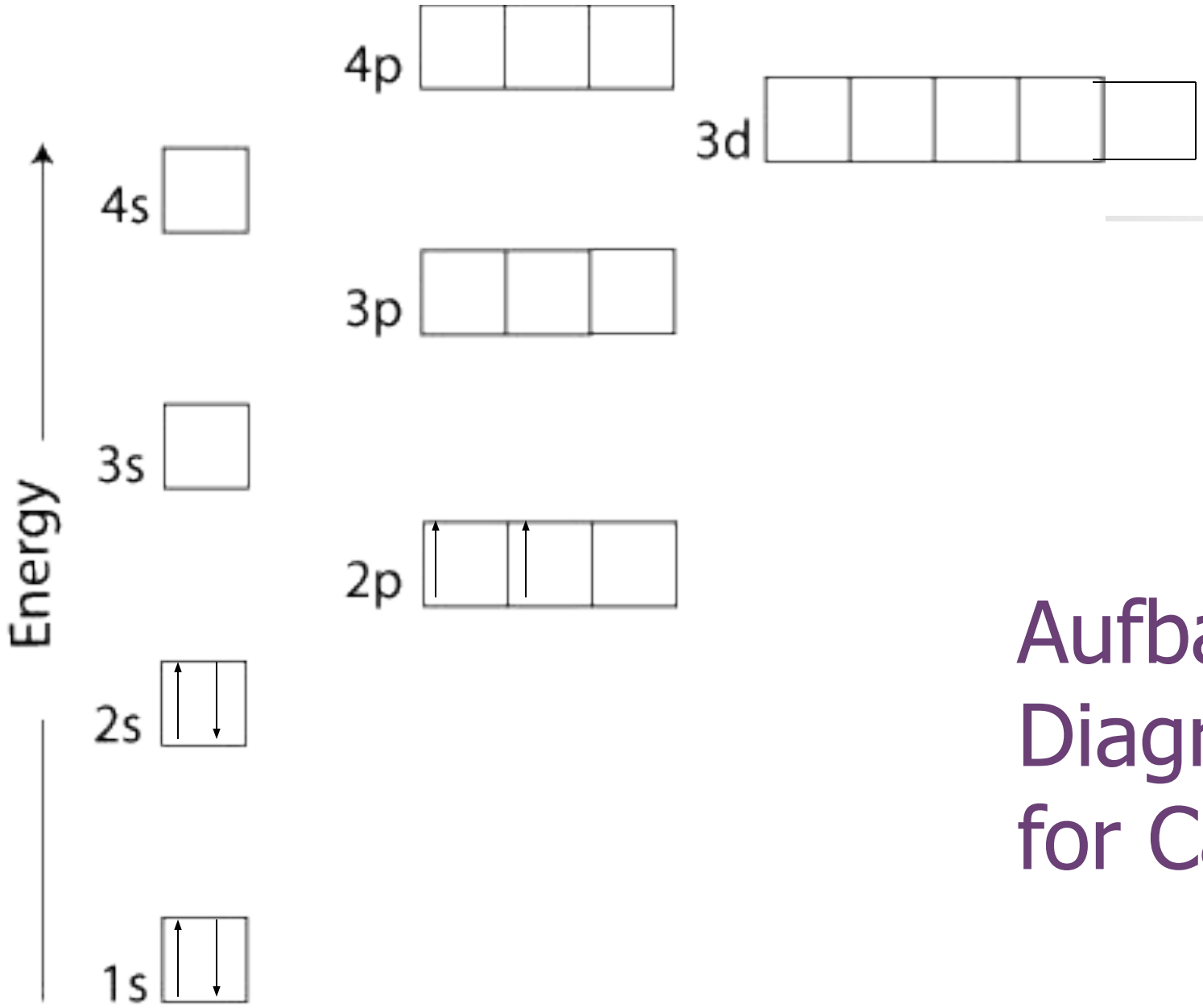
Aufbau Diagram for Lithium



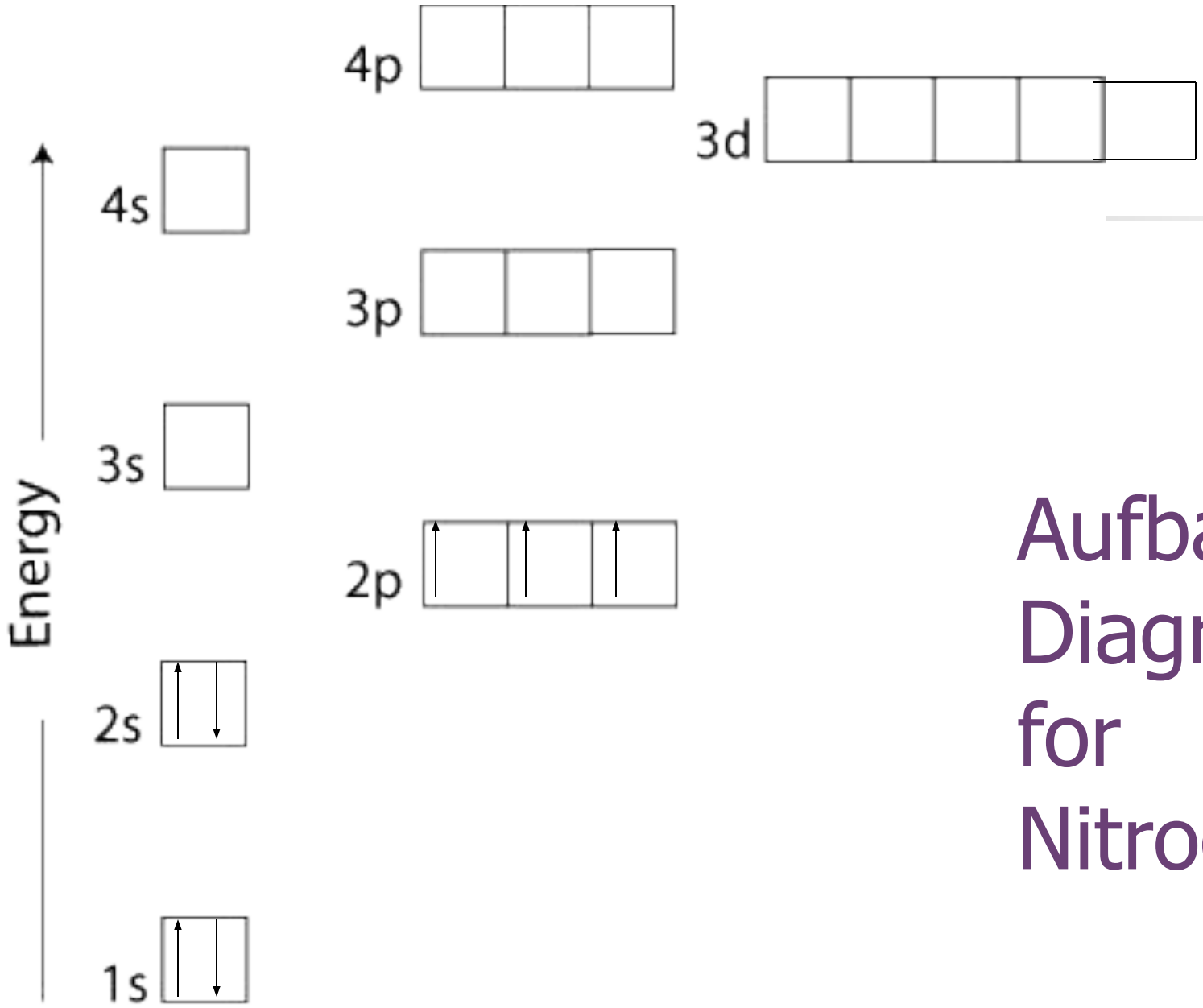
Aufbau Diagram for Beryllium



Aufbau Diagram for Boron



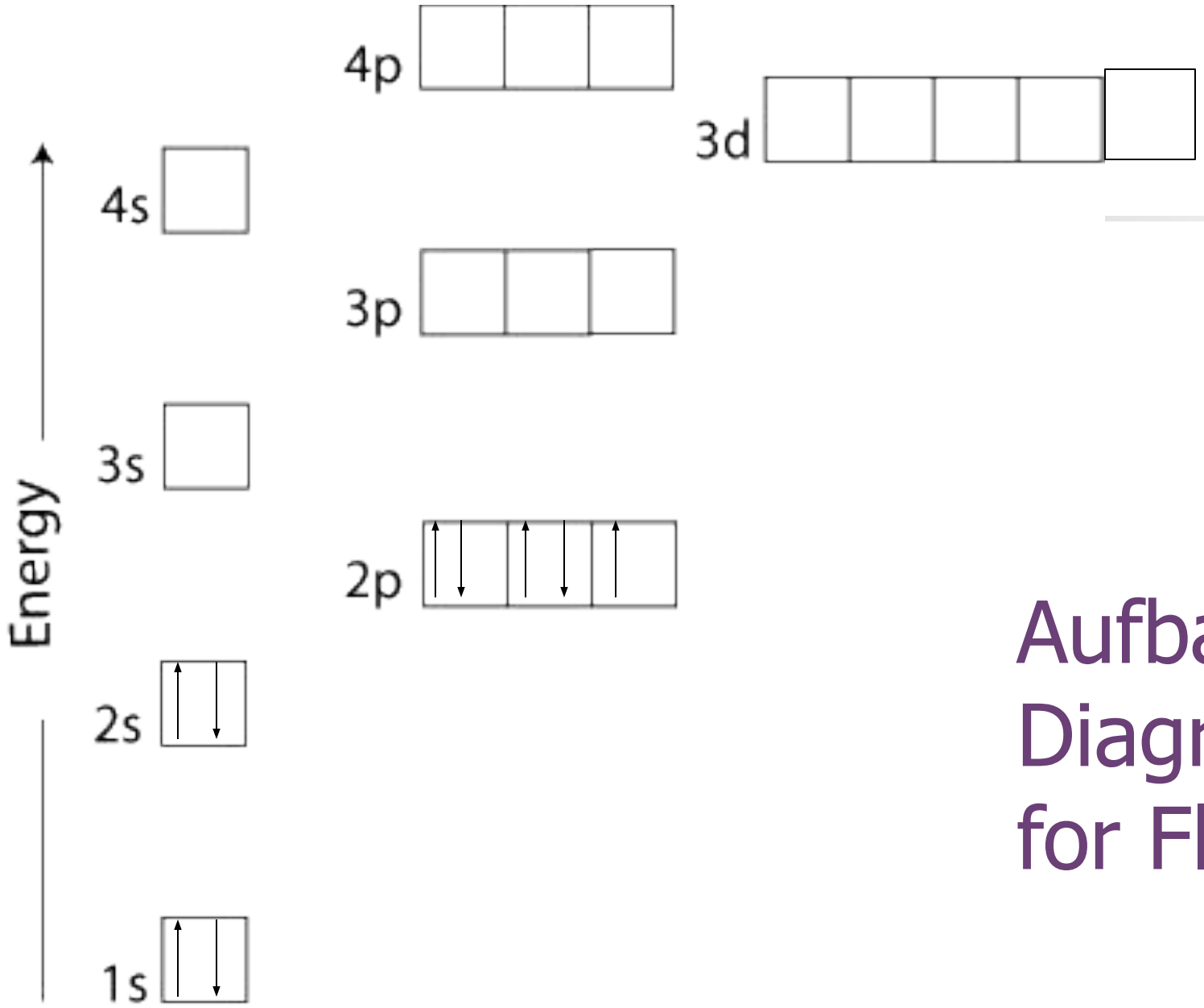
Aufbau Diagram for Carbon



Aufbau Diagram for Nitrogen

Notations of Electron Configurations

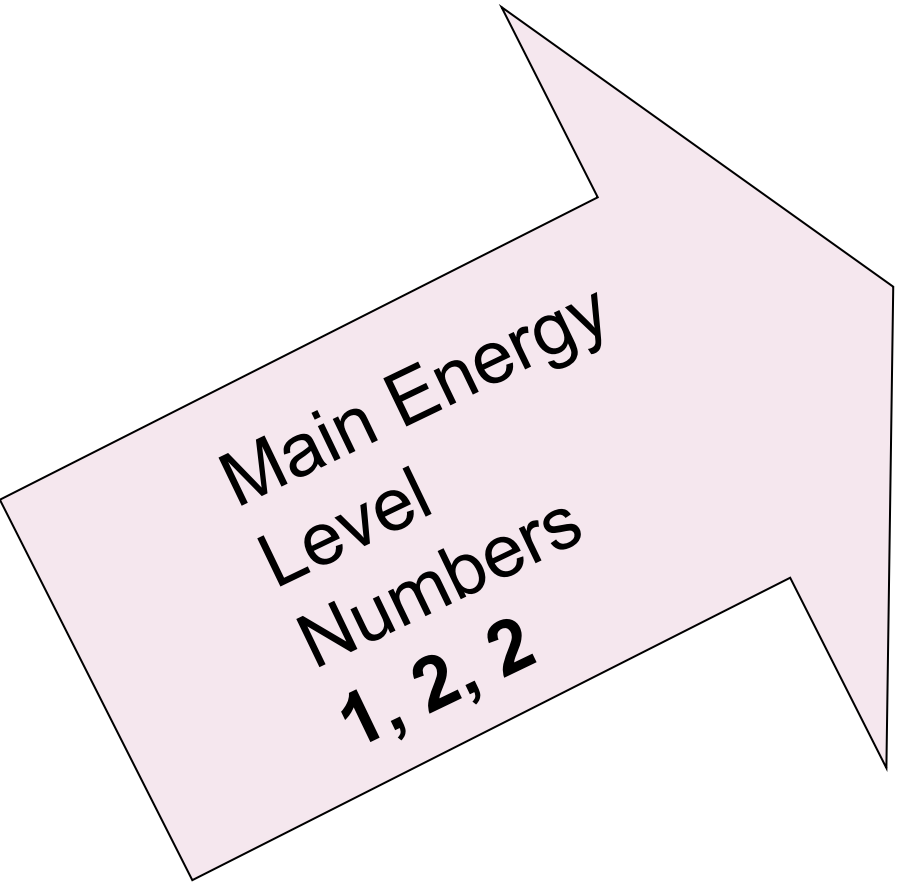
- Standard
- Shorthand



Aufbau Diagram for Fluorine

Standard Notation of Fluorine

Number of electrons in the sub level 2,2,5



$1s^2\ 2s^2\ 2p^5$

Sublevels

Shorthand Notation

- Use the last noble gas that is located in the periodic table right before the element.
- Write the symbol of the noble gas in brackets.
- Write the remaining configuration after the brackets.
- Ex: Fluorine: [He] $2s^2$ $2p^5$

Blocks in the Periodic Table