Quantum Numbers and Orbital Diagrams

Quantum Numbers

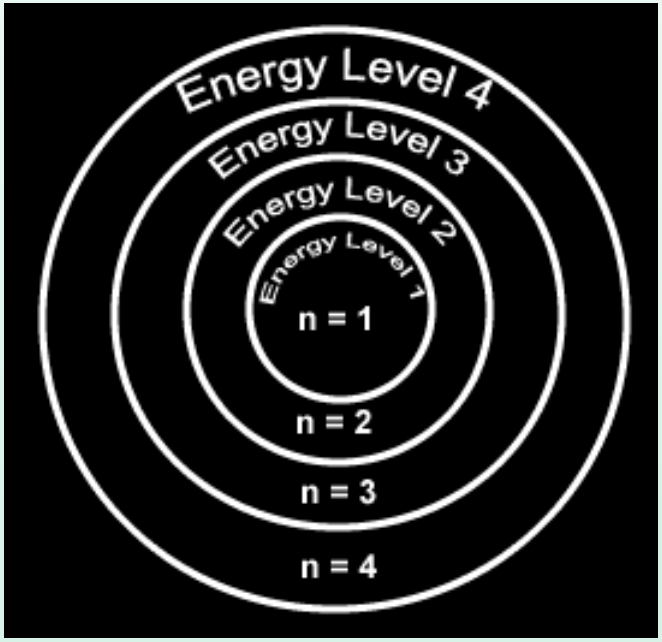
- *Each electron in an atom has a unique set of 4 quantum numbers which describe it.*
- *When you list all four quantum numbers it basically is writing an "address" to identify exactly which electron you are talking about and where it is located.*
- *We should know what they represent, but we don't need to "assign" them in any practice problems.*

Quantum Numbers

Name	Symbol	Denotes
Principal quantum number	n	
Angular momentum quantum number	l	
Magnetic quantum number	m or m_l	
Spin quantum number	s or m_s	

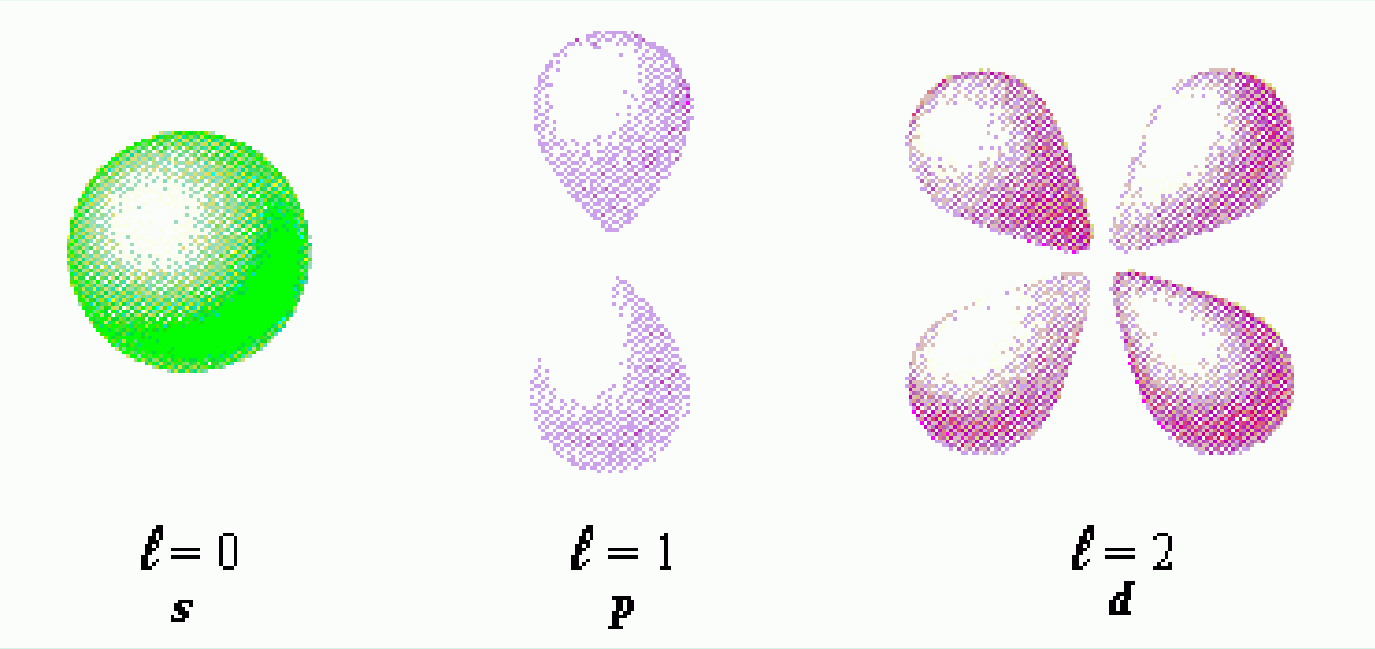
Principal Quantum Number

Denotes the shell (energy level) in which the electron is located.



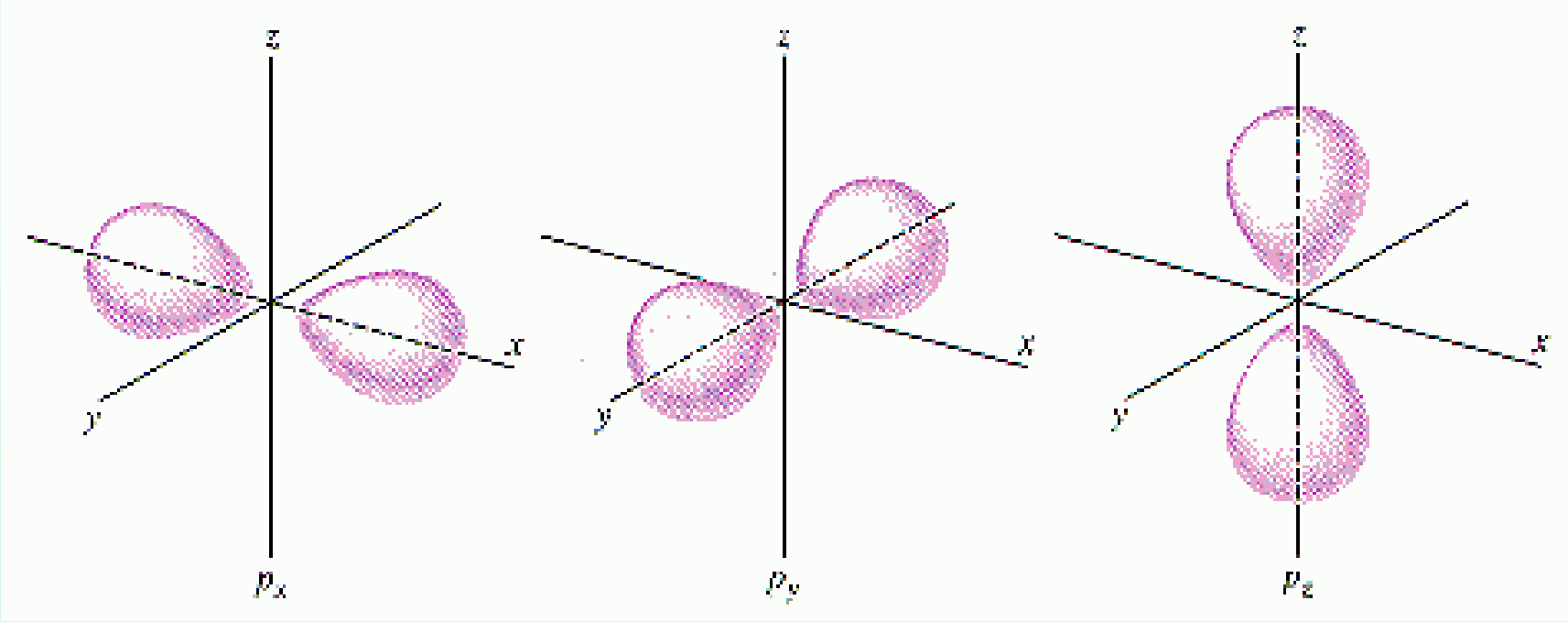
Angular Momentum Quantum Number

Denotes the orbital shape (subshell) in which the electron is located.



Magnetic Quantum Number

Denotes the orientation of the electron's orbital with respect to the three axes in space.



Spin Quantum Number

Denotes the behavior (direction of spin) of an electron within a magnetic field.

Possibilities for electron spin:

$$+\frac{1}{2} \qquad -\frac{1}{2}$$

Electron Configuration is an address!

$2p_x$ +½

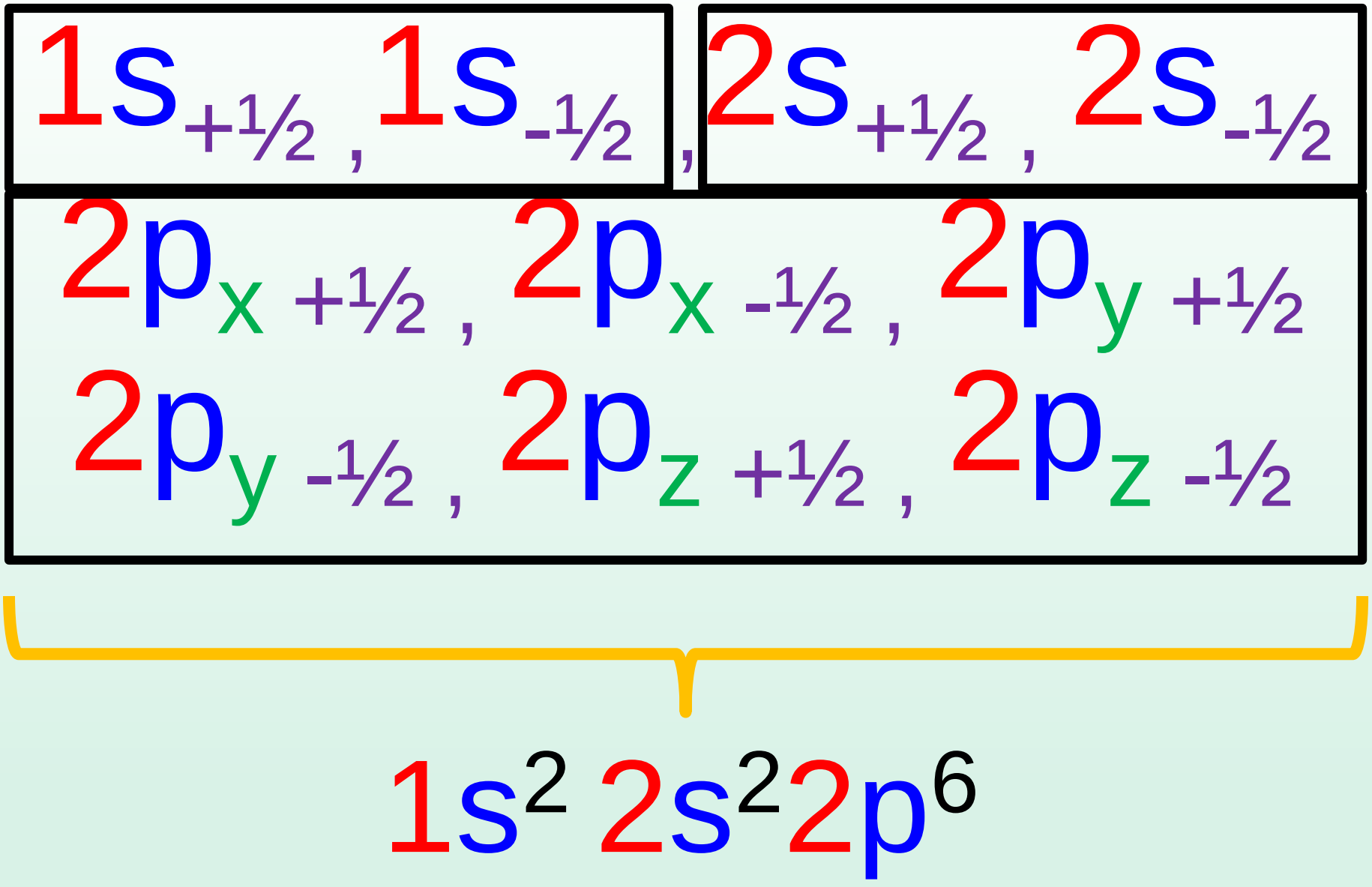
Energy Level

Type/Shape of Orbital

Orientation

Spin up or Spin down + ½ , - ½

For <u>every single</u> electron…


1s+½ , 1s-½ , 2s+½ , 2s-½
2px +½ , 2px -½ , 2py +½
2py -½ , 2pz +½ , 2pz -½
1s2 2s2 2p6

Want to describe where ALL the e^-s in an atom were?

Shrink it down and only list the basics!

Energy levels

Shapes of Orbitals

Number of electrons in each orbital

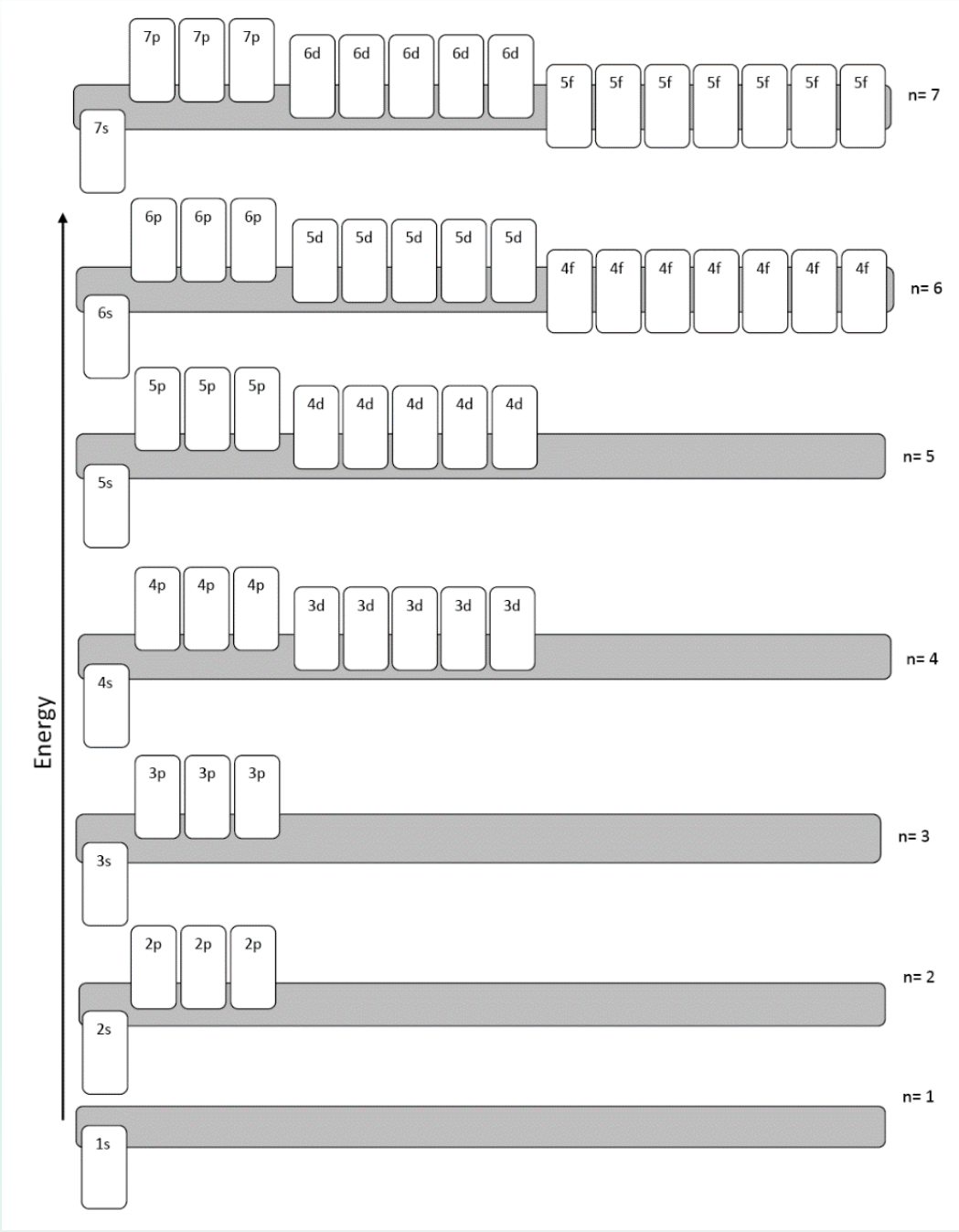
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

$= 2+2+6+2+4 = 16\ e^-$ Sulfur!

How do you know what order the electrons and orbitals go in???

Orbital Diagram

A chart that shows you the order that the orbitals go in.

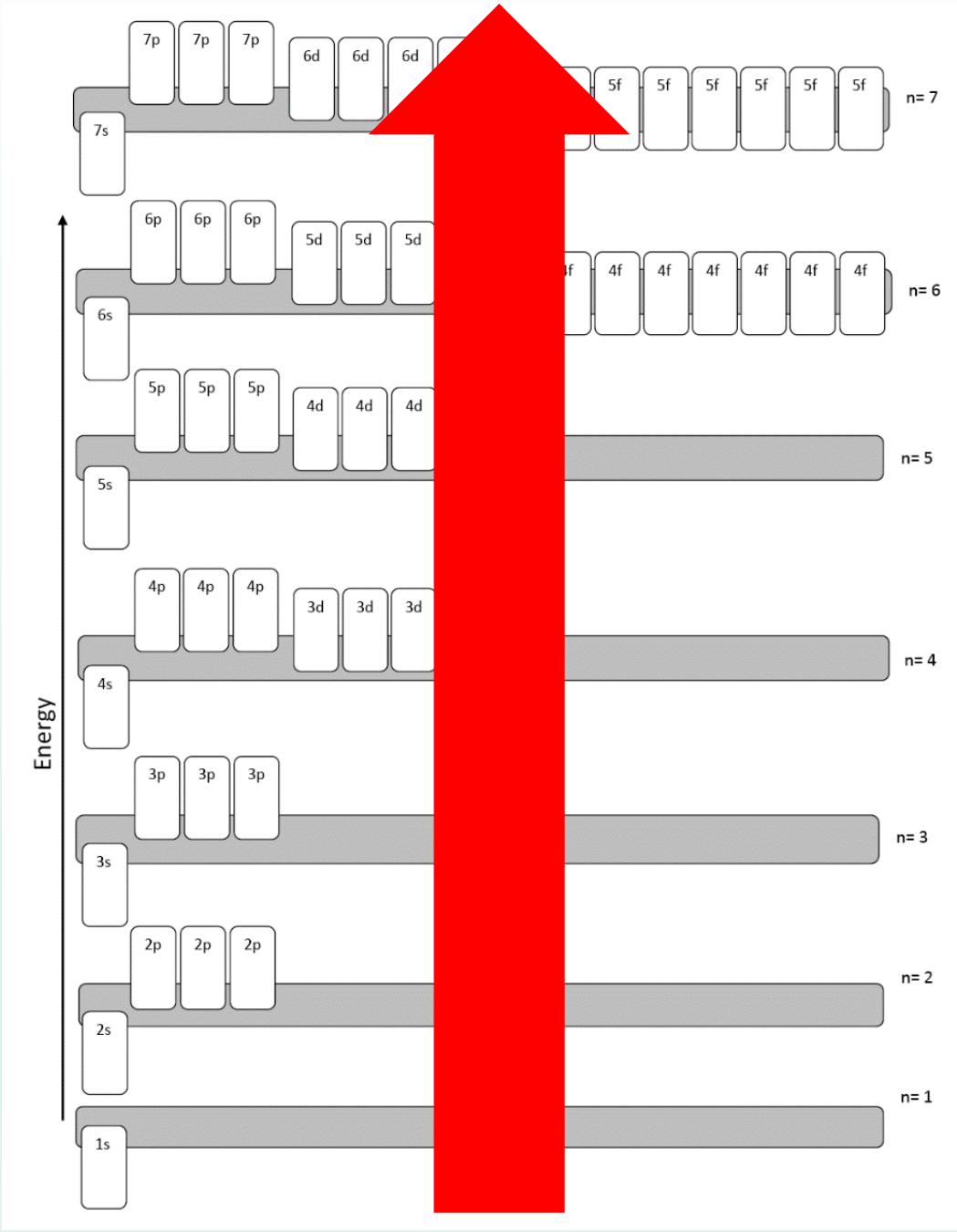


Electron Configuration Rules…

Aufbau Principle:

Electrons fill lowest possible energy level first.

- *They are lazy!*

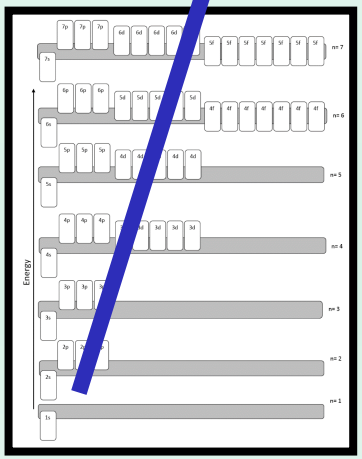

Energy
n= 7
7s
7p
7p
7p
6d
6d
6d
5f
5f
5f
5f
5f
5f
n= 6
6s
6p
6p
6p
5d
5d
5d
4f
4f
4f
4f
4f
4f
4f
n= 5
5s
5p
5p
5p
4d
4d
4d
n= 4
4s
4p
4p
4p
3d
3d
3d
n= 3
3s
3p
3p
3p
n= 2
2s
2p
2p
2p
n= 1
1s

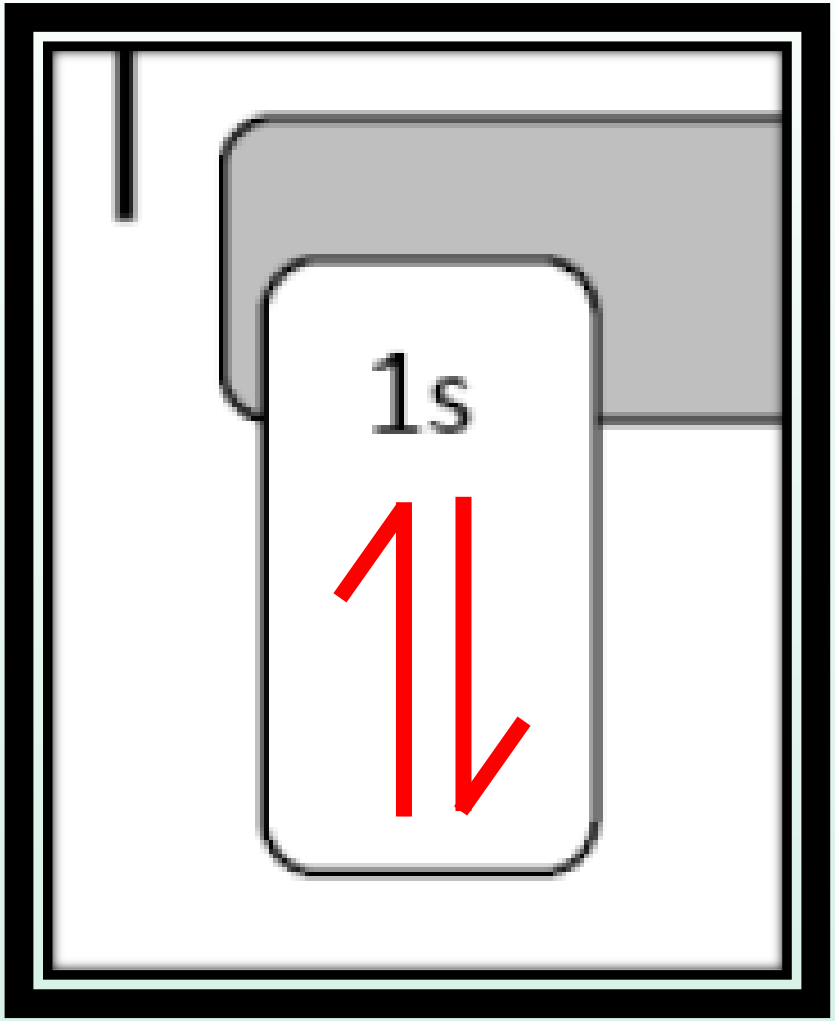
Electron Configuration Rules…

Pauli Exclusion Principle:

No two electrons may have the same set of four quantum numbers.

- *Any single orbital may only contain two electrons, **BUT** one has to be spin up, and one has to be spin down.*


Energy
n= 7
n= 6
n= 5
n= 4
n= 3
n= 2
n= 1

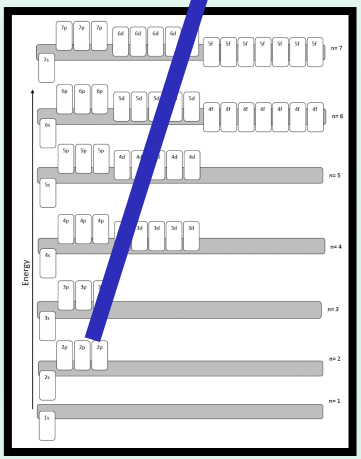

1s

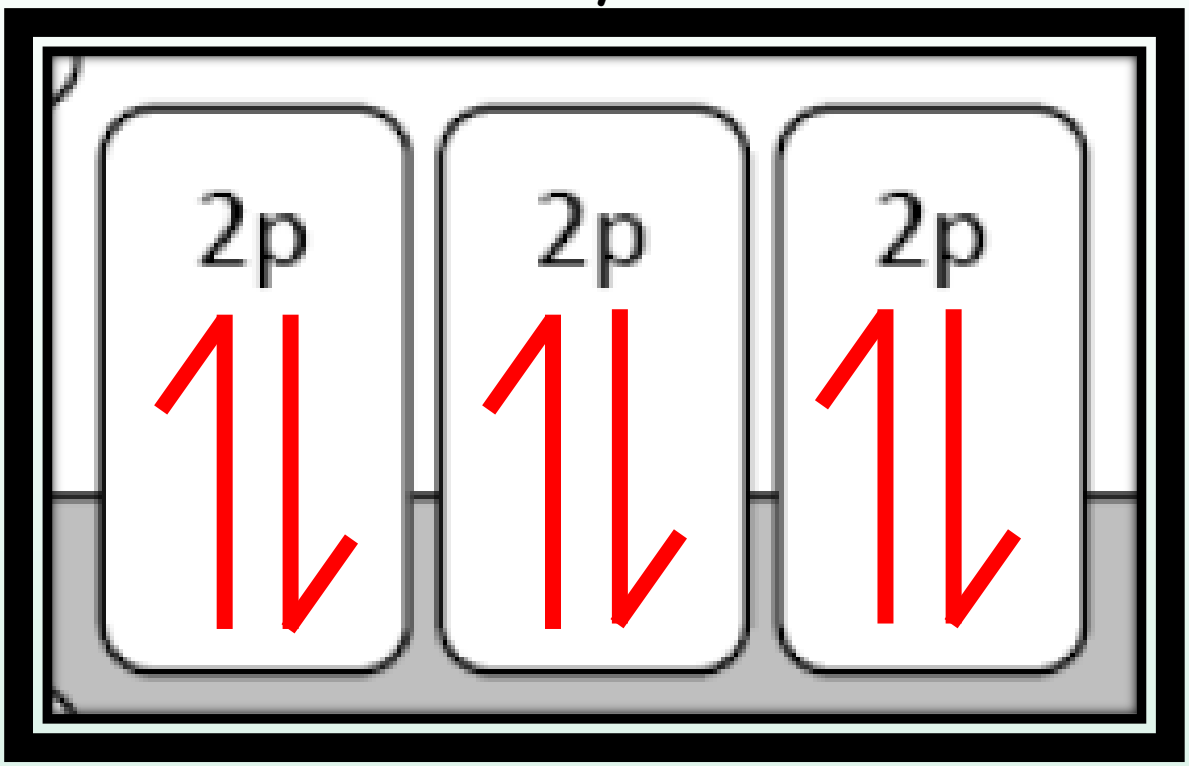
Electron Configuration Rules…

Hund's Rule:

Electrons will fill each equal energy orbital before pairing up

- *Spread them out before your pair them up*
- *"You don't want to share a bedroom with your sibling unless you really have to!"*
- *Electrons want elbow room!*




p_x
p_y
p_z
2p
2p
2p

Steps to finding all the electrons

1) Pick an **atom**

2) Find the number of **electrons it has**

3) Start putting electrons into the **orbitals**
Use an **ORBITAL CHART/DIAGRAM**

4) List which **orbitals** you used and **how many** electrons in each one

Let's practice together…