Electron Configuration and Orbital Notation

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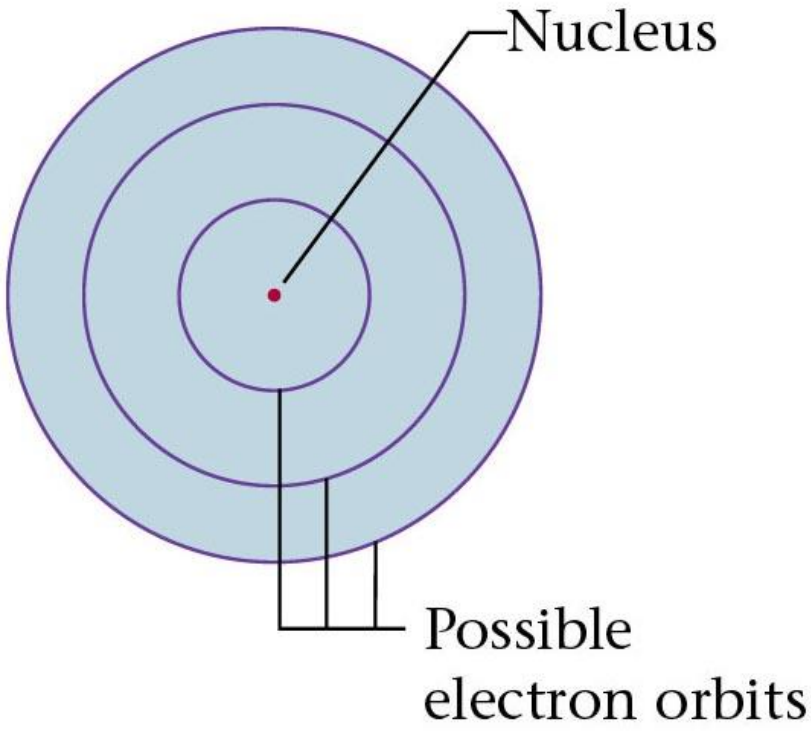
- Father of the Modern P.T.

Periods and Group

- Period – horizontal row on P.T.
- Each period represents an energy level (think back to models of the atom)
  - Atoms in period 1 have 1 energy level, atoms in period 5 have 5 energy levels
- Group – vertical column P.T.
- Also known as families

Where are the electrons?
-The Bohr Atom



- Bohr Model
  - Based on Line Emission Spectrum of Hydrogen
  - Atoms consists of nucleus and energy Levels
  - Stated electrons followed specific circular paths called orbits

Quantum Mechanical Model

Consists of Energy levels, sublevels, and orbitals

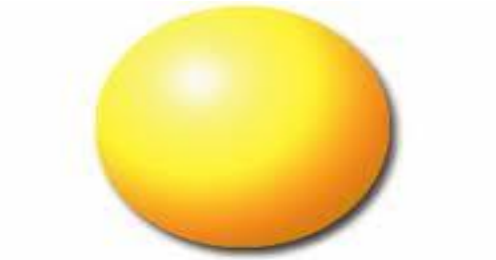
Key Points:

1. Electrons do not follow orbits, nor can location be known exactly
2. Electrons are located within orbitals (probable location of electron)

Sublevel (also called subshell)

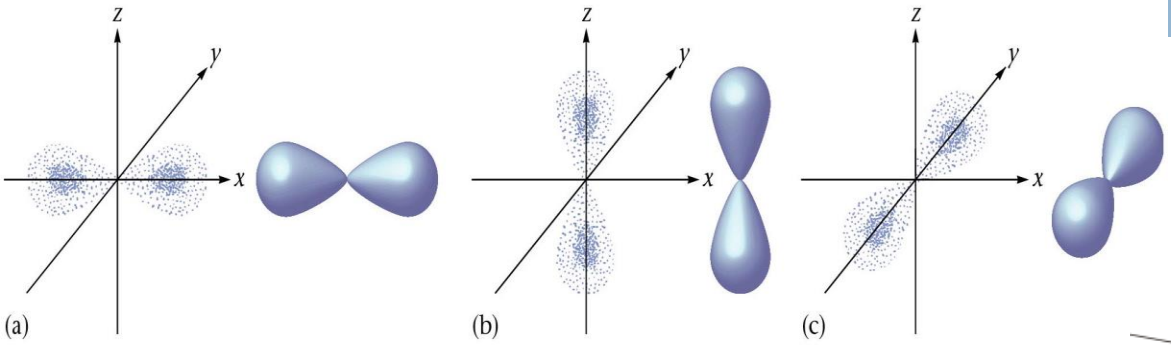
- Found within energy levels
- Designated by s, p, d, or f
- Letter corresponds to orbital shapes found in sublevel

"s" sublevel (1 orbital)

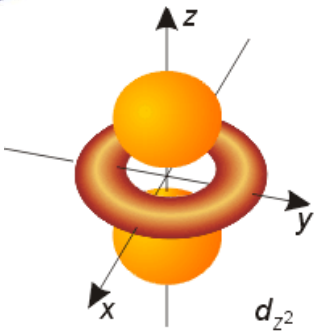


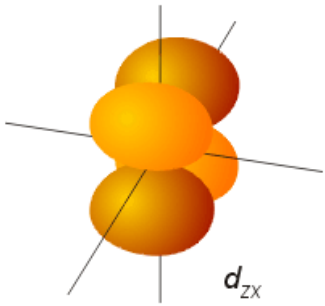
The shape of **s** orbitals is a sphere. Electrons can move anywhere within the sphere.

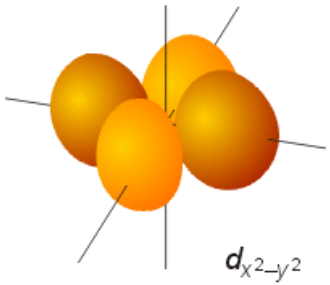
The p sublevels (three orbitals)

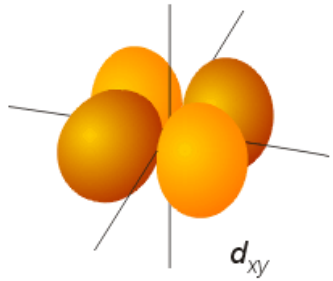


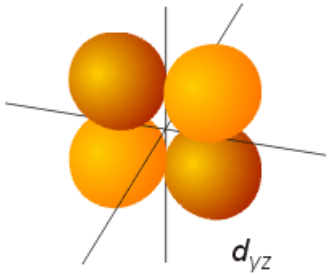
The d sublevel (five orbitals)



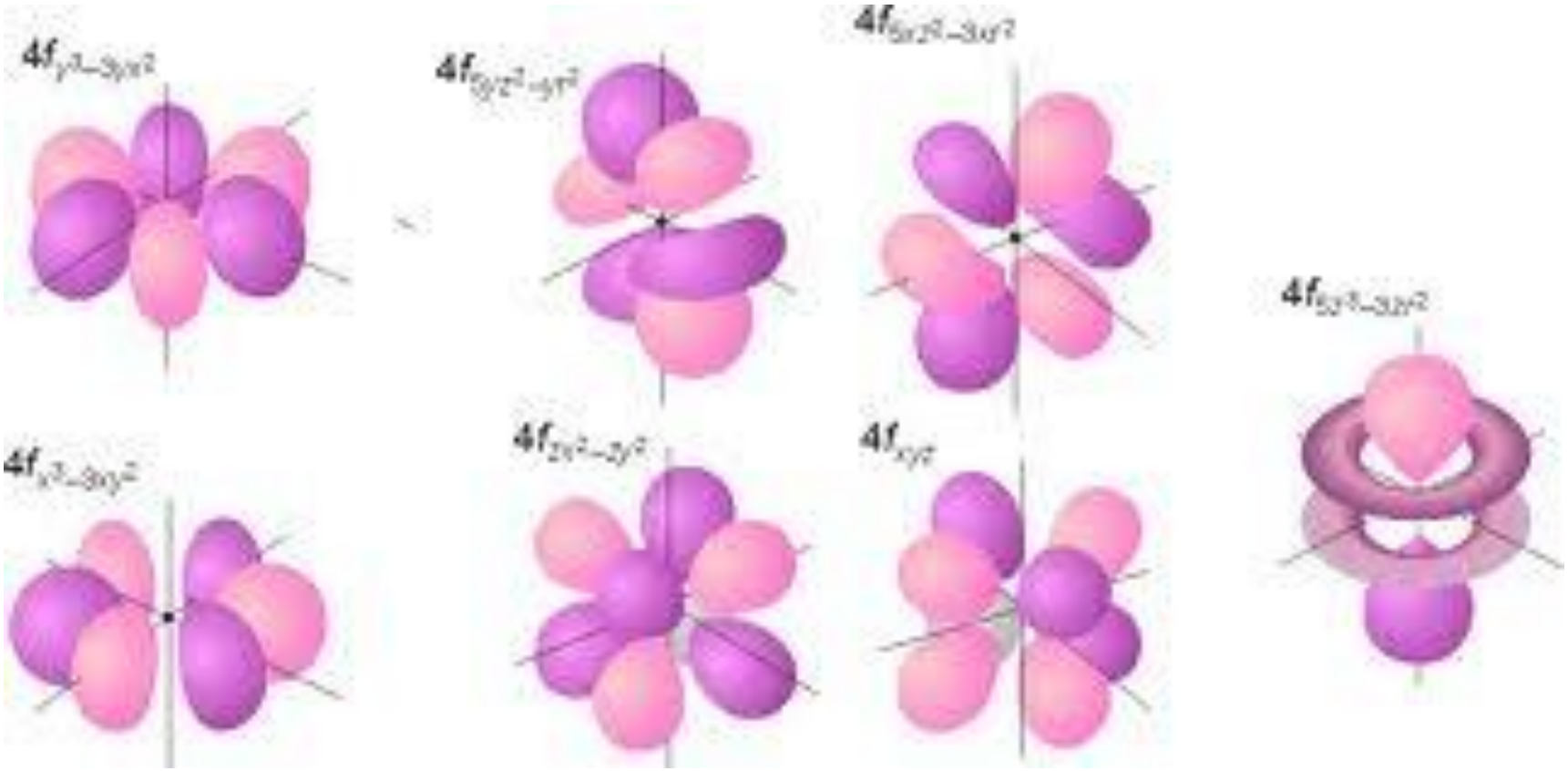




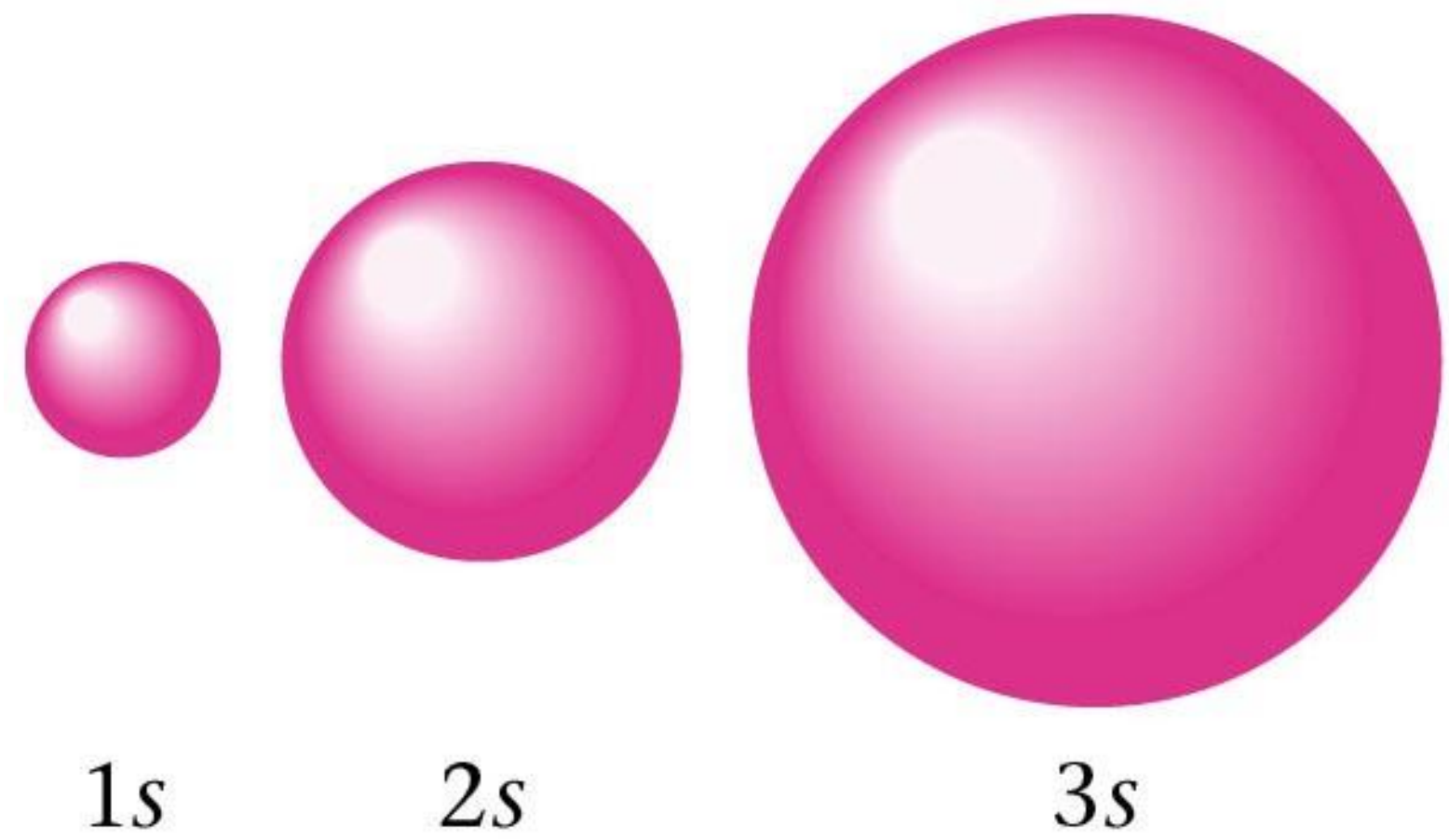


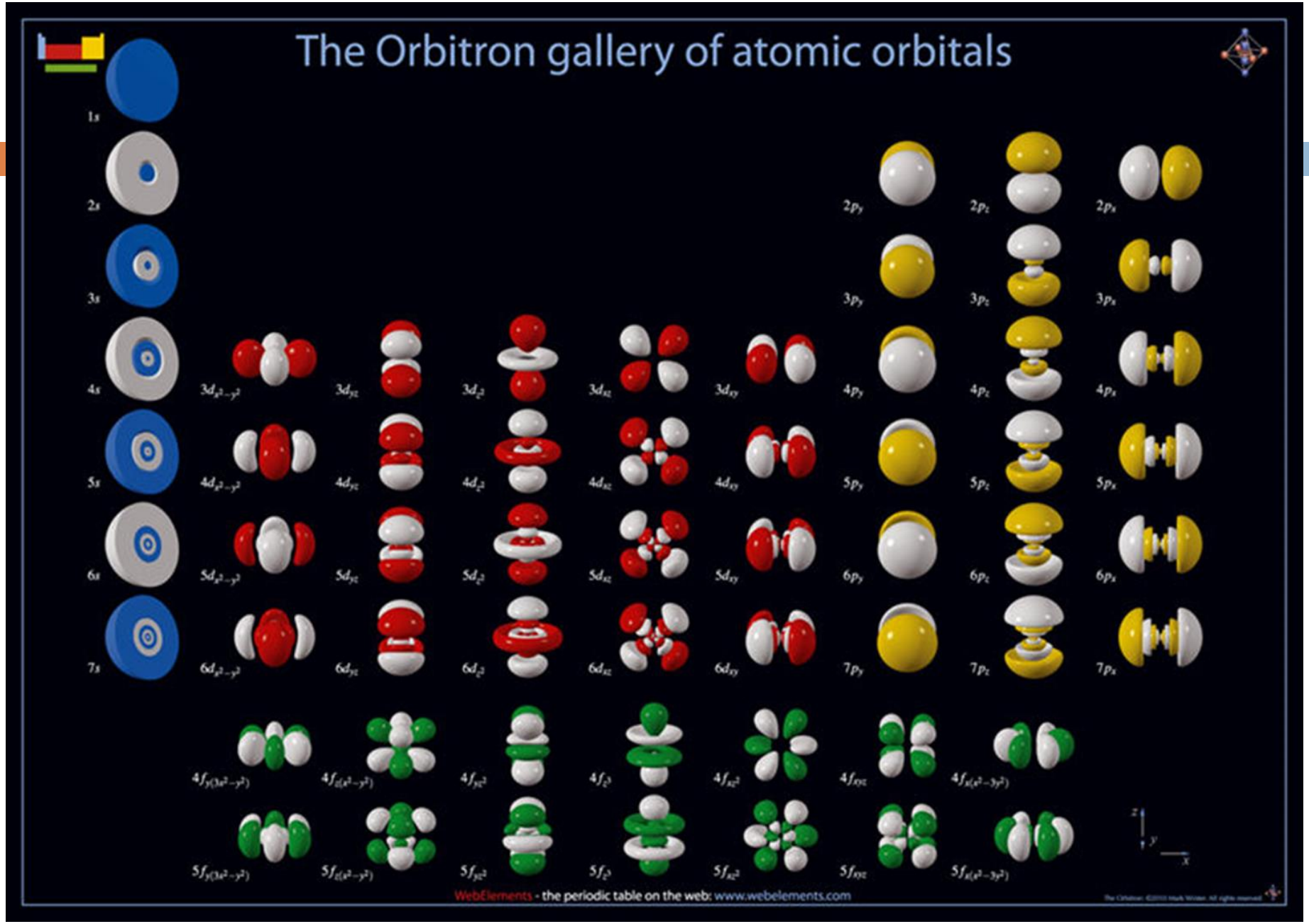


The f sublevel (7 orbitals)



Relative size of the 1s, 2s, 3s orbitals




The Orbitron gallery of atomic orbitals
1s
2s
3s
4s
5s
6s
7s
2p_y
2p_z
2p_x
3p_y
3p_z
3p_x
4p_y
4p_z
4p_x
5p_y
5p_z
5p_x
6p_y
6p_z
6p_x
7p_y
7p_z
7p_x
3d_(z²−r²)
3d_(xz)
3d_(z²)
3d_(x²−y²)
3d_(xy)
4d_(z²−r²)
4d_(xz)
4d_(z²)
4d_(x²−y²)
4d_(xy)
5d_(z²−r²)
5d_(xz)
5d_(z²)
5d_(x²−y²)
5d_(xy)
6d_(z²−r²)
6d_(xz)
6d_(z²)
6d_(x²−y²)
6d_(xy)
4f_(y(3x²−r²))
4f_(z(x²−y²))
4f_(xyz)
4f_(z³)
4f_(xz²)
4f_(x(x²−3y²))
5f_(y(3x²−r²))
5f_(z(x²−y²))
5f_(xyz)
5f_(z³)
5f_(xz²)
5f_(x(x²−3y²))
z
y
x
WebElements - the periodic table on the web: www.webelements.com

Orbitals

- Generalized location of electron
  - You know I'm probably in this room all day, you just don't know if I'm at my desk or in the storeroom or walking around
- Does not have sharp edges
- 1 orbital can contain a maximum of 2 electrons

Electron Configuration

- Electron configuration: description of what sublevels and orbitals are filled by electrons in any given atom (like a roadmap of the electrons in an atom)
- Determined by the number of electrons the atom has
- Governed by 3 rules!

e- configuration rules

- Aufbau Principle: an electron occupies the lowest energy level & orbital available
- Pauli Exclusion Principle: only two electrons can occupy any orbital, and they must have opposite spins
- Hund's Rule: Each orbital in a given sublevel (s, p, d, or f orbital) must have 1 electron before any can have two

Electron Configurations

how many electrons in that orbital

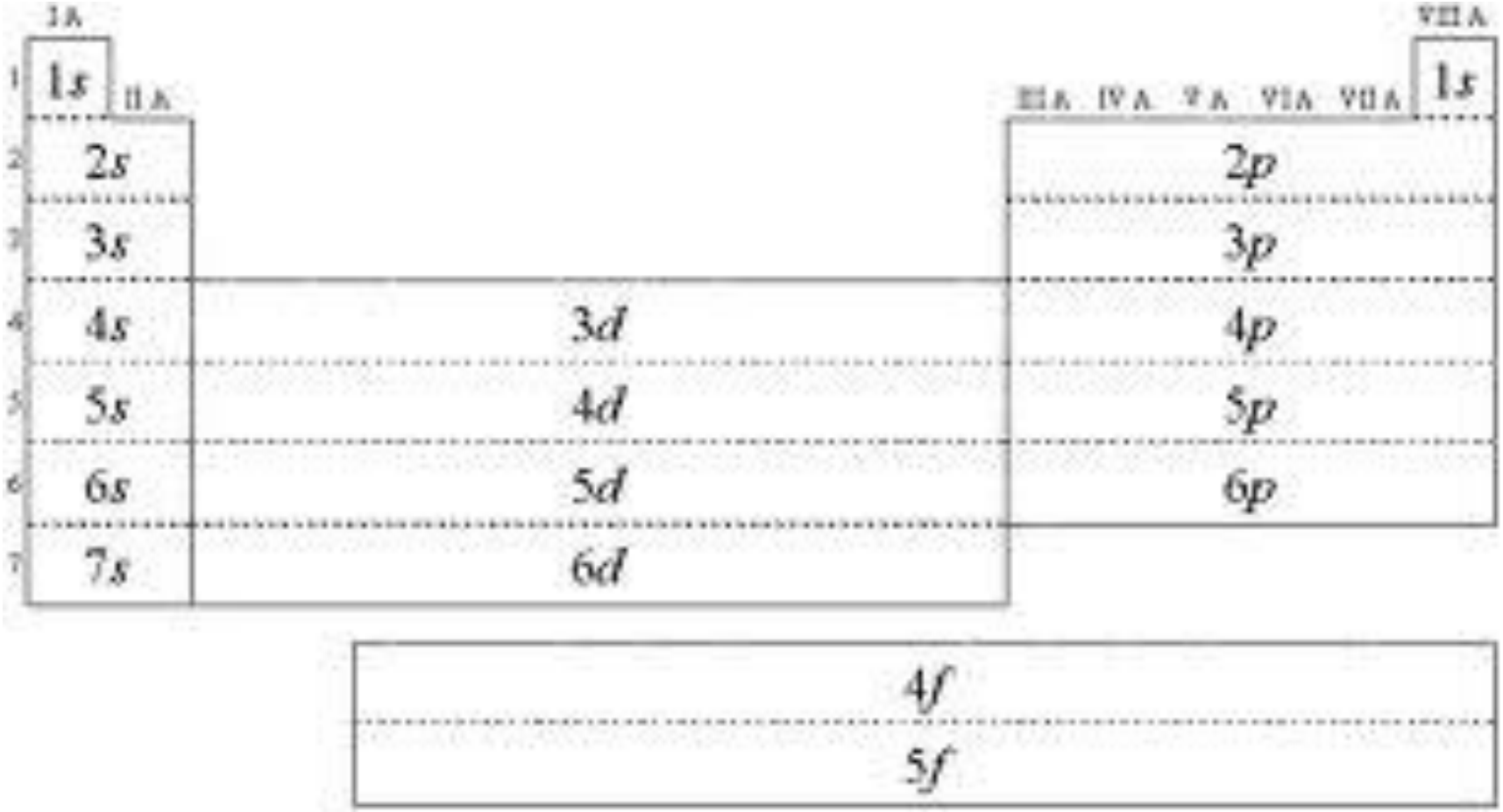
- Nitrogen: $1s^2 2s^2 2p^3$

energy level

orbital

(atomic number = 7)

Outline the sections on your blank periodic table to match this diagram. Use different colors for each sublevel.

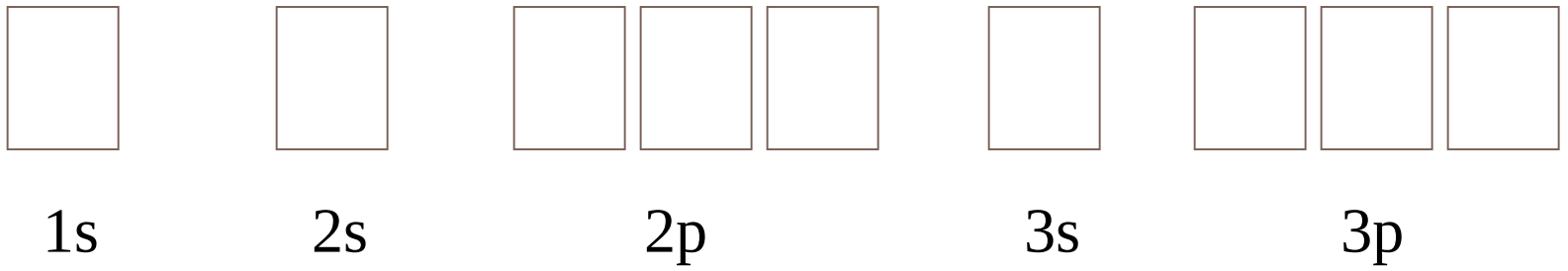


Orbital Notation - Pictures

- Using the periodic table from the previous slide, we can also create picture representations of the electron configuration (called orbital notation)
- We use arrows (↑↓) to represent the electrons
- Remember those three rules:
  - Fill lowest energy levels first
  - Any subshell with multiple orbitals must get one arrow in each orbital first (in the same direction) before doubling up
  - Two arrows in each orbital (one up, one down)

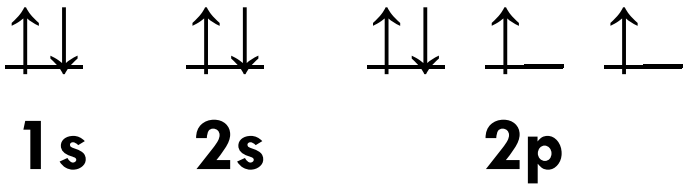
Orbital Notation ctd

- Each s subshell only has 1 orbital (holding 2 arrows)
- Each p subshell has 3 orbitals (holding 2 arrows each = 6)
- Each d subshell has 5 orbitals (holding 2 arrows each = 10)
- The orbitals are represented by boxes or just lines



Orbital Notation Example

- Write the orbital notation for Oxygen
- How many electrons (arrows) does neutral oxygen have? 8



Shorthand – Noble Gas Notation

- Group 18 on the periodic table are called the Noble Gases --- To create a shorthand for electron configuration, we use the noble gases as a reference
- For example, the electron configuration of silicon is:

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

- to write the shorthand, we find which Noble gas comes before silicon --- Neon (Ne)
- Neon's electron configuration is:

$$1s^2 2s^2 2p^6$$

- The noble gas notation for silicon then would be:

$$[Ne]3s^2 3p^2$$

Noble Gas Notation Practice

- Write the noble gas notation for manganese
- First, find which noble gas comes before manganese--- Ar

Argon

- Full electron configuration:

$$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$$

- Noble Gas Notation:

$$[Ar]4s^2 3d^5$$