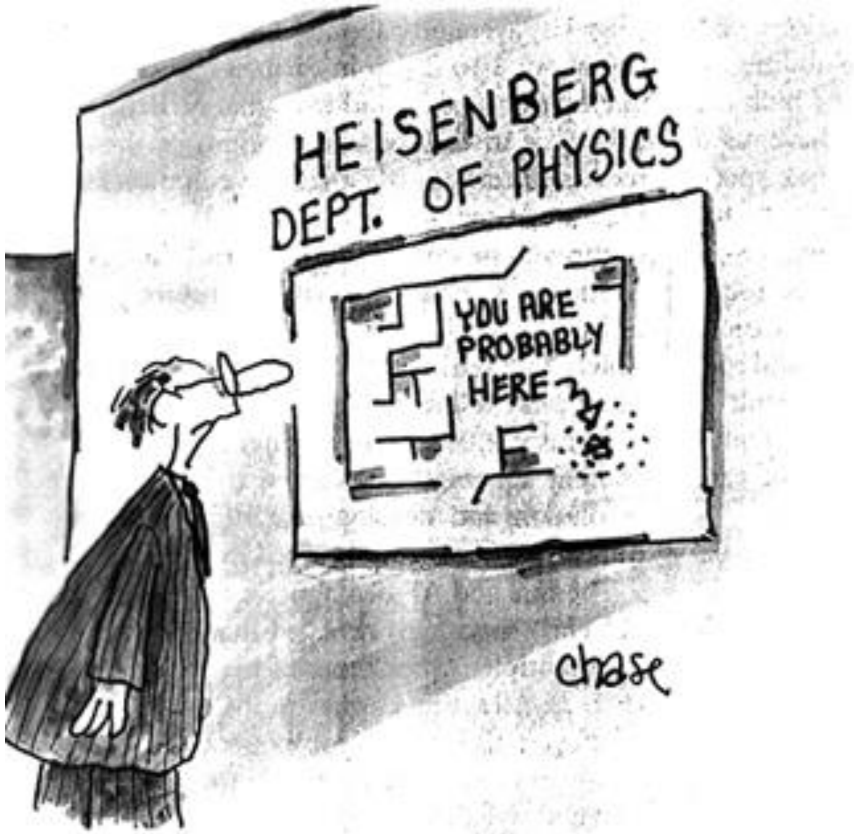
Electron Arrangements



https://www.pinterest.com/pin/457256168390467572/

Outcomes:

Write electron configurations for elements of the periodic table. *Include: selected elements up to atomic number 36 (Krypton)*

Relate the electron configuration of an element to its valence electron(s) and its position on the periodic table.

Electron Arrangements

In grade 9 you learned how to draw Bohr diagrams that showed the arrangement of electrons in orbits around a central nucleus.

We have just seen that:

- The orbits are really **ENERGY LEVELS** (**QUANTUM** numbers) that **ELECTRONS** occupy.
- Within each energy level there are **ORBITALS** which show the **PROBABLE LOCATION** of an electron with a certain **QUANTUM** of **ENERGY**.

Now we can show a more correct electron arrangement for a much wider range of elements…

Electron Arrangements

First we must see how these orbitals are arranged:

- Each **PRINCIPLE ENERGY LEVEL (n)**, has **n^2 ORBITALS** or sublevels.
  - Ie. Energy level: 1 has 1^2 = ***1 orbital***
    2 has 2^2 = ***4 orbitals***
    3 has 3^2 = ***9 orbitals***

- Each orbital is given the letter designation of **s, p, d OR f.** and each of these orbitals has a different **SHAPE**.

- There are also a different **NUMBER** of each type of orbital possible in each **ENERGY LEVEL (n)**
    - s = 1 orbital
    - p = 3 orbitals
    - d = 5 orbitals
    - f = 7 orbitals

  Notice the pattern!

Electron Arrangements

The table below summarizes the types and number of orbitals available in each energy level.

Principle Energy Level or Principle Quantum Number (n)	Number of orbitals (n^2)	Orbital Types
1	1	1 s-orbital
2	4	1 s-orbital + 3 p-orbitals
3	9	1 s-orbital + 3 p-orbitals + 5 d-orbitals
4	16	1 s-orbital + 3 p-orbitals + 5 d-orbitals + 7 f-orbitals

5 25 1 s-orbital + 3p's + 5d's + 7f's + 9g's

***Notice that in any energy level there can only be:

→ ***1 s-orbital***

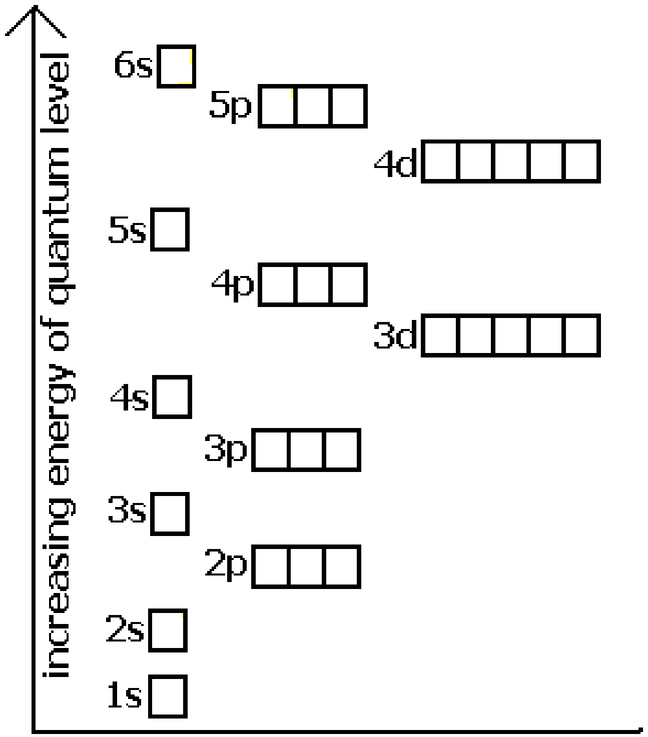
→ ***3 p-orbitals (in energy levels 2 and up)***

→ ***5 d-orbitals (in energylevels 3 and up)***

→ ***7 f-orbitals (in energy levels 4 and up)***

Electron Arrangements

The energy levels and orbitals are arranged as follows:

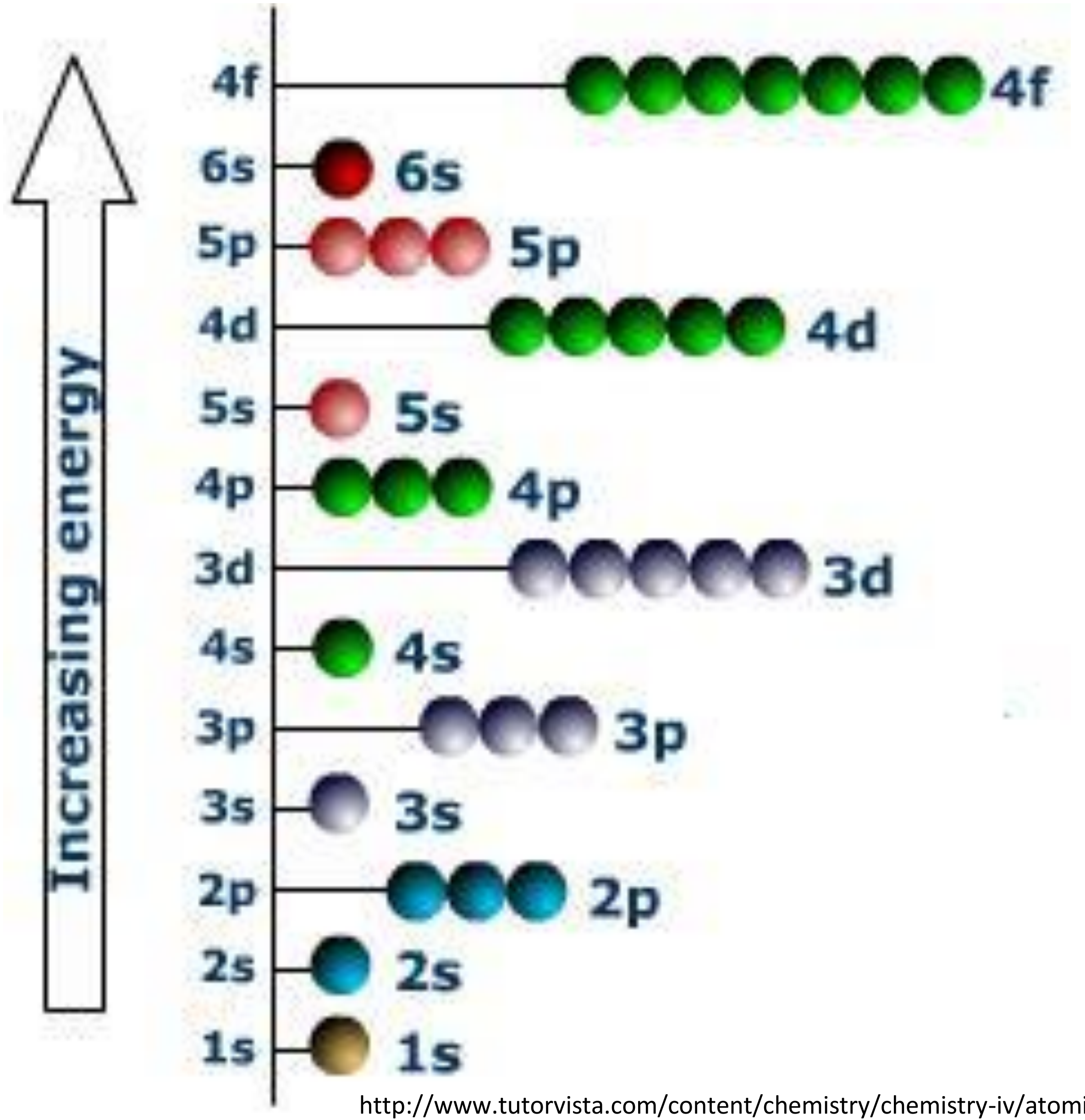


Adapted from: http://www.docbrown.info/page07/ASA2ptable2.htm

- Each box represents an electron orbital, and can hold 2 electrons.
- You will probably notice that the **3d** orbital has **MORE ENERGY** than the **4s** orbital.

→ This is because one energy level can **OVERLAP** the next energy level.

Electron Arrangements

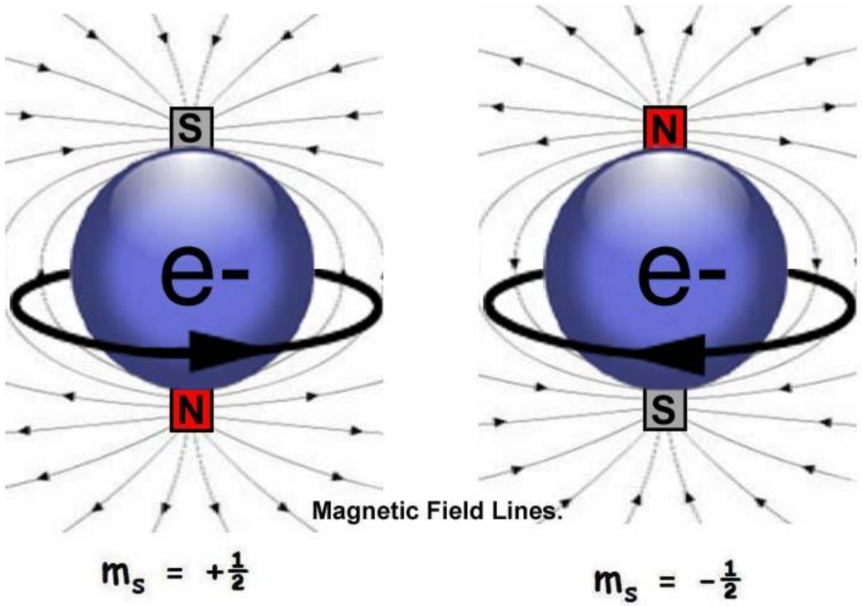


http://www.tutorvista.com/content/chemistry/chemistry-iv/atomic-structure/atoms-configurations.php

Rules for Filling the Orbitals

1. **The Aufbau Principle**
   - Every electron will occupy the **LOWEST** energy orbital **POSSIBLE**.
   - The term aufbau is from the German term aufbauen which means to **BUILD UP**.

2. **The Pauli Exclusion Principle**
   - Said that two **IDENTICAL** electrons **CANNOT** occupy the same **QUANTUM STATE** (orbit)
     →electrons **REPEL** each other
   - He proposed that electrons are constantly **SPINNING**, and when they spin they create a **MAGNETIC FIELD** (like the earth)

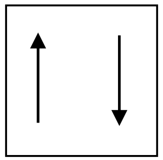


http://centrobioenergetica.squarespace.com/magnetismo/

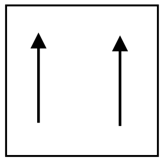
Rules for Filling the Orbitals

2. **The Pauli Exclusion Principle (Con't)**
   - If two electrons have **OPPOSITE SPINS**, they **CAN** occupy the same **ORBITAL**.
   - Therefore, a maximum of **TWO** electrons can occupy a single **ORBITAL**.
   - We denote electron spins with an **ARROW UP** (positive spin) or an **ARROW DOWN** (negative spin)

Example:



OK

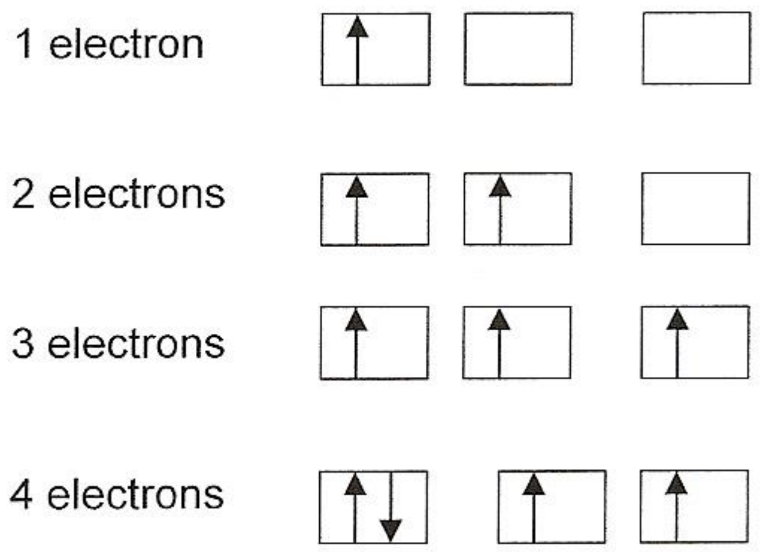


NOT OK

Rules for Filling the Orbitals

3. **Hund's Rule**
   - When electrons fill orbitals, they obey the aufbau principle and fill such that the **NUMBER OF UNPAIRED ELECTRONS IS MAXIMIZED**.
   - That is, before filling the first p-orbital with two electrons, an electron is placed into the p_x-orbital, then an electron into the p_y-orbital then the p_z-orbital before filling the px-orbital.

Example: The 2p orbitals would be filled as follows:

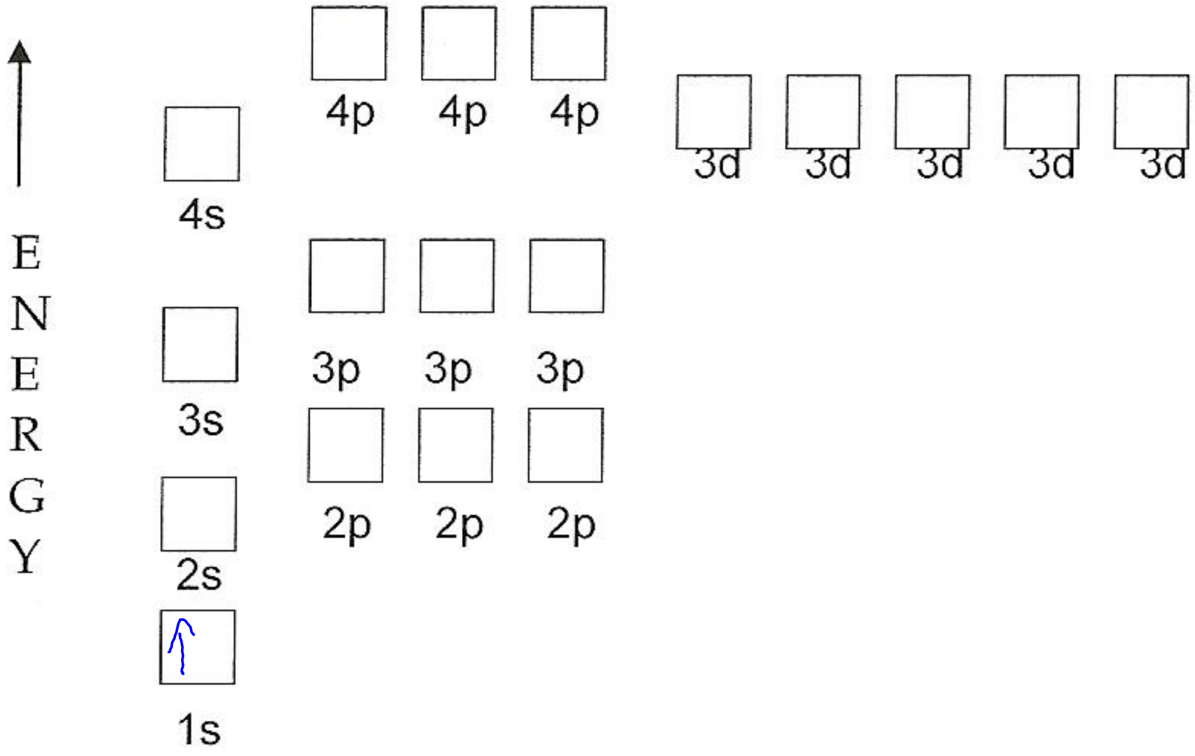


Examples

Fill in the electron configuration charts for the following elements:

Hydrogen

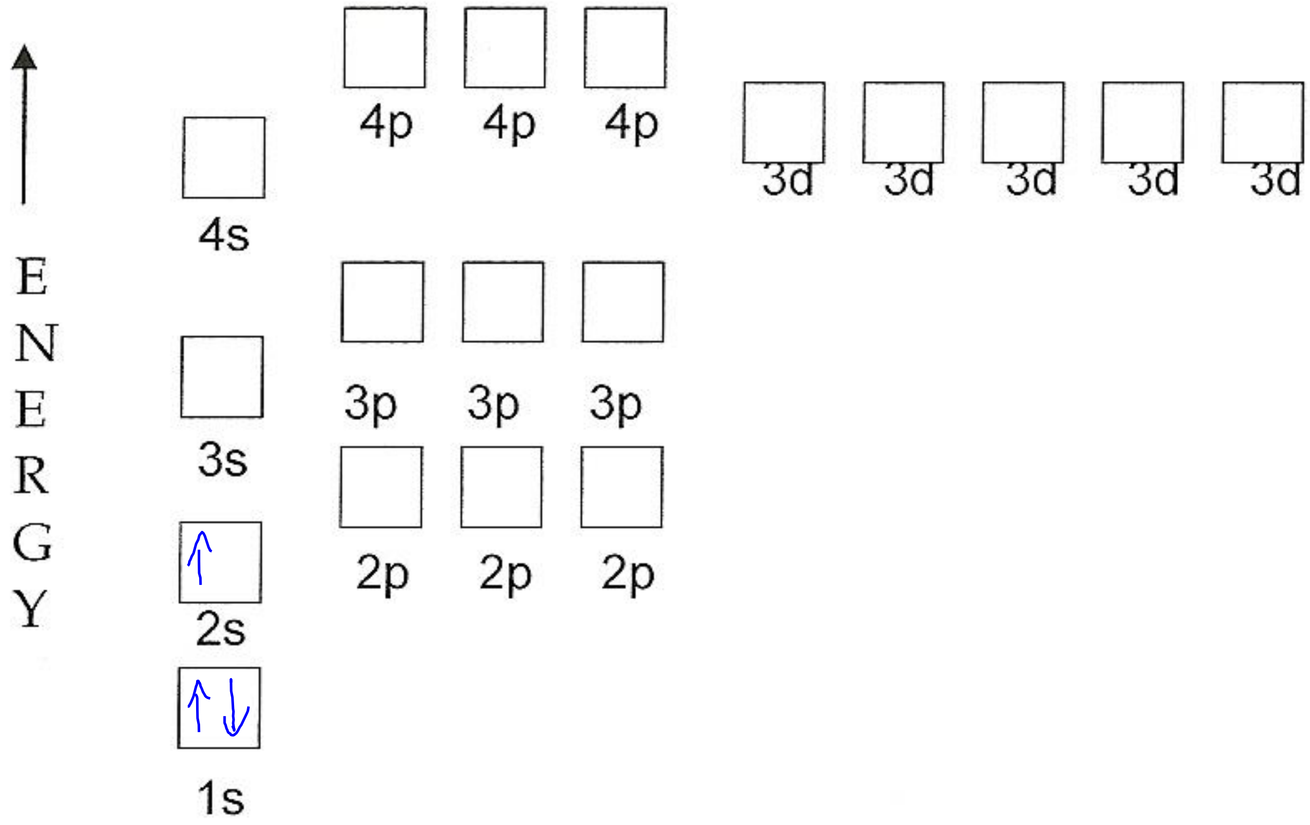
1e⁻



Examples

Lithium

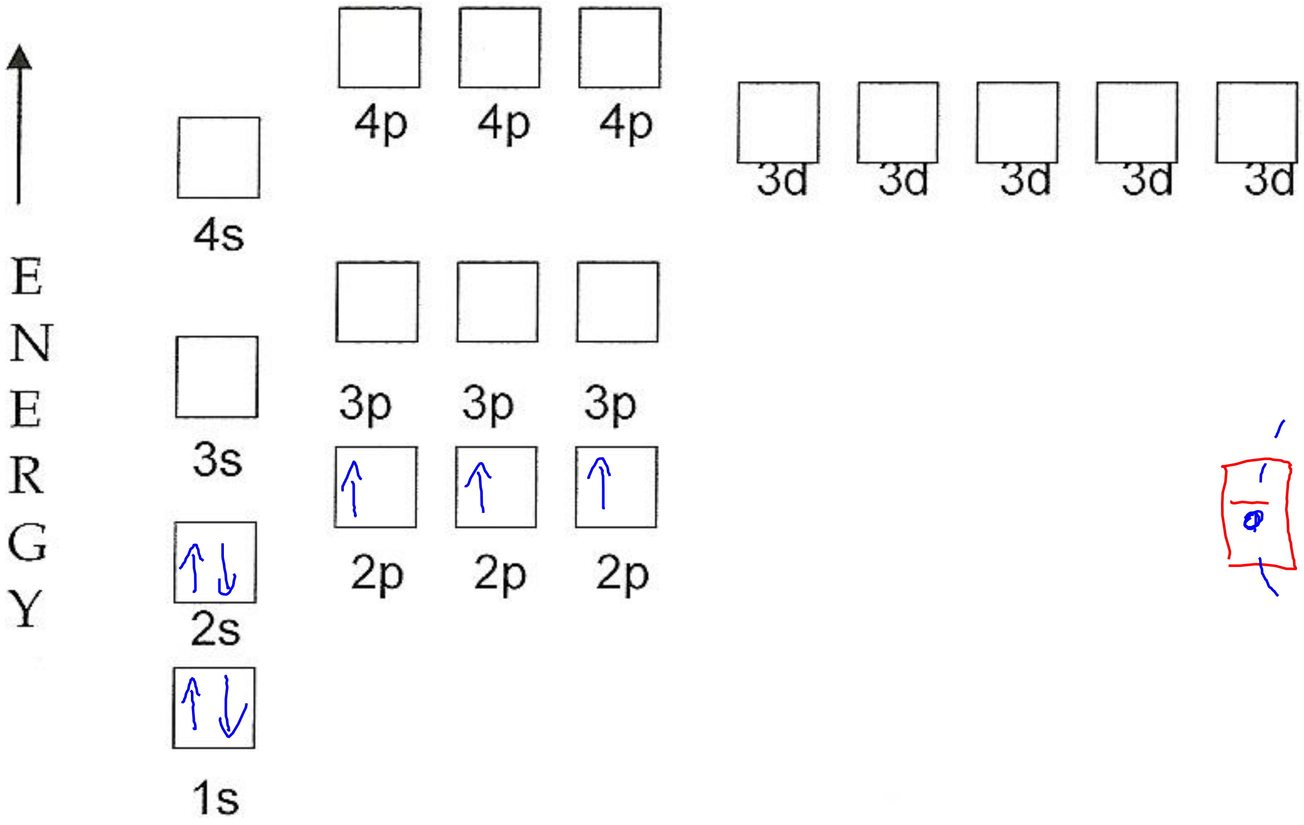
$3e^-$

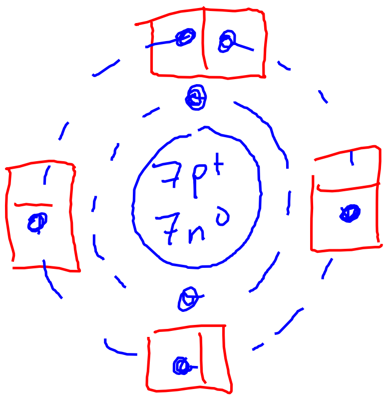


Examples

Nitrogen

7e⁻

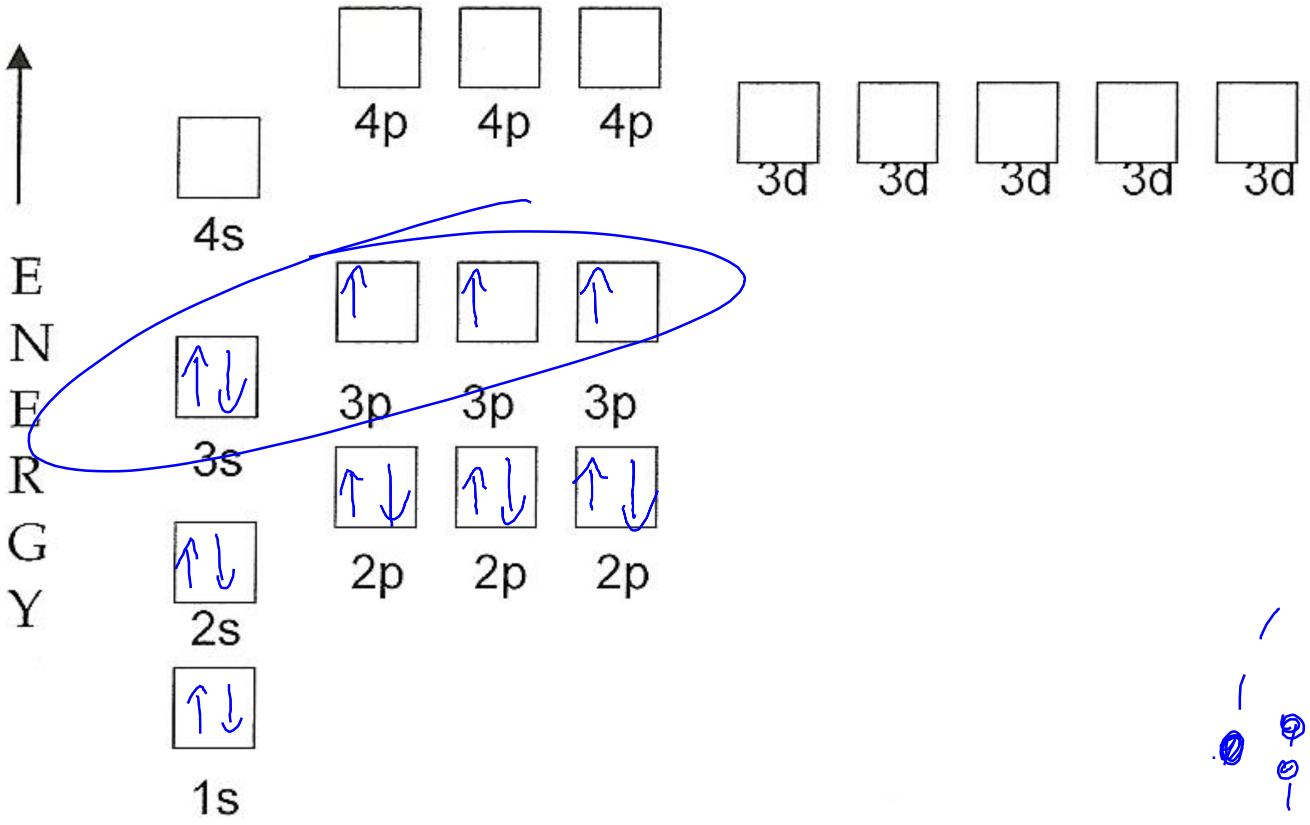


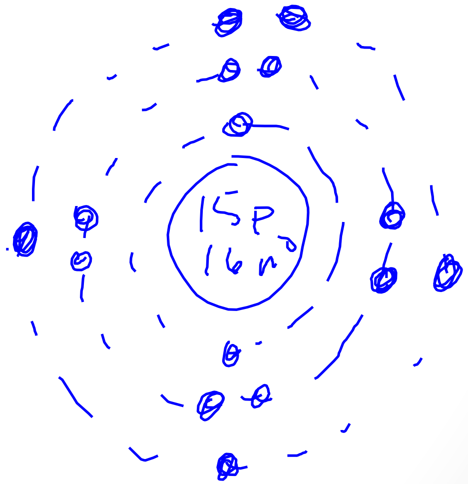


Examples

Phosphorus

15e

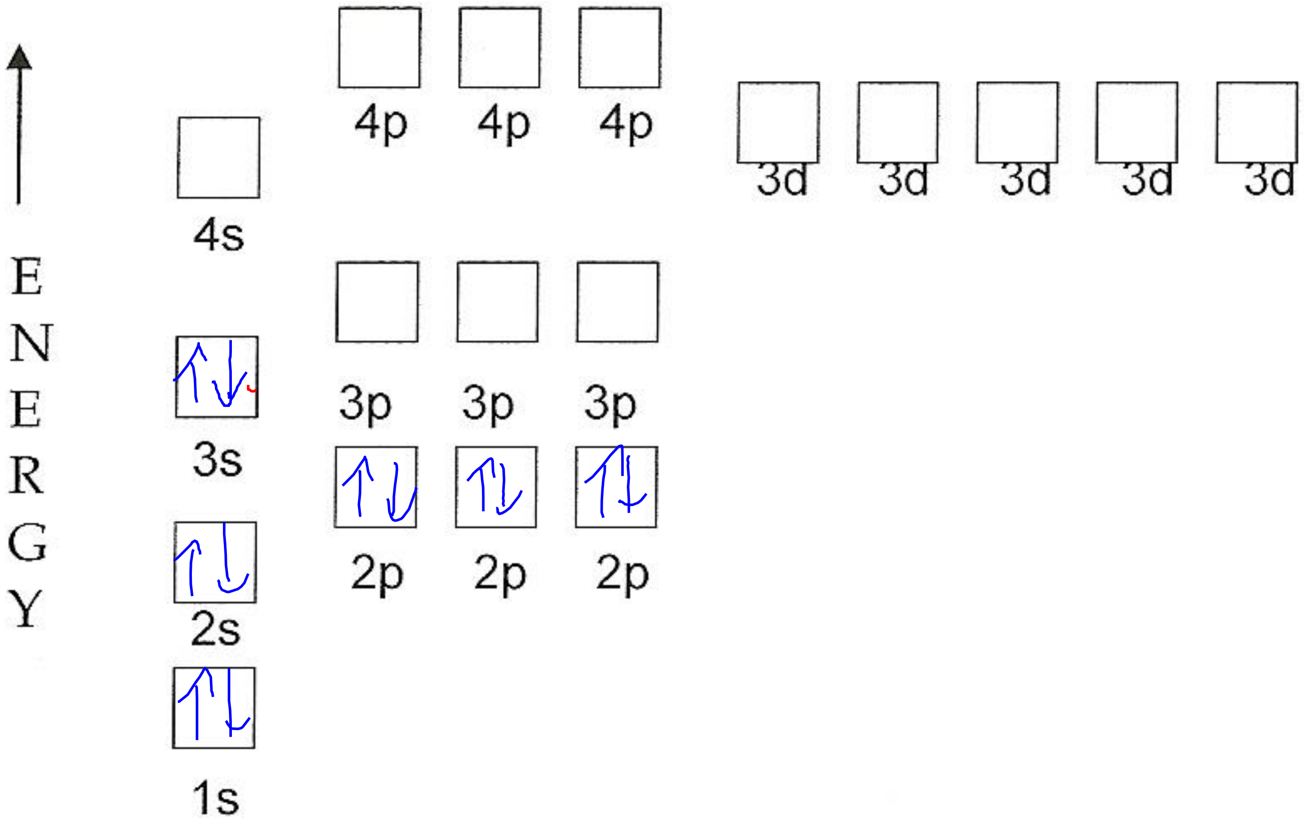




Try these ones...

Magnesium

12e⁻



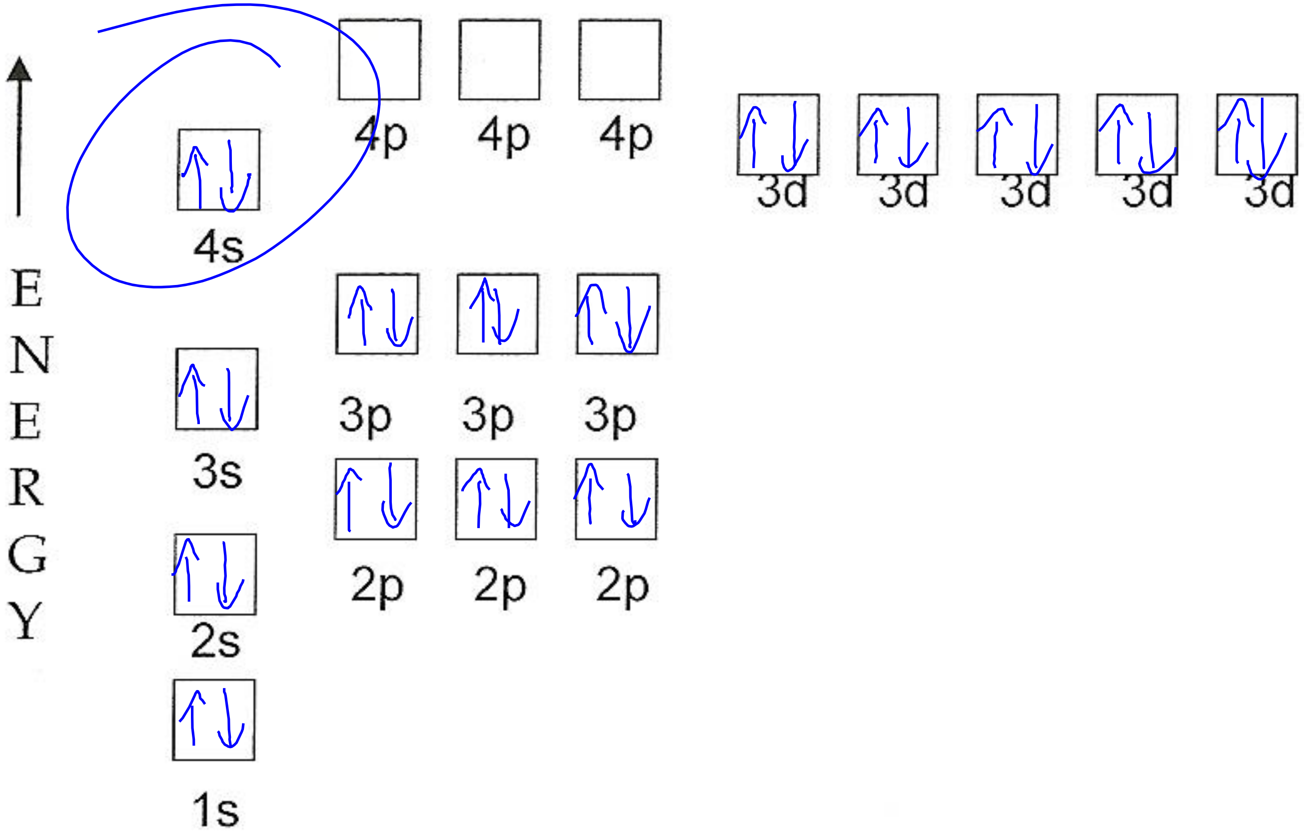
Mg

Try these ones...

Zinc

30e⁻

Zn^{2+}



Try these ones...

Calcium