

Lesson 9: Spin and Core notation

Orally: Several experimental observations can be explained by treating the electron as though it were spinning. The spin can be clockwise or counterclockwise, and so there are two possible values of the **spin quantum number** that describe the electron. Quantum theory was able to explain the experimental results if the spin quantum number was taken to be either $+1/2$ or $-1/2$.

Question: Why should you care which way electrons are spinning?

Answer: Spin determines how many electrons can occupy an orbital, and also, which orbitals electrons will fill first within a subshell.

Each electron in an atom is unique because no two electrons have the exact same combination of the 4 quantum numbers (This is the **Pauli Exclusion Principle**) Three quantum numbers (n , l , and m_l) are needed to describe the orbital the electron occupies. Since there are two possible values for the fourth quantum number (i.e, spin), there may not be more than $2e^-$ in each orbital.

Orally: The concept of spin can be illustrated using an orbital diagram

Orbital diagram: shows the location and spin of electrons in an atom. An up arrow on an orbital diagram means “spin up” or $+1/2$, and a down arrow means the other.

Orally: try not to worry about which is which. It really doesn't matter.

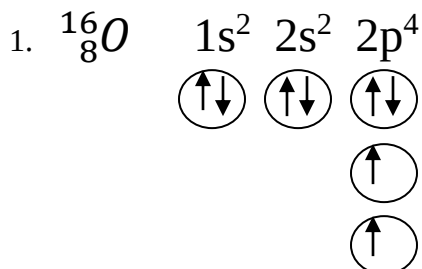
Orally: Electrons repel each other, and tend to align their spins whenever possible.

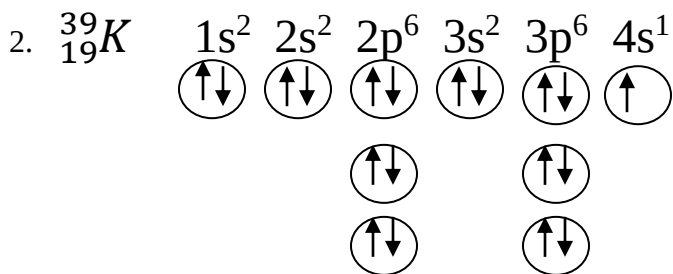
When filling up a subshell on an orbital diagram, spread the electrons among different orbitals to keep them as far apart as possible, and have spins go in the same direction when possible. (This is called **Hund's rule**).

Orally: Observations that are consistent with spin $+1/2$ and $-1/2$ show that electron configurations gain stability by having electrons spin in the same direction. In fact, some electrons prefer to move to a higher energy earlier than one might predict to gain stability via spin.

(Have students practice writing the e^- configuration for the following elements and then show them how to fill in the orbital chart.)

Spin diagrams (Orbital filling charts)





Orally: Question: Why does the 4s fill before the 3d?!

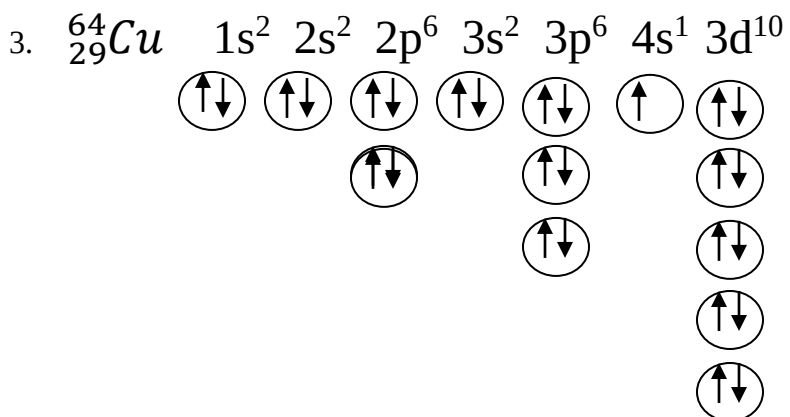
Answer: Studies based on the excitation of the electron in hydrogen do not reveal this trend because it is a single electron system. Atoms that have more than one electron repel so orbitals with fewer nodes (or no nodes like an S cloud) represent a slightly lower energy level. One can predict this the effect using Madelung's rule: Electrons fill orbitals according to $n + l$. Since the $n + l$ value for 4s is lower than the 3d, the 4s fills first. Recall that the l quantum number represents the number of nodal planes.

(Refer students to pg.152 and 153, then show the link below to illustrate. Also note what happens to the diagram when you get to Chromium)

<http://dwb4.unl.edu/chemAnime/ECONFIG/ECONFIG.html>

(shows electronic configurations using up and down arrows)

Exceptions for spin diagrams (Group 6 and 11): borrow highest s electron and move to d.



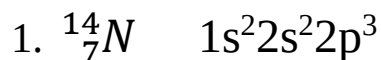
Orally: Often an x is used instead of an arrow up/down. Either approach is fine.

Core notation: A shorthand notation for electronic configurations.

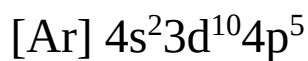
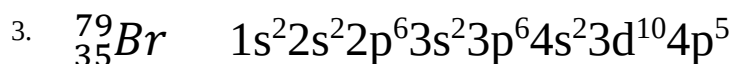
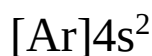
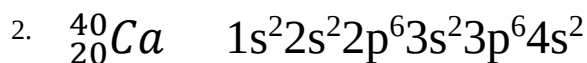
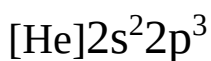
Orally: Discuss the price is right showcase showdown.

1. Core electrons (i.e., electrons that do not participate in a reaction) are expressed by the nearest noble gas.
2. Valence electrons (i.e., outer electrons that participate in bonding) are written using “quantum notation”.

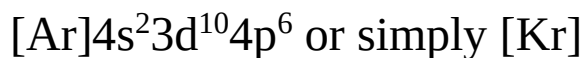
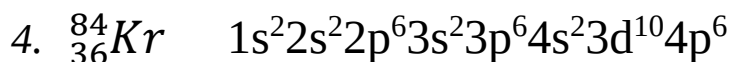
Exercises: Write the core notation for:

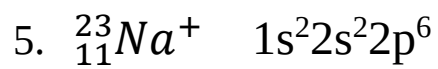


Orally: Pick the noble gas that has the closest number of electrons to nitrogen without going over. Since Helium is the only choice, the first two electrons represent core electrons and the rest are valence.



Orally: What about noble gases? There are two ideas about what to do here. Hebden suggests that you represent all atoms and ions with a smaller noble gas and some folks don't care.





Orally: The sodium ion is isoelectronic with neon. What does isoelectronic mean?

Assign pg. 157 #27, 28