

ChemQuest 15

Electron Configurations and the Periodic Table

Name: _____

Date: _____

Hour: _____

Information: Relating Electron Configurations to the Periodic Table

In this section you will see how the periodic table serves as a road map for writing electron configurations. Get your periodic table out and get ready. Remember that a row on the periodic table goes horizontally from left to right. Columns are vertical (up and down).

Critical Thinking Questions

- Write the electron configurations for Li, Na and K. (Remember for electron configurations, arrows are not necessary.)
 $\text{Li} = 1s^2 2s^1$
 $\text{Na} = 1s^2 2s^2 2p^6 3s^1$
 $\text{K} = 1s^2 2s^2 2p^6 3s^2 3p^4 4s^1$
- What is similar about the electron configurations of all of the elements in question 1? Look at the very end of their configurations.
 Each of them ends with s^1 .
- Lithium (Li) is in row 2 of the periodic table, sodium (Na) is in row 3, and potassium is in row 4. How do their row numbers affect how their electron configurations end?
 Li in row 2 ends with $2s^1$. Na in row 3 ends in $3s^1$. K in row 4 ends in $4s^1$. The row number is the same as the ending number of the sublevel.
- Write the electron configurations for Be, Mg, and Ca.
 $\text{Be} = 1s^2 2s^2$
 $\text{Mg} = 1s^2 2s^2 2p^6 3s^2$
 $\text{Ca} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
- What is similar about the ending of the electron configurations for all of the elements in question 4?
 Each of them ends with s^2 .
- Beryllium (Be) is in row 2 of the periodic table, magnesium (Mg) is in row 3, and Calcium (Ca) is in row 4. How do their row numbers affect how their electron configurations end?
 Be in row 2 ends with $2s^2$. Mg in row 3 ends in $3s^2$. Ca in row 4 ends in $4s^2$. Again, the row number is the same as the ending number of the sublevel.
- Given what you have done in questions 1-6, complete the following statement.
 Elements ending in s^1 are in column number 1 or IA and those ending in s^2 are in column number 2 or IIA of the periodic table.

- Name the element that have an electron configuration ending with... (the first is done for you)
 a) $5s^1$ Rubidium (Rb) b) $6s^2$ Barium (Ba) c) $7s^1$ Francium (Fr)
- Write the electron configurations for B, Al, and Ga and note their similarities.
 $\text{B} = 1s^2 2s^2 2p^1$
 $\text{Al} = 1s^2 2s^2 2p^6 3s^2 3p^1$
 $\text{Ga} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$
- Write the electron configurations for N, P and As and note their similarities.
 $\text{N} = 1s^2 2s^2 2p^3$
 $\text{P} = 1s^2 2s^2 2p^6 3s^2 3p^3$
 $\text{As} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$
- Complete the following statement: Elements ending in p^1 are in column number 13 or IIIA of the periodic table and elements ending in p^3 are in column number 15 or VA of the periodic table. Therefore, elements ending in p^2 must be in column 14 or IVA of the periodic table.
- Name the elements that have an electron configuration ending with...(the first is done for you)
 a) $3p^4$ Sulfur (S) b) $5p^6$ Xenon (Xe) c) $6p^5$ Astatine (As)
- Write the electron configurations for Ti, Zr, and Hf and note their similarities.
 $\text{Ti} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
 $\text{Zr} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^2$
 $\text{Hf} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^2$
- Write the electron configurations for Cr, Mo, and W and note what is similar about them.
 $\text{Cr} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$
 $\text{Mo} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^4$
 $\text{W} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^4$
- Complete the following: Elements ending in d^2 are in column number 4 or IVB and those ending in d^4 are in column number 6 or VIB. Therefore, elements ending in d^3 are in column number 5 or VB. Elements ending in d^7 must be in column number 9 or VIIIB.
- Notice from question 6 that an element that ends in $3s$ is in the 3rd row. Also, from questions 9-12 it should be clear that an element that ends in $3p$ is in the 3rd row. However, notice that an element that ends in $3d$ is in the 4th row instead of the 3rd row. Offer an explanation for this.
 The d sublevels have extra high amounts of energy. Remember for example, that is why the $3d$ sublevel comes after the $4s$ sublevel. This same explanation accounts for the fact that the d sublevels are "misplaced" by one row on the periodic table.
- Name the elements that have an electron configuration ending with...(the first is done for you)
 a) $4d^3$ Niobium (Nb) b) $5d^8$ Platinum (Pt) c) $3d^6$ Iron (Fe)

18. There are three major divisions on the periodic table: the “s block”, the “d block” and the “p block”. Where are these blocks of elements located? Give the column numbers of their locations. (Yes, there is also an “f block” but we won’t use that much.)

s block: columns 1-2 d block: columns 3-12 p block: columns 13-18

Information: Abbreviating the Electron Configurations

Electron configurations can be shortened using a special group of elements called the noble gases. They are found in the column furthest to the right on the periodic table: helium, neon, argon, krypton, xenon, and radon. These gases are very non-reactive.

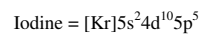
All of the noble gases have electron configurations that end in p^6 . Because of their unique non-reactivity, they are often used to abbreviate long electron configurations.

Take note of krypton’s electron configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$.

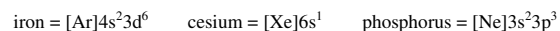
Now notice that strontium’s electron configuration is the same as krypton’s except that strontium has 38 electrons instead of 36. Strontium’s electron configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2$. Strontium has the same electron configuration as krypton and then two additional electrons in the 5s orbital. Therefore strontium’s electron configuration can be abbreviated as $[\text{Kr}]5s^2$. This notation means that strontium has all of krypton’s electrons plus two more in the 5s sublevel.

As another example, consider iodine. Instead of writing a long electron configuration, we can abbreviate it. Follow these steps:

1. Going backward from iodine on the periodic table, find the previous noble gas. It is krypton.
2. Take note of what krypton’s electron configuration ends with. It ends with $4p^6$ since it is in the 4th row and in the p^6 column.
3. Iodine has 17 more electrons than krypton and so you can begin by writing $[\text{Kr}]$ followed by orbitals for 17 more electrons. After $4p^6$ comes $5s^2$...



Any of the noble gases can be used for abbreviations. Here are a few more examples:



Study the above examples and make sure you understand why they are written that way.

Critical Thinking Questions

19. Write abbreviated electron configurations for the following elements:

- a) Ruthenium (Ru) $\text{Ru} = [\text{Kr}]5s^2 4d^6$
- b) Arsenic (As) $\text{As} = [\text{Ar}]4s^2 3d^{10} 4p^3$
- c) Tellurium (Te) $\text{Te} = [\text{Kr}]5s^2 4d^{10} 5p^4$