

ChemQuest 11

An Electron's Address

Name: _____

Date: _____

Hour: _____

Information: Energy Levels and Sublevels

As you know, in his solar system model Bohr proposed that electrons are located in energy levels. The current model of the atom isn't as simple as that, however.

Sublevels are located inside energy levels just like subdivisions are located inside cities. Each sublevel is given a name. Note the following table:

TABLE 1

<u>Energy Level</u>	<u>Names of sublevels that exist in the energy level</u>
1 st energy level	s
2 nd energy level	s and p
3 rd energy level	s, p, and d
4 th energy level	s, p, d, and f

Note that there is no such thing as a “d sublevel” inside of the 2nd energy level because there are only s and p sublevels inside of the 2nd energy level.

Critical Thinking Questions

- How many sublevels exist in the 1st energy level?
One: only the s sublevel exists.
- How many sublevels exist in the 2nd energy level?
Two: the s and the p sublevels exist.
- How many sublevels exist in the 3rd energy level?
Three: the s, p, and d sublevels exist.
- How many sublevels would you expect to exist in the 5th energy level?
The number of sublevels equals the energy level number, so in the 5th energy level we should expect 5 sublevels to exist.
- Does the 3f sublevel exist? (Note: the “3” stands for the 3rd energy level.)
No, in the 3rd energy level there are only s, p, and d sublevels. The following sublevels exist in the 3rd energy level: 3s, 3p, and 3d.

Information: Orbitals

So far we have learned that inside energy levels there are different sublevels. Now we will look at orbitals. **Orbitals** are located inside sublevels just like streets are located inside subdivisions. Different sublevels have different numbers of orbitals.

TABLE 2

Sublevel	# of Orbitals Possible
s	1
p	3
d	5
f	7

Here's an important fact: only two electrons can fit in each orbital. So, in an s orbital you can have a maximum of 2 electrons; in a d orbital you can have a maximum of 2 electrons; in any orbital there can only be two electrons.

Since a d sublevel has 5 orbitals (and each orbital can contain up to two electrons) then a d sublevel can contain 10 electrons ($= 5 \times 2$). Pay attention to the difference between "sublevel" and "orbital".

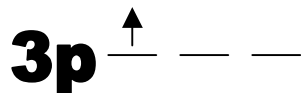
Critical Thinking Questions

6. How many orbitals are there in a p sublevel? **3**
7. How many orbitals are there in a d sublevel? **5**
8. a) How many total sublevels would be found in the entire 2nd energy level? **Two, since the 2nd energy level has s and p sublevels.**
 b) How many orbitals would be found in the entire 2nd energy level? **4 orbitals: the 2s sublevel has 1 orbital and the 2p sublevel has 3 orbitals for a total of 4 orbitals.**
9. a) How many electrons can fit in an f sublevel?
(2 electrons per orbital) x (7 orbitals in an f sublevel) = 14 electrons
 b) How many electrons can fit in an f orbital?
Any orbital can only hold 2 electrons.
10. How many electrons can fit in a d orbital? in a p orbital? in any kind of orbital?
Each orbital can hold a maximum of 2 electrons.
11. In your own words, what is the difference between a sublevel and an orbital?
Orbitals are contained within sublevels. A sublevel is a grouping of orbitals.
12. How many electrons can fit in each of the following energy levels:
 1st energy level = **2 because only 2 can fit in an s sublevel and the first energy level only has an s sublevel.**
 2nd energy level = **8; 2 in the 2s sublevel and 6 in the 2p sublevel giving a total of 8.**
 3rd energy level = **18; 2 in the 3s sublevel, 6 in the 3p sublevel, and 10 in the 3d sublevel giving a total of 18.**
 4th energy level = **32; 2 in the 4f, 6 in the 4p, 10 in the 4d, and 14 in the 4f.**

Information: Representing the Most Probable Location of an Electron

The following is an “address” for an electron—a sort of shorthand notation. The diagram below represents an electron located in an orbital inside of the p sublevel in the 3rd energy level.

EXAMPLE #1:

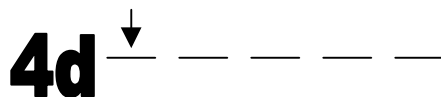


Some important facts about the above diagram:

- The arrow represents an electron.
- The upward direction means that the electron is spinning clockwise.
- “3p” means that the electron is in the p sublevel of the 3rd energy level.
- Each blank represents an orbital. Since there are three orbitals in a p sublevel, there are also three blanks written beside the p.
- In the diagram, the electron is in the first of the three p orbitals.

Here’s another example:

EXAMPLE #2:



Critical Thinking Questions

13. In example #2, why are there 5 lines drawn next to the d?

In a d sublevel there are 5 orbitals and therefore there needs to be 5 lines drawn.

14. In example #2, what does it mean to have the arrow pointing down?

A downward arrow indicates that the electron is spinning counterclockwise.

15. Write the notation for an electron in a 2s orbital spinning clockwise.

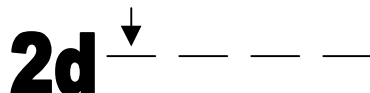


16. Write the notation for an electron in the first energy level spinning clockwise.

Note: in the first energy level, the only sublevel is a 1s.



17. What is wrong with the following notation? You should find two things wrong.



There is no such thing as a d sublevel in the 2nd energy level. Also, a d sublevel needs to have 5 lines drawn for the 5 orbitals in the d sublevel.

18. Write the notation for an electron in the 4th energy level in an f sublevel spinning clockwise.

