Title: Electron Configuration

Author: Karen Ryan

Subject Area(s): Chemistry/Physical Science

Grade(s): 9-12

Description of Lesson: POGIL Lesson for Credit

Length of Lesson: 1 class period

Student Objectives:

Materials:

For the teacher: See below lesson
Handouts of POGIL lesson
Cooperative Learning Group Cards
Answer Sheet

For each group: See below lesson
Lesson Handout
Cooperative Learning Cards

For the class: See below lesson
Answer Sheets

Procedure:

See complete lesson (next page)

Scientific Explanation: In atomic physics and quantum chemistry, the electron configuration is the arrangement of electrons in an atom, molecule, or other physical structure.

Assessment:
Grading during POGIL activity
Class discussions
Tests and Quizzes

Missouri and Kansas Standards Addressed:

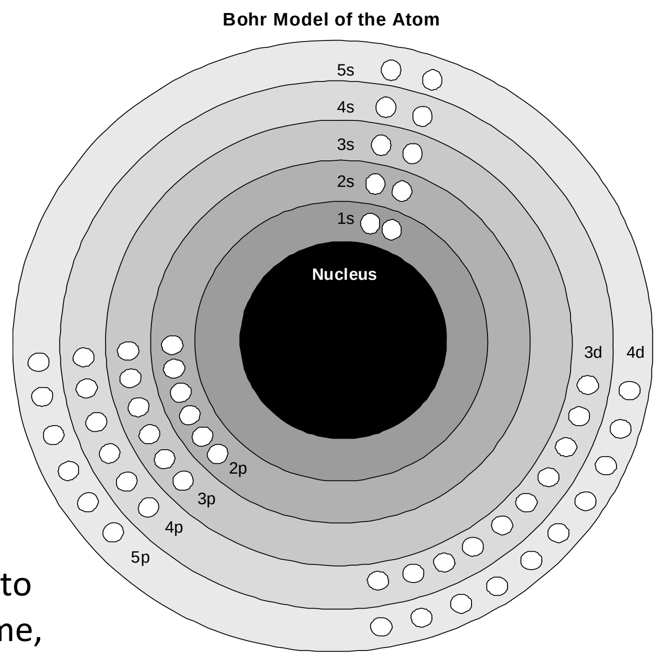
Missouri Science Standards (GLE's):

Strand 1.1, Concept F. The Periodic Table organizes the elements according to their atomic structure and chemical reactivity.

Strand 1.1, Concept H. Chemical Bonding is the combining of different pure substances (elements, compounds) to form new substances with different properties

NAME__________________________ **DATE**___________
HOUR__________

ELECTRON CONFIGURATION



The **electron configuration** of an atom describes the orbitals occupied by **electrons** on the atom. The basis of this prediction is a rule known as the **Aufbau Principle**, which assumes that electrons are added to an atom, one at a time, starting with the lowest energy orbital, until all of the electrons have been placed in an appropriate orbital.

Using the Bohr Model, answer the following questions:

1. How many numbered energy levels are in the diagram?

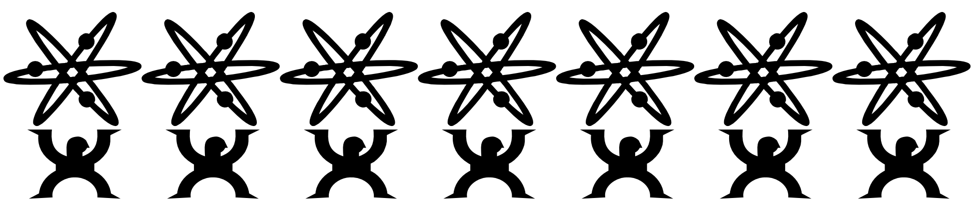
2. What ranges of energy levels are used for your answer in 1?

3. List the letters associated with the numbers in question 2?

4. List the letters in the order they appear from the nucleus outward.

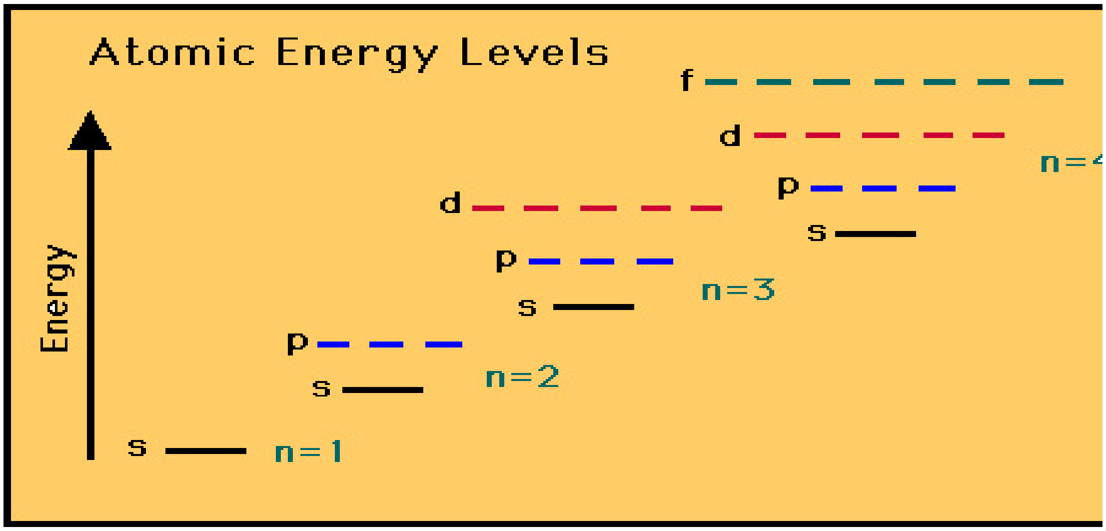
5. What are the letter/number combinations that are in the first circle outside of the nucleus?

6. What are the letter/number combinations that are in the second, third, fourth and fifth circles outside the nucleus?



Electrons can only occupy so-called atomic orbitals with well defined energy levels corresponding to the principal quantum number, n. The lowest level will have n = 1, the next n = 2, and so on.

The maximum number of electrons which can "fit" into these energy levels is given by the formula $2n^2$, where n is the principal quantum number.



So, the first energy level will accommodate a maximum of 2 electrons (2 x 1 x 1), the second level 8 (2 x 2 x 2), the third 18 (2 x 3 x 3) and so on.

Within each of these energy levels are the sublevels s,p,d and f.

Using the diagram, answer the following questions:

7. What is the range of relative energy levels, n?

8. What does the arrow on the left represent?

9. Why are there different numbers of lines next to the different letters?

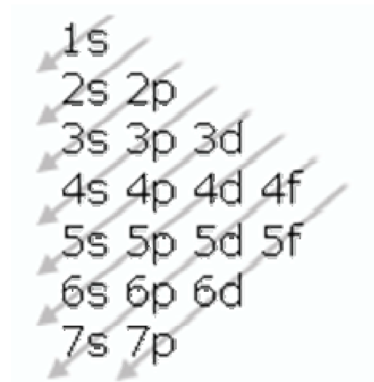
Note that the level with n = 1 is limited to a single s orbital.

10. What orbitals are in the n=2 level? And what orbitals are in the n=3, n=4 and n=5 levels?

Two general methods are used to show electron configurations.

The subshell notation uses numbers to designate the principal shells and the letters *s*, *p*, *d*, and *f* to identify the subshell.

A superscript following the letter indicates the number of electrons in the designated subshell.

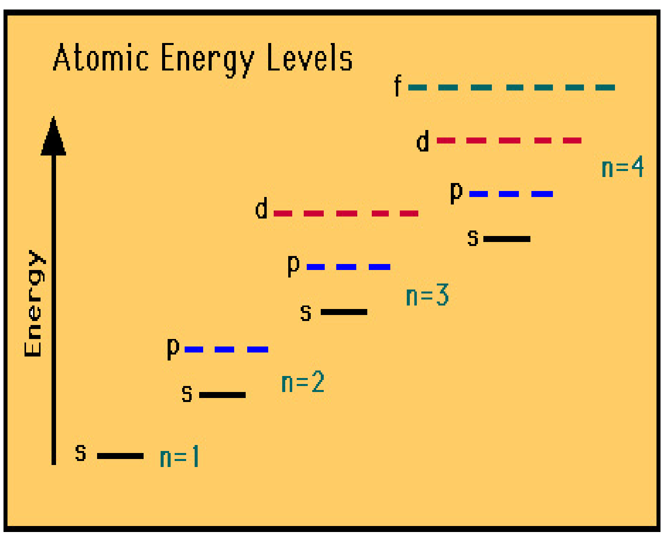


A mnemonic diagram for the aufbau principle known as the diagonal rule is shown. This helps to write the electron configuration in the correct increasing energy levels.

The ground state electron configuration for hydrogen would be H = $1s^1$

Next, comes helium and it would be He = $1s^2$.

Now, Lithium is Li= $1s^2\,2s^1$.



11. In the mnemonic diagram on the right, what do the arrows represent?

12. How do the arrows help you write the electron configurations?

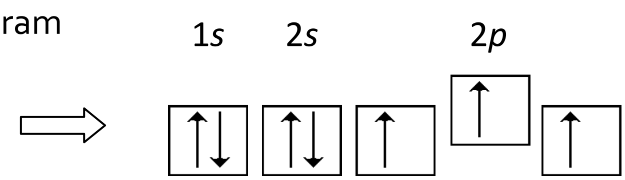
13. Continue to follow the diagrams and write the electron configuration for the following elements:

Be= B= C= N=

A drawback to the previous method of showing the electron configuration is that it does not tell how the three 2*p* electrons are distributed among the three 2*p* orbitals.

An orbital diagram, in which boxes are used to indicate orbitals within a subshell and arrows to represent electrons in these orbitals, is used to show this distribution. The direction of the arrows represents the directions of the electron spin

<u>*Pauli's exclusion principle*</u> must now be applied.
One expression of the Pauli Exclusion Principle is that *no two electrons in the same atom can be in the same quantum state.* This means that no two electrons can have the same set of quantum states of: orientation of intrinsic **spin**.
This is illustrated by the second electron to enter the 1s orbital having a spin opposite to the spin of the electron which is already there
The orbital diagram for nitrogen is



The way we arrive at electron configurations such as the one for nitrogen above is to use a set of rules collectively of the aufbau principle.

- Electrons occupy orbitals of the lowest energy available
- No two electrons in the same atom may have all four quantum numbers alike
- When entering orbitals of the same energy, electrons initially occupy them singly ant with the same spin
- Electrons fill orbitals in order of the quantum number sum (n + l). For equal (n + l) sums, fill levels in order of increasing n.

Notice in the orbital diagram for Nitrogen, that the arrows fill all 3 boxes.

This is using ***<u>Hund's rule</u>***: fill a set of orbitals of equivalent energy (the 2p orbitals in this case) in such a way that as many electrons as possible remain unpaired.

Practice

14. Now for some practice using the diagrams from this lesson write the electron configurations for the following elements in the orbital diagram form (boxes).

Hydrogen

Helium

Lithium

Beryllium

Boron

Carbon

Oxygen

Fluorine

Neon

14. For the same elements in 12, write the superscript format.

Hydrogen

Helium

Lithium

Beryllium

Boron

Carbon

Oxygen

Fluorine

Neon

When your group has finished, and everyone understands the process, ask Mrs. Ryan for the answer sheet.

Next to each answer, using a grading pen, write a (+) for correct and a (–) for incorrect.

If incorrect, write an explanation for what you misunderstood or formulate a question for help.

You have successfully finished another POGIL activity!

Congratulations!

Next time, you will learn about the exceptions to the rules.

Your homework is to use the 2 methods you learned today and write the electron configurations for elements 19-24.

This is due tomorrow.