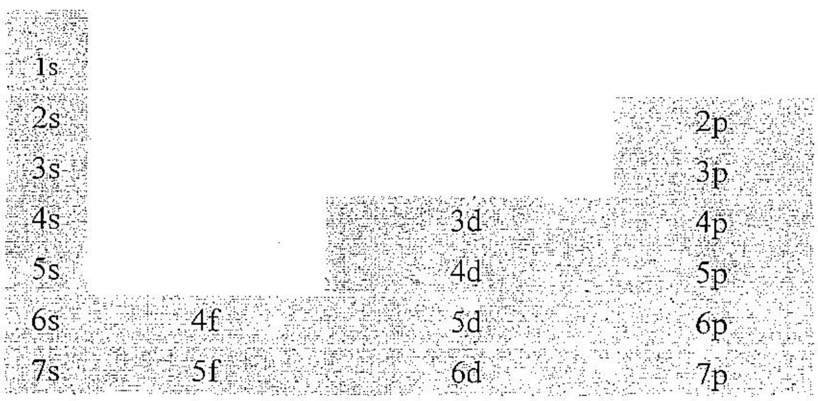
Introduction to Electron Configuration

Energy levels, subshells and orbitals

Electrons are placed in energy levels, described as principal quantum numbers (n). The principal quantum number is distinguished by the rows (periods) of the periodic table. There are seven periods on the periodic table, therefore, n= 1 - 7.

These energy levels are sub-divided into subshells (labeled s, p, d or f). The s subshell is the lowest energy and begins in level 1. The p subshell is higher energy and therefore doesn't begin until level 2. The d is higher energy and begins in level 3 and the f is even higher energy and begins in level 4. The subshells are further sub-divided into orbitals (s has 1 orbital, p has 3 orbitals, d has 5 orbitals and f has 7 orbitals). Each orbital can hold 2 electrons.

Rules for writing electron configurations
The **Aufbau principle** states that energy levels must be filled from the lowest to the highest and you may not move on to the next level unless the previous level is full. Use the periodic table as a guide (read left to right):



Hund's Rule says that when placing electrons in orbitals of equal energy, place one in each orbital before doubling up in order to arrive at the lowest energy configuration. The **Pauli Exclusion Principle** states that when electrons do share an orbital, they must be of different "spin.

Writing electron configurations
Orbital notation uses boxes to show orbitals and arrows to signify electrons. An up arrow and a down arrow have different "spins." **Configuration notation** uses superscripts to show the number of electrons in a subshell (specific orbitals are not shown). The **noble gas notation** uses a noble gas (the far right column) to represent the inner, or core, electrons and just shows the outer level of electrons using the same method as spectroscopic.

Exceptions to the rules
There are a few exceptions to the rules listed above when filling electron configurations. A half-full "s" orbital and a "d" subshell with 5 or 10 is more stable than following the Aufbau Principle. **Cr, Mo, W:** s1 d5 and **Cu, Ag, Au:** s^1 d^{10}Reference:
http://www.chemistry24.com/highschool_chemistry/electron-configuration.html

Questions and Answers

| Return to the Atoms, Elements and Molecules Index Page |

How many electrons fit in each shell around an atom?

The maximum number of electrons that can occupy a specific energy level can be found using the following formula:

$$\text{Electron Capacity} = 2n^2$$

The variable n represents the Principal Quantum Number, the number of the energy level in question.

Energy Level (Principal Quantum Number)	Shell Letter	Electron Capacity
1	K	2
2	L	8
3	M	18
4	N	32
5	O	50
6	P	72

Keep in mind that an energy level need not be completely filled before electrons begin to fill the next level. You should always use the Periodic Table of Elements to check an element's electron configuration table if you need to know exactly how many electrons are in each level.

Related Pages:

5. Complete the following table to indicate the total number of orbitals in each energy level (n). In the remaining columns, specify how many of those orbitals are s, p, d, and f.

Level *n*	Total # of orbitals	# of *s*-orbitals	# of *p*-orbitals	# of *d*-orbitals	# of *f*-orbitals
1					
2					
3					
4					

8.

Edible Atom Lab

This is an excellent lesson to use to revisit the basics of the structure of atoms.

Supplies:
Lots of candy...
Large sugar cookies, M&M's, skittles, marshmallows, chocolate chips, sprinkles, frosting, popcorn, raisins, jelly beans, plates, napkins, (something to drink - optional) etc. (Avoid treats with peanut butter).

Procedure:
Set the candy in bowls at different stations in your room or on each lab table. (Have students use a spoon to pick up unwrapped candy). The object of this lab is for students to choose an element from the periodic table and design the atom complete with protons, neutrons, electrons and if you get really crazy you can have them add mesons, quarks and gluons. Limitation on the atomic number should be related to the amount of candy. However, you should keep the numbers reasonable to avoid anyone getting sick from eating too much candy. Suggestion: Have one name of an element listed on a back of a 3x5 index card (used in next section). Have students draw cards (some cards will may have the same element). This will keep students from getting very little while others get a lot.

Before the student atom creation can be eaten, the student must make a labeled drawing of their atom and give all information of the element on a 3x5 index card. (Atomic Number, Atomic Mass, Symbol, Element Name, 1 use for the element, metal, non-metal, or metalloid) After you check that all info is correct... then it's eat 'em up time.

(disk: Edible Atom Lab.doc)

SCIENCE

Edible model of an atom

Approved for 10 Points Re-certification

Target Curriculum: Science

Target Grade: 9

SOLs: SCI.PHS.3 SCI.PHS.4
Time: 1 block (1 1/2 hours)

Objective:
Technology Objective: The student will use search strategies to retrieve electronic information in researching the atomic structure in the cloud model.
Science Objective:
The student will construct a model of an atom. VA SOL SCI PHS 3
The student will be able to define nucleus, atomic number, protron, electron, neutron, and electron cloud. VA SOL SCI PHS 3 & SCI PHS 4
The student will be able to place the correct number of electrons in the various orbits. VA SOL SCI PHS 3
The student will be able to identify particle charge (positive, neutral, and negative) VA SOL SCI PHS 3
The student will be able to relate the number of protrons to an element's atomic number.
VA SOL SCI PHS 3 & SCI PHS 4

Purpose:
The student will construct a cloud model of the atomic structure of an element of their choice. The purpose of this is for the student to demonstrate their knowledge and understanding of the atomic structure in the cloud model.

Materials:
Each student will be provided:
1 paper plate
1 sugar cookie
1 small bag of M&M's, Skittles, or some other small colored candies
1 tube of icing
1 note card
1 pencil/pen
1 pack of colored pencils

Procedure:
Each student will decide what element they are going to contruct.
Each student will place the sugar cookie in the center of the plate and identify it as the nucleus.
They will then use the icing to "glue" in place the correct amount of candies in the nucleus to represent the protons and neutrons of the element. (Each a different color)
The student will then "draw" with the icing the orbits and place the correct number of

electrons in the electron cloud.(Choosing a third color for the electrons)

Observations:
On the note card the student will place his/her name.
The student will write the name of their element.
The student will provide a color code for each different particle.
The student will have the correct number of protons and neutrons.
The student will have the correct number of electrons in their correct orbit.
The student will write the elements atomic number, atomic mass, and chemical symbol.

Conclusions:
The student will be able to share all his/her observations stated above with the teacher in an informal oral presentation.

Class Discussion Questions:
Class discussion was conducted by pairing students and having them discuss the similarities and differences in the atomic structure of their elements.

Cautions and Concerns:
Just be sure to grade the project before they are consumed (Smile).