Atomic Structure: Periodic Table

Strand Atomic Structure and Periodic Relationships

Topic Investigating electron configuration and the periodic table

Primary SOL CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of

d) families or groups;
e) periods;
f) trends including atomic radii, electronegativity, shielding effect, and ionization energy;
g) electron configurations, valence electrons, and oxidation numbers.

Related SOL CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include

h) use of appropriate technology including computers, graphing calculators, and probeware for gathering data, communicating results, and using simulations to model concepts.

Background Information

The **periodic table** is a tabular display of the chemical elements, organized on the basis of their properties. Elements are presented in increasing atomic number. The main body of the table is a 18 × 7 grid, with gaps included in to keep elements with similar properties together, such as the halogens and the noble gases.

The primary determinant of an element's chemical properties is its electron configuration, particularly the valence shell electrons. For instance, any atoms with four valence electrons occupying p orbitals will exhibit some similarity. The type of orbital in which the atom's outermost electrons reside determines the "block" to which it belongs. The number of valence shell electrons determines the family, or group, to which the element belongs.

The total number of electron shells an atom has determines the period to which it belongs. Each shell is divided into different subshells which, as atomic number increases, are filled roughly in the order depicted in the table at hand (according to the Aufbau principle); hence, the structure of the periodic table. Since the outermost electrons determine chemical properties, those with the same number of valence electrons are generally grouped together.

Students focus on the structure of the periodic table of the elements and the names of the portions—metals, nonmetals, and metalloids—as well as the group names and special series names.

Materials

- Periodic table of the elements
- Colored pencils
- Rulers

- Construction paper

Vocabulary

column, periodic trend, radius, row, trend

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Lead the class in completing a KWL chart about periodic families.
2. Review the following background information with the class:
   - The periodic table has seven periods (horizontal rows) and 18 groups or families (vertical columns).
   - If you analyze the periods, you see that all of the elements in a period have the same number of electron energy levels: the first period has 1 electron energy level; the second period has 2 electron energy levels; and so forth.
   - There is a pattern in the groups as well: the elements in group 1 have 1 electron in their outer energy level; the elements in group 2 have 2 electrons in their outer energy level; the elements in group 13 have 3 electrons in their outer energy level; the elements in group 14 have 4 electrons in their outer energy level; and so forth.
   - Groups 3 through 12 are not included in the trend. That is because they are **transition elements,** which follow a slightly different trend due to the overlap of energy levels and the way those energy levels fill.
   - The number of electrons in an element's outer energy level determines the element's chemical properties. Therefore, since all of the elements of a group have the same number of electrons, they will react similarly to each other. The elements in the first group have a special name—the **alkali metals**. The elements in group 2 also have a special name, the **alkaline earth metals**. The alkali metals are the most reactive group of metals on the periodic table. Francium is the most reactive of the group; reactivity increases as you go from the top to the bottom of this column.
   - Group 17 is the **halogen** group of elements. The halogen group is the most reactive nonmetal group on the periodic table. Fluorine is the most reactive nonmetal in this group, and reactivity decreases as you go from the top of the column to the bottom.
   - Group 18 is known as the **noble gas** or inert gas group. It is named this because all of its elements are stable and unlikely to react or bond with other elements. Notice that all of these elements have 8 electrons in their outer shell, with the exception of Helium, which has only 2 electrons in its outer energy level. This, however, is not really an exception because Helium's single energy level (unexcited) can hold only a maximum of 2 electrons.

Procedure

1. Give students guided practice in identifying the group, series, and section in which a given element is located. Further guided practice should be used to introduce group and period trends of atomic radii, ionic radii, and electronegativity across periods and down groups.
2. Give students some sample elements from each period, and have them identify the period and group within which each element is located. Repeat this exercise until 10 students in a row can answer correctly.

3. Give students some sample pairs of elements across periods and down groups, and have them predict changes in atomic radii, ionic radii, and electronegativity. Repeate this exercise until 8 out of 10 students answer correctly.
4. Have students do a "Photographic Periodic Table" project in which each student is assigned to bring in a photograph showing a particular element's use in today's world. Help students recognize uses of pure elements as opposed to compounds. The use depicted in the photograph should be specific to the element form and not a compound, if possible.

Assessment

- **Other**
  - Quiz students on the periodic table, focusing on group and series names by general recognition and by locating elements within a group and/or period.
  - Have students complete *The Periodic Table Challenge* at http://www.ilpi.com/genchem/periodicquiz.html to test whether they know the elements by position in the periodic table. Here they see a blank table and must type in the element symbols in the correct places. This site gives hints to help students remember/guess each element.

Extensions and Connections (for all students)

- Have students create an enlarged two-dimensional model of the periodic table, color-coded with the following periodic trends: atomic numbers, masses (rounded), symbols, alkali metals, alkaline earth metals, transition metals, lanthanide series, actinide series, other metals, nonmetals, noble gases, metalloids, and halogens.

Strategies for Differentiation

- Use an enlarged periodic table and clay spheres or construction paper circles to show the increase in size of atoms (atomic radius). Mount these going down groups 1, 2, and 17. Show the decreasing size by mounting these across periods 2 and 3.
- Invite a chemist to discuss the relevance of the periodic table to his/her work.
- Have stations for each element with examples when applicable, and have students use the computer to find application for each.
- Have students find three compounds in which the elements are found.
- Have students create a graphic organizer, using a blank periodic table on which they draw arrows to label how each periodic trend changes.