

Elements and Electron Configuration

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

- c) mass and charge characteristics of subatomic particles;
- 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;
- h) chemical and physical properties.

Related 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

- a) average atomic mass, mass number, and atomic number;
- b) isotopes, half-lives, and radioactive decay.

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 an 18×7 grid, with gaps included 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.

During the initial phase of this activity, students will work independently to gather information. They will need directions to both electronic and printed sources of information and help in interpreting that information. When students meet in cooperative teams to analyze and synthesize information about the team's family/group and period of elements and to develop a presentation for the rest of the class, they will need help in using spreadsheet and presentation software.

This project can be completed within five or six class periods. Students may work individually in the school media center and/or classroom, as well as at home, but they must use class time for working in cooperative teams and for completing the project. Approximately three hours of class time should be allocated for this teamwork.

Materials

- Access to Internet databases and library references about the chemical elements
- Computer spreadsheet and presentation software
- Attached blank template for the periodic table of the elements

Vocabulary

anion, boiling point, cation, conductivity, density, electron, horizontal, melting point, negative charge, positive charge, radius, vertical

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

Introduction

1. Before beginning the activity, give students the opportunity to observe, in the laboratory and on the Internet, and describe several common elements and some of the elements' reactions.
2. Have students practice using a spreadsheet by selecting a periodic property, such as density, and graphing it as a function of increasing atomic number for the first 20 elements.

Procedure

Individual Assignments

1. Using the online *Periodic Table of the Elements: A Resource for Elementary, Middle School, and High School Students* from the Los Alamos National Laboratory's Chemistry Division (see Resources at the end of this lesson), assign each student an element from a list of elements that includes four from each of the following families:
 - Group 1—alkali metals: lithium, potassium, rubidium
 - Group 2—alkaline earth metals: beryllium, magnesium, strontium, barium
 - Group 15—nitrogen, phosphorus, antimony, bismuth
 - Group 16—oxygen, selenium, tellurium, polonium
 - Group 17—halogens: fluorine, chlorine, bromine, iodine
 - Group 18—noble gases: helium, neon, argon, krypton
2. Groups 13 and 14 may be added if class size necessitates it. Transition elements may be added for capable classes. It is important to have at least four elements in a group represented so that trends can be seen when students meet in their cooperative teams. It is also important that at least one element in a family/group be missing so that teams can predict properties. Finally, it is ideal to have as many groups from the periodic table represented as possible.
3. Give students a list of information to find about their assigned elements. The list could include important isotopes, electron configuration and orbital filling diagram, valence electrons, electron dot diagram, common ions, including electron configurations for ions, physical properties, including boiling point, melting point, electrical conductivity, density, atomic radius, shielding effect and ionization potentials, and electronegativity, chemical properties, including reactivity in oxygen, water, and acids. The list could also include general information, such as abundance on earth, sources, uses, and historical information.

Cooperative Family-of-Elements Teams

1. After the individual assignments are complete, have students meet in family-of-elements teams (based on valence electron configurations) to compile and examine properties.
2. Have each team make a spreadsheet to compile quantitative data (boiling point, melting point, density, radius, conductivity, and ionization potential) and use the spreadsheet to make a graph(s) showing changes in properties as a function of atomic number in their family.
3. Ask teams to determine which element(s) are missing from their families and to use their graphs, as well as other information collected, to predict properties of the missing element(s). Allow students to refer back to the computer databases to verify predictions.
4. Have each team prepare and submit a summary of the family properties that includes their graphs, the predictions for the missing elements, and an evaluation of the accuracy of the predictions. Evaluate these summaries for accuracy and completeness.
5. Allow time for each team to prepare a presentation for the “family reunion scrapbook.” Presentations may be in the form of a poster, electronic slide presentation, or Web pages that share the team’s family-of-elements information with the rest of the class.

Assessment

- **Questions**

Give each student a copy of the attached template for the periodic table. As students view the family reunion scrapbook, direct them to summarize family descriptions and trends on the template. Then, ask students to use the family information to identify trends across periods and to annotate their periodic table. Focus students’ attention on answers to the following questions:

- How do valence electron configurations change going across periods?
 - Where are the families that commonly form anions? That form cations?
 - How do boiling point, melting point, and density change?
 - What trends in atomic radius, shielding effect, first ionization energy, and electronegativity can you identify?
- **Journal/Writing Prompts**
 - Relate trends in atomic radius to trends in one other variable.
 - **Other**
 - Students’ work in the classroom provides an opportunity for authentic assessment of group interactions: using time and resources effectively, working cooperatively, and enlisting the suggestions and contributions of each team member. Develop rubrics for evaluating students’ completion of independent element assignments, participation in the team’s work, and the family reunion scrapbooks. Make the rubrics available to students before they begin work on the project. The scrapbooks can be evaluated according to completeness and accuracy of information presented, evidence of contributions by all team members, evidence that the standards listed for this project have been met, and the effectiveness of the graphical and visual representations of family properties.

Extensions and Connections (for all students)

- Have students model electron dot diagrams for elements, using index cards with the element symbol and atomic number and small candies or dried beans to represent valence electrons.
- Have students use these models to demonstrate the formation of cations and anions. These models can be used in subsequent activities to model oxidation–reduction and the formation of ionic and covalent bonds, as well as Lewis dot diagrams for covalent molecules.

Strategies for Differentiation

- Provide visual symbols, pictures of elements, and/or actual element samples as they are found in nature.
- Have students use Web images or a draw/paint program to give visual representations of each characteristic investigated.
- Have students use interactive applications/Web animations found on the Internet to visualize characteristics named in Procedure #2.
- Invite a local pharmacist to do a presentation on elements.
- For Procedure #2 characteristics, have students focus on one or two characteristics at a time and in small groups to identify trends and relationships within their assigned periodic table group.
- Have groups do a summary presentation of how two or three of the investigated characteristics are connected to one another.

Periodic Table of the Elements

Name: _____ Date: _____

1																	18	
	2												13	14	15	16	17	
		3	4	5	6	7	8	9	10	11	12							

Directions

1. Add group and period numbers to this periodic table.
2. Write the symbol, and fill in the Lewis Dot Diagrams for the first four rows and all elements in groups (columns) 1, 2, and 13–18.
3. Use a colored pencil to shade in the two columns where electron configurations end with s^1 and s^2 .
4. Find the six columns that end with a “p” sublevel, and shade these in with a different color.
5. Use a third color to shade in the columns that are filling “d” sublevels.
6. Annotate the table with some sample data to show how boiling point, melting point, and density change across periods.
7. Use colored arrows to show trends in atomic radius, shielding effect, first ionization energy, and electronegativity, going down groups and going across periods. Be sure to provide a color code for the arrows.