Chemical Bonds

Strand Matter

Topic Investigating ionic and covalent bonds

Primary SOL PS.4 The student will investigate and understand the organization and use of the periodic table of elements to obtain information. Key concepts include
c) formation of compounds through ionic and covalent bonding.

Related SOL PS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
k) research methods are used to investigate practical problems and questions;
m) models and simulations are constructed and used to illustrate and explain phenomena.

PS.2 The student will investigate and understand the nature of matter. Key concepts include
b) elements, compounds, mixtures, acids, bases, and salts.

Background Information

Compounds are formed when two or more elements chemically combine. Elements form compounds by filling their outermost energy level of electrons. Once an atom's outermost energy level is full, the atom becomes relatively stable. There are two types of compounds covered in this lesson—ionic and covalent.

One way an element can fill its outermost energy level is by either gaining or losing valence electrons. Two or more ions held next to each other by electrical attraction creates an ionic compound. One of the ions in an ionic compound has a positive charge (called a cation) and the other has a negative charge (anion). Cations are usually metal ions and anions are either nonmetals or polyatomic ions (ions with more than one atom).

Atoms can fill their outermost energy level by sharing electrons creating a covalent bond. Instead of metals bonding with nonmetals as in ionic compounds, nonmetals, and metalloids covalently bond only with other nonmetals and metalloids. Molecules are compounds where the atoms are bonded covalently.

Materials

- Resource materials on ionic and covalent bonding
- Construction or white paper
- Drawing utensils

Vocabulary

compound, covalent bond, ion, ionic bond

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

Introduction

1. Have students think about the ways an object owned by Person A can be used by two people. *(The object can be kept by Person A; or the object can be transferred to Person B; or the object can be shared between the two.)*
2. Inform students that atoms have the same arrangement with electrons. Noble gases tend to keep their electrons. Elements from Groups 1 and 2 on the periodic table tend to transfer their electrons to Groups 16 and 17. Elements in the center of the periodic table tend to share electrons.

Procedure

1. Organize students into teams of two students each, and have pairs research the concepts of ionic and covalent bonds. Be sure to give the major topics that students are expected to include: concepts of ionic and covalent bonds, diagrams with ionic and covalent bonds, examples of ionic and covalent bonds, and the location on the periodic table that most likely will result in ionic or covalent bonds. They are to demonstrate to the teacher that they have acquired enough knowledge on the characteristics of ionic and covalent bonding to apply it to a relevant model.
2. Students should work collaboratively from their research to design an illustration of a model for ionic and covalent bonding. The model should include the main characteristic of ionic bonding (transfer or giving away) and of covalent bonding (sharing) as well as locations on the periodic table that may help predict the resulting type of bond. Models could take a metaphorical approach, using real-world, non chemistry-related symbols for the ionic and covalent bonding processes.
3. Students should be encouraged to use a variety of ways to demonstrate their knowledge, such as through visual aids (e.g., poster, presentation software, 3-D modeling), role-play, or creative writing (e.g., song, poem).

Observations and Conclusions

1. Ask students to work together in a group of four (two pairs) to summarize the things they learned about ionic and covalent bonding. Instruct each group to evaluate the models by making T-charts that list each model's benefits and drawbacks. Allow each group to share one or two ideas that were learned (or clarified) from the 4-person group discussions.
2. Place or draw a large T-chart on the board and accumulate the benefits and drawbacks of all the models. Discuss one of the benefits of modeling: how they help simplify and explain complex phenomena. Then discuss one of the drawbacks or limitations of modeling: how the models could not explain all of the characteristics of the phenomena.

Assessment

- **Questions**
  - What are ions?
  - How does an atom become an ion?
  - Why do atoms form bonds with other atoms?

  - How would you compare and contrast ionic and covalent bonding? Provide at least two examples of each.
- **Other**
  - Make cards with elements that would form ionic bonds and ones that might form covalent bonds. Using a periodic table as a tool, have students predict the type of bond formed and justify their predictions.

Extensions and Connections (for all students)

- Have students write a children's book that would describe the types of bonds.
- Have students research the characteristics of compounds that have ionic bonds and substances that have covalent bonds.

Strategies for Differentiation

- Provide students with the main characteristics of ionic and covalent bonds and have them sort each characteristic into a chart. Include examples of each bond.
- As an extension and connection, have students create a non verbal cartoon strip, rather than a children's book, to describe the types of bonds.
- Allow students to create and provide a presentation to demonstrate their knowledge of the material.
- Have advanced students research polyatomic ions to explain how they bond, and have them draw a diagram of an example.