Lesson Title	Bonding Over Silicate Gardens
Length of Lesson	30 minutes
Created By	Erin Anderson
Subject	Chemistry
Grade Level	9-12
State Standards	5a, c; 6A, 6b, 6c
DOK Level	II, III
DOK Application	Classify, Explain Phenomena in Terms of Concepts
National Standards	B. Physical Science
Graduate Research Element	**POLAND LESSON:** Ionic bonds are most prevalent in mineral formation, especially where sulfides are concerned in bays.

Student Learning Goal: Understand that hardness relates to bond strength. Using a double replacement reaction, we are able to form metal silicate minerals in just a few seconds, by adding crystallized metal chlorides into a sodium silicate solution. These types of reactions occur all the time in water, where ionic bonds easily separate into ions that are ready to be combined with different ions and/or charged species.

State Standards:
5A. Describe what determines covalent, ionic, and metallic bonds.
5C. Relate bond type of the position of elements on the Periodic table, electron configuration, and properties of the compound formed.
6A. Write chemical formulas of ionic compounds using monatomic and polyatomic ions.
6B. Write chemical formulas of molecular compounds using prefixes.
6C. Write names of compounds from their formulas.

National Standards: B. Physical Science: Structure and properties of matter & Chemical Reactions

- Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. These outer electrons govern the chemical properties of the element.
- Bonds between atoms are created when electrons are paired up by being transferred or shared. A substance composed of a single kind of atom is called an element. These atoms may be bonded together into molecules or crystallize solids. A compound is formed when two or more kinds of atoms bind together chemically.
- The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of

the molecule, including the constituent atoms and the distances and angles between them.

Materials Needed (supplies, hand-outs, resources): 15 mason jars, 1 L sodium silicate solution, iron chloride (yellow), copper chloride (light green), cobalt nitrate (dark blue), manganese nitrate (white), zinc sulfate (white), sand, weigh boats (3), solid bismuth, solid gallium, solid copper.

Lesson Performance Task/Assessment:
Students will divide into groups of 5. They will have a worksheet to answer (see Teacher's Notes for link to worksheet). First, they will describe what an ionic bond is and how the strength of the ionic bond relates to covalent bonds and metallic bonds. They must give examples of each type of bond. Coat the bottom of each mason jar with a layer of sand. Students should calculate how much water and sodium silicate solution they need to mix for a 1:5 ratio of sodium silicate to water. If the mason jar volume is 100 ml, students should need to mix 80 ml of tap water with 20 ml of sodium silicate solution. Students will carefully drop in a crystal of each metal chloride into their jars to create their own silicate garden, filled with ionic bonds. Wait for 10 minutes for the gardens to form.

Lesson Relevance to Performance Task and Students:
Students are creating ionic bonds, which is what the lesson is all about!

Anticipatory Set/Capture Interest: Have several different solid metals lying in weigh boats. Scratch metals with finger nails. Scratch metals against each other. Show that metallic bonds are fairly weak.

Guided Practice:
1. Is the hardness of a solid related to bond strength?
2. What kind of bond is sand?
3. Why does sand not react with the sodium silicate solution?
4. What would happen if we dropped solid metal into the solution?

Independent Practice: Students will create their silicate gardens, carefully writing out the reactions that are occurring and the new bonds that are forming. Color changes will also be noted.

Remediation and/or Enrichment: All IEP's will be supported. For remediation, I will be available for questions. If needed, the different bond types will be recovered. For enrichment, we will discuss ionic bonds that exist in everyday life.

Check(s) for Understanding:
1. What type of bond did we create when we made our silicate garden?

2. What kind of bond is sand?
3. Does a covalent bond ever contain a metal?

Closure: Students will complete their silicate gardens and worksheet.

Possible Alternate Subject Integrations: Art, Earth Science

Teacher Notes:

Supplemental worksheet was found at this website:
http://www.colinamiddle.net/dmatras/Chapter%205/pages/Ionic%20Bonding%20Worksheet-1.pdf