NATURE OF SALT

NASA SUMMER OF INNOVATION

UNIT
Physical Science – States of Matter

GRADE LEVELS
4th -6th

CONNECTION TO CURRICULUM
Science

TEACHER PREPARATION TIME
10 minutes

LESSON TIME NEEDED
45 minute *Complexity: Basic*

LESSON DESCRIPTION
Students examine the molecular structure of salt and the elements that compose it.

OBJECTIVES
Students will:

- Explain the general relationship between an element's Periodic Table Group Number and its tendency to gain or lose electron(s).
- Explain the difference between molecular compounds and ionic compounds.
- Use a model to demonstrate sodium chloride's cubic form which results from its microscopic crystal lattice.
- Describe the nature of the electrostatic attraction of the oppositely charged ions that holds the structure of salt together.

NATIONAL STANDARDS

National Science Education Standards (NSTA)
Science as Inquiry

- Understanding of scientific concepts
- Skills necessary to become independent inquirers about the natural world

Physical Science

- Properties of objects and materials

MANAGEMENT
It is suggested that the “Electrolysis of Water” activity listed in the additional resources section of this lesson be performed prior to introducing this lesson to students. It can be done as a demonstration or as a full engagement activity with students.

CONTENT RESEARCH
Chemically, table salt consists of two elements, **sodium** (Na) and **chloride** (Cl). Neither element occurs separately and free in nature, but are found bound together as the **compound** sodium chloride. It occurs naturally in many parts of the world as the **mineral** halite and as mixed **evaporites** in salt lakes. Seawater contains an average of 2.6% (by weight) sodium chloride, or 78 million metric tons per cubic kilometer, an inexhaustible supply. Table salt, when viewed with a magnifying glass, can be seen to consist of tiny, cube-shaped flakes. - *From The Salt Institute*.

Did you ever wonder why the oceans are filled with salt water instead of fresh? Just where did salt come from? And is it the same salt you find on a dining room table? Most of the salt in the oceans came from land. Over millions of years, rain, rivers, and streams have washed over rocks containing the compound sodium chloride (NaCl), and carried it into the sea. Some of the salt in the oceans comes from undersea **volcanoes** and **hydrothermal vents**. When water evaporates from the surface of the ocean, the salt is left behind. - *From the Office of Naval Research*

MATERIALS

- Periodic Table
- Chemistry reference book or web access (optional)
- Spheres of styrofoam (some spheres should be about twice the size of others)
- Clay
- Toothpicks
- Straws

A LIST OF KEY CONCEPTS

- **Molecular compounds** are made of individual molecules that are bound together by shared **electrons**.
- **Ionic compounds** consist of two or more ions that are held together by electrical attraction. One of the ions has a positive charge (called a **cation**) and the other has a negative charge (termed **anion**).
- **Salt** is an ionic compound, consisting of a crystal, lattice structure of the two ions Na+ and Cl-.

MISCONCEPTIONS

- Salt water is full of sodium chloride molecules.
- Salt is NOT made of NaCl molecules. Salt is made of a three dimensional checkerboard of oppositely charged atoms of sodium and chlorine. A salt crystal is like a single gigantic molecule of ClNaClNaClNaClNaClNa. When salt dissolves, it turns into independent atoms.
- Salt water is not full of "sodium chloride." Instead it is full of sodium and chlorine. The atoms are not poisonous and reactive like sodium metal and chlorine gas because they are electrically charged atoms called "ions." The sodium atoms are missing their outer electron. Because of this, the remaining electrons behave as a filled electronic shell, so they cannot easily react and form chemical bonds with other atoms except by electrical attraction. The chlorine has one extra electron and its outer electron shell is complete, so like sodium it too cannot bond with other atoms. These oppositely charged atoms can attract each other and form a salt crystal, but when that crystal dissolves in water, the electrified atoms are pulled away from each other as the water molecules surround them, and they float through the water separately.

LESSON ACTIVITIES

Students use salt to investigate ionic and molecular compounds. (http://aquarius.nasa.gov/nature_of_salt.html)

ADDITIONAL RESOURCES

Electrolysis of salt water
http://aquarius.nasa.gov/electrolysis.html

Poster of a periodic table.
http://www.nasa.gov/pdf/190388main_Cosmic_Elements_Poster_Front.pdf

DISCUSSION QUESTIONS

Where does salt come from? There's a huge amount of salt in the world -- about 3.5% of the weight of the world's oceans plus massive underground (and underwater) deposits. *It occurs naturally in many parts of the world as the mineral halite and as mixed evaporates in salt lakes. Most of the salt in the*

oceans came from land. Some of the salt in the oceans comes from undersea volcanoes and hydrothermal vents.

Why is the ocean salty? *Seawater contains an average of 2.6% (by weight) sodium chloride, or 78 million metric tons per cubic kilometer, an inexhaustible supply.*

What is salt used for? *Salt has 14,000 known uses. Manufacturing textiles, glass, rubber, leather, even drilling oil wells, depends on salt. Common uses of salt include seasoning of food, deicing for safe roads, feeding animals and plants, and softening hard water.*

Will salt dissolve in all liquids? *No. In process of dissolving, molecules of the solute are inserted into a solvent and surrounded by its molecules. In order for the process to take place, molecular bonds between molecules of solute (i.e. salt) have to be broken and molecular bonds of the solvent also have to be disrupted. Both of these require energy. When sugar dissolves in water, new bonds between salt and water are created. During this process energy is given off. The amount of this energy is sufficient to break bonds between molecules of salt and between molecules of water. Salts are built of positive and negative ions which are bound together by the force of attraction of their opposite charges. If energy needed to break their ionic bounds is lower then the energy given off by an interaction of the ions with solvent (i.e. water), the salts will dissociate and interact with solvent and thus dissolve. If the bonds between solvent or solute are too strong and there is not enough energy provided while dissolving to brake them, the solute will not dissolve.*

ASSESSMENT ACTIVITIES
The activity description includes a suggested student worksheet to assess understanding.

ENRICHMENT
Consider using the following activity to enrich the concepts taught in this lesson.

Study gravity-driven fluid flow caused by differences in solution density.
http://www.nasa.gov/pdf/315955main_Microgravity_Gravity_Driven.pdf