Elements of Chemistry
The Periodic Table
Teacher's Guide

Grade Level: 9–12	**Curriculum Focus:** Physical Science	**Lesson Duration:** Two class periods

Program Description

Introduce students to the most important organizing tool of modern chemistry, the periodic table of the elements. Students learn how the table was developed and why elements have specific positions.

Onscreen Questions

- How did Dmitri Mendeleyev develop the periodic table?
- What patterns are in the periodic table?
- How has scientific knowledge of the elements benefited people?
- Why is it important to ingest iodized salt?

Lesson Plan

Student Objectives

- Describe the atomic structure of an element.
- Organize the first 18 elements of the periodic table according to their atomic mass, number of electron shells, and valence electrons, then compare their order within the periodic table.
- Identify common physical properties and uses of elements within a family.

Materials

- *Elements of Chemistry: The Periodic Table* video
- Computer with Internet access
- Periodic table
- Index cards

Procedures

1. Create a card for each of the first 18 elements of the periodic table. Include the following information at the top of each card, leaving at least half of the card empty so that students can fill in more information:

    - Atomic number
    - Element symbol
    - Atomic name
    - Atomic mass

    Make enough copies of these cards so that small groups of students will each have one set. Also, make sure that all classroom periodic tables are put away or covered up.

2. Review the definition of an element and an atom. Next, review the basic structure of an atom, including the nucleus, protons, neutrons, and electrons. Choose one of the first 18 elements on the periodic table. Show the class how to draw a model for that element using the element's atomic number and atomic mass. Point out how many electron shells are in the model, as well as the number of valence electrons, or electrons in the outermost shell.

3. Divide the class into small groups. Give each group one set of element cards (one for each of the first 18 elements on the periodic table.) Based on the facts on the card, ask groups to fill in the bottom of each card with the following information:

    - Number of protons, electrons, and neutrons
    - A model of an atom of that element
    - Number of electron shells in the atom
    - Number of valence electrons

4. Next, ask each group to arrange their cards in order using the following rules:

    - Cards must be placed in the order of their atomic number.
    - All cards in the same column must have the same number of valence electrons.
    - All cards in the same row must have the same number of electron shells.

5. When groups have completed this task, reveal a periodic table to the class. Ask them to compare the order of their cards with the order of the periodic table.

6. Point out that the periodic table is arranged according to the same rules they used. The rows of the periodic table are called "periods," and the columns are called "groups." Since elements in the same group have the same number of valence electrons, they react in similar ways. This is why elements in the same group have similar properties.

7. Point out the elements that fall in the center of the periodic table. They are called "transitional elements." The groups and periods of these elements follow the same basic rules, but their electrons are configured differently. All of the elements in this block have the same number of valence electrons because electrons are added to interior shells instead of the valence shell.

8. Identify the following families on the periodic table, and assign one to each classroom group:
    - Halogens
    - Noble gases
    - Alkali metals
    - Alkaline Earth metals
    - Transition metals

9. Have students work with a partner to determine the physical properties of one element in their assigned family: density, boiling point, melting point, and conductivity. In addition, ask them to name at least two common uses for that element.

10. Have partners share what they learned with their groups. Discuss and identify common physical properties of elements within their family. Were elements in that family used in similar ways?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students produced accurate cards for the first 18 elements of the periodic table, including all of the requested information; showed a clear understanding of atomic number, valence electrons, and electron shells by placing their cards in the correct order; worked well within their group to identify several common properties of elements within their assigned family.
- **2 points:** Students produced adequate cards for the first 18 elements of the periodic table, including most of the requested information; showed a satisfactory understanding of atomic number, valence electrons, and electron shells by placing most of their cards in the correct order; worked well within their group to identify some common properties of elements within their assigned family.
- **1 point:** Students produced inaccurate cards for the first 18 elements of the periodic table, including little of the requested information; showed an unsatisfactory understanding of atomic number, valence electrons, and electron shells and could not place their cards in the correct order; had difficulty working within their group and could identify few or none of the common properties of elements within their assigned family.

Vocabulary

alloy

Definition: A solid substance made by mixing a metal with another substance, usually another metal, to have specific properties that metals alone lack

Context: The earliest metalworkers combined different elemental metals in search of the best alloys for weapons and tools.

element

Definition: A substance composed of one type of atom and cannot be chemically separated

Context: Antoine Lavoisier was the first to define an element as a pure substance that cannot be broken down.

group

Definition: A column or group of columns in the periodic table; elements in one group have the same number of electrons in the outermost shell

Context: Elements in each group share similar chemical properties.

period

Definition: A row of the periodic table; each row corresponds to the number of electron shells in an atom of the elements in that row

Context: The elements in the second period each have two electron shells, and the elements in the sixth period have six electron shells.

periodic table of the elements

Definition: An organization of Earth's elements arranged according to atomic number, the number of protons each element's nucleus contains

Context: The structure of the periodic table corresponds directly to atomic structure. This makes the table an invaluable tool for determining the property and behavior of elements and predicting how they will interact.

semiconductor

Definition: An element that conducts electricity at higher temperatures, but stops electricity from flowing at lower temperatures

Context: The temperature of silicon transistors determines whether they conduct or block electrical currents.

valence electrons

Definition: The electrons contained in the outermost shell in an atom of an element; the electrons available for chemical bonding

Context: All the transition metals have the same number of valence electrons because electrons are added to interior shells instead of the valence shell.

Academic Standards

National Academy of Sciences

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K–12. To view the standards, visit this Web site:

http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following science standards:

- Physical Science: Structure and properties of matter

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Physical Sciences: Understands the structure and properties of matter; Understands the nature of scientific knowledge
- Technology: Understands the nature of technological design

DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How to Use the DVD

The DVD starting screen has the following options:

Play Video—This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index—Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. To play a particular segment, press Enter on the remote for TV playback; on a

computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

***Curriculum Units*—**These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

***Standards Link*—**Selecting this option displays a single screen that lists the national academic standards the video addresses.

***Teacher Resources*—**This screen gives the technical support number and Web site address.

Video Index

I. A Need for Order (2 min.)

Discover how the development of modern chemistry can be traced to medieval alchemists looking for the secret to eternal life and wealth.

II. Mendeleyev's Insight (2 min.)

Learn how the Russian chemist Dmitri Mendeleyev revolutionized the study of chemistry with his creation of the periodic table of the elements.

III. Today's Table (4 min.)

Learn about modern scientific contributions that have modified Mendeleyev's original periodic table.

IV. A Tour of the Table (16 min.)

Explore the elements that help us travel in space, build stronger ships, use computers effectively, mend broken bones, and safely fight fires.

V. The Man Who Saved a Million Brains (25 min.)

Travel to Tibet, China, and Australia and discover how a doctor promotes the use of iodine to fight a serious disorder.

Curriculum Units

1. The Original Periodic Table

Pre-viewing question
Q: What do you know about Dmitri Mendeleyev?
A: Answers will vary.

Post-viewing question
Q: What made Mendeleyev's discovery about the elements so revolutionary?
A: Mendeleyev's discovery about the Earth's elements was revolutionary because he left gaps for undiscovered elements, for which he predicted their properties. The scientific community laughed at Mendeleyev until a French scientist discovered one of his predicted elements in 1875.

2. Rearranging the Periodic Table

Pre-viewing question
Q: What kinds of information does the periodic table include?
A: The table includes the name of each element, along with its atomic mass, atomic number, and symbol. The table also includes groups and periods of the elements.

Post-viewing question
Q: What is the periodic law?
A: The guiding principle of the periodic table is known as the periodic law, which states, "When elements are arranged in order of increasing atomic number, their physical and chemical properties show a periodic pattern."

3. Helium and the Space Shuttle

Pre-viewing question
Q: What makes it possible for humans to travel in space?
A: Answers will vary.

Post-viewing question
Q: What role does helium play in the operation of the space shuttle?
A: A space shuttle's orbital maneuvering system, or OMS, requires helium to operate. To ignite it, helium gas is released, which forces other liquids from their tanks into the engine, where they combine and ignite. Because it has a full valence shell, helium is completely inert, so there is no danger of reacting with the fuel or the oxidizer. This prevents any loss of usable fuel as well as minor damaging explosions.

4. Silicon as a Semiconductor

Pre-viewing question
Q: How do you use computers?
A: Answers will vary.

Post-viewing question
Q: How does a semiconductor react to temperature changes?
A: At high temperatures, semiconductors conduct electricity as if they were metals. At low temperatures, they act as insulators, stopping electrical currents from flowing.

5. Calcium and Bones

Pre-viewing question
Q: What kinds of things contain calcium?
A: Answers will vary.

Post-viewing question
Q: How do our bodies use calcium?
A: Calcium helps regulate the heart, clots the blood, and forms and maintains bones and teeth. As much as 90 percent of the body's calcium is in the bones. It exists in the form of phosphate and carbonate salts.

6. Steel and Steel Alloys

Pre-viewing question
Q: What are some uses of steel and steel alloys?
A: Answers will vary.

Post-viewing question
Q: How is steel created?
A: Steel is molten iron ore with added carbon. When iron is heated, its crystal structure expands and it absorbs the smaller atoms of carbon. As iron cools, the carbon is trapped inside the iron molecules, which creates steel, a much stronger metal.

7. Bromine Fights Fires

Pre-viewing question
Q: What ingredients are necessary for a fire to burn?
A: A fire needs heat, fuel, and oxygen.

Post-viewing question
Q: How does a brominated flame retardant work to fight the spread of fire?
A: A brominated flame retardant, or BFR, reduces combustibility and hinders the spread of fire. The bromine in a BFR disrupts the chain reaction that keeps fire burning, so it effectively extinguishes a flame, which is the component that allows fire to spread.

8. Iodine Deficiency

Pre-viewing question
Q: Why is iodine an important nutrient for the human body?
A: Iodine is needed for normal cell metabolism, which converts food to energy. Normal thyroid function and thyroid-hormone production depends on iodine.

Post-viewing question
Q: Why is there iodine deficiency in some areas of the world?
A: In Tibet and similar areas, glacial conditions and high altitudes deplete iodine in water and the soil.