Elements of Chemistry
Compounds and Reactions
Teacher's Guide

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

Program Description

Explore how fewer than a hundred elements combine to form the millions of substances found in the universe. Students will learn about a variety of chemical reactions, including electrochemistry.

Lesson Plan Summary

Students think about common substances and the elements they are made of before selecting several to investigate. They predict the substances' elements and research their chemical composition. Then they write a paragraph describing the chemical composition of each substance and how it is used. Students share their results to create a class list of what they learned.

Onscreen Questions

- How do changes in matter affect life on Earth?
- What are some useful chemical reactions?
- What role did hydrogen play in powering the Hindenburg?
- How might hydrogen have contributed to the Hindenburg disaster?

Lesson Plan

Student Objectives

- Identify common substances and predict the elements they are made of.
- Discover some common substances and their chemical composition.
- Identify elements in common substances and describe how they form compounds.
- Write a description of the substance and how it is used.

Materials

- *Elements of Chemistry: Compounds and Reactions* video
- Computer with Internet access
- Paper and pencils
- Newsprint and markers

Procedures

1. Begin the lesson by asking students to write down some common substances they use every day, such as shampoo, toothpaste, sunscreen, and cleaning fluids. Then ask them to write down the elements they think these substances are made of. Have students put away the papers until the end of the lesson.
2. Tell students that they will work in small groups to learn about the chemical composition of common substances. Then take a few moments to assign students to their groups.

Note: For this lesson, each group will need access to a computer. Make sure that students can have some computer time so that they can complete the lesson.

3. Tell students to visit the American Chemical Society Web site below, which lists a collection of 52 common substances. http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2%5C1rp%5Crp1.html.
4. Each group of students should do the following:
   - Choose at least 15 substances to focus on. Possible choices include the following sunscreen, toothpaste, licorice, chocolate, or lipstick.
   - Predict the elements each substance is made of.
   - Click on the substance and read the description. Identify the elements and read how they form the compounds that make up the substance.
   - Write a brief paragraph describing why the substance is useful and at least two additional facts about it.
5. Before students begin work on the activity, have them watch the video *Elements of Chemistry: Compounds and Reactions.* The first three segments ("A Matter of Change"; "Bonds: Keeping It Together"; "Reacting to Chemical Changes") give background information that will help students complete the lesson.
6. Give students time in class to work on this activity. Remind students to complete all three parts of the assignment.
7. During the next class period, allow students to finish the assignment if necessary. Then bring the groups together to share results.

8. Keep a class list of products the students investigated. Include the name of the substance and a brief description. A sample entry for sunscreen is shown below.

   Sunscreen
   Sunscreen protects our skin from the dangers of the sun's ultraviolet rays. Sunscreens are organic or inorganic. Organic sunscreens use organic compounds such as octyl methoycinnamate. Inorganic sunscreens mix the element titantium with dioxide and zinc with oxide. To create the most powerful combinations, inorganic and organic sunscreens may be combined.

9. Conclude the lesson by asking students to revisit the lists from the beginning of the lesson. What have they learned about how common substances are produced? How would they modify their original ideas?

Assessment

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

- **3 points:** Students made thoughtful predictions about what each substance was made of; researched each substance thoughtfully and carefully; and wrote clear, accurate descriptions of each substance.
- **2 points:** Students made satisfactory predictions about what each substance was made of; researched each substance adequately; and developed satisfactory descriptions of each substance.
- **1 point:** Students had difficulty making predictions about what each substance was made of; did not complete research of the substances; and did not write descriptions of each substance.

Vocabulary

atom

Definition: The smallest unit of an element

Context: Democritus, a Greek philosopher who lived around 440 B.C, was one of the first people who believed that matter was composed of tiny particles, which he called *atomos*, Greek for "uncuttable."

chemical change

Definition: A change in the chemical composition of two elements as a result of the formation of bonds between atoms

Context: During a chemical change, the elements rearrange and may look different, but the original number of atoms remains unchanged.

compound

Definition: A substance made of two or more elements chemically combined in a specific way

Context: The elements in a compound combine to form a new substance.

element

Definition: A substance that cannot be broken down into any other substances through physical or chemical reactions

Context: The known elements are organized in a periodic table.

compound

Definition: A substance composed of atoms of two or more elements in chemical combination

Context: Many materials are compounds, which are comprised of several atoms held together by invisible forces.

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 national standards:

- Physical Science: Structure and properties of matter; Chemical reactions

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
- Language Arts: Viewing—Uses viewing skills and strategies to understand and interpret visual media; Writing: Uses the general skills and strategies of the writing process, Gathers and uses information for research purposes; Reading: Uses reading skills and strategies to understand and interpret a variety of informational texts

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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 Matter of Change (4 min.)
Examine physical, chemical, and nuclear changes in matter and see how they help shape the power of the universe.

II. Bonds: Keeping It Together (6 min.)
Learn how ionic and covalent bonds occur and examine the importance of valence electrons to both types of compounds.

III. Reacting to Chemical Change (6 min.)
Investigate different kinds of chemical reactions and explore the processes of oxidation and combustion.

IV. What Caused the Hindenburg Disaster? (34 min.)
Investigate the cause of the Hindenburg airship disaster and find out more about this terrible tragedy.

Curriculum Units

1. Changes in Matter

Pre-viewing question
Q: What are the three states of matter?
A: The three states of matter are solid, liquid, and gas.

Post-viewing question
Q: What is the difference between a chemical change and a mixture?

A: A chemical change alters the chemical composition of a substance. A mixture combines substances but does not change them chemically.

2. Ionic and Covalent Compounds

Pre-viewing question
Q: What chemical compounds might you use often?
A: Answers will vary.

Post-viewing question
Q: How are ionic bonds formed?
A: The opposite positive and negative ions attract each other to form ionic bonds.
A neutral atom becomes a positively charged ion when it loses a valence electron. If an atom gains valence electrons it would become a negative ion.

3. Chemical Reactions, Oxidation, and Combustion

Pre-viewing question
Q: What is a chemical reaction?
A: A chemical reaction is a process in which one or more substances are converted into new substances with different physical and chemical properties.

Post-viewing question
Q: How do synthesis, single replacement, and double replacement reactions differ?
A: A synthesis reaction is a union of substances to make a new compound. A single replacement reaction displaces one element in a compound with another. A double replacement reaction is an exchange of elements to form new compounds.

4. The First Hindenburg Investigation

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

Post-viewing question
Q: What were some problems with the initial Hindenburg inquiry?
A: The initial Hindenburg inquiry was closed in 18 days. The final report was published before all the forensic tests had been done, and some critical information was missing. Also, the investigation took the Zeppelin Company's word about what had happened, rather than investigate further. Only two experienced pilots were consulted for the inquiry, and neither was impartial.

5. Hydrogen and the Hindenburg

Pre-viewing question
Q: What are some uses of hydrogen?

A: Answers will vary.

Post-viewing question
Q: Why was the Hindenburg inflated with hydrogen instead of helium?
A: The Hindenburg was originally designed for helium; but it was a German ship and the only helium suppliers were in America, and the export of helium was restricted. And unlike helium, hydrogen will burn if it mixes with oxygen.

6. Timeline of Disaster

Pre-viewing question
Q: How are timelines helpful when analyzing history?
A: Answers will vary.

Post-viewing question
Q: Based on the timeline of events, what do you think caused the Hindenburg disaster?
A: Answers will vary.

7. Fuel Leak

Pre-viewing question
Q: Give examples of major historic disasters and accidents and how were they caused?
A: Answers will vary.

Post-viewing question
Q: Why do modern investigators believe in at least one probable fuel leak on the Hindenburg?
A: Modern investigators feel that at least one fuel leak was more than likely.
The airship encountered strong headwinds crossing the Atlantic; approached its landing site at 80 miles an hour; and took a tight turn—all circumstances that would have stressed its frame, electrical line, and fuel lines

8. The End of the Airship Era

Pre-viewing question
Q: Have you ever conducted an inquiry or investigation?
A: Answers will vary.

Post-viewing question
Q: With modern knowledge of what happened to the Hindenburg, how safe might airship travel be today?
A: Answers will vary.