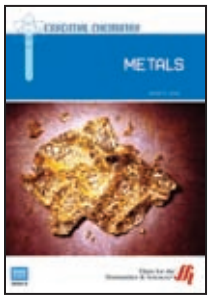

Films for the Humanities & Sciences®

Instructor's Guide

Essential Chemistry
METALS

Introduction

This Teacher's Guide provides information to help you get the most out of *Metals.* The contents of the guide will allow you to prepare your students before using the program and to present follow-up activities to reinforce the program's key learning points.

The five-part *Essential Chemistry* series covers core chemistry concepts in a fast-paced, straightforward style. After watching the films, students should have a grasp of the basics of states of matter, the periodic table, chemical reactions, metals, and atoms, molecules, and compounds. Subject matter experts explain these topics in a clear, concise manner, making them both interesting and transparent to students. Accompanying visuals bring chemical reactions and technical explanations to life. Overall, the five films in this series are practical, easy to understand, and should help students clarify the building blocks of the science of chemistry.

The series includes the following titles:

- *Atoms, Molecules, and Compounds*
- *Chemical Reactions*
- *Metals*
- *The Periodic Table*
- *States of Matter: Gases, Liquids, and Solids*

Learning Objectives

After viewing the program, students will be able to:

- Describe how metals play a role in many areas of everyday life
- Distinguish between alkali, alkaline earth, and transition metals
- Describe individual elements in each metal group
- Explain chemical reactions involving metals
- Define compounds and alloys

Educational Standards

National Standards

This program correlates with the National Education Standards Overview from the National Academies of Science. The content has been aligned with the following educational standards and benchmarks from this organization.

- The physical properties of compounds reflect the nature of the interactions among their molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.
- Chemical energy is associated with the configuration of atoms in molecules that make up a substance. Some changes of configuration require a net input of energy whereas others cause a net release.
- Increased knowledge of the properties of particular molecular structures helps in the design and synthesis of new materials for special purposes.

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English Language Arts Standards

The activities in this Teacher's Guide were created in compliance with the following National Standards for the English Language Arts from the National Council of Teachers of English.

- Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English, copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

Technology Standards
The activities in this Teacher's Guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project.

- Creativity and Innovation: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
- Critical Thinking, Problem Solving, and Decision Making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

The National Education Technology Standards reprinted with permission from the International Society for Technology Education.

Program Overview

On the periodic table, three-quarters of all the elements are classified as one sort of metal or another. Divided into five sections, this program provides a thorough overview of metals: Metals in Our World (includes iron, lithium, magnesium, mercury, potassium, silver, sodium, uranium, zinc); Alkali Metals (history and properties of lithium, sodium, potassium, rubidium, cesium, francium); Alkaline Earth Metals (history and properties of beryllium, magnesium, calcium, strontium, barium, radium); Transition Metals (properties of iron, cobalt, nickel, copper, silver, gold, zinc, cadmium, mercury); and Metals and Chemical Reactions (exothermic and endothermic reactions, oxidation and combustion reactions, acid/base reactions).

Main Topics

Topic 1: Metals in Our World
Approximately 75% of elements are metals, meaning that metals play a huge role in our world and everyday experiences. This section introduces students to some of the ways we interact with metals on a regular basis.

Topic 2: Alkali Metals
Here, students learn more about the specific elements that make up Group 1 on the periodic table.

Topic 3: Alkaline Earth Metals
Here, students learn more about the specific elements that make up Group 2 on the periodic table.

Topic 4: Transition Metals
Here, students learn more about the specific elements that make up Groups 3 through 12 on the periodic table.

Topic 5: Metals and Chemical Reactions
In this final chapter, the film explores different types of chemical reactions in which metals are involved. As many metals are highly reactive with both air and water, reactions such as oxidation and combustion occur. Students are reminded at the close of the film what a significant role metals play in our daily routines.

Fast Facts

- 95% of mined potassium is used in the production of fertilizer.
- Iron has more uses and applications than does any other metal — more than 90% of all metal refined is iron, used in the creation of cars, buildings, and ships, among many other applications.
- Silver is widely used for commercial and industrial purposes, including photographic film and paper. About 25% is used by the electronics industry.
- Mercury is both volatile and toxic — and is easily absorbed into the body. Although it is an effective poison for insects, it has been banned from use in commercial agriculture due to the danger it poses to agricultural workers, and its negative effect on the environment.
- Potassium, discovered in 1807, was the first alkali metal to be identified.
- Lithium is the lightest of the alkali metals — it is soft enough to cut with a knife.
- The alkaline earth metal calcium is the fifth most abundant element in the earth's crust, and has an enormous number of applications.
- Gold, a transition metal, is considered to be valuable because it is rare, durable, and malleable.
- The transition metal mercury is a unique element. It is the only metallic element that exists in liquid form at room temperature, and is a poor conductor of heat, which is unusual for a metal.
- An exothermic reaction gives off energy. An endothermic reaction requires energy to happen. Most reactions are endothermic.

Vocabulary Terms

alkali metals: Elements that make up Group 1 on the periodic table. Alkali metals are highly reactive; a higher atomic number indicates more reactivity. Many play important roles in industry and medicine.

alkaline earth metals: Elements that make up Group 2 on the periodic table. These are slightly less reactive than alkali metals. Calcium and radium are examples of alkaline earth metals.

alloy: A physical mixture of two or more metals.

combustion: A reaction that produces heat and usually light.

compound: A material formed by the chemical combination of elements.

electroplating: To coat/plate with a metallic substance through electrolysis. Nickel is often used in electroplating.

half life: Length of time needed for half of the atoms in a sample to decay.

oxidation: The chemical combination of a substance with oxygen. Rusting is an example of oxidation.

radium: Discovered by Marie and Pierre Curie, this is an extremely radioactive alkaline earth metal with an atomic number of 88. Along with the discovery of the electron and Einstein's theory of relativity, the discovery of radium marked the beginning of the modern era of science.

transition metals: Elements that make up Groups 3 through 12 on the periodic table. Many transition metals are found in pure form in nature. Copper, silver, and gold are examples of transition metals.

Pre-Program Discussion Questions

1. What are some examples of metals? How do you personally use or interact with metals in your daily life?
2. How are metals grouped on the periodic table? Why are they grouped this way?
3. How would you describe the physical appearance of a common metal?
4. How might some metals react with air and water? Do all metals react with air and water?
5. What is an acid? What is a base? Give examples of each.

Post-Program Discussion Questions

1. Name and describe the three groups of metals.
2. What is an alloy? Why is an alloy created? Give an example of a specific alloy and its uses.
3. Describe oxidation and combustion.
4. How would you describe the physical appearance of a metal (such as magnesium or cobalt) discussed in the film?
5. Define 'ductile'. Define 'malleable'. Why are these useful qualities in an element or alloy?

Activity Ideas

- Have students research one of the less common metals from among the three metal groups. They can either summarize their findings in a short paper, or create a presentation for the rest of the class. Details to research should include metal group, atomic number, discovery year, name of scientist(s) who discovered it, appearance, unique or interesting properties, and uses.

- As a class, find and bring in examples of metals (or metal compounds/alloys) to view and compare. This might include silver jewelry, copper wire, a mercury thermometer, table salt, a piece of iron, zinc sunscreen, etc. For each item viewed and reviewed, brainstorm or research common and uncommon ways it is used in everyday and scientific applications.

- As appropriate in a lab setting, create and observe the chemical reactions of oxidation (such as exposing iron to oxygen and creating rust) and combustion (applying a flame to a metal). Remember to do so safely and in a controlled environment. Have students observe how and why these chemical reactions change the appearance of the substances being affected. You may also have students relate some real-life examples of when they have viewed these reactions outside of the lab.

- Ask students to identify and research three alloys. Research should describe the elements in the alloy, why the alloy is created, what its uses are, and how the alloy is more beneficial than an individual element alone. Students might work together in small groups to complete this research.

- Assign Groups from the periodic table to small groups of students. Students should create visual representations of the elements they are assigned, perhaps as an enlarged and illustrated version of part of the periodic table. Students should be creative in adding a depiction of each element — they might use an actual small piece of the element, a photo, or perhaps a portrait of the scientist who discovered it or flag of the country where it was discovered. Have groups present their artwork and explain why they illustrated the elements as they did.

Assessment Questions

1. Which compound is commonly known as table salt?
    a) Sodium nitrate
    b) Sodium lithium
    c) Sodium chloride
    d) Iron sodium

2. Which is the heaviest natural element?

3. Approximately 90% of zinc produced in the U.S. is used for _____.
    a) insect poison
    b) rechargeable batteries
    c) research purposes
    d) galvanized steel

4. True or False? Compounds containing mercury are almost always used in commercial agriculture to deal with pests.

5. Why is magnesium an important component to some alloys?

6. Which are the most reactive metals?
    a) Alkaline metals
    b) Alkali metals
    c) Alkaline earth metals
    d) Transition metals

7. What is an alloy?

8. Which metal helps ensure that the body's enzymes function correctly?
    a) Magnesium
    b) Calcium
    c) Nitrate
    d) Beryllium

9. A(n) _____ reaction gives off energy and heat.

10. What color are cobalt compounds?
    a) Green
    b) Black
    c) Silver-white
    d) Blue

Assessment Questions Answer Key

1. Which compound is commonly known as table salt?
   a) Sodium nitrate
   b) Sodium lithium
   c) Sodium chloride
   d) Iron sodium

A: (c) Sodium chloride, represented as NaCl.

2. Which is the heaviest natural element?

A: Uranium, used in the production of atomic weapons and nuclear reactors.

3. Approximately 90% of zinc produced in the U.S. is used for _____.
   a) insect poison
   b) rechargeable batteries
   c) research purposes
   d) galvanized steel

A: (d) galvanized steel, the production of which involves coating steel with a layer of zinc to protect it from reacting with air.

4. True or False? Compounds containing mercury are almost always used in commercial agriculture to deal with pests.

A: False. Although mercury is an effective poison against insects, its negative effects on the environment and on agricultural workers have caused it to be banned from use in commercial agriculture.

5. Why is magnesium an important component to some alloys?

A: Because of its low density. Magnesium is mixed with other metals to form alloys that are light and strong, making it useful as structural material.

6. Which are the most reactive metals?
   a) Alkaline metals
   b) Alkali metals
   c) Alkaline earth metals
   d) Transition metals

A: (b) Alkali metals, Group 1 on the periodic table, are highly reactive; their reactivity increases with their atomic number.

7. What is an alloy?

A: An alloy is a physical mixture of two or more metals (often creating a more useful substance).

8. Which metal helps ensure that the body's enzymes function correctly?
   a) Magnesium
   b) Calcium
   c) Nitrate
   d) Beryllium

A: (a) Magnesium, the seventh most abundant metal in the earth's crust.

9. A(n) _____ reaction gives off energy and heat.

A: Exothermic. However, most reactions are endothermic, meaning they require energy instead of giving energy off.

10. What color are cobalt compounds?
    a) Green
    b) Black
    c) Silver-white
    d) Blue

A: (d) Blue. Because of its color, cobalt is often used to make tile and jewelry.

Additional Resources

American Chemical Society
http://acswebcontent.acs.org/home.html

General Chemistry Online!
http://antoine.frostburg.edu/chem/senese/101/index.shtml

NIST Chemistry WebBook
http://webbook.nist.gov

Nobel Prizes in Chemistry
www.nobelprizes.com *(click on "Chemistry")*

The Elements
www.periodictable.com

The Minerals, Metals, and Materials Society
www.tms.org

MatWeb: The Online Materials Information Resource
www.matweb.com

ASM International (The Materials Information Society)
www.asminternational.org

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Transition Metals (DVD/VHS)
Transition metals are the largest group of elements on the periodic table. Segments in this program include Exploring Transition Metals (properties of the transition metals); Manganese: Strengthening Steel (why manganese is so useful in making steel); Iridium: Meteor Mass Extinction (the uses of iridium, plus how this element led to a theory about the disappearance of the dinosaurs); Gold: Wealth from Water (the extraction of gold dust from river water); and Floating City of Steel (the design and manufacturing work involved in building an aircraft carrier—a true floating city of steel). A Discovery Channel Production. (55 minutes) © 2006 (# 39671)

Alkali Metals (DVD/VHS)
Much less dense than most other metals, alkali metals are also extremely chemically reactive. Segments in this program include *Exploring Alkali Metals* (properties of the alkali metals); *Lithium: Aircraft Alloys* (why lithium is an ideal partner for aluminum in aircraft alloys); *Sodium: Salt from the Sea* (a desalination operation on Catalina Island, California); *Cesium: Atomic Clocks* (the role of cesium in calibrating atomic clocks and global positioning systems); and *The Insider's Guide to Fantastic Fireworks* (how fireworks are made, plus advancements in pyrotechnic technology). A Discovery Channel Production. (55 minutes) © 2005 (# 39667)

Alkaline Earth Metals (DVD/VHS)
Almost as unstable as alkali metals, soft and silvery alkaline earth metals react easily with water. Segments in this program include *Exploring Alkaline Earth Metals* (properties of the alkaline earth metals); *Calcium: Building Bones* (the relationship between calcium and the human skeletal system); *Strontium: Fatal Fallout* (the uses of strontium, plus the dangers of the radioactive isotope strontium 90); *Radium: Curie's Cure* (radium's role as a cancer-fighting tool); and *Inside the Body's Bones* (how a little girl's body repairs her broken arm). A Discovery Channel Production. (55 minutes) © 2005 (# 39668)

Oxidation (DVD/VHS)
Oxidation and reduction are discussed in terms of electron transfer, leading to the idea of electrode potentials. Illustrations are provided using the space shuttle, the Breathalyzer, a cannon, and a more complex electron transfer experiment. The program includes a discussion of the electrochemical cell as an oxidation/reduction process, and demonstrates some of the uses of electrochemistry on a larger scale. (35 minutes) © 1992 (# 5774)

Corrosion Chemistry (DVD/VHS)
After illustrating how iron is refined and steel is made, *Corrosion Chemistry* explains the causes of corrosion, necessary conditions for corrosion to occur, which metals will corrode, redox reactions, galvanic cells, and corrosion minimization. Laboratory experiments and animated graphics are interspersed throughout. *Viewable/printable educational resources are available online.* (30 minutes) © 2006 (# 40285)

The Chem Lab: Safety in Every Step (DVD/VHS)
This informative introduction to the chemistry laboratory that shows high school and first-year college students precisely how to conduct themselves in a safe and professional manner. Familiarity with the properties and safe handling of all materials used in the lab is stressed, including how to dispose of hazardous waste, and the proper use of safety gear and equipment is explained. How to react in the case of a lab emergency is also discussed. *A viewable/printable instructor's guide is available online.* Correlates to the National Science Education Standards developed by the National Academies of Science; Project 2061 Benchmarks for Science Literacy from the American Association for the Advancement of Science; and the National Education Technology Standards from the National Education Technology Standards Project. (19 minutes) © 2008 (# 39218)

<u>Chemistry Video Library</u> (DVD/VHS)
Contains 19 video clips on atomic and molecular structure, chemical reactions, elements, and forensics:

- Elements, Atoms, and Atomic Models
- Atomic Number and the Periodic Table
- Introduction to Chemical Reactions
- Fire
- Fireworks
- Elements Used in Space Travel
- Carbon
- Crime Lab
- Forgery
- Mummies
- Atoms, Energy Levels, and Isotopes
- Bonding, Compounds, and Mixtures
- Fuel Cells
- Biochemistry
- Introduction to Elements
- Light
- Crime Scene Investigation
- DNA
- Arson

The *Chemistry Video Library* is part of the complete *Discovery Channel/Films for the Humanities & Sciences Science Video Library.* Correlates to National Science Education Standards. A User's Guide is included, containing an overview; a numbered index of clips, with brief descriptions and lengths; time codes (for VHS only); suggested instructional strategies; and a list of additional resources.
A Discovery Channel/FFH&S Production. © 2003 (# 30958 DVD; # 30973 VHS)

<u>Periodic Table of Elements Poster Set</u> (eight 17" x 22" posters)
This valuable collection of posters includes a boldly designed periodic table with a wealth of clearly organized information. And since understanding the elements does not stop with the Periodic Table, this series also offers several ways to take a closer look at key aspects of the elements, their properties, and their applications in everyday life. A Cambridge Educational Product. © 1999 (#10120)

The posters are:

- The Periodic Table of Elements
- How to Read the Periodic Table of Elements
- What Is an Element?
- Metals
- Active Metals
- Transition Metals
- What Are Isotopes?
- Non-Metals