

The Periodic Table of the Elements

Other Metals

Teacher's Guide

Grade Level: 6–8

Curriculum Focus: Physical Science

Lesson Duration: Two class periods

Program Description

Introduce students to the fundamental features of this useful group of elements. Look at how the most abundant metal on Earth brings electrical power to our homes, schools, and offices. Explore a property of tin that may have played a role in the demise of France's grand army. Investigate how lead-based plumbing could have slowly poisoned the people of Rome. And see how aluminum, other elements, and emerging technologies are transforming transportation.

- Exploring Other Metals (5 min.)
 - Aluminum: Providing Power (6 min.)
 - Tin: Napoleon's Nemesis (6 min.)
 - Lead: Rome's Poisoned Plumbing (6 min.)
 - Future of the Car (21 min.)
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Onscreen Questions

- What properties do the other metals share?
 - Why did the Romans use lead in their plumbing?
 - What makes aluminum such a useful metal for cars?
 - What other elements might be used in the cars of the future?
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Lesson Plan

Student Objectives

- Identify and describe the other metals.
- Discuss the properties and common uses of aluminum.
- Research an aluminum product and create an advertisement for it that highlights the relevant properties of aluminum.

Materials

- Other Metals program
- Periodic table
- Print and online resources about aluminum
- Computer with Internet access
- Color copier or printer

Procedures

1. After watching the program, have students identify the metals on a periodic table. Remind them that there are different types of metals, each with unique properties. Review the different types of metals and their locations on the periodic table. (*Alkali metals are in group 1; alkaline-earth metals are in group 2; transition metals are in groups 3 through 12; and the "other metals are found in groups 13 through 15, although other elements are found in these groups as well.*) Use the periodic table to identify the other metals. (*aluminum, gallium, indium, tin, thallium, lead, bismuth*)
2. Discuss the properties of the other metals – they are opaque, have relatively high densities, and are generally ductile or bendable. Ask students to use what they learned in the video to compare the other metals with transition metals. Possible answers include the following:
 - The other metals are softer than transition metals.
 - They have lower boiling and melting points.
 - They are more electropositive (they lose valence electrons more easily).
3. Tell students that the most abundant metal in the Earth's crust is aluminum. This other metal is also used in millions of products made around the world. Ask students to name some of the properties of aluminum that make it so useful. Possible answers include the following:
 - Excellent conductor of heat and electricity
 - Nonmagnetic
 - Nonsparking
 - Malleable (the second most malleable metal after gold)
 - Lightweight
 - Durable
 - Resists rust
4. Have the class identify products made from aluminum, including those mentioned in the video. Create a list on the board, such as the following:
 - Automobiles
 - Electrical transmission lines

- Car, train, and plane parts
 - Building materials
 - Baseball bats
 - Soda cans
 - Nails
 - Teabag staples
5. Tell students that their assignment is to research a product made with aluminum and then use what they learned to create an advertisement for it. They can create a print, radio, television, or online ad. However, their mockup, storyboard, or script must highlight the relevant and useful properties of aluminum. Provide appropriate print and online resources about aluminum products. The following Web site provides helpful information:
- Aluminum Applications
<http://www.world-aluminium.org/applications/index.html>
6. As students present their advertisements to the class, review some of the new properties of aluminum students learned about. Then discuss our ability to recycle aluminum. Ask students: What are some new products that could be created by recycled aluminum in the future?

Assessment

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

- 3 points: Students were active in class discussions; identified several properties of the other metals and aluminum; developed a creative, engaging advertisement that clearly highlights the relevant properties of aluminum.
- 2 points: Students participated in class discussions; identified some properties of the other metals and aluminum; developed a complete advertisement that highlights the relevant properties of aluminum.
- 1 point: Students did not participate in class discussions; identified few or no properties of the other metals and aluminum; developed an incomplete or inaccurate advertisement that does not clearly highlight the relevant properties of aluminum.

Vocabulary

aluminum

Definition: A soft, silver-white metal that is light, ductile, resistant to corrosion, and an excellent conductor of heat and electricity

Context: Aluminum is used in millions of products across the globe.

conductor

Definition: A substance or body that allows electricity, heat, or sound to pass through it

Context: Aluminum is an excellent conductor of heat and electricity

corrosion

Definition: A process in which something, especially a metal, is gradually destroyed by chemical action

Context: Since tin does not react readily with oxygen or water, it is often used to protect other metals from corrosion.

electropositive

Definition: Having the tendency to release valence electrons to other elements during chemical reactions

Context: The atoms of the other metals are more electropositive than the transition metals.

metal

Definition: An element that is a good conductor of heat and electricity, and is usually shiny and hard at normal temperatures

Context: The metal copper was first used for transmission wires because it conducts electricity so well.

Academic Standards

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
- Science: Earth and Space Sciences – Understands Earth's composition and structure

The National Council for the Social Studies (NCSS)

The National Council for the Social Studies (NCSS) has developed national standards to provide guidelines for teaching social studies. To view the standards online, go to

<http://www.socialstudies.org/standards/strands/>.

This lesson plan addresses the following thematic standards:

- Physical Science
- Earth and Space Science
- Science and Technology

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- <http://school.discovery.com/teachingtools/teachingtools.html>
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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 five segments (see below), indicated by video thumbnail icons. Watching all parts in sequence is similar to watching the video from start to finish. Brief descriptions and total running times are noted for each part. 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. Exploring Other Metals (5 min.)

The group known as the other metals contains some of the most widely used elements in the world. Learn about the common properties and uses of these metals.

II. Aluminum: Providing Power (6 min.)

Aluminum is the most abundant metal on our planet. Explore its properties and numerous uses, which include conducting electricity all over the world.

III. Tin: Napoleon's Nemesis (6 min.)

Learn about the properties of tin and examine the possibility that this element helped lead to the deaths of many French soldiers in Russia during the winter of 1812-13.

IV. Lead: Rome's Poisoned Plumbing (6 min.)

Once used in plumbing materials, lead is now considered dangerous for human consumption. Learn about lead's properties and see how lead poisoning may have contributed to the fall of ancient Rome.

V. Future of the Car (21 min.)

While some may dream about sleeker, more efficient cars for the future, others are already building them now. Examine prototypes of hydrogen-powered cars and learn how hybrid electric cars work.

Curriculum Units

1. All About the Other Metals

Pre-viewing question

Q: What are some commonly used metals?

A: Answers will vary.

Post-viewing question

Q: How do the other metals compare with the transition metals?

A: The other metals are generally softer, have lower boiling and melting points, and are more electropositive than the transition metals.

2. Aluminum: Properties and Common Uses

Pre-viewing question

Q: How do you use aluminum in your life?

A: Answers will vary.

Post-viewing question

Q: What are some common uses of aluminum?

A: Aluminum is often used to make car, train, and plane parts. It is also used in building materials and baseball bats and, because it resists rust, it goes into everything from soda cans to nails to the staples on tea bags.

3. Conducting Electricity

Pre-viewing question

Q: What elements are good conductors of electricity?

A: Answers will vary.

Post-viewing question

Q: Why is aluminum, rather than copper, used to deliver electrical power?

A: Even though copper conducts electricity more effectively than aluminum, one pound of aluminum can carry twice as much electrical power as a pound of copper because aluminum is three times lighter. Copper was first used to make electrical wires, but after World War II aluminum replaced it in high-voltage lines.

4. Tin: Properties and Uses

Pre-viewing question

Q: What do you know about tin?

A: Answers will vary.

Post-viewing question

Q: What are some common uses of tin?

A: Tin is often used to protect other metals, such as iron in plating and foils, because it does not react readily with oxygen or water. It is also added to other metals to make superconducting magnets and is combined with fluoride in some toothpaste to help fight microbes and tooth sensitivity.

5. Tin Buttons and Napoleon's Greatest Defeat

Pre-viewing question

Q: What do you know about Napoleon's campaign of 1812?

A: Answers will vary.

Post-viewing question

Q: Why do some people believe that the tin buttons were partly to blame for the casualties in Napoleon's army?

A: A unique property of tin is that when its temperature drops below 56°F, the silvery white metal turns to gray tin, which is nonmetallic and powdery. Scientists believe that the freezing temperatures of the Russian winter may have turned the buttons on the French uniforms into crumply gray tin, rendering them useless and making the French soldiers more susceptible to the deadly cold.

6. Lead: Properties and Uses

Pre-viewing question

Q: What do you know about lead and its uses?

A: Answers will vary.

Post-viewing question

Q: What are some common uses of lead?

A: Lead is most commonly used in the production of lead-acid batteries, such as those found in automobiles. It is also used in radiation shielding, X-ray machines, and nuclear reactors.

7. Lead Poisoning in Ancient Rome

Pre-viewing question

Q: What were the greatest achievements of ancient Rome?

A: Answers will vary.

Post-viewing question

Q: Why is lead dangerous for human consumption?

A: The human body cannot distinguish lead from calcium, so it does not get rid of lead. Over time, lead poisoning can cause stomach pain and nervous system disorders, and it can damage the kidneys, red blood cells, and the brain.

8. Cars of Tomorrow

Pre-viewing question

Q: How have cars changed during your lifetime?

A: Answers will vary.

Post-viewing question

Q: What features would an ideal car include? Consider energy use, cost, and consumer items.

A: Answers will vary.

9. The 21st-Century American Car

Pre-viewing question

Q: What can you do to conserve energy?

A: Answers will vary.

Post-viewing question

Q: Why should cars weigh less in the future?

A: To obtain the fuel efficiency automobile manufacturers desire, the average American car must be made of lighter-weight materials, such as aluminum. According to one automobile executive, for every 100 pounds saved, mileage can be improved by one mile per gallon. Additionally, emissions can be reduced because it requires less power to achieve the same acceleration and performance in a lighter vehicle. However, aluminum is expensive and not as flexible as steel.

10. Hybrids, Hypercars, and Automobile Emissions

Pre-viewing question

Q: How have automobiles and fuel emissions affected the area where you live?

A: Answers will vary.

Post-viewing question

Q: How does a hybrid car work?

A: Hybrids employ a pollution-free electric motor and a flexible, longer-range internal-combustion engine. In a so-called parallel hybrid, an engine is at each end of the car. At low speeds in polluted city areas, an electric motor drives the front wheels. A black box, which controls the electric motor, switches over to a gasoline engine as the speed increases. Hybrids have a smaller battery pack and can be charged on the move by the gasoline engine.

11. The Hydrogen Age

Pre-viewing question

Q: How do you depend on fossil fuels?

A: Answers will vary.

Post-viewing question

Q: What is a fuel cell and how does it work?

A: These cells that power a motor combine hydrogen and oxygen to produce electricity, and their only byproduct is water. In a fuel cell, a platinum catalyst splits atoms into protons and electrons. The tiny protons escape to bond with oxygen to make water. Trapped by a membrane, the large electrons flow into an electric motor. In fuel cell cars, the fuel cell replaces the gas engine and the batteries. There is still an electric motor and a powerful electronic box. The hydrogen is received from a reformer, which extracts it from other gasses like methanol.

12. Refueling the Cars of Tomorrow

Pre-viewing question

Q: What are the major drawbacks of current automobile technology?

A: Answers will vary.

Post-viewing question

Q: How difficult will it be to sell the American public on hydrogen cars and solid fuel?

A: Answers will vary.