Films for the Humanities & Sciences®

Instructor's Guide

Essential Chemistry
THE PERIODIC TABLE

Introduction

This Teacher's Guide provides information to help you get the most out of *The Periodic Table.* 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 the contents and general organizational structure of the periodic table
- Understand the history of elements and creation of the periodic table
- Explain how elements are grouped and the like properties they share
- Describe how different elements/groups of elements interact with each other

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.

- From time to time, major shifts occur in the scientific view of how things work. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Continuity and change are persistent features of science.
- When elements are listed in order by the masses of their atoms, the same sequence of properties appears over and over again in the list.
- Some atoms and molecules are highly effective in encouraging the interaction of others.

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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

This program, part of the five-film *Essential Chemistry* series, examines the history of the periodic table and how it is organized. Throughout the film, students examine how elements are grouped and why, and how different groups interact with other elements on the table. The program examines how new elements are discovered and where they fit in with those currently listed on the periodic table, and the properties of all elements that define their reactivity and behavior. In learning about the history and creation of the periodic table through this program, students develop a more holistic understanding of why and how this chart came to be, and why it is helpful to the study and advancement of chemistry and all science. After watching this film, students should be able to explain the basic history and organization of the periodic table as well as why the elements listed fit into their various groupings.

Main Topics

Topic 1: History
The film starts by reviewing the history of the discovery of elements and their initial organization on the first periodic table.

Topic 2: Metals
After a discussion of periods, groups, and columns, the film describes alkali metals, alkaline earth metals, and transition metals. Also included is information on lead and hydrogen.

Topic 3: Lanthanides, Actinides, and Transuranium Elements
Here, the film describes the lower half of the periodic table and some of the elements that are found there, including super-heavy elements.

Topic 4: The BCNOs
Named for the first letter of the first element in each group, the BCNOs — boron, carbon, nitrogen, and oxygen — are groups 13 through 16 on the periodic table. The BCNOs are very reactive.

Topic 5: Halogens and Noble Gases
In the final section of the film, students learn that groups 17 and 18 contain both the most chemically reactive elements (halogens) and the least reactive elements (noble gases).

Fast Facts

- Dmitri Mendeleev created the first periodic table and published it in 1869. He included question marks to denote places on the table where he believed there *should* be elements, but of which the science of his day was unaware.
- Elements are arranged from left to right across the periodic table by order of increasing atomic number.
- Because of their negative effects on human health, the Environmental Protection Agency regulates lead, nitrous oxides, sulfur oxides, volatile organic compounds, ozone, and particulate matter.
- Noble gases were so named because of their 'patrician' quality of not interacting easily or at all with other elements.
- Oxygen reacts with more elements than does any other element.
- Carbon, hydrogen, and nitrogen are part of all living things.
- Halogens (group 17) are the most chemically reactive elements.
- Columns in the periodic table indicate groups of the elements where all have the same number of electrons in their outermost electron shell.
- Transuranium elements are very heavy, with atomic numbers greater than 92.
- Helium freezes at very low temperatures, making it ideal for cooling.

Vocabulary Terms

alchemy: A medieval philosophy which included the practice of trying to transform ordinary metals into gold.

atomic number: The number of protons in an atom. Used to identify elements on the periodic table.

atomic weight: The average mass of an atom in an element.

compound: A substance made from multiple elements that have combined (example: water is a compound of the elements hydrogen and oxygen).

element: Substance composed of atoms that have the same atomic number.

halogens: Any of a group of five nonmetallic elements with similar properties. The halogens, group 17 on the periodic table, are fluorine, chlorine, bromine, iodine, and astatine. Because they are missing an electron from their outermost shell, they react readily with most metals to form salts.

noble gases: Any of the six gases helium, neon, argon, krypton, xenon, and radon (group 18 on the periodic table). Because the outermost electron shell of atoms of these gases is full, they do not react chemically with other substances except under certain special conditions. Also called 'inert gas'.

organophosphates: Any of several organic compounds containing phosphorus, some of which are used as fertilizers and pesticides. These compounds can be deadly when they interact with the nervous system.

period: A row in the periodic table. All elements in a period have the same number of electron shells.

transition metals: Any of the metallic elements within groups 3 to 12 in the periodic table that have an incomplete inner electron shell. Also called 'transition elements', they are characterized by multiple valences, colored compounds, and the ability to form stable complex ions.

Pre-Program Discussion Questions

1. How would you describe a periodic table? For what is it used?
2. How might the practice of alchemy or the identification of fire, earth, air, and water as core 'elements' have influenced the study of chemistry and the creation of the periodic table?
3. What is an element? What elements do you hear about frequently? Can you name an element that most people may not have heard of?

4. Why do different substances interact differently with each other? What might dictate how elements interact?
5. How might the periodic table have contributed to or advanced the study of chemistry?

Post-Program Discussion Questions

1. What patterns in elements contributed to the design of the periodic table?
2. Who published the first periodic table, and why? Why is it said that he invented the table?
3. What is an atomic number? Point to an atomic number on a periodic table. What is atomic weight? Point to atomic weight on a periodic table.
4. Which element forms more compounds than any other? Which reacts with the most elements?
5. How do compounds of elements benefit us in everyday life? How can they be harmful?

Activity Ideas

- Have students create flashcards with information on one element per card. Then have them compete against each other by trying to name the element after reading the descriptive information on the card. Students should aim to answer correctly in the shortest length of time.

- Assign sections of the periodic table to small groups of students and ask them to research their assigned section in detail. Groups should then create PowerPoint presentations on their sections and present them to the rest of the class.

- Using Styrofoam balls and toothpicks (or other materials), have students build models of atoms of different elements. Students will need to determine the appropriate number of protons, neutrons, and electrons in the element they build.

- Create and then play a card-matching game in which students must pair the name of an element with its symbol on the periodic table. In creating the game, students should research why some elements have symbols that are not immediately obvious (such as why the symbol for Gold is Au).

- Have students gather information on who discovered each element and when, along with any interesting circumstances around the discovery. They should then present the information to the class, possibly in the form of a 'jeopardy' game.

Assessment Questions

1. What is the atomic number of silver?
    a) 4
    b) 107
    c) 47
    d) 11

2. What is each line in the periodic table called?
    a) Group
    b) Period
    c) Metalloid
    d) Triad

3. What was the chief aim of alchemy?

4. Which element is the B in the BCNO group?
    a) Bismuth
    b) Borium
    c) Berkelium
    d) Boron

5. Which of the following elements is a part of all living things?
    a) Gold
    b) Carbon
    c) Helium
    d) Iron
    e) Water

6. What is the heaviest naturally occurring element?
    a) Uranium
    b) Gold
    c) Lead
    d) Iron

7. Which element is the lightest?

8. Which elements appear as distinct colors when an electric charge runs through them?
    a) Organophosphates
    b) Noble gases
    c) Metals
    d) Alkaline earth metals

9. Who created the first periodic table?

10. What is a transuranium element?
    a) An element with an atomic number higher than 92
    b) An element with an atomic number lower than 92
    c) A metalloid
    d) An alkali metal

Assessment Questions Answer Key

1. What is the atomic number of silver?
    a) 4
    b) 107
    c) 47
    d) 11

A: (c) 47. Silver's atomic weight is 107.8682.

2. What is each line in the periodic table called?
    a) Group
    b) Period
    c) Metalloid
    d) Triad

A: (b) Period. Elements in the same period have the same number of electron shells.

3. What was the chief aim of alchemy?

A: Attempting to change ordinary metals into gold.

4. Which element is the B in the BCNO group?
    a) Bismuth
    b) Bohrium
    c) Berkelium
    d) Boron

A: (d) Boron. The BCNO elements are groups 13 through 16; boron is at the top of group 13.

5. Which of the following elements is a part of all living things?
    a) Gold
    b) Carbon
    c) Helium
    d) Iron
    e) Water

A: (b) Carbon. Hydrogen and nitrogen are also a part of all living things.

6. What is the heaviest naturally occurring element?
    a) Uranium
    b) Gold
    c) Lead
    d) Iron

A: (a) Uranium. Uranium is used in the creation of fission bombs.

7. Which element is the lightest?

A: Hydrogen. Hydrogen has one proton in its nucleus.

8. Which elements appear as distinct colors when an electric charge runs through them?
    a) Organophosphates
    b) Noble gases
    c) Metals
    d) Alkaline earth metals

A: (b) Noble gases. For example, argon appears as a bright blue and neon appears as red.

9. Who created the first periodic table?

A: Dmitri Mendeleev, in 1869.

10. What is a transuranium element?
    a) An element with an atomic number higher than 92
    b) An element with an atomic number lower than 92
    c) A metalloid
    d) An alkali metal

A: (a) An element with an atomic number higher than 92. All of the transuranium elements are radioactive.

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

An Interactive Periodic Table of the Elements
www.chemicalelements.com

Periodic Elements, Tables and Chemistry
www.chemicool.com

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The Periodic Table of the Elements (DVD/VHS)
Created to illustrate recurring, or 'periodic,' trends in the properties of the elements, the periodic table is the undisputed key to understanding the building blocks of our world. Animations, demonstrations, dramatizations, and dozens of real-world applications bring the elements to life in this ten-part series. Discussion questions are embedded throughout. A Discovery Channel Production. (10-part series, 55 minutes each) © 2006 (# 39666)

The Periodic Table (DVD/VHS)
This program from the BBC archives provides a comprehensive overview of the development of the periodic table. It discusses the work of John Dalton, Johann Döbereiner, and John Newland, and the creation of the first table by Dmitri Mendeleyev in the late 19th century. Later refinements by Henry Moseley, and the 1950s discovery of the artificial element #93 by Edwin MacMillan, are also discussed. The evolution of the table over the past two centuries is clearly and cleverly illustrated through computer animation and song. A BBC Production. (21 minutes) © 1985 (#7381)

The Periodic Table and the Human Element (DVD/VHS)
A series of personal stories, told by working scientists, that provide the human perspective to the annals of chemistry. The programs demonstrate the chemical principles while showing the human properties of some of the boldest frontiersmen and women of chemistry. A co-production of BBC Continuing Education & Training and Films for the Humanities & Sciences (6-part series, 26-30 minutes each) (# 3063)

Mendeleyev: Father of the Periodic Table (DVD/VHS)
This portrait of the father of the Periodic Table of Elements shows an extremely intelligent and intuitive scientist who was an energetic popularizer of science and took a strong interest in finding practical uses for the conclusions of abstract science. The program explains the thought-processes that led to his understanding of the relationships between families of elements and his prediction of the existence of other elements — a man of boundless drive and intellectual curiosity, a child of the 19th century, and a father of scientific method. (28 minutes) (# 2713)

Chemistry Video Library (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)

Periodic Table (CD-ROM)
This comprehensive CD-ROM provides an in-depth examination of the periodic table, its elements, and history. A tutorial contains an introduction to the table and also incorporates information on Boyle's Dozen, The First Thirty, The New Elements, Mendeleyev's ideas, periods and groups, and periodic trends. Elements are fully illustrated with videos and photographs. From the color-coded periodic table screen, users may display properties and compare data in graph and table form, and search the database for information according to specific criteria. The periodic table may be displayed by group labels, period labels, element background, or specific information selected by the user. Choose from the historical, physical, chemical, atomic, or resource information screens to fully investigate individual elements. Includes a complete glossary of terms. Available for Windows only. (# 7415)

Periodic Table of Elements Poster Set (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

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. A Films for the Humanities & Sciences Production.
(19 minutes) © 2008 (# 39218)