Films for the Humanities & Sciences®

Instructor's Guide

Essential Chemistry
CHEMICAL REACTIONS

Introduction

This Teacher's Guide provides information to help you get the most out of *Chemical Reactions.* 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:

- Define what a chemical reaction is and provide several examples
- Distinguish between a change of state and a chemical reaction
- Define and describe 'reactants' and 'products'
- Depict a basic equation for a chemical reaction
- Understand various chemical bonds and types of chemical reactions

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.
- Sometimes, scientists can control conditions in order to obtain evidence. When that is not possible, practical, or ethical, they try to observe as wide a range of natural occurrences as possible to discern patterns.
- The number of protons in the nucleus determines what an atom's electron configuration can be and so defines the element. An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons.
- An enormous variety of biological, chemical, and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.
- 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.

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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.

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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, explains and provides examples of chemical reactions. When two or more elements or chemical compounds come into contact with each other and there is enough energy present, a chemical change may take place. This is different than a change of state, where only a physical change occurs. After viewing this film, students should be able to distinguish the two and give real-life examples of each. The film also covers chemical bonding and reviews the different types of chemical reactions, such as synthesis and decomposition. Additionally, students will review how to write and balance a basic chemical equation, something they will certainly want to practice in more detail following a viewing of *Chemical Reactions*. Finally, this film reminds students how chemical reactions and catalysts play important roles in even our basic existence, emphasizing the importance of learning and retaining this knowledge.

Main Topics

Topic 1: Chemical Reactions
In this section, the film defines a chemical reaction and provides examples. Students compare and contrast a change of state to a chemical reaction, and also learn the terms 'reactant' and 'product.'

Topic 2: Chemical Bonding
Here, students learn about chemical bonds and how subatomic particles affect bonding and the breaking and rearrangement of chemical bonds. Students practice writing chemical equations, and also define covalent and ionic bonds.

Topic 3: Types of Chemical Reactions
In this section of the film, students review different kinds of chemical reactions. The definitions of acids and bases are covered, as well as exothermic and endothermic reactions. Viewers are also reminded of the importance of utilizing safety equipment when working in a laboratory.

Topic 4: Reaction Rates
Here, students review the speed of a chemical reaction, which is measured in how much product is produced or reactant used up in a certain amount of time. Students also examine terms such as concentration, catalyst, and inhibitor.

Topic 5: Reactions All Around Us
In this final section, the film reminds students of the chemical reactions all around us in the world and even in our bodies. From photosynthesis to detective work in solving crimes, chemical reactions make our everyday lives possible.

Fast Facts

- When a substance undergoes a chemical changes, the chemical substance is altered. Chemical change is also called a chemical reaction.
- It's important for chemists to carefully examine suspected chemical reactions, as there are many ways a substance can be changed without a chemical reaction taking place — such as a change of state.
- In a chemical reaction, the mass of all reactants will add up to the mass of all products — this is called the Law of Conservation of Mass.
- Most molecules are made of covalent bonds, including proteins and DNA.
- Important lab safety equipment includes hood, exhaust fan, safety shield, goggles, and heat-resistant gloves.

- Photosynthesis is an endothermic reaction, meaning it must absorb energy to occur. In this case, plants use energy from the sun to convert carbon dioxide and water into glucose and oxygen.
- In order for atoms, ions, or molecules to react, two conditions must be met: they must come into contact with each other, and there must be enough kinetic energy.
- Increasing the concentration of a solution increases its reaction rate.
- Photoautotrophs are organisms that specifically use light energy to make their own food.
- Bioluminescence is the ability to produce light through a chemical reaction.

Vocabulary Terms

catalyst: A chemical that can speed up a chemical reaction without actually being involved in the reaction itself. It does not change, is not used up, and can be used over and over.

covalent bond: A bond between two or more atoms that share electrons.

diatomic elements: Elements that contain two atoms of the same element joined together by chemical bonds. Oxygen, nitrogen, iodine, bromine, chlorine, and fluorine are all diatomic elements.

double displacement reaction: A reaction where atoms from two different compounds switch places. Reactants are always two compounds and products are always two different compounds.

inhibitor: A chemical that can slow down or stop a chemical reaction.

ionic bond: Chemical bond in which electrons are transferred from one atom to another.

octet rule: In chemical bonding, the tendency to lose, gain, or share electrons to ensure the outermost shell contains eight electrons.

products: In a chemical reaction, the new substances created through chemical change, plus any ash, water vapor, or carbon dioxide (represented by the right side of a chemical equation).

reactants: The compounds or molecules reacting together to form new substances (represented by the left side of a chemical equation).

reaction rate: Speed of a chemical reaction, measured by how much product is produced or how much reactant is used up in a certain amount of time.

single displacement reaction: Reaction where one element switches places with another element in a compound. Reactants are always an element and a compound, and products are always a different element and a different compound.

Pre-Program Discussion Questions

1. What is an example of a chemical reaction? Have you ever viewed a chemical reaction? Please describe.
2. What is photosynthesis? Is photosynthesis a chemical reaction? Why or why not?
3. When water freezes and becomes ice, is this a chemical reaction? Why or why not?
4. Can you write out or give an example of a chemical equation?
5. What information do you already know about protons, neutrons, and electrons? Where have you used or seen these terms before?

Post-Program Discussion Questions

1. Describe a chemical reaction and chemical bonding.
2. How are chemical reactions and changes of state different? How are they similar?
3. What is a negative ion? What is a positive ion? When do these occur?
4. Give two examples of chemical reactions in everyday life. How might doctors use chemical reactions in their work? What about police officers?
5. Name and describe two specific types of chemical reactions.

Activity Ideas

- Working in small groups, have students create posters comparing and contrasting the types of chemical reactions described in this film (synthesis, decomposition, single and double displacement, and acid-base reaction). Posters should include visual representations of the reactions and descriptions of each, along with examples of chemical equations for each. Students should present and describe their finished posters, and these also might be displayed around the room.

- Using materials such as Styrofoam balls, pipe cleaners, dowels, clay, etc., students should build models of different covalent bonds. As these include proteins and DNA, models could vary from very simple to quite complex. Students should present and explain the covalent bonds they have created to the rest of the class.

- As appropriate in your lab or classroom setting, create and observe some chemical reactions. As mentioned in the film, some obvious examples are fireworks (perhaps depicted by lighting a sparkler), rusting metals, and frying an egg. Ask students to observe what happens during the reactions and what products are created after they are complete. You may also want to cause some changes to states of matter (e.g. melting ice) and have students compare and contrast these changes to those that take place during a chemical reaction.

- Invite students to research a chemical reaction that's a part of everyday life and write a short paper on it. Papers should describe how and why the reactions take place and what results from them, as well as why these reactions are useful or necessary. The last section of the film mentioned reactions such as digestion, photosynthesis, and chemosynthesis — students might investigate one of these, or instead look into topics such as how doctors and police officers make use of chemical reactions to successfully perform their jobs. Students should share their new knowledge with the rest of the class through short presentations.

- Assign small groups of students various chemical equations to balance. These could range from very basic to quite complex depending on where you are in your study of chemistry. Have groups exchange solutions to check each other's work, and also try solving a very difficult or complex equation together as a class.

Assessment Questions

1. In a chemical reaction, the new substance(s) created, plus any ash, water vapor, or carbon dioxide, are called _____.
    a) products
    b) reactants
    c) ions
    d) neutrons

2. Changes of state involve a _____ change, rather than a chemical one.

3. _____ are key players in chemical bonding, and move around in energy levels called shells or orbitals.
    a) Protons
    b) Octets
    c) Electrons
    d) Valences

4. True or False? Chemical reactions are powerful enough to create new atoms of elements.

5. Which of the following is not a diatomic element?
    a) Chlorine
    b) Nitrogen
    c) Iodine
    d) Copper

6. When temperature increases, what happens to most chemical reactions?

7. How can one make a gas more concentrated?

8. A chemical that speeds up a chemical reaction without actually being involved in the reaction is called a(n) _____.
    a) inhibitor
    b) catalyst
    c) rate of reaction
    d) concentrator

9. Which unit is used to measure the amount of product produced or reactant used up in a chemical reaction?
    a) Grams
    b) Kilograms
    c) Moles
    d) All of the above

10. In what kind of reaction does one reactant break apart to form two or more products?

Assessment Questions Answer Key

1. In a chemical reaction, the new substance(s) created, plus any ash, water vapor, or carbon dioxide, are called _____.
    a) products
    b) reactants
    c) ions
    d) neutrons

A: (a) products. These are found on the right side of a chemical equation.

2. Changes of state involve a _____ change, rather than a chemical one.

A: Changes of state involve a physical change, rather than a chemical one. Most of the time, changes of state can be reversed with the addition or removal of heat, while it's more difficult to revert substances in a chemical reaction back to their original state.

3. _____ are key players in chemical bonding, and move around in energy levels called shells or orbitals.
    a) Protons
    b) Octets
    c) Electrons
    d) Valences

A: (c) Electrons. Electrons have a negative charge and orbit the nucleus of an atom.

4. True or False? Chemical reactions are powerful enough to create new atoms of elements.

A: False. In a chemical reaction, atoms cannot be created or destroyed, just rearranged.

5. Which of the following is not a diatomic element?
    a) Chlorine
    b) Nitrogen
    c) Iodine
    d) Copper

A: (d) Copper. The diatomic elements are all gases and always contain two atoms of the same element, joined by chemical bonds.

6. When temperature increases, what happens to most chemical reactions?
A: They speed up. Conversely, if temperature is reduced, chemical reactions generally slow down.

7. How can one make a gas more concentrated?
A: By decreasing the volume. When gas particles are closer together, the gas is more concentrated.

8. A chemical that speeds up a chemical reaction without actually being involved in the reaction is called a(n) _____.
    a) inhibitor
    b) catalyst
    c) rate of reaction
    d) concentrator

A: (b) catalyst. The catalyst in a chemical reaction does not change, is not used up, and can be used over and over.

9. Which unit used to measure the amount of product produced or reactant used up in a chemical reaction?
    a) Grams
    b) Kilograms
    c) Moles
    d) All of the above

A: (d) All of the above. The speed of a chemical reaction is measured by the amount of product produced or reactant used up in a certain amount of time.

10. In what kind of reaction does one reactant break apart to form two or more products?
A: Decomposition. In a synthesis reaction, only one product ever results.

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")*

CHEMystery: An Interactive Guide to Chemistry
http://library.thinkquest.org/3659

eMolecules
www.emolecules.com

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Nuclear Chemistry: Inside the Atom (DVD/VHS)
From the ancient Greek concept of "atomos" to today's fission and fusion technologies, this program guides viewers through the landscape of atomic theory and the hidden world of subatomic particles. Topics include the makeup of atomic nuclei and the factors that make them stable or unstable; the discovery and use of radioisotopes; and the difference between fission and fusion. Providing historical perspective, the video illustrates major discoveries about the nucleus and presents concise profiles of pioneering atomic physicists—such as Henri Becquerel, Irène Joliot-Curie and Frédéric Joliot, Ernest Rutherford and Frederick Soddy, and many others. *Viewable/printable educational resources are available online.* (20 minutes) © 2007 (# 40291)

Corrosion Chemistry (DVD/VHS)
This program is designed to introduce students to the chemistry involved in the process of corrosion. 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)

Chemical Changes: Everyday Reactions (CD-ROM)
From cooking to the way cars work, everyday life is an inexhaustible source of chemical reactions. Richly illustrated with video, animation, photographs, and diagrams, this captivating CD-ROM enables students to investigate different types of chemical reactions and the way they are used to create new products. To help make the learning process fun, activities, puzzles, and quizzes are included throughout. In addition, pictures, diagrams, and text can easily be extracted from the disc for use in project work. Correlates to the National Science Education Standards developed by the National Academies of Science and Project 2061 Benchmarks for Science Literacy from the American Association for the Advancement of Science. Comes with activity sheets. A Cambridge Educational Production. Can be used with both Windows and Macintosh. © 1999 (# 9377)

Chemical Equations (DVD/VHS)
Filled with real-life demonstrations that support instructive written examples, this program reinforces the basic principles of solving equations for chemical reactions. A brief historical overview describes Marie and Antoine Lavoisier's establishment of the law of conservation of mass, as well as the theoretical contributions of John Dalton. The importance of balancing equations is emphasized, along with a thorough exploration of reaction types. Step-by-step guides to combination, decomposition, single replacement, double replacement, and combustion reactions will give beginning- and intermediate-level students a working knowledge of formulation processes. *Viewable/printable educational resources are available online.* (32 minutes) © 2004 (# 35315)

Chemical Equilibrium (DVD/VHS)
This miniseries uses analogy and computer animation to introduce chemistry students to the concepts of chemical reactions. It explores and examines the theories of steady state, dynamic equilibrium, kinetic molecular theory, reaction tendencies, and the equilibrium constant. The forward and reverse reactions of various chemical changes are illustrated, including the production of hydrogen iodide, hydrogen chloride, and ammonia. Finally through demonstrations of Le Châtelier's principle and the Haber process, students will gain a better understanding of the importance of chemical equilibrium to scientific study. (6-part series, 10 minutes each) © 1992 (# 3595)

Laws of Chemical Change and Heat Flow (DVD/VHS)
The first lesson provides examples of the Law of Conservation and Mass and the Law of Definite Proportions. Recycling of elements is examined. In lesson two, exothermic and endothermic reactions are demonstrated by an experiment that uses the chemical contents of a pocket warmer and dry ice. The third lesson includes demonstrations of oscillating reactions and clock reactions, as well as interesting though hazardous experiments such as a hydrogen explosion, acetone peroxide explosion, surface polymerization, and silver mirror reaction. (35 minutes) © 1997 (# 6838)

The Chem Lab: Safety in Every Step (DVD/VHS)
"Maximize your knowledge and minimize your risk!" That's the primary message of this program, an 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)

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)