GRADE 7 & 8: REACTIONS & INTERACTIONS

PROJECT CONN-CEPT

Connecticut State Department of Education
165 Capitol Avenue Hartford CT 06145
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Project CONN-CEPT Science Units

Astronomy: Sun, Moon, and Stars (K-2)
The World of Matter (1)
Living Things: Changes, Stages and Cycles (2-3)
Eurekas and Ecosystems (4-5)
Light: A Rainbow of Exploration (4-5)
Sound's Story: H-Ear the Pitch (4-5)
Structure and Function: What's Their Junction? (6)
Weather: The Never-Ending Story (6)
Cells: The Story of Life (7)
Reactions and Interactions (7-8)

Project CONN-CEPT Social Studies Units

Time, Change, and Continuity in History (K)
Local Government (3)
What Makes a Region? An Investigation of the Northeast (4)
Goods, Services, Resources, Scarcity and Systems: An Exploration of State Economics (4-5)
Concepts and Tools of the Geographer (6)
With Liberty and Justice for All: A Study of the U.S. Constitution (6-8)

Units in Preparation

Junior Economist: People, Resources, Trade (1-2)
A Habitat is a Home for Plants and Animals: Needs, Resources, Adaptation and Systems (1-2)
May the Force be With You, Forces, Motion and Simple Machines (2-3)
Comparing Cultures: Traditions, Dwellings, Language, and Cultural Evolution (2-3)
Peopling of the Americas (4-5)
Going to the Source: Using Primary Resources in United States History (6-8)
Exploring the World's Oceans: Chemistry, Geology and Biology (7)
Reactions and Interactions: Chemical Reactions (7-8)

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A Shared Story

The exhibit hall was huge, and publishers' banners, suspended from the ceiling, waved back and forth in the air conditioned room. Hundreds of conference participants filled the aisles. Vendors of curriculum materials, eager to share their colorful and glossy wares with passing teachers and administrators, stood at the edge of their displays offering warm smiles, prizes, and publishers' catalogues.

Charlene and Andrew had carefully planned their tour through the aisles and divided up so that they could see all the materials. They looked forward to their time in the vendor area because they needed curriculum materials in social studies and science for their upper elementary and middle school students. They hoped they would find something good. They wanted coherent, comprehensive units that addressed their state and national standards, had good assessments, required students to think their way through content, provided teachers with teaching strategies, and some guidance regarding how to differentiate the curriculum for students with varied learning needs.

They looked at many cleverly designed curriculum packages and kits. Most materials were collections of episodic learning activities. Some contained coherent learning activities for students, but did not teach to the critical concepts and principles embedded in state and national standards. Other materials, claiming to be comprehensive, did not contain aligned pre- and post-assessments, user-friendly teacher information, suggestions for teaching, or techniques for differentiating. Several kits attended to concepts and principles, but none was comprehensive enough to address all the standards for a particular grade level. At least two kits would be required to cover the prerequisite standards. Worse, the cost for the two kits would not include the price for the consumables that would have to be purchased each year to keep the kits adequately stocked. They could hardly pay for the cost of one kit!

Charlene and Andrew met at the back of the hall and compared notes. They were disappointed because they realized that the high-quality, standards-based curriculum materials they wanted were not in the racks. Now what? Were there other vendors? If so, who were they and how could they be contacted? If there were no vendors with the materials they needed, could they write the needed curriculum themselves? Who could help them? Did the district have money to pay stipends for curriculum development? How could they possibly write all the curricula that was required to address the state assessments?

We dedicate this curriculum unit, as well as others written under this Javits grant, to all the teachers who have had experiences like Charlene and Andrew. We hope the unit presented here will meet the needs of educators who live in real classrooms, contend with real time constraints, prepare students adequately for high-stakes assessments, seek high-quality curriculum materials, and strive to meet the varied learning needs of all their students.

Deborah E. Burns
Jeanne H. Purcell

PREFACE

In 2002, the Connecticut State Department of Education was awarded a Javits grant from the U.S. Department of Education called Project CONN-CEPT. The major focus of grant activities was the creation of standards-based curriculum units, K-8, in science and social studies. These rigorous curriculum units have been created for all students because every child must have access to the highest quality curriculum. At the same time, the units also have a particular focus on the needs of advanced learners—those who know more, learn more rapidly, think more deeply, or who are more innovative in a particular area of study. It was our goal to embed learning opportunities for advanced learners that were tightly aligned with the concepts and principles that guided the unit.

The Parallel Curriculum Model

This standards-based curriculum unit has been designed using the *Parallel Curriculum Model* (PCM) (Tomlinson, Kaplan, Renzulli, Purcell, Leppien, & Burns, 2002). The *Parallel Curriculum Model* is a set of four interrelated designs that can be used singly, or in combination, to create or revise existing curriculum units, lessons, or tasks. Each of the four parallels offers a unique approach for organizing content, teaching, and learning that is closely aligned to the special purpose of each parallel. The four parallels include: the Core Curriculum Parallel, the Curriculum of Practice, the Curriculum of Connections, and the Curriculum of Identity.

The *Core Curriculum* addresses the core concepts, principles, and skills of a discipline. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. The *Curriculum of Connections* builds upon the Core Curriculum. It is a plan that includes a set of guidelines and procedures to help curriculum developers connect overarching concepts, principles, and skills within and across disciplines, time periods, cultures, places, and/or events. This parallel is designed to help students understand overarching concepts, such as change, conflict, cause and effect, and patterns, as they relate to new content and content areas. The *Curriculum of Practice* is a plan that includes a set of guidelines and procedures to help students understand, use, generalize, and transfer essential knowledge, understandings, and skills in a field to authentic questions, practices, and problems. This parallel is designed to help students function with increasing skill and competency as a researcher, creator, producer, problem solver, or practitioner in a field. The *Curriculum of Identity* is a plan that includes a set of guidelines and procedures to assist students in reflecting upon the relationship between the skills and ideas in a discipline and their own lives, personal growth, and development. This parallel is designed to help students explore and participate in a discipline or field as it relates to their own interests, goals, and strengths, both now and in the future.

The *Parallel Curriculum Model* also contains a new concept called Ascending Intellectual Demand (AID). Ascending Intellectual Demand offers practitioners a way to think about a discipline and each student's steady, progressive movement from novice to expert within that discipline. As students are ready, teachers ask students for increasing levels of cognition, affect, and application. As such, AID is a framework teachers use to increase the challenge level for students by asking them to behave and act in expert-like ways. (Tomlinson, Kaplan, Purcell, Leppien, Burns, & Strickland, 2006).

This unit has been designed using the Core Curriculum parallel. Core Curriculum addresses the essential concepts, principles, generalizations, and skills of a subject area. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. Although the majority of lessons in this unit have been designed using the Core Curriculum parallel, it also contains several lessons that provide students with opportunities to explore other parallels that are closely connected to the subject matter.

Our Invitation...

We invite you to peruse and implement this curriculum unit. We believe the use of this unit will be enhanced to the extent that you:

- **Study PCM**. Read the original book, as well as other companion volumes, including *The Parallel Curriculum in the Classroom: Units for Application Across the Content Areas, K-12 and The Parallel Curriculum in the Classroom: Essays for Application Across the Content Areas, K-12*. By studying the model in depth, teachers and administrators will have a clear sense of its goals and purposes.
- **Join us on our continuing journey to refine these curriculum units.** We know better than to suggest that these units are scripts for total success in the classroom. They are, at best, our most thoughtful thinking to date. They are solid evidence that we need to persevere. In small collaborative and reflective teams of practitioners, we invite you to field test these units and make your own refinements.
- **Raise questions about curriculum materials.** Provocative, compelling and pioneering questions about the quality of curriculum material—and their incumbent learning opportunities—are absolutely essential. Persistent and thoughtful questioning will lead us to the development of strenuous learning opportunities that will contribute to our students' life-long success in the 21st century.
- **Compare the units with material developed using other curriculum models.** Through such comparisons, we are better able to make decisions about the use of the model and its related curriculum materials for addressing the unique needs of diverse learners.
- **Examine PCM as one bridge between general and gifted education.** We believe that the rigorousness of PCM has much to offer *all* students, not just those who may be already know, do, or understand at very different levels of sophistication.

ACKNOWLEDGEMENTS

We would like to thank our mentors, Carol Tomlinson and Carolyn Callahan. They have been our constant supporters and guides as we moved into uncharted territory related to curriculum development and differentiation.

Over the years we have been guided by the wise counsel of our curriculum writers: Cheryll Adams, Renee Alister, Karen Berk, Fie Budzinsky, Meagan Bulger, Yvette Cain, Lori Cipollini, Leslie Chislett, Megan Coffey, Edie Doherty, Claire Farley, Kurt Haste, Carla Hill, MaryAnn Iadarolla, Caitlin Johnson, Megan Lamontagne, Donna Leake, Lisa Malina, Kay Rasmussen, Martha Rouleau, Cindy Strickland, Mary Grace Stewart, Kim Turret, Ann Marie Wintenberg, and Karen Zaleski. They have worked tirelessly on their curriculum units and provided us with many insights into the curriculum writing process. Although we had a road map at the outset of the writing process, our writers helped us to craft new roads when the old ones no longer worked. We thank them for their integrity, care, innovativeness, and encouragement.

We thank all of the people who featured into the field testing process. These people include teachers in Cheshire, Hartford and Portland Public Schools. We especially want to thank the following building administrators who supported our work: Tory Niles and John Laverty from Hartford; Linda Cahill and Deborah Granier from Portland; and Steve Proffitt, Diane DiPietro, Sharon Weirsman, Russ Hinkley, Beverly Scully, and Mary Karas from Cheshire. The insights from teachers and administrators helped to make our curriculum units stronger and more practical.

Kim Allen, from Project LEARN, provided us with assistance and support in all of our endeavors and made sure that we stayed the course in solid financial standing. Nancy Wight and Gail Heigel, from Cheshire Public Schools, spent untold hours formatting, typing, duplicating, collating, and distributing the experimental units and ordering the numerous student materials and teacher resources that supplement these lessons. They are the masters of due diligence and attention to detail. We also wish to thank Eileen Williams and Patricia Johnson, from the State Department of Education, for formatting, typing, and preparing the pre-assessments and post assessments for the units. They worked tirelessly for many hours after work and on weekends to meet our deadlines and never lost their smiles.

We thank Cheshire Public Schools and the Connecticut State Department of Education for allowing us to take on this tremendous task and allowing us the hours within day (and night) to accomplish all that was required.

Our families and friends deserve special recognition because they offered unwavering support and encouragement. We recognize they made personal sacrifices, and we hope that we have grown as a result.

Most of all, we would like to thank Judy Walsh on whose shoulders these units truly stand. With the greatest of care and unparalleled thoughtfulness and consideration, Judy has edited each manuscript, worked collaboratively with each author to refine each lesson, written lessons when it was necessary, and provided a sense of humor and her wisdom as a teacher. She is selfless and seeks only to advance each author and the project. In every way, she has been our "North Star" on the project.

Format for the Project CONN-CEPT Curriculum Units

Each Project CONN-CEPT curriculum unit is formatted in the same way and contains four components: an overview, the lessons, a content map, and a comprehensive list of resources required in the unit. The *overview* is a chart that includes the lesson principles, concepts and skills, the time allocation, the standards that are explicitly addressed within each lesson, and a brief description of each lesson. The overview provides potential users with a "snap-shot" of the unit, related standards, and classroom activities.

The *lessons* follow the overview and vary in number depending upon the content area and grade level of the unit. Each lesson is comprehensive and addresses 10 curriculum components: content, assessments, introductory and debriefing activities, teaching strategies, learning activities, grouping strategies, products, resources, extensions, and differentiation activities. For the most part, each lesson provides specific information about each of these components. An aligned pre- and post-assessment is included for the entire unit, and aligned formative assessments are provided at critical junctures in the unit. Additionally, each lesson contains all the required black-line masters and materials.

Many lessons contain two features that are unique to Project CONN-CEPT materials: opportunities for Ascending Intellectual Demands (AID) and talent-spotting activities. Ascending Intellectual Demand is a term used to describe learning opportunities that require students to work at increasing levels of discipline-specific expertise (Tomlinson et al). They are appropriate for any student who demonstrates advanced ability or expertise in a discipline. The AID opportunities are labeled using the acronym AID. Additionally, many lessons contain searchlight opportunities. Searchlight opportunities are rich moments during a lesson for teachers to observe students and note those who appear to have heightened interest in the topic under investigation. To support these students' emerging interests, extension ideas are provided.

A *content map* comes after the lessons. Like the overview, the content chart is a snap-shot of the important knowledge in a unit: the major and minor principles, concepts, skills, themes and guiding questions. Teachers who want in-depth information about the knowledge contained in the unit will find this chart useful.

A comprehensive list of *resource materials* concludes each unit. Although the required materials are also listed at the beginning of each lesson, the comprehensive listing provides teachers with a one-page summary of all the materials and it facilitates planning.

Introduction to Reactions and Interactions –Grades 7 & 8

This unit on reactions and interactions has been designed using the Core Curriculum parallel. Core Curriculum addresses the core concepts, principles, generalizations, and skills of a subject area. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. Although the majority of lessons in this unit have been designed using the Core Curriculum parallel, it also contains several lessons that provide grade 7/8 students with opportunities to explore the methodology of the practicing professional (Curriculum of Practice), the opportunity to connect the material to another discipline (Curriculum of Connections), and the chance to reflect on themselves as emerging scientists (Curriculum of Identity).

The unit contains 35 lessons that are outlined in the chart below. The first column contains the lesson number and the name of the parallel(s) that the lesson addresses. The second column contains a series of numbers. The numbers reflect the national standards—culled from *National Science Education Standards* (National Research Council, 1996) and *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)—that are addressed in each lesson and that are listed and numbered below. Connecticut's standards are also listed in a similar fashion. For brevity's sake, only one or two standards are listed in each row of the chart and represent the major focus of individual sessions. However, the lessons have been designed to build upon each other, and each session builds iteratively upon many of the standards.

Column three contains the principles that guide the lesson. The principles—which state relationships among essential concepts—reflect what we want students to know and be able to do upon completing the lessons. They are derived from the standards, reflect both declarative and procedural knowledge, and illustrate the careful attention that has been given to "teasing apart" the complexity of ideas contained within standard statements.

Column four includes a brief description of the lesson. It provides an overview of some of the teaching and learning activities that are designed to occur within the classroom.

National Standards

Physical Science

1. A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties. (*National Science Education Standards*, 5-8)
2. Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group. (NSES*, 5-8)
3. Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter. (NSES, 5-8)
4. The temperature and acidity of a solution influence reaction rates. Many substances dissolve in water, which may greatly facilitate reactions between them. (*Benchmarks for Science Literacy*, 6-8)
5. There are groups of elements that have similar properties, including highly reactive metals, less-reactive metals, highly reactive nonmetals (such as chlorine, fluorine, and oxygen), and some almost completely nonreactive gases (such as helium and neon). An especially important kind of reaction between substances involves a combination of oxygen with something else—as in burning or rusting. Some elements don't fit into any of the categories; among them are carbon and hydrogen, essential elements of living matter. (BSL**, 6-8)

Science and Technology

6. Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot. (NSES, 5-8)

Science as Inquiry

7. Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models. (NSES, 5-8)
8. Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding. (NSES, 5-8)
9. Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances. (NSES, 5-8)

10. Scientists differ greatly in what phenomena they study and how they go about their work. Although there is no fixed set of steps that all scientists follow, scientific investigations usually involve the collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected evidence. (BSL, 6-8)

Models

11. Models are often used to think about processes that happen too slowly, too quickly, or on too small a scale to observe directly, or that are too vast to be changed deliberately, or that are potentially dangerous. (BSL, 6-8)

* National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

** American Association for the Advancement of Science. (1993). *Project 2061: Benchmarks for science literacy*. New York: Oxford University Press

Connecticut Related Content Standards
Grades 6-8

I Scientific Inquiry (Expected Performances – C INQ. 1, C INQ. 2, C INQ. 3)

Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.

Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation.

Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.

Scientific Literacy (Expected Performances – C INQ. 4, C INQ. 5, C INQ. 9, C INQ. 10)

Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science.

Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media.

Scientific Numeracy (Expected Performances – C INQ. 6, C INQ. 7, C INQ. 8)

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Grade 6

6.1 Properties of Matter (Expected Performances – C 1, C 2, C 3)

How does the structure of matter affect the properties and uses of materials?

Materials can be classified as pure substances or mixtures, depending on their chemical and physical properties.

- Mixtures are made of combinations of elements and/or compounds, and they can be separated by using a variety of physical means.

- Pure substances can be either elements or compounds, and they cannot be broken down by physical means.

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Lessons	Standards	Lesson Principles	Lesson Description
Pre-assessment (CORE) 50 minutes			This lesson includes a pre-assessment that samples the content in this unit: chemical changes, physical changes, the differences between physical and chemical changes, the interdependence of science, technology and society, elements and their groupings, compounds, and the skills involved with scientific inquiry.
1 (CORE/AID) 45 minutes	1, 2, 6, 7 CT Standards: I (Expected Performances: C INQ 10)	• The interactions between matter cause physical or chemical changes. • There are differences between physical and chemical changes. • Chemical and physical changes occur everywhere, all the time between all states of matter. • Chemical changes have certain attributes, such as producing new substances, temperature changes and gas or light production. • Scientific discoveries and inventions may have both beneficial and detrimental consequences.	This lesson introduces physical and chemical changes to assist students in building an understanding of the differences and ultimately the respective roles and impact of physical and chemical changes on the natural environment. In pairs students differentiate the reactions and interactions in an assigned picture. They will also identify the changes that might have the potential to be detrimental to the environment. An AID opportunity invites students who need more challenge to design a cartoon that highlights some aspect of a chemical change that is not beneficial to our environment or to society.
2 (CORE) 45 minutes	1, 2, 6, 7 CT Standards: I (Expected Performances: C INQ 1, 2, 10)	• The interactions between matter cause physical or chemical changes. • There are differences between physical and chemical changes. • Chemical and physical changes occur everywhere, all the time and between all states of matter. • Chemical changes have certain attributes, such as producing new substances, temperature changes and gas or light production. • Scientific discoveries and inventions may have both beneficial and detrimental consequences.	In this lesson students continue their exploration of the nature of physical and chemical changes. They share their insights regarding changes that occur in the environment, using pictures of a range of environmental scenes. They explore the attributes of physical and chemical changes, as well as the fact that these changes involve all states of matter.
3 (CORE) 45 minutes	1, 2, 10 CT Standards: I (Expected Performances: C INQ 1, 3, 5) 6.1 (Expected Performances C3)	• The interactions between matter cause physical or chemical changes. • There are differences between physical and chemical changes. • Chemical changes have certain attributes such as producing new substances, temperature changes and gas or light production. • Substances involved in a physical change can be reversed through physical means. • Some interactions of matter form mixtures. • Mixtures are examples of physical change.	In this lesson students further investigate the differences between an interaction of substances that can be reversed by physical means and a reaction between the substances that produces new substances. In a lab activity, they will explore some of the differences between physical changes, like the creation of mixtures, and chemical changes, such as the chemical reactions between acids and bases.

Lessons	Standards	Lesson Principles	Lesson Description
4 (CORE) 45 minutes	1, 2, 9 CT Standards: I (Expected Performances: C INQ. 1, 8, 9, 10) 6.1 (Expected Performances: C 3)	• The interactions between matter cause physical or chemical changes. • There are differences between physical and chemical changes. • Chemical changes have certain attributes such as producing new substances, temperature changes and gas or light production. • Substances involved in a physical change can be reversed through physical means. • Some interactions of matter form mixtures • Mixtures are examples of physical changes.	In pairs students finish the lab activities from the previous lesson, analyze their observations, draw conclusions, and answer questions as to which chemical interactions produced physical and chemical changes.
5 (CORE) 1 hour, 30 minutes	2, 3, 7, 9 CT Standards: I (Expected Performances: C INQ. 1, 5, 8, 9, 10) 6.1 (Expected Performances: C 3)	• The interactions between matter cause physical or chemical changes. • There are differences between chemical and physical changes. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes. • Substances involved in a physical change can be reversed through physical means. • Mixtures are made up of different states of matter. • Mixtures can be divided into types. • Solutions are mixtures that contain substances that are dissolved.	As a class students discuss the lab activities and answers to the lab questions from Lesson 3 and 4 and differentiate between physical and chemical changes they observed in the lab activities. They are introduced to the idea of solutions, as a special type of mixture in which the substances being mixed dissolve, and to the concept that substances vary in their ability to dissolve. Those students who need further challenge are introduced to special types of mixtures called suspensions, colloids and emulsions (GT Lessons 1-4).
6 (CORE/AID) 45 minutes	1, 2, 3 CT Standards: I (Expected Performances: C INQ. 1, 3, 5, 8) 6.1 (Expected Performances: C3)	• Chemical and physical changes occur everywhere, all the time and between all types and states of matter. • There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes.	In this lesson students create a visual display to share their understanding of mixtures with other students and staff. These displays will include examples and questions that can challenge the visitors who see them. In addition, students will start studying chemical reactions more specifically by taking a household food item, a banana, and watching its effect on an unripe tomato! Students who need more of a challenge can conduct an AID investigation on the ways the ripening process is used by industries.

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Lessons	Standards	Lesson Principles	Lesson Description
7 (CORE) 45 minutes	1, 2, 3, 7 CT Standards: 1, 6.1	• Chemical and physical changes occur everywhere, all the time and between all types and states of matter. • There are differences between physical and chemical changes • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that have properties that are different than the original reactants.	In this lesson, students will be introduced to a lab investigation that focuses on discovering some of the characteristics that differentiate chemical and physical changes. The chemical reactions in the lab investigation demonstrate: (a) different states of matter reacting, (b) the common characteristics of chemical changes—production of new substances(s), temperature change and gas or light production, and (c) chemicals that are in students' lives.
8/9 (CORE/AID) 1 hour, 30 minutes	2, 3, 7 CT Standards: I Expected Performances: C INQ. 1, 3, 5, 8, 9, 10) 6.1 (Expected Performances: C 2)	• Chemical and physical changes occur everywhere, all the time and between all types and states of matter. • There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures. • Chemical changes have certain attributes such as producing new substances, temperature changes and gas or light production.	Students continue the study of chemical changes by completing lab activities that provide them with opportunities to use scientific thinking. The labs reinforce the concept that in chemical reactions the products come from the rearrangement of reactants to form new substances with different properties than the original reactants. They also provide students with an opportunity to identify some of the common characteristics of chemical changes. AID opportunities offer further study on the labs as well as a field trip to a solid waste management plant.
10-12 (CORE/AID) 2 hours, 15 minutes	2, 3, 4 CT Standards: I (Expected Performances: C INQ. 1, 3, 5, 8, 9, 10). 6.1 (Expected Performance: C 2)	• Chemical and physical changes occur everywhere, all the time and between all types and states of matter. • There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that can be identified and that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures. • Chemical changes have certain attributes such as producing new substances, temperature changes and gas or light production.	Two teacher demonstrations and a review of the previous four days' activities will probe students' understandings of the nature of chemical reactions. Students will work in pairs to answer questions on characteristics of chemical changes.

Lessons	Standards	Lesson Principles	Lesson Description
13 (CORE) 45 minutes	2, 3, 5 CT Standards: I (Expected Performances: C INQ. 1, 2, 3, 5) 6.1 (Expected Performances: C 2)	• Chemical and physical changes occur everywhere, all the time and between all types and states of matter. • Chemical change produces new substances that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures.	In pairs students examine examples of chemical changes (e.g. sodium reacts violently with water to form chlorine gas) and discover that the characteristics of products formed during a chemical reaction have nothing to do with the properties of the original substances.
14 (CORE) 45 minutes		All principles covered in lessons 1-13	This lesson includes an assessment of students' understanding of the unit content thus far.
15 (CORE/ 45 minutes		All principles covered in lessons 1-13	In this lesson students will review the results of the assessment of their understanding of chemical and physical changes.
16 (CORE) 45 minutes	1, 4 CT Standards: I (Expected Performances: C INQ. 1, 3, 5, 8, 9, 10) 6.1 (Expected Performances: C 2)	• Most matter in nature is found mixed with other matter. • Solutions are mixtures that contain substances that are dissolved. • Mixtures are made up of different states of matter. • When a substance dissolves in another substance, its particles go in-between the other's particles.	In this lesson students deepen their understanding of what actually happens when substances mix to form solutions. Three teacher demonstrations serve as visual anchors for students as they assimilate the concept of dissolving.
17 (CORE) 45 minutes	4, 11 CT Standards: I (Expected Performances: C INQ. 1, 4, 5, 7, 8, 9, 10)	• Some of the interactions between matter are predictable. • Changing temperature affects the rates of reactions. • Changing particle size affects the rates of reactions. • Changing surface area affects the rates of reactions.	By executing five different labs students will discover that temperature, surface area and concentration are three common factors that influence the rate of physical and chemical changes.
18-19 (CORE) 1 hour, 30 minutes	4, 6 CT Standards: I (Expected Performances: C INQ. 1, 6, 7, 9, 10) 6.1 (Expected Performances: C 2)	• Some of the interactions between matter are predictable. • Changing temperature affects the rates of reactions. • Changing particle size affects the rates of reactions. • Changing surface area affects the rates of reactions. • Changing concentration affects the rates of reactions.	Using the results from various simple experiments as evidence, students will discover some of the factors that affect the rate of physical and chemical changes. They will conclude that temperature, surface area and concentration are three common factors that affect reactions between substances. They will discuss the importance of these factors in real world events and products, such as fish kills and carbonated beverages, respectively.

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Lessons	Standards	Lesson Principles	Lesson Description
20-21 (PRACTICE/ IDENTITY) 1 hour, 50 minutes	1, 4 CT Standards: I (Expected Performances: C INQ. 1, 3, 4, 5, 8, 10) 6.1 (Expected Performances: C 2)	• Some of the interactions between matter are predictable. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes. • Although substances may look the same physically, they can be distinguished by their reactivity with other substances.	Students will perform some simple chemical tests on substances in order to experience the work that analytical chemists do for a living. After compiling results from various tests on different solid substances that have been mixed together, they will use the data from this work to test an unknown sample. In addition, they will determine what some of the components are in certain household products. At the end of the lesson, students reflect about the work they have done and whether their personal qualities and values would be a good fit for a career as a chemist.
22 (CORE/AID) 45 minutes	3, 5 CT Standards: I (Expected Performances: C INQ. 1, 2, 9, 10) 6.1 (Expected Performances: C 1)	• Matter is made of elements that can be by themselves or joined to form compounds. • Although substances may look physically the same, they can be distinguished by their reactivity with other substances. • Compounds are made from combining different elements in different arrangements. • Many compounds can be produced from a much smaller number of basic kinds of materials, elements. • Matter can be acidic, basic or neutral.	A discussion with the class on the process of re-arrangements that occur during chemical reactions leads into a study of elements and the resulting compounds they can produce. Students are assigned a poster research project on one of the elements. An AID opportunity invites students with exceptional ability to do a second project.
23-24 (CORE/AID) 1 hour, 30 minutes	3, 4, 5 CT Standards: I (Expected Performances: C INQ. 2, 10) 6.1 (Expected Performances: C 1)	• Matter is made of elements that can be by themselves or joined to form compounds. • Compounds are made from combining different elements in different arrangements. • Many products can be produced from a much smaller number of basic kinds of materials • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties.	Students will investigate the nature, discovery, uses, impact and history of the elements. They will also research some of the compounds that can be made from their assigned elements. The research activity will culminate in a poster presentation.

Lessons	Standards	Lesson Principles	Lesson Description
25-26 (CORE) 1 hour, 30 minutes	3, 4, 5 CT Standards: I (Expected Performances: C INQ. 10) 6.1 (Expected Performances: C 1)	• Matter is made of elements that can be by themselves or joined to form compounds. • Tables can be used to organize large amounts of information and therefore make data more manageable. • Different elements have different physical and chemical properties. • Elements can be grouped by their chemical properties. • Reactivity is an example of a chemical property of elements. • Elements can be categorized into metals, non-metals and semi-metals. • Groups of elements have similarities much like families.	Students will discover that elements can be grouped based on some similarities in properties into "families." They will become familiar with the concept of periodicity of elements by participating in a kinesthetic activity. In addition, students will begin to understand the benefits of creating a periodic table, especially its use as a tool for prediction and explanation.
27-28 (CORE) 1 hour, 30 minutes	3, 4, 5 CT Standards: I (Expected Performances: C INQ. 1, 5, 9, 10) 6.1 (Expected Performances: C 1)	• Matter varies in its ability to chemically react with other matter. • The nature of matter can be explored through scientific investigations. • Different elements have different physical and chemical properties. • Elements can be grouped together depending on their physical and chemical properties. • Reactivity is an example of a chemical property of elements • Elements can be categorized into metals, non-metals and semi-metals. • Elements vary in their chemical reactivity	In these lessons students work in lab groups of two as they visit various lab stations to observe the reactivity of various substances to determine if certain substances are more reactive than others are and if they can be categorized based on their reactivity. Then in groups of four, students compare their results and answer questions on the lab. A class debriefing reviews the varying chemical properties of elements as well as families of elements.
29-30 (CONNECTIONS/ AID) 1 hour, 30 minutes	3, 5, 10 CT Standards: 6.2 (Expected Performances: C 1)	• Scientists communicate knowledge about matter in clear and varied ways. • Matter is made of elements that can be used by themselves or joined to form compounds. • Compounds are made from combining different elements in different arrangements. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties. • Groups of elements have similarities much like families.	In this lesson students will have an opportunity to take their understanding of an element and its family members and combine it with their perception of the characteristics of a hero. Using a creative story format, they will demonstrate their insight into seemingly disparate disciplines, science and language arts. AID opportunities allow students with exceptional creativity to present their story to another class, publish it in a local newspaper, or create a visual representation of it.

Lessons	Standards	Lesson Principles	Lesson Description
31-34 (CONNECTIONS) 3 hours	5, 6, 8 CT Standards: I (Expected Performances: C INQ 2) 6.1 (Expected Performances: C 1, C 2)	• The study of matter, the subsequent technology and the social and historical context in which this study takes place are interdependent. • Matter is made of elements. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties. • Scientific discoveries and inventions have beneficial and detrimental consequences.	Students will research and document some aspect of an element's history, either its discovery or its importance to society in terms of use.
35 (CORE) 50 minutes		All principles in the unit	Post assessment

References

American Association for the Advancement of Science. (1993). *Project 2061: Benchmarks for science literacy*. New York: Oxford University Press.

Connecticut State Department of Education. (2004). *Core science curriculum framework*. Hartford, CT: Connecticut State Department of Education.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Tomlinson, C. A., Kaplan, S. N., Renzulli, J. S., Purcell, J., Leppien, J., & Burns, D. (2002). *The parallel curriculum: A design to develop high potential and challenge high-ability learners*. Thousand Oaks, CA: Corwin Press.

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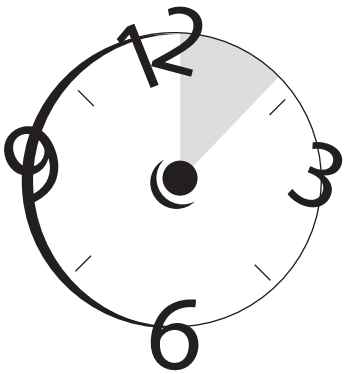
“Pre-assessment”

Pre-assessment

Core

Time Allocation: 50 minutes
Required Materials and Resources on Page 230



Lesson Overview

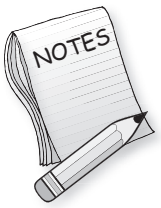
Students take the pre-assessment for Modules 1 & 2 for the entire class time today.

Guiding Questions

- What do I know about physical and chemical reactions?
- What do I know about mixtures, elements and compounds?

BIG IDEA

What do I Know About Physical and Chemical Reactions and Interactions?



Content Goals

Universal Themes

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

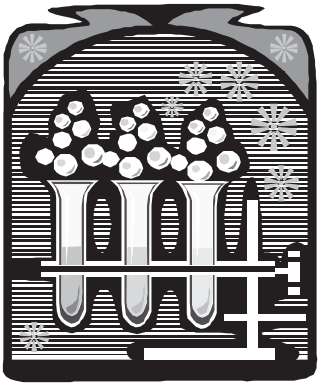
- The interactions between matter cause physical or chemical changes.
- There are differences between physical and chemical changes.
- Matter is made of elements that can be by themselves or joined to form compounds.
- Compounds are made from combining different elements in different arrangements
- Matter has physical and chemical properties.
- Different elements have different physical and chemical properties.
- Different compounds have different physical and chemical properties.
- Groups of elements have similarities, much like families.
- The study of matter, the subsequent technology and the social and historical context in which this study takes place are interdependent.

Concepts

- Matter
- Chemical change
- Physical change
- Mixture
- Solution
- Dissolving
- Physical properties
- Chemical properties
- Element
- Compound

- "Families" of elements
- Periodicity
- Interdependence of science, technology and society
- Environmental and social consequences

Teacher Information
N/A



Skills
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- See relationships
- Draw conclusions

Materials and Resources
Reactions and Interactions Unit Pre-assessment.

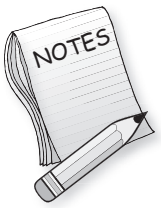
Preparation Activities
Copy **Reaction and Interactions Unit Pre-assessment** for each student.

Introductory Activities
Explain to students that the pre-assessment will be used as a tool by you to measure their previous knowledge. Emphasize that they should make their best effort on the assessment but should not worry if they do not know some of the questions.

Pre-assessment
Reaction and Interactions Unit Pre-assessment

Teaching and Learning Activities (50 minutes)
Distribute the **Reactions and Interactions Unit Pre-assessment.**

Products and Assignments
Students' assessment results



Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

N/A

Name _____ Date _____

Reactions and Interactions Unit Pre-assessment

1. Describe two examples of chemical changes?

2. Identify one chemical change that is beneficial and indicate why or how it is beneficial.

3. Identify one chemical change that is detrimental and indicate why or how it is detrimental.

4.

A) What are some differences between chemical and physical changes?

B) When we see a change occur in our daily lives or in the environment, why should we if care if it is physical or chemical?

5. Name two elements and two compounds and describe how they are useful to us.

REACTIONS AND INTERACTIONS

Name _____ Date _____

6. Describe what happens when a solid dissolves in a liquid?

7. Why are environmental accidents that form mixtures generally easier to clean up than those that cause chemical changes like fires?

8. If you were given three containers each holding a white solid powder, how would you go about determining if the containers held the same or different powders?

9. The element sulfur is yellow and has a sharp, offensive odor. When it chemically reacts with hydrogen gas, it forms a new substance called hydrogen sulfide that smells like rotten eggs. Do you think the smell is coming from the sulfur in the new substance or do you think it is a coincidence? Please explain your answer.

10. Why are science, technology and society interdependent?

11. A) What do elements in a "family" have in common?

    B) What is the advantage of grouping elements in a family on the periodic table?

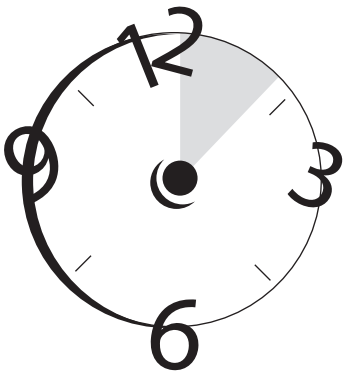
12. Why do you think matter maters?

Physical and Chemical Changes

Core/AID

Time Allocation: 45 minutes

Required Materials and Resources on Page 230



Lesson Overview

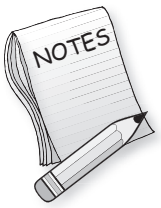
Change, both natural and man-made is ubiquitous, yet students seldom recognize its implications. This lesson introduces physical and chemical changes to assist students in building an understanding of the differences and ultimately the respective roles and impact of physical and chemical changes on the natural environment. In this lesson the teacher will assess students' prior knowledge of chemical versus physical changes. It is important to identify how much students already know about these differences in order to design activities that will build on students' prior understandings about the nature, products, rates, beneficial and detrimental consequences of physical and chemical changes.

Guiding Questions

- Why does matter matter?
- What do you already know about chemical and physical changes?
- Can you recognize a physical versus a chemical change?
- What are some of the differences between physical and chemical changes?
- Do chemical changes occur everywhere, all the time and between all states of matter?
- What are some of the detrimental environmental consequences of chemical reactions?

BIG IDEA

Physical and chemical changes, what are the differences between them?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- The interactions between matter cause physical or chemical changes.
- There are differences between physical and chemical changes.
- Chemical and physical changes occur everywhere, all the time and between all states of matter.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.
- Scientific discoveries and inventions may have both beneficial and detrimental consequences.

Concepts

- Matter
- Interaction
- Reaction
- Physical change
- Mixture
- Chemical change
- Product
- Temperature
- Gas
- Light
- Environmental consequence

Teacher Information

N/A

Physical and Chemical Changes

Skills

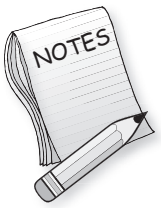
- Make observations
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and Contrast
- See relationships
- Draw conclusions
- Draw
- Create

Materials and Resources

1. Gather at least 10-12 pictures from various magazines that show physical and chemical changes. These will be used to stimulate student thinking about the differences between physical and chemical changes and the implications of these changes.
2. Make sure that each picture contains at least one negative consequence of either physical or chemical changes to the environment.
3. Include some pictures of common places and activities that can be used to illustrate the idea that physical and chemical changes occur everywhere, all the time and between all states of matter.

Preparation Activities

1. Collect baby food jars with lids for the lab in Lesson #3.
2. Make copies of the poem "What Does It Matter?"
3. Make copies of rubric for "What Does It Matter?"
4. Hang the pictures around the room.
5. Post the poem on the wall.



Introductory Activities (25 minutes)

- Introduce the unit's essential question, "Why should it matter to us what happens to matter?" Read the poem.

What Does It Matter?

Matter matter everywhere!
Why on earth should we care!
Reactions in water, land and air,
some we make. Should we dare?

Chemical changes- around us for sure.
Ozone depletion, resources impure,
eternal life for which we lust.
Many wonder what's the fuss?

There are consequences to one's actions, they say.
What results from reactions can be a price to pay.
Explore the science that provides the insight
to make decisions that involve foresight.

~*Fie Budzinsky*

- Ask students, "How, when and where does matter interact?"
- Elicit from students their understandings about the interaction of matter in their lives (e.g., putting sugar in coffee, eating food and its interactions through the process of digestion, cutting apart an unwanted credit card, plants growing and taking nutrients and water from soil to produce "food" (sugars), cars rusting, labeling a CD, cleaning clothes, frying an egg, baking a cake, throwing garbage in a pail, making a compost pile, decaying that occurs over time in a compost pile and hemming a dress). **SEARCHLIGHT:** Be on the lookout for students who seem insightful about this topic and/or are able to handle independent research and enjoy sharing their findings with others. Suggest to these students that they do the Extension Activity at the end of the lesson.
- Briefly jot down the students' examples on the board or overhead.
- Ask the students to describe the nature of the changes they have identified in terms of the reversibility of the change and whether a new substance was formed.

- Lead students to understand that some of these changes are more permanent in nature (e.g., frying an egg and the process of photosynthesis) and are not easily reversed. Other changes can be reversed by physical means (e.g., putting sugar in coffee and hemming a dress).
- Use the terms physical change or chemical change to identify all the examples the students listed.
- Record the students' current understandings of the attributes of physical and chemical changes, highlighting any differences that become apparent between the two types of change. Students may mention that a chemical change "makes something new" or that "the substances that are produced do not look like the original substances.
- Students will be less likely to mention that a gas can often be produced and can be recognized by the bubbling that occurs during the reaction. It does not matter at this point whether they recognize the common signs of a chemical change. The main purpose of this activity is to help students recognize that chemical changes are everywhere and are occurring all the time. This recognition of the ubiquitous nature of chemical changes will eventually lead to questions about the consequences of some of those changes for the environment and its organisms.
- Save this list. It can be used to determine growth in understandings about physical and chemical changes after the module's activities are completed.

Pre-assessment

N/A

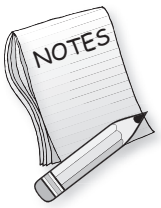
Teaching and Learning Activities (20 minutes)

1. Share with students that they will be studying the nature of matter, as well as its interactions and reactions throughout this unit.

2. Assign the students to groups of two.

3. Explain to them that today's final task is to differentiate the reactions and interactions that they see in the picture that is assigned to them from those that are displayed around the room.

4. In addition, they are to note whether the interactions are physical or chemical changes.



5. Remind students that they must identify at least one physical change and two chemical changes in their picture.

6. Students are then to identify which of these changes might have the potential to be detrimental to the environment.

7. Instruct them that the goal is to answer the question, "Why does matter matter?"

8. Tell students that they will be sharing their analyses of the interactions contained in their assigned picture tomorrow.

9. Distribute copies of poem, "What Does It Matter?" to each student.

10. Distribute and review the rubric for the essay.

11. Explain to students that for homework they are to re-read the poem and write a one-paragraph essay describing what they think the poem means.

12. Inform students that the essay will be collected the next day.

Products and Assignments

N/A

Extension Activities (AID)

1. Students who need more challenge and may have been identified as being creative or artistic should be given the opportunity to design a cartoon that highlights some aspect of a chemical change that is **not** beneficial to our environment or to society. A conversation with the art teacher(s) might assist you in identifying students.
2. If possible, an authentic audience should be found for these cartoons. The cartoons can be published in a school or district-wide newsletter to staff or parents. They can be displayed in a public place (e.g., hallway or school entrance area), so that the students' messages, regarding the potential damage from chemical changes that are not strategically planned or monitored, can be shared with others. Students need to realize that they too

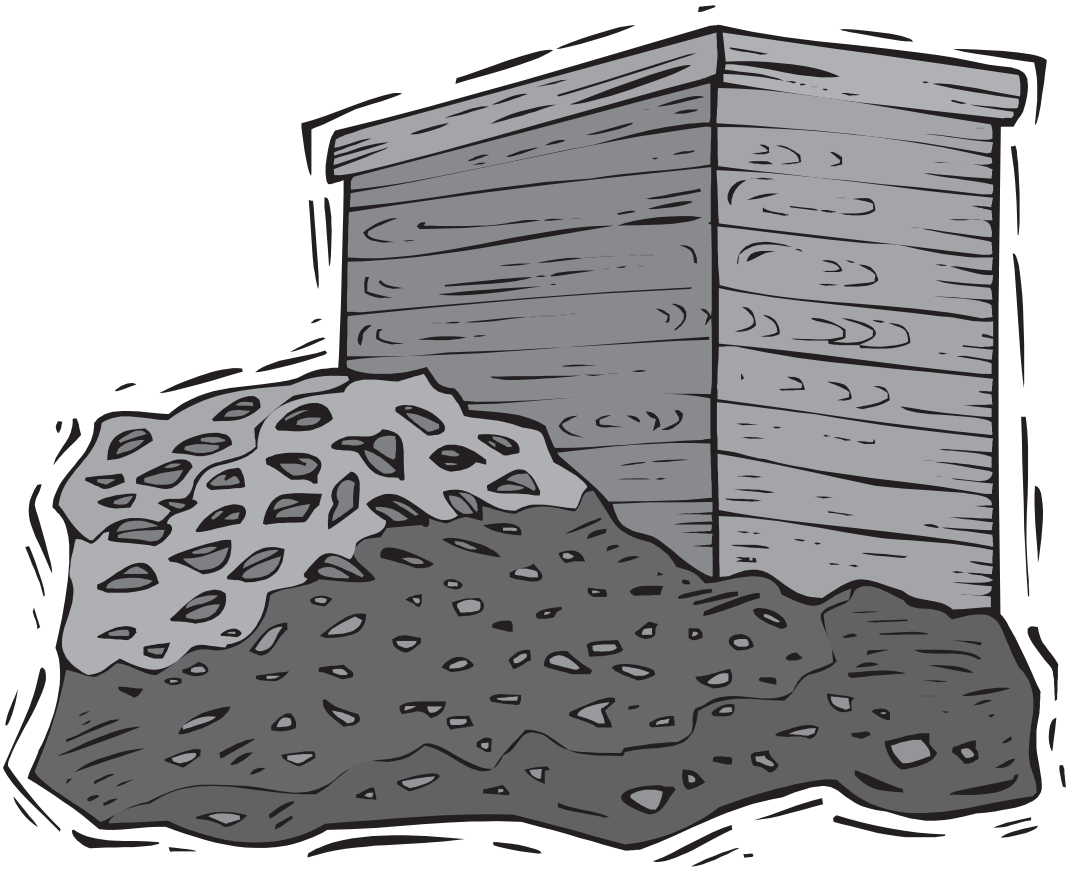
can make a difference. They can contribute to the public's understanding of the importance of decisions citizens make, especially with regard to matter and what we do with it.

Post Assessment

N/A

Debriefing and Reflection Opportunities

N/A



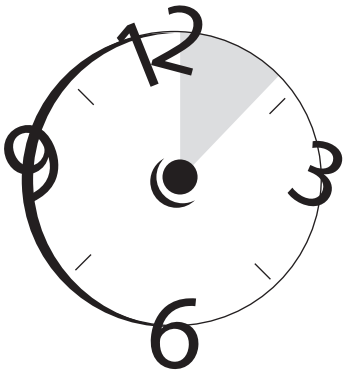
Name: _____ Date: _____

"What Does It Matter?" Essay Rubric

Criteria	1	2	3	4	Your Score
Understanding of Material	Student has an apparent misunderstanding of why the study of matter matters.	Student has a limited understanding of why the study of matter matters, displayed by vague, unclear language.	Student is developing an understanding of why the study of matter matters, as several ideas and examples are provided.	Student has a clear understanding of why the study of matter matters, displayed by clear, concrete language and complex ideas.	1 2 3 4
Focus	Essay addresses topic but loses focus by including irrelevant ideas.	Essay is focused on topic and includes few loosely related ideas.	Essay is focused on the topic and includes relevant ideas.	The essay is focused, purposeful, and reflects clear insight and ideas.	1 2 3 4
Mechanics	The essay has frequent errors in spelling, grammar and punctuation.	The essay has errors in grammar and punctuation, but spelling has been proofread.	The essay has occasional grammatical errors and questionable word choice.	The essay is nearly error free, which reflects clear understanding and thorough proofreading.	1 2 3 4
Structural Organization	The essay lacks logical progression of ideas and clear transitions.	The essay includes a brief skeleton (introduction, body, and conclusion) but lacks transitions.	The essay includes logical progression of ideas aided by appropriate transitions.	The essay is clearly organized, fully developed, and uses appropriate and varied transitions.	1 2 3 4
Support	There are little or no solid supporting ideas or evidence for the essay content.	There are some supporting ideas and/or evidence for the essay content.	The support lacks specificity and is loosely developed.	The essay contains specific, developed details and superior support and evidence for its content.	1 2 3 4

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

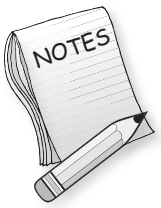
In this lesson students continue their exploration of the nature of physical and chemical changes. They share their insights regarding changes that occur in the environment, using pictures of a range of environmental scenes. They explore the attributes of physical and chemical changes, as well as the fact that these changes involve all states of matter.

Guiding Questions

- Can I recognize a physical versus a chemical change?
- What are some of the differences between physical and chemical changes?
- Do chemical changes occur everywhere, all the time and between all state of matter?
- What are some of the detrimental environmental consequences of chemical reactions?

BIG IDEA

What are the Differences Between Physical and Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

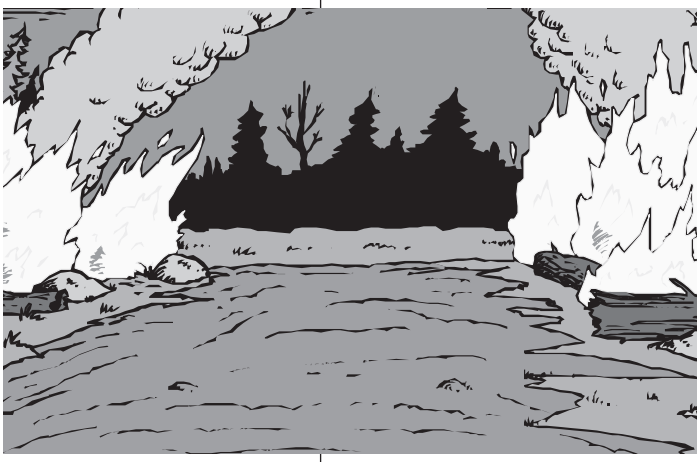
- The interactions between matter cause physical or chemical changes.
- There are differences between physical and chemical changes.
- Chemical and physical changes occur everywhere, all the time and between all states of matter.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.
- Scientific discoveries and inventions may have both beneficial and detrimental consequences.

Concepts

- Matter
- Interaction
- Reaction
- Physical change
- Mixture
- Chemical change
- Product
- Temperature
- Gas
- Light
- Environmental and social consequences

Teacher Information

N/A



Skills

- Make observations
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and Contrast
- See relationships
- Draw conclusions
- Draw
- Create

Materials and Resources

N/A

Preparation Activities

1. Make sure the pictures are still posted around the room.
2. Post the poem on the wall.

Introductory Activities (15 minutes)

- Collect student essays on the poem, "What Does It Matter?"
- Tell students that you will be reading the essays tonight and assessing them, using the rubric that you handed to them yesterday.
- Tell students that they will have a few more minutes to finish their analysis of the interactions between matter in their assigned picture and that they will be sharing their analyses with the other class members.

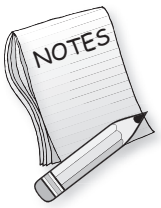
Pre-assessment

N/A

Teaching and Learning Activities (25 minutes)

1. Select as many student pairs as time will permit to explain the analysis of their assigned picture to the entire class.

2. Students' analyses should bring out the attributes of physical and chemical changes.



3. As students identify what the physical and chemical changes are in the pictures, ask them questions like:

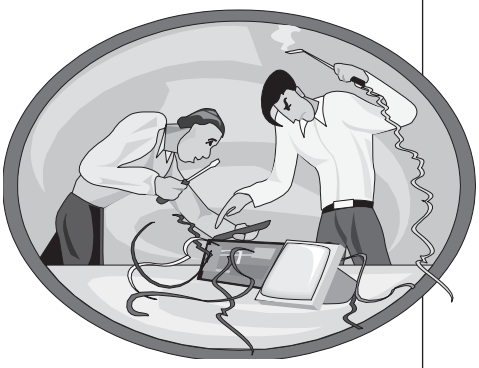
   "What is one of the products? What characteristics does it have? Is the product anything like the original reactants? How is it different? Can the chemical change you described be reversed? How sure are you that a new substance was produced? How do you know? What are some of the characteristics of the chemical change you identified?"

4. For example, if students have analyzed a picture of a burned forest, they may answer the above questions as follows:

   "Some of the products are ash and smoke. Ash is not like a living tree. It does not look like it in any way. It is black and non-living. It does not have all the complexity of a tree. You cannot reverse the damage done by the fire. You cannot rebuild the tree from the ashes or for that matter from any of the products from the fire. I am sure a new substance is produced. I guess I could test the ash somehow and see if it has different properties (characteristics) than the tree. One of the characteristics of this chemical change is that it produced new things. It also involved fire and lots of heat."

5. Ask the students if the chemical change identified in the fire example involved one or more states of matter.

6. Repeat steps # 4 and 5 with appropriate questions that pertain to a physical change in the same picture. For example, students might mention that during a fire the water in the ground or in a lake nearby would be heated and some of it would evaporate. Questions could be asked regarding the states of matter involved and the products of this physical change.



7. As each pair of students shares their findings, use questions similar to the ones above to bring students to understand that chemical changes occur everywhere, between all states of matter and produce all states of matter. Emphasize the attributes that allow us to differentiate between a physical and chemical change: e.g., chemical changes produce new substance(s), involve temperature change, cannot be undone by physical means, show evidence of gas being produced, such as bubbles, whereas physical changes do not.

Products and Assignments

- Students' essays on the poem, "What Does It Matter?" These essays will be evaluated for content and form. However, no grades will be put on the essays themselves, as some may be used on a bulletin board display.
- (AID) If the student cartoons from the precious day's assignment show insight and creativity, find a broader audience with whom to share this work, such as the school newspaper, especially if the cartoons convey the connections between science, technology and society.

Extension Activities

N/A

Post Assessment

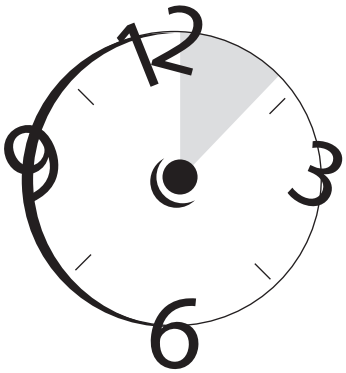
N/A

Debriefing and Reflection Opportunities (5 minutes)

Ask students how true they think the statement is that chemical and physical changes occur everywhere, all the time and between all states of matter.

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

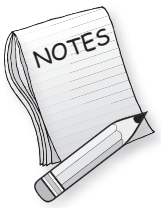
In this lesson the teacher and students discuss students' interpretations of the poem, "What Does it Matter" from Lesson 1. It is important for students to realize that science and its associated technologies cannot be separated from the society in which it occurs. They must understand that society's priorities, needs and values influence the science that is explored and the products that result. Students in this lesson will further investigate the differences between an interaction of substances that can be reversed by physical means and a reaction between substances that produces new substances. In a lab activity, they will explore some of the differences between physical changes, like the creation of mixtures, and chemical changes, such as the chemical reactions between acids and bases.

Guiding Questions

How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes?

BIG IDEA

What are the Differences Between Physical and Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- The interactions between matter cause physical or chemical changes.
- There are differences between physical and chemical changes.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.
- Substances involved in a physical change can be reversed through physical means.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.

Concepts

- Matter
- States of matter
- Interaction
- Reaction
- Chemical reaction
- Chemical change
- Physical change
- Mixture

Teacher Information

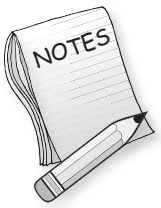
The difference between the words "interaction" and "reaction" in this unit are subtle. An interaction does not necessarily result in a reaction. The latter is usually reserved for chemical changes. An interaction can produce either a physical change or chemical change. When it produces a chemical change, it is usually described as a "reaction."

Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Identify patterns
- Categorize

Materials and Resources

1. Two new pictures that contain a mixture, representing a physical change, and also contain at least one chemical change
2. Baby food jars with lids (2 per group)
3. Box of cloves (30 cloves per group)
4. A box of iron-fortified cereal with raisins so the heterogeneous nature of a mixture can be made obvious. Add raisins to the cereal if it does not come with them
5. Plastic sandwich bag (one for each group)
6. Plastic bowls (1 for each group)
7. Bar magnet (1 for each group) Set of 2, Part # 62290* for $9.25 + S&H
8. White tissues (1 per group)
9. Water
10. Cooking oil (25 ml per group)
11. Food coloring (1 dispenser per group)
12. Sugar (1 pinch per group)
13. Eyedropper (1 per group)
14. Watch glass or small beaker (1 per group)
15. 10-ml graduated cylinder (1 per group)
16. 100-ml graduated cylinder (1 per group)
17. Beaker (500 ml) or large quart jar (1 for each group)
18. Small beaker or clear plastic cup (1 for each group)
19. Baking soda (1 tablespoon per group)
20. Citric acid (1 tablespoon per group) 500g, Part #94488-06*, $11.80 +S&H
21. Plastic tablespoons (1 per group)
22. Paper towels (preferably brown) (2 sheets per group)
23. Hand lens (1 per group)



24. (Optional) Filter funnel and filter paper or watch glass or small glass plate to evaporate water from the cereal

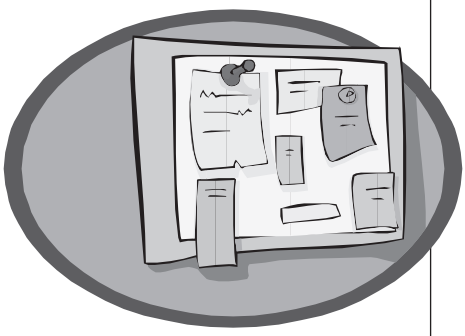
    * The part numbers are from *Science Kit & Boreal Laboratories* (1-800-828-7777), 777 East Park Drive, P.O. Box 5003, Tonawanda, NY 14151-5003

Preparation Activities

1. Set up a bulletin board, preferably in a highly visible spot in the school, where the poem and the student essays can be seen by the rest of the school population. This will serve as a mechanism not only to display student work but also to inform other students, staff and parents of the importance of studying matter and its interactions and reactions.
2. Post the poem, "What Does It Matter?" and later add the student essays to it.
3. Copy **What is the Nature of the Interactions?** lab activity for each student.

Introductory Activities (25 minutes)

- Return student essays and rubric score sheets.
- Ask for student volunteers to read "What Does It Matter?" essays.
- Invite students to react to each of their peer's essay with the hopes of exploring the idea that matter and what we do with it matters very much.
- Collect the essays from the students who are willing to share them with the rest of the student body and staff members, via a bulletin board display.
- Hang up two more pictures that contain both physical and chemical changes in order to review yesterday's lesson.
- Direct students to identify the interactions and reactions between substances that represent physical and chemical changes.
- Get enough different examples to ensure that both mixtures (interactions resulting in a temporary change in which the original reactants can be retrieved, physical changes, and chemical reactions (reactions that result in the production of new substances), are clearly evident.
- Encourage students to identify interactions and reactions such as, fire, rusting, sugar or salt dissolving, rotting food, baking a cake, removing stains, making tacos, spraying hair spray into the air, making salad dressing, boiling water, dry ice "smoking" (subliming, changing from a solid directly into a gas) and putting milk on cereal. Tell students that they



will be conducting a lab activity in which they will use the characteristics of physical and chemical changes to differentiate between interactions and reactions of matter.

Pre-assessment

N/A

Teaching and Learning Activities (20 minutes)

1. Assign students to lab pairs.

2. Distribute **What is the Nature of the Interactions?** lab activity assignment.

3. Instruct students to start the lab activity and assure them that they will have a chance to finish it the next day.

4. Inform students that they will be answering lab-related questions for homework in the near future.

Products and Assignments

Students' essays

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

Debriefing for this day's lab activities will occur on the following day.

What is the Nature of Some Interactions? Part 1

Teacher Name: _____

Student Name: _____

	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
1. a) Give a sandwich bag to each lab pair. b) Put 100 ml of cereal into the bag. c) Squeeze air out and seal the bag. d) Crush the cereal into a fine powder without ripping the bag. e) Pour cereal into a plastic bowl and add just enough water to cover the cereal. f) Use the bar magnet as a stirrer and stir the mixture for about 5-10 minutes. g) Use tissue paper to remove any particles on the magnet. h) Observe them with a hand lens. i) (Optional) Filter the cereal/ water combination or pour a small amount on a watch glass or glass plate and let sit overnight.		Today: Next day:	Today: Next day:	Today: Next day:

What is the Nature of Some Interactions? Part 1

	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
2. a) Put 25 ml of water in a beaker. b) Add 25 ml of oil. Observe c) Add three drops of food coloring. Observe.		Oil and water: Food coloring, oil and water:		

What is the Nature of Some Interactions? - Part 2

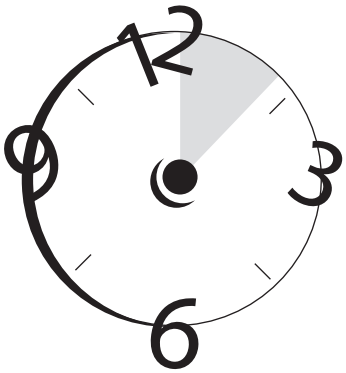
Teacher Name: _____

Student Name: _____

	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
3. a) Put a pinch of sugar into a couple of drops of water placed on a watch glass or on the bottom of a small beaker. The water should remain clear. b) Write down what you see today and what you see tomorrow.		Today: Next day:	Today: Next day:	Today: Next day:
4. a) Get a 500-ml beaker or quart jar and two tablespoons. b) Place a tablespoon of baking soda on a paper towel. c) Place a tablespoon of citric acid on a paper towel. d) Using a hand lens, look at each substance and describe what you see. e) Fill the beaker half full with water. Add the 2 solids to the water. Write down your observations.		A) Two dry solids combined: B) Two solids plus water:		
5. a) Take 2 baby food jars and fill them 1/2 full with water. b) Add 15 cloves to each jar and cover with lids.		Today: One week later:		

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

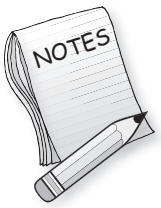
In pairs students finish the lab activities from the previous lesson, analyze their observations, draw conclusions, and answer questions as to which chemical interactions produced physical and chemical changes.

Guiding Questions

- How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes?

BIG IDEA

What are the Differences Between Physical and Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- The interactions between matter cause physical or chemical changes.
- There are differences between physical and chemical changes.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.
- Substances involved in a physical change can be reversed through physical means.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.

Concepts

- Matter
- Interaction
- Reaction
- Chemical reaction
- Chemical change
- Physical change
- Mixture

Teacher Information

N/A

Skills

- Identify characteristics
- Describe characteristics
- Analyze

- Compare and contrast
- Identify patterns
- Categorize

Materials and Resources

What is the Nature of the Interactions? Lab Activity

Preparation Activities

Copy Questions for **What is the Nature of the Interactions? Lab Activity** for each student.

Introductory Activities

N/A

Pre-assessment

N/A

Teaching and Learning Activities (43 minutes)

1. Tell students to finish the lab activities, especially the observations from Part 1, Section 1 and Part 2, Sections 1 and 3.

2. Distribute the Questions for What is the Nature of the Interactions? Lab Activity.

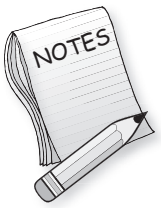
3. Explain to students that they are to start the lab questions with their partners and must complete the questions for homework.

4. Circulate and assist students as needed.

5. Tell students that since they will be doing a lab in two days that requires them to bring in a shoebox, one ripe banana and two green tomatoes, they need to tell their parents ahead of time.

Products and Assignments

N/A



Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (2 minutes)

Review with students the question, "How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes?" Tell them to keep this question in mind as they finish the lab activity for homework.

Name _____

Date _____

Questions for What is the Nature of the Interactions? Lab Activity

1. Do you think that dry cereal is a mixture? (A "Yes" or "No" response is insufficient. Explain why you think it is or is not a mixture. For example, state evidence you found that influenced your opinion.)

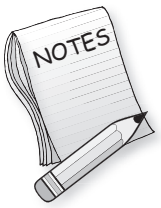
2. When water was added to the cereal, was this an example of a physical or chemical change? Explain your answer.

3. What material do you think was on the bar magnet? Do you think there was truth in the cereal box advertising?

4. Did the oil and water form a mixture? Was there any evidence of a chemical or physical change? Explain you answer.

5. When the food coloring was added, where did it go and what was produced? Was there any evidence after the food coloring was added of either a chemical or physical change?

6. What type of change was the interaction between the sugar and water, and what evidence do you have to support your conclusion?

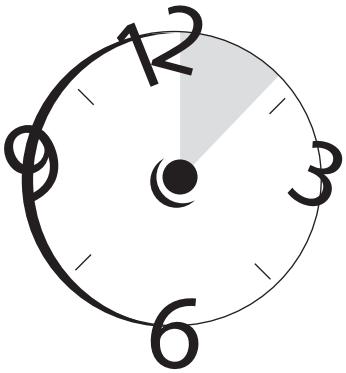


7. When the two solids, baking soda and citric acid in step #4 were first combined, was this mixture a physical or chemical change and how do you know?

8. What evidence do you have that the interaction between the baking soda, citric acid and water was a physical change or chemical change?

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

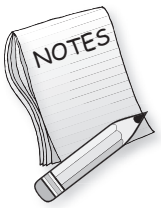
As a class students discuss the lab activities and answers to the lab questions from Lessons 3 and 4. and differentiate between physical and chemical changes they observed in the lab activities. They should recognize mixtures as examples of physical changes. In addition, students will recognize that various kinds of mixtures exist. They are introduced to the idea of solutions, as a special type of mixture in which the substances being mixed dissolve and to the concept that substances vary in their ability to dissolve. Those students who need further challenge are introduced to special types of mixtures called suspensions, colloids and emulsions (See G & T Lessons 1-4).

Guiding Questions

- How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes?
- How are different types of mixtures part of my life?
- What can cause mix-ups regarding mixtures?

BIG IDEA

What are the Differences Between Physical and Chemical Changes?



Content Goals

Universal Themes

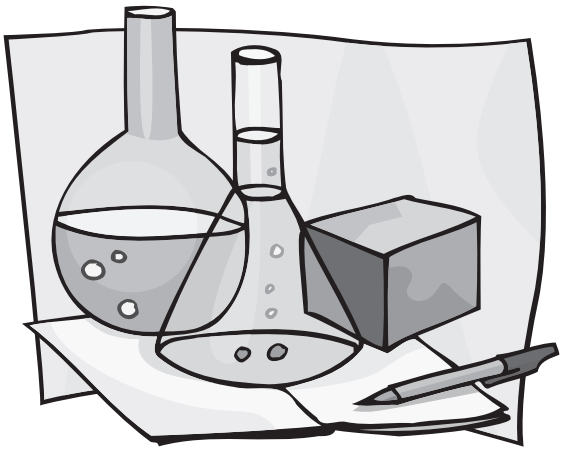
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- The interactions between matter cause physical or chemical changes.
- There are differences between chemical and physical changes.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.
- Substances involved in a physical change can be reversed through physical means.
- Mixtures are made up of different states of matter.
- Mixtures can be divided into types.
- Solutions are mixtures that contain substances that are dissolved.

Concepts

- States of matter
- Chemical reaction
- Chemical change
- Physical change
- Mixture
- Solution
- Dissolve
- Solute
- Solvent



Teacher Information

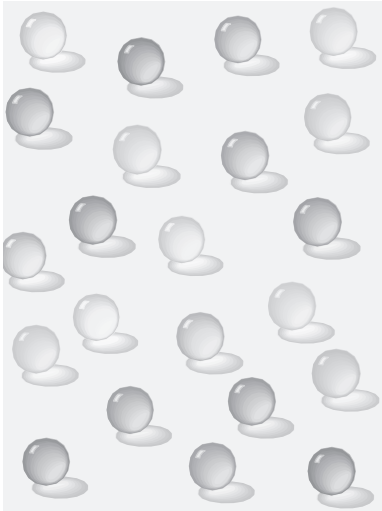
- A solution is a special type of mixture in which the one substance completely dissolves in another.
- A solute is the substance being dissolved.
- A solvent is the substance in which the solute is dissolved.
- Homogeneous mixtures are alike throughout as compared to heterogeneous mixtures that are not. The "greenhouse effect" is a theory that global warming is occurring because of the addition of gases to the atmosphere. These gases are predominantly from people's industrial activities which burn fossil fuels that produce carbon dioxide gas. According to the National Academy of Sciences, the earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated warming during the past two decades. There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities. Human activities have altered the chemical composition of the atmosphere through the buildup of greenhouse gases – primarily carbon dioxide, methane, and nitrous oxide. The heat-trapping property of these gases is undisputed, although uncertainties exist about exactly how earth's climate responds to them.

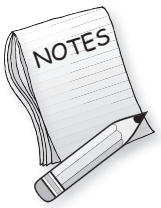
Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Identify patterns
- Categorize

Materials and Resources

1. Tincture of iodine (optional as an example of a solution)
2. Piece of steel (optional as an example of a solution)
3. Glass container big enough to hold gumballs or marbles
4. Small gum balls or marbles
5. Small pieces of candy like *Skittles*
6. Global warming website from the U.S. Environmental Protection Agency http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html





Preparation Activities

1. In preparation for Lesson #6, have students bring in an overripe banana and two green tomatoes.
2. In preparation for Lesson #14, Rates of Reaction, put a newspaper on a windowsill in a sunny area. Put another copy of the same newspaper in a closet.

Introductory Activities

Collect the student answers to the lab questions for assessment purposes.

Pre-assessment

N/A

Teaching and Learning Activities (35 minutes)

1. Discuss the answers with the students using the Answers to Questions for the **What is the Nature of the Interactions? Lab Activity** as a guide (see below). Use the terms, *solute* and *solvent* when discussing the cereal and water, sugar and water, baking soda, citric acid and water, respectively. These are not to be memorized, but students will become familiar with them as they are applied in discussions.

2. As you review the answer to item #8, tell students that some mixtures form what is known as solutions (e.g., sugar and water, salt and water and tincture of iodine).

3. Use the gumballs or marbles and small pieces (e.g., Skittles) of candy to demonstrate the dissolving process. Place the glass container of gumballs on the table. Slowly pour in the candy pieces. Tell students that the candy pieces are the equivalent of the sugar that you add to water and the water is presented by the gumballs or marbles. The sugar goes in-between the water particles, just like the Skittles goes in-between the gumballs or marbles, which is why the level of water does not appear to rise when you add sugar to water.

4. Introduce the terms, *solute* and *solvent*. Tell students that the water is the solvent because it is doing the dissolving and the sugar is the solute because it is the substance being added to the solvent and ultimately being dissolved.

5. Invite students to describe some of the major differences, besides being made with different substances, between the cereal mixture and the sugar and water solution. Lead students to understand that the cereal mixture is not alike throughout (the raisins should help make that obvious), whereas the sugar/water mixture is. Introduce the terms, *homogeneous* and *heterogeneous*, again not for memorization or testing purposes. They will have to understand the differences between them for the homework assignment.

6. Inform students that solutions are always homogeneous because they are always alike throughout.

7. Invite students to give some other examples of solutions.

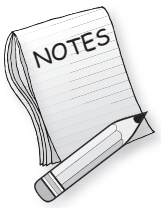
8. Ask students to identify which substance is the solvent and which is the solute.

9. After reviewing all the answers, introduce the idea that mixtures in general and solutions in particular occur between all states of matter.

10. Query students for examples from the lab or from their experiences for the following: gas/gas (e.g., air), gas/liquid (e.g., oxygen in oceans, lakes, etc.), gas/liquid (e.g., whipped cream), liquid/liquid (e.g., orange juice), liquid/solid (e.g., older dental fillings of mercury in silver), solid/solid (e.g., granite, heterogeneous mixture and steel, a homogeneous mixture).

11. Make further connections to the world around the students by mentioning that physical changes to the environment, such as wind blowing a leaf from one place to another can be reversed easily. However, a chemical change such as the burning of coal and oil produces which produces carbon dioxide cannot be reversed by physical means.

12. Ask students if they have heard of the term "greenhouse effect." Briefly discuss what it is. Ask students what contributes to this problem (see Teacher Information and Materials and Resources sections).
13. Give other examples of chemical changes causing environmental problems, such as the discharge of chemical waste into rivers or oceans by factories that produce consumer products like cars and fabric.



14. Discuss the consequences to the environment of other chemical changes that are used to produce consumer products or consumer services (e.g., hair dressing and dry cleaning industries release chemical waste products into our environment, water filters release sodium into our ground water, and the plastics industry produces products that do not decay easily).

15. Talk to students about the potential harm of even a physical change, like the dissolving of salt in water. Relate the story of groundwater contamination in Killingworth, Connecticut. When the town maintenance crew left the salt that was to be used on the roads in the winter in an unsealed place, it leached into the groundwater over time, as rain fell on the salt pile. This salt could have been removed by boiling off the water (distillation) if the water that had dissolved the salt was contained. However, that was virtually impossible in this case, as the groundwater traveled quickly through rocks underneath the surface and in all directions. Some of the local residents are now being supplied with bottled water at the town expense because of the groundwater contamination. This is an example of a physical change to the environment that could not be resolved by a simple reversal or separation technique.

16. Distribute and review the homework assignment. Highlight the fact that **they are to bring in a shoebox, one ripe banana and two green tomatoes**.

17. Inform students who were part of the group of students participating in the extended work on suspensions, colloids and emulsions that they are to do the same assignment except bring in examples of those particular kinds of mixtures (see G & T Lessons 1-4).

Products and Assignments

- Students' **Questions for the What is the Nature of the Interactions? Lab** Activity

Extension activities

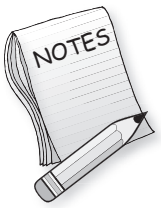
G & T Lessons 1-4

Post Assessment

N/A

Debriefing and Reflection Opportunities (10 minutes)

1. Reinforce the idea that mixtures are a big part of students' everyday lives. In nature most matter is found mixed with other matter. Tell students that understanding the types and nature of mixtures allows scientists and researchers to design and produce products that meet the myriad demands of consumers. Strengthen the idea that with some understanding of mixtures, students can become more informed consumers and citizens, as it relates to the impact mixtures can have on the environment.
2. Invite students to share examples from their lives of new products that meet the needs and demands of consumers.



Name _____

Date _____

Answers to Questions for the What is the Nature of the Interactions? Lab Activity

1. Do you think that dry cereal is a mixture? (A "Yes" or "No" response is insufficient. Explain why you think it is or is not a mixture. For example state evidence you found that influenced your opinion).

Yes, it is a mixture because I can see all these different parts together. In addition, I was able to get parts out of it.

2. When water was added to the cereal, is this an example of a physical or chemical change? (Explain your answer).

It was a physical change because I did not make any new substances. The water evaporated overnight, and the cereal was still there. Or the filtering showed that the water could be separated from the cereal; therefore, it was a physical change because the original substances could be retrieved, and we made no new substances.

3. What material do you think was on the bar magnet? Do you think there was truth in the cereal box advertising?

It probably was iron because it was attracted to the bar magnet. Yes, there seems to be some truth to this advertising, as I have evidence of iron being present.

4. Did the oil and water form a mixture? Was there any evidence of a chemical or physical change? Explain you answer.

It did not form a mixture because the two layers stayed separate. There was no evidence of a chemical or physical change.

5. When the food coloring was added, where did it go and what was produced? Was there any evidence after the food coloring was added of a chemical or physical change?

The food coloring went into the water layer (dissolved). The mixing of the food coloring with the water was a physical change because I could get the dye in the food coloring back if I evaporated the water.

6. What type of change was the interaction between the sugar and water, and what evidence do you have to support your conclusion?

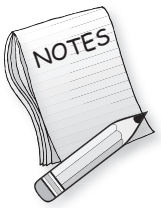
It was a physical change because the sugar was retrieved after the water evaporated.

7. When the two solids, baking soda and citric acid in Step #4 were first combined, was this a physical or a chemical change and how do you know?

It was a physical change because both of the original substances were still there, just mixed together.

8. What evidence do you have that the interaction between the baking soda, citric acid and water was a physical change or chemical change?

It was a chemical change because I saw bubbles coming from the interaction.



Name _____ Date _____

Parents are welcome to assist you with this work. Maybe you can teach them a thing or two! Wouldn't that be fun! For those students who had experiences with suspensions, colloids and emulsions, bring in two types of those mixtures.

Your homework assignment is to:

1. Create both a heterogeneous mixture and homogeneous mixture (solution) from ingredients in your kitchen that we have not discussed in class. Place the mixtures in baggies of some sort so that we can display your mixtures on our bulletin board entitled, "No Mix-up Here!" Bring them to class tomorrow.

2. Find or draw pictures of one mixture each for the following states of matter: You cannot use any of the examples we discussed in class, some of which are noted next to the states of matter combination.

Gas/liquid (cannot use oxygen dissolved in oceans, lakes, etc.)

Liquid/liquid (cannot use vinegar, which is water in acetic acid, or orange juice)

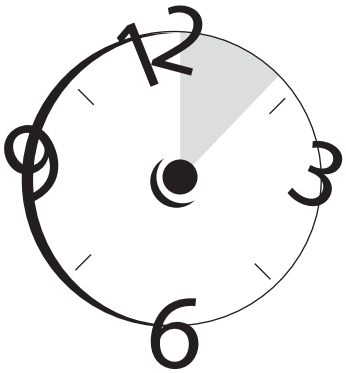
Solid/solid (hint: think of metal alloys we discussed like steel)

Liquid/solid (cannot use sugar in water or dental filling)

Reminder to students: Please bring in one shoebox, one overripe banana and two green tomatoes.

Physical and Chemical Changes

Parallel: Core/AID
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

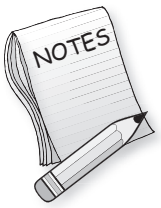
In this lesson students create visual displays to share their understanding of mixtures with other students and staff. These displays will include examples and questions that can challenge the visitors who see them. In addition, students will start studying chemical reactions more specifically by taking a household food item, a banana, and watching its effect on an unripe tomato! This activity should stimulate students' curiosity and begin to deepen their under-standing of the importance and abundance of chemical reactions in everyday life.

Guiding Questions

- How much did I learn about mixtures?
- What does chemistry have to do with the ripening of fruit?

BIG IDEA

What are the Differences Between Physical and Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- There are differences between physical and chemical changes.
- Chemical changes produce solids, liquids and/or gases.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.

Concepts

- States of matter
- Chemical change
- Physical change
- Mixture
- Reactant
- Product
- Heterogeneous
- Saturation
- Suspension (G & T)
- Colloid (G & T)
- Emulsion (G & T)

Teacher Information

The overripe banana produces ethylene that causes the tomato in the box to ripen faster than the tomato outside of the box.

Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- See relationships
- Draw conclusions

Materials and Resources

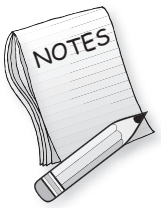
1. Construction paper
2. Scissors
3. White lined paper
4. Glue sticks (1 per 2 students)
5. Metric rulers
6. Black marker (1 per 2 students)
7. Shoe box (1 per group)
8. Overripe bananas (1 per group)
9. Green tomatoes (2 per group)

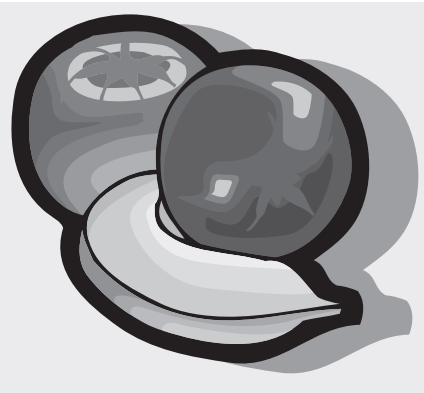
Preparation Activities

1. Secure a bulletin board area in a hallway where students and staff can learn about mixtures from student work. Make sure the board is entitled, "No Mix-up Here!" and that three areas are available that are labeled "Homogeneous Mixtures," "Heterogeneous Mixtures," and "Special Mixtures."
2. Have markers, scissors and rulers ready for students to create "questions" to be posted on the bulletin board display.
3. Copy **Instructions for Characteristics for Chemical Changes Lab** for students.
4. Copy **Characteristics of Chemical Changes Data Collection Sheet** (Reactions 1-5) for students.
5. Set up materials for the first reaction.

Introductory Activities (5 Minutes)

- Collect students' homework assignments, the homemade mixtures and answers to question #2.





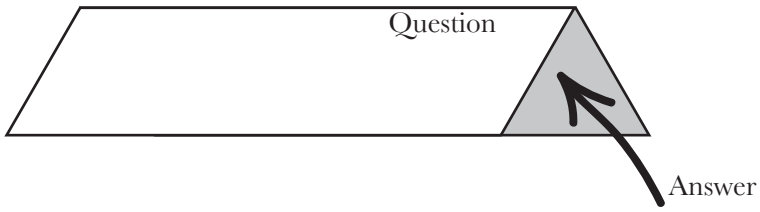
- Invite students to give some examples from their homework answers that address the mixtures that were requested (e.g., gas/liquid, a possible answer could be nitrogen in the blood that causes the bends; liquid/liquid, a possible answer could be lemon juice and water; solid/solid, possible answers could be brass, bronze or white gold or 14-carat versus 18-carat gold; and liquid/solid, a possible answer could be bullion cube dissolved in water, or Kool-Aid and water). **SEARCHLIGHT:** Be on the lookout for students who have a rich background and/or need a further challenge. (See AID activity in Extension Activities)
- Inform students that they will be creating a display about mixtures in which they will share their understandings and help other staff members and students better understand the fact that mixtures are a very important part of our lives.
- Explain to them that in addition to displaying their examples of mixtures, they will have to make up a question about mixtures and post it on the board, so that passersby can test their knowledge by reading, answering and checking their answers to questions pertaining to mixtures.
- Advise students that after this activity is completed, the class will be introduced to the next lab investigation that focuses on discovering some of the characteristics that are characteristic of chemical changes and not of physical changes.

Pre-assessment

N/A

Teaching and Learning Activities (35 minutes)

1. Instruct students to cut a piece construction paper into halves, making the cut along a vertical line drawn from top to bottom in the middle of the paper. Then take 1/2 of the paper and fold it in half again, lengthwise. Cut a piece of lined paper to glue on the outside of the flap and a second piece to glue to the inside of the folded paper. The former will contain the question and the latter will contain the answer to the question that is written on the outside of the flap of the folded construction paper.



2. Ask students to count off, and at the same time collect their mixtures and put the student number on the outside of the mixture baggie using a black marker.

3. Direct students to write down a question about their mixture (e.g., which ingredient in the mixture #2 is the solvent?) and to make sure they reference their bag number in the question itself.

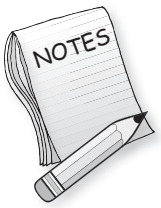
4. Instruct students to place the answer to their question on the inside of the flap.

5. As the students deliver their bags to you, ask them to identify the nature of the mixture, homogeneous or heterogeneous, and indicate if the mixture is other than a solution, such as suspension, colloid or emulsion.

6. Review the questions and answers and if accurate, tell the students to staple the questions to the bulletin board in an area of their choosing but under their proper column.

7. After the bulletin board is done, reconvene students in preparation for the next activity.

8. Ask students what kind of change is involved in the process of making mixtures. Why is it a physical change?



9. Inform students that they will now begin to investigate more examples of chemical changes. Warn them, however, that you have included some physical changes just to keep them on their toes but will not be telling them which ones are the physical changes.

10. Share with students that they will be carrying out several reactions over the next couple of days, documenting their observations, deciding whether a chemical or physical change has occurred, and providing evidence for their decision and why they think so. Explain that they will also be asked to compare and contrast their results with other lab groups, which is why you will be assigning them lab group numbers that they will reference when they put their results on the Class Results Chart on the board.

11. Distribute the Instructions for **Characteristics for Chemical Changes Lab**.

12. Distribute **Characteristics of Chemical Changes Data Collection Sheet** (Reactions 1-5).

13. Pair students into lab partners. Assign a group number to each lab pair that will be used in the next day's lesson.

14. Instruct students to do reaction #1 only.

Products and Assignments

N/A

Extension Activities (AID)

Students who need a further challenge and can handle independent research should be asked to investigate how the ripening process is used in industries (e.g., some golf course tournaments use ethylene to ensure that all the azaleas bloom at the same time.). Have them share their findings with other class members through poster displays or PowerPoint presentations after the lab is completed.

Post Assessment

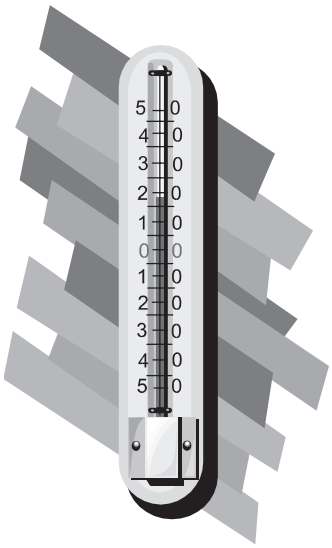
N/A

Debriefing and Reflection Opportunities (5 minutes)

After the bulletin board is completed, reconvene students in preparation for the next activity. Ask students what kind of change is involved in the process of making mixtures. Why is it a physical change? Make sure they realize that physical changes can be reversed through physical means. For some of the mixtures they made, ask them how they might get back the original ingredients. What separation techniques might they employ?

Instructions for Characteristics of Chemical Changes Lab

1. Each student will wear safety glasses throughout this lab.
2. Each group will go to the stations around the room and carry out the reactions as instructed at the site. Remember to use the thermometer at each station, except for the match and soda stations, to see if there is any change in temperature during the reactions.
3. Each group will identify the states of matter included in the reactions and/or interactions and individually record and discuss their observations.
4. Each student will think and discuss with his or her partner whether what was observed was a chemical or physical change and then provide support for the opinion.
5. The lab partners will discuss all the questions at the end of the lab sheet, and then each partner will answer the questions on his or her own lab sheet.



Characteristics of Chemical Changes Data Collection Sheet (Reactions 1-5)

Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
1. a) Take a shoebox and place one ripe banana in it. Place an unripe tomato in it as well. b) Place an equally unripe tomato next to the outside of the box.		Today: Day 2: Day 3: Day 4:	Today: Day 2: Day 3: Day 4:	
2. a) Wet the inside of a test tube or vial. b) Place a pinch of iron powder in the test tube or vial. c) Invert the container and iron powder into a 250-ml beaker filled about 1/4 full with water. You can also use an 8 or 10 oz. glass filled about 1/4 full with water instead of a beaker. d) Observe this system for 4 days.		Today: Day 2: Day 3: Day 4	Today: Day 2: Day 3: Day 4:	

Characteristics of Chemical Changes Data Collection Sheet (Reactions 1-5)

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
3. a) Place a piece of steel wool on the eraser end of a pencil. b) Secure the steel wool with a rubber band. c) Invert a glass and place the pencil into a glass with the point toward the mouth opening of the glass. d) Fill a small dish/pan and put the inverted the glass into the dish of water. The point of the pencil will be in the water. e) Observe this system for 4 days.		Today: Day 2: Day 3: Day 4	Today: Day 2: Day 3: Day 4:	
4. a) Repeat step #3 above but put the pencil and steel wool in a dish filled with salt water. Make the salt water as concentrated as possible by dissolving the salt until it does not dissolve anymore. This is the point of *saturation* and it is determined when excess salt stays in the bottom of the dish and will not dissolve in spite of constant stirring.		Today: Day 2: Day 3: Day 4	Today: Day 2: Day 3: Day 4:	

Characteristics of Chemical Changes Data Collection Sheet (Reactions 1-5)

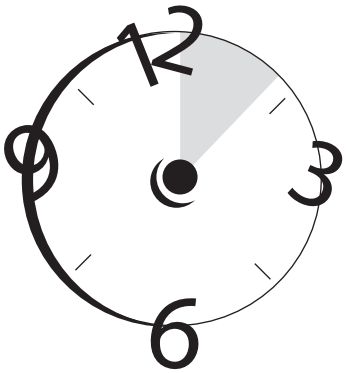
Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
5. a) Place a thermometer in a jar and close the jar with the lid. Record the temperature. b) Soak 1/2 of a steel wool pad in vinegar for 2 minutes. Squeeze out the excess vinegar. c) Place the thermometer and steel wool inside the jar and close the lid. d) Record the temperature after 5 minutes.				

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

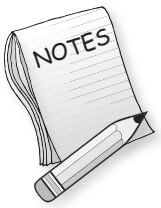
In this lesson, students will be introduced to a lab investigation that focuses on discovering some of the characteristics that differentiate chemical and physical changes. The physical changes associated with mixtures that were examined in previous lessons are not similar to the behaviors characteristic of chemical changes. The chemical reactions in the lab investigation were chosen because they demonstrate: (a) different states of matter reacting, (b) the common characteristics of chemical changes—production of new substance(s), temperature change and gas or light production, and (c) chemicals that are in students' lives. Thus, they emphasize that chemical reactions are everywhere and are an important part of our lives.

Guiding Questions

What are some of the characteristics of chemical changes?

BIG IDEA

What's so Special About Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- There are differences between physical and chemical changes.
- Chemical changes produce solids, liquids and/or gases.
- Chemical change produces new substances that have properties that are different than the original reactants.

Concepts

- States of matter
- Chemical change
- Physical change
- Reactant
- Product

Teacher Information

Iron rusts, using up oxygen, thus decreasing the pressure in the test tube/vial. The water rises in the tube, as the oxygen is used up to form rust (iron oxide). The water should rise to occupy 1/5 of the original volume of the test tube, as oxygen makes up about 20% of air. The rusting process is more rapid in the presence of salts, like table salt (NaCl), which makes the water more conductive and thus speeds up the reaction.

Skills

- Identify characteristics
- Describe characteristics

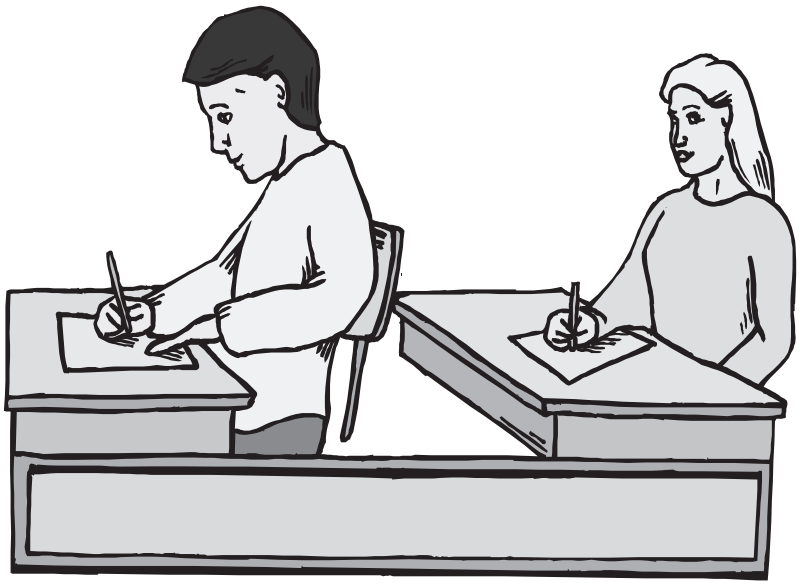
- Analyze
- Compare and contrast
- Draw conclusions

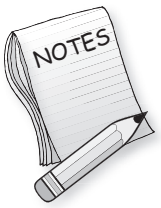
Materials and Resources

1. Water
2. Iron powder (can be ordered from *Frey Scientific* 1-800-225-FREY, item number 15579036 for $6.20 plus eight percent shipping and handling (one pinch per group)
3. Test tube or plastic vials (one per group)
4. Glass beaker or drinking glass (as many as possible with a minimum of three per group)
5. Steel wool pads without soap that can be purchased at a hardware store (two per group)
6. Pencil
7. Rubber band
8. Flat dish (two per group)
9. Vinegar (large jug)
10. Small thermometers to fit in a capped jar (one per group)

Preparation Activities

1. Set up materials for reactions #2-5.
2. Place the **Class Results Chart** on the board (see below).
3. Copy the **Class Results Chart** for students so students can enter the results from other groups.





Introductory Activities (5 minutes)

- Remind students to check their shoeboxes and note any changes.
- Share with students that they will continue their exploration of the nature of chemical change with a focus on discovering some of the attributes that are characteristic of chemical changes and not of physical changes.

Pre-assessment

N/A

Teaching and Learning Activities (40 minutes)

1. Share with students that they will be carrying out reactions #2-5, documenting their observations and deciding whether a chemical or physical change has occurred and explaining their reasoning.

2. Distribute a **Class Results Chart** to each student.

3. Instruct students to decide whether they think a given reaction is an example of a physical or chemical change and to place either a "P" or a "C" in the table next to and under the appropriate reaction number and group number, respectively both on the board and on their copy of the **Class Results Chart.**

4. Advise students that they will be asked later on to cite evidence that they used to draw their specific conclusions regarding the nature of the reactions being examined.

Products and Assignments

N/A

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

N/A

Class Results Chart

Rx #	Grp #1	Grp #2	Grp #3	Grp #4	Grp #5	Grp #6	Grp #7	Grp #8	Grp #9	Grp #10	Grp #11	Grp #12
1												
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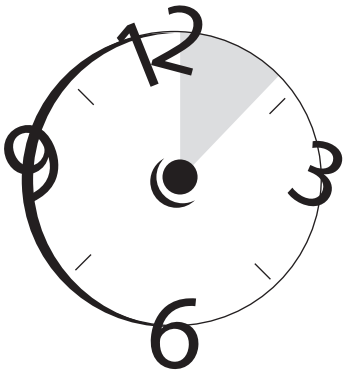
Physical and Chemical Changes

Parallel: Core/AID
Time Allocation: 1 hour, 30 minutes
Required Materials and Resources on Page 230



Lesson Overview

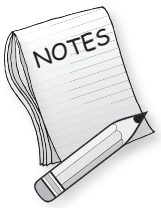
Students continue the study of chemical changes by completing the lab activities, reactions #6-23. This lesson provides students with opportunities to use scientific thinking with its rigorous demands for evidence, justification and explanation to produce valid conclusions. It reinforces the concept that in chemical reactions the products come from the rearrangement of reactants to form new substances with different properties than the original reactants. The lesson also provides students with an opportunity to identify some of the common characteristics of chemical changes, such as temperature change and the production of new substances, heat, light or sound.

Guiding Questions

What are some of the characteristics of chemical changes?

BIG IDEA

What's so Special About Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- There are differences between physical and chemical changes.
- Chemical changes produce solids, liquids and/or gases.
- Chemical change produces new substances that have properties that are different than the original reactants.
- Chemical changes involve a rearrangement of reactant structures.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.

Concepts

- States of Matter
- Chemical change
- Physical change
- Reactant
- Product
- Rearrangement of reactant structures

Teacher Information

- Limewater can be made by taking lime (available at a hardware store) and putting it in into water in a quart jar. Let it sit overnight and pour off the clear liquid (decant the supernatant liquid) from the solid, undissolved lime, on the bottom of the jar. You will have a saturated solution of limewater. It must be covered to prevent the carbon dioxide in the air from dissolving and reacting with it to form calcium carbonate (a white solid that will form when students blow into the limewater during the experiment).

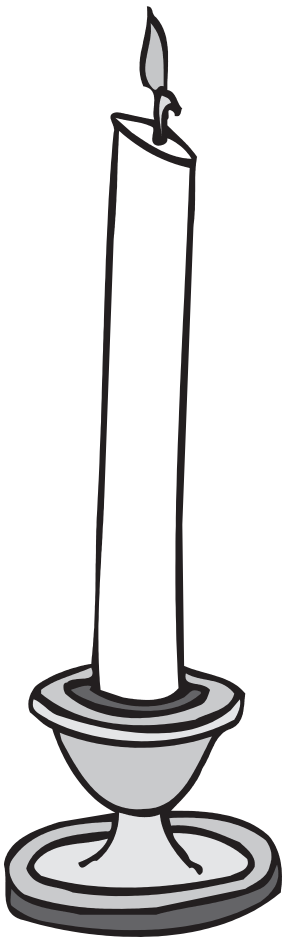
- When limewater reacts with the carbon dioxide given off by the burning of a candle, the product that forms is calcium carbonate ($CaCO_3$).
- Ammonia, sold in grocery stores, is ammonia gas dissolved in water thus forming ammonium ions and hydroxide ions, better known as ammonium hydroxide.
- Silica and water will appear to form a chemical change. The addition of a drop or two of water initially changes the shiny, clear silica beads into a white, opaque solid. However, after a day or so the water evaporates and the shiny, clear beads are back indicating the change was physical. Silica gel is hygroscopic, which means it absorbs water from the air and will release it again if the environment is dry.

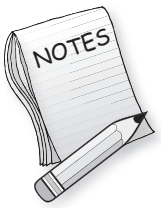
Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Draw conclusions

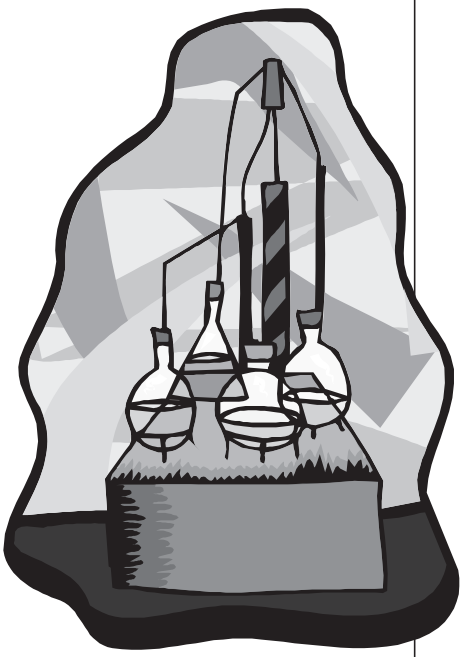
Materials and Resources

1. The chemicals listed can be obtained from most high school science departments, or ordered from *Frey Scientific*, P.O. Box 8101 Mansfield, Ohio 44901-8101, or ordered via the Web at www.freyscientific.com. Eight percent of the cost is also added for shipping and handling. In addition, any chemicals deemed hazardous incur additional shipping charges of $15 for 1-3 chemicals and $24 for 4 or more chemicals.
2. Crushed chalk or shells (make sure they are not synthetic) or whole eggs (crushed chalk and egg shells are made of calcium carbonate)
3. Alka-Seltzer tablets and packaging (contains sodium bicarbonate) (1 tablet per group)
4. Baking soda and labeled box (sodium bicarbonate)
5. Vinegar
6. Candle (1 for every 2 groups)
7. Can lid (1 for every 2 groups)
8. Box of safety matches
9. Bucket of water and/or sand for the front of the room (flame dowser)





10. Rubbing alcohol (found at grocery stores)
11. Hydrogen peroxide (found at grocery stores)
12. Epsom's salt (magnesium sulfate, MgSO4. The ingredients on the milk of magnesia label will be compared to the product of the reaction between Epsom salt and household ammonia (ammonium hydroxide).
13. Milk of magnesia (magnesium hydroxide, Mg (OH) 2) (1 bottle with label)
14. Ammonia hydroxide (ammonia water is found at grocery stores)
15. Alum (hydrated potassium aluminum sulfate compound, KAl (SO4)2*12 H2O). This can be ordered from *Frey Scientific* using part # 15567953 at $6.95 for 500 grams, plus shipping and handling.
16. Baby food jar or canning jar with lid (1 per group)
17. Ice
18. Baggie (1 per group)
19. Hot plate (1 per group preferred but it can work with only one hot plate, as it can be shared among all groups)
20. Silica
21. Limewater (calcium hydroxide, Ca (OH)2)
22. Straw (1 per group)
23. Thermometer (1 per group)
24. Powdered bleach (1 teaspoon per group)
25. Liquid bleach (teacher demonstration)
26. Stirring rods (1 per group)
27. Plastic spoons for taking reactants
28. Graduated cylinders or measuring cups
29. (Optional) zinc pieces and 6 Molar hydrochloric acid (10 ml), wooden splint and a test tube -- The zinc pieces and 6 Molar hydrochloric acid can be ordered referring to part # 15570518 (100/pk) for $6.95 and part # 15578955 for 500 ml at $8.50 + shipping and handling, respectively.



Preparation Activities

1. Copy Questions for the **Characteristics of Chemical Changes**.
2. Copy the Extension Activity and Questions for the **Characteristics of Chemical Changes Lab** (AID).
3. Have a bucket of water and/or sand available to extinguish any unwanted flames.
4. Set up materials for the remaining reactions. The teacher should do the last

three reactions as demonstrations. The last reaction with zinc is optional, as obtaining hydrochloric acid may be difficult. However, if the reaction is done, it is an excellent way to show the test for hydrogen gas. As the zinc reacts with the acid it produces hydrogen. Take a glowing splint and lower it into the beaker with the metal and acid. The hydrogen gas will cause the splint to make a popping sound as the hydrogen ignites.

Introductory Activities (5 minutes)

- Remember to have students examine their shoeboxes and iron powder and steel wool setups daily (Day 1 and 2).
- Distribute the **Characteristics of Chemical Changes** (Reactions 6-23) (Day 1)
- Distribute the Questions for the **Characteristics of Chemical Changes** Lab. Those students who finish early will begin answering questions #1 and 2 from the Questions for the **Characteristics of Chemical Changes** Lab (Day 2).

Pre-assessment

N/A

Teaching and Learning Activities (80 minutes)

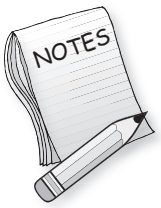
1. Finish the **Characteristics of Chemical Changes Lab** (reactions #6-23), including the last three teacher demonstrations activities (Day 1 and 2).

2. Remind students to put their results on the board as they finish every three activities or so (this will avoid a large crowd at the end of the lab activities trying to put their data on the board at the same time (Day 1 and 2). **SEARCHLIGHT:** Use this opportunity to look for students who seem to have more insight into chemistry.

3. Ask some students who have a deeper understanding of the chemistry of substances and need to be challenged to a greater extent to investigate the composition of the substances used in this lab activity and discover their chemical formulas. They will complete the Extension **Questions for the Characteristics of Chemical Changes Lab** (AID).

Products and Assignments

- Instruct students to finish answering questions # 1 and 2 from the **Questions for the Characteristics of Chemical Changes Lab** for homework (Day 2).



• Assign Extension Questions for the **Characteristics of Chemical Changes Lab** for certain students who need more challenge with critical thinking (AID).

Extension Activities

For those students who need more challenge with critical thinking and who are able to handle independent research, there are two suggestions for activities below:

1. Extension Activity and Questions for the **Characteristics of Chemical Changes Lab (AID)** (See last page in this lesson)
2. A field trip to a solid waste management plant could help students recognize that solid waste management is a national crisis. The importance of recycling waste materials would be highlighted through this experience. This author has taken her students on a field trip to a local sewage treatment facility (Middletown, CT) and found the experience enlightening for students. A good reference article called "What Happens" published in *The Science Teacher* in December, 1991 describes a field trip to the largest landfill in the world, New York City's Fresh Kill Landfill where barges of garbage are unloaded. It also describes a trip to Ed Hook Water Pollution control Plant in the Brooklyn Navy Yard (AID).

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

Although the next three lessons are a classification and discussion of the last four lessons, allow some time for students who need scaffolding to ask questions.

Characteristics of Chemical Changes (Reactions 6-23)

Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
6. Combine one Alka-Seltzer tablet and 100 ml (about a 1/2 cup of water) in a glass jar or beaker.				
7. a) Put a thermometer into a glass jar or beaker. Record the temperature. b) Add 1 tablespoon of baking soda and about 15 ml (1 tablespoon) of vinegar to the glass jar or beaker. c) Record the temperature several times as you observe the interaction of substances.				
8. a) Pair up with another group to do this activity. b) Add 1 teaspoon of baking soda to 60 ml (1/4 cup) of vinegar in a jar that has a lid. Immediately put the lid over the top. Do not screw it on. c) Light a match and melt a bit of candle on the bottom so it sticks to a can lid d) Uncover the jar and immediately pour its contents but not the liquid or solid contents on the flame. Hold the jar so the mouth is a little higher than the flame and a short distance away.				

REACTIONS AND INTERACTIONS

Characteristics of Chemical Changes (Reactions 6-23)

Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
9. Combine 1 tablespoon of baking soda and 15 ml water (1 tablespoon) in a glass jar or beaker.				
10. Look at the tip of a match and note the color. Light a match in air and let it burn out. Note the color of the tip.		Color of tip before lit: Color of tip after lit:		
11. Combine 15ml (1 tablespoon) of alcohol with 15 ml water in a glass jar or beaker.				
12. Combine 15 ml (1 tablespoon) of hydrogen peroxide with 15 ml of water in a glass jar or beaker.				

Characteristics of Chemical Changes (Reactions 6-23)

Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
13. Combine 1 teaspoon of Epsom's salt with 15 ml (1 tablespoon) of ammonia water in a glass jar or beaker.				
14. Combine 1 teaspoon of alum with 15 ml (1 tablespoon) of ammonia water in a glass jar or beaker.				
15. Place a capped canning (fruit, baby food) jar containing water on a hot plate with a baggie of ice sitting on top of the lid.				
16. Take a packet of silica gel and dump it into a beaker containing water.		Today: Next day:	Today: Next day:	Today: Next day:
17. Place Wint-o-green Lifesaver in a sealed plastic bag, tie. Put wrapped lifesaver in the jaws of pliers. Go to the closet, close the door and wait one minute until your eyes have adjusted to the darkness. Squeeze lifesaver and look at it carefully. What do you observe?				

REACTIONS AND INTERACTIONS

Characteristics of Chemical Changes (Reactions 6-23)

Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
18. a) Pour some limewater into a beaker. b) Get a straw and one partner blow into the beaker of limewater through the straw.				
19. a) Place a thermometer in a beaker or glass container and fill the container with water. b) Add 1 teaspoon of powdered bleach and stir. Be careful not to spill any of this powder. If it is spilled, tell the teacher and then wipe it up immediately with a wet paper towel and throw it away immediately. c) Record the temperature every 30 seconds until it stops changing.		Color of tip before lit: Color of tip after lit:		
20. a) Fill a beaker 1/2 full of water and add 2 drops of food coloring c) Call the teacher over to dispense liquid bleach. (Teacher adds 1 eyedropper of bleach to the water/food coloring solution.)				

Characteristics of Chemical Changes (Reactions 6-23)

Name: _____

Date: _____

Reactants	States of Matter	Observations	What do you think happened? (chemical or physical change)	Why do you think so?
21. (Teacher demonstration) WEAR SAFETY GLASSES a) Combine 5 ml of ammonia water and add 5 ml of liquid bleach in a beaker or glass jar. Be careful the reaction does not splatter the liquid out of the beaker. b) Have a student come to the front of the room and share his or her observations with the rest of the class.				
22. (Teacher demonstration) Light a piece of paper on fire over a sink.				
23. (Teacher demonstration) a) Combine a piece of Zn with 10 ml of hydrochloric acid in a test tube. b) Take a wooden splint, light it, blow it out so it just glows and lower it into the mouth of the test tube.				

Name_____ Date_____

Questions for Characteristics of Chemical Changes Lab

1. Which reactions do you think represent chemical changes? Identify them by number. Give at least one reason for each reaction you think represents a chemical change.

2. Which reactions do you think represent physical changes? Identify them by number. Give one reason why you think they are physical changes and not chemical changes.

3. Which reaction(s), if any, at first appeared to be a physical change but after time showed evidence of being a chemical change?

4. Identify as many reasons as you can as to how a chemical change can be distinguished from a physical change.

5. Why do you think you find the silica, the chemical found in #16, in boxes holding electronics, in boxes holding new shoes, etc.?

6. What could be in your breath to cause the reaction in #18 to occur?

7. What conclusion can you draw about what happens to substances when they react with more than one type of substance? Use the results of reactions #7, 9, 13 and 14 to help you.

8. What do you think kept the water from rising up the tube initially when you inverted the test tube with the iron filings in reaction #2?

9. What does what happened to the water level in reactions #2, 3 & 4, after several days, suggest to you?

10. Is there any evidence of a chemical change in reactions #2, 3 & 4? If so, what is the evidence?

11. What fraction of the total test tube or vial volume was filled with water, 1/2, 1/3, 3/4, etc. in reactions #2, 3 & 4?

12. What is the percentage of oxygen in air?

13. What are the two main gases that make up the mixture of air?

14. What might have been used up from the air in reactions #2, 3 & 4?

15. What do you think caused the differences between the tomato inside the shoebox and the tomato outside the box?

16. Is watching a banana ripen more exciting than watching grass grow? Explain your answer.

17. a) How does the color of the light produced by the crushing of the Lifesaver compare to the color of the Lifesaver itself?

b) How could you justify this change as a physical change?

c) How could you justify this change as a chemical change?

Name _____ Date _____

Extensions Questions for the Characteristics of Chemical Changes Lab

1. Look on the label of the Epsom's salt container and write down the name of the compound.

2. Ammonia is a gas at room temperature, and when it is dissolved in water it becomes household ammonia that is sold in the grocery stores. The name of the compound formed when ammonia dissolves in water is ammonia hydroxide. When you mixed Epsom salt and ammonia, you got a cloudy liquid from which settled out a white substance. This cloudy substance is actually produced and marketed as "Milk of Magnesia." Look on the label of the "Milk of Magnesia" container and figure out the name of the white, milky product in your reaction and write it below:

3. If I told you the formula for Epsom's salt was Mg (SO4)2 and ammonia hydroxide was NH4OH, what do you think the formula for the "milky" substance is?

4. Reaction #6 and #9 both produced gases. Look at the label on the baking soda and Alka-Seltzer boxes. What is the common ingredient? Look up the formula of this substance in the dictionary and write it here.

5. Redo reaction # 9 and light a match and put the flame into the cup while the reaction is taking place. What happens to the flame?

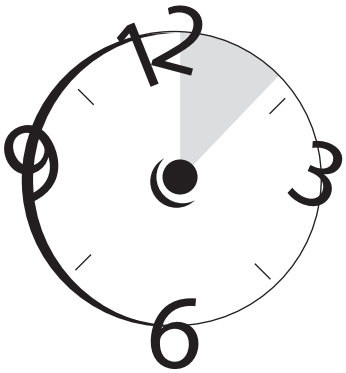
6. Based on this result and the fact that oxygen makes a flame glow more brightly; hydrogen makes a glowing splint pop; and the formula you found in item # 4 above, what do you think this gas is?

7. How does a safety match work? What is the chemical or chemicals responsible for a safety match being able to ignite upon striking it?

8. How can so many different substances come from so few ingredients called elements, like carbon, magnesium and iron?

Physical and Chemical Changes

Parallel: Core/AID
Time Allocation: 2 hours, 15 minutes
Required Materials and Resources on Page 230



Lesson Overview

The entire focus of this lesson is to examine and discuss the results of the previous four days' activities and to probe students' understandings of the nature of chemical reactions. Students should be able to recognize chemical reactions and describe some of the characteristics of chemical reactions as compared to physical changes. They should recognize the fact that in all the chemical reactions there was evidence of a new substance being formed. In addition, they should conclude that chemical changes involve energy changes of some kind.

A discussion and analysis of class results will reinforce the process of scientific process that includes having one's results analyzed and sometimes criticized by others. By comparing their results with others', students will receive feedback regarding the quality of their work. They will also recognize the advantage of pooling data in terms of providing validity for conclusions.

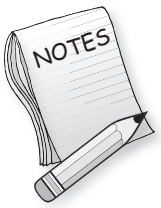
Finally, students should come to the conclusion that chemical changes are ubiquitous in nature and that most of what we depend on (e.g., food, household cleaners and clothes) are produced through one or more chemical reactions. In short, they should be able to answer the question as to whether or not chemical and physical changes occur everywhere, all the time and between all types and states of matter.

BIG IDEA

What's so Special About Chemical Changes?

Guiding Questions

- What are some of the characteristics of chemical changes?
- Do chemical and physical changes occur everywhere, all the time and between all types and states of matter?
- How can so many different substances come from so few ingredients (AID)?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- There are differences between physical and chemical changes.
- Chemical changes produce solids, liquids and/or gases.
- Chemical change produces new substances that can be identified and have properties that are different than the original reactants.
- Chemical changes involve a rearrangement of reactant structures.
- Chemical changes have certain attributes such as, producing new substances, temperature changes and gas or light production.

Concepts

- States of Matter
- Chemical change
- Physical change
- Reactant
- Product
- Temperature change
- Light production
- Color change
- Rearrangement of reactant structures

Teacher Information

- Milk of Magnesia is an antacid that mainly contains magnesium hydroxide. The latter has a low solubility in water and after time does settle out to the bottom of the container. That is why it is important to shake a bottle of Milk of Magnesia up before taking a dose.

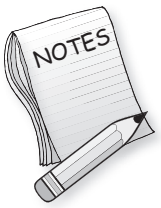
- The striker pads of match covers/boxes have red phosphorous, in two forms: P_2S_5 and P_4S_3. Safety matches have tips that contain an oxidizer that reacts with the phosphorous on match covers or boxes.
- These phosphorous containing compounds react with oxygen when friction is applied and burst into flames. For instance one of the reactions is $2P_2S_5 + 15O_2 \rightarrow 2P_2O_5 + 10SO_2$
- The Hindenburg caught fire on May 6, 1937, as it headed to New Jersey for a landing after a transatlantic flight. The book, *Horror Overhead*, by Richard Boning could be recommended to students interested in reading about this tragedy and its connection to hydrogen gas.
- Various processes one of which is triboluminescence also known as mechanoluminescence or fractoluminescence can emit light. Triboluminescence comes from the Greek words, *tribein*, which means to rub and *luminescence*, which means light emission.

Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Categorize
- Draw conclusions

Materials and Resources

1. Baking soda and labeled box (sodium bicarbonate) (1 teaspoon)
2. Vinegar (1/4 cup) (about 60 ml)
3. Glass jar with a lid
4. Tubing (1 1/2 feet)
5. Beaker 1/2 filled with limewater (calcium hydroxide, Ca(OH)2) and covered with plastic wrap
6. Empty soda bottle
7. Powdered yeast (1/2 package)
8. Sugar 5 ml (1 teaspoon)
9. Modeling clay to seal off the soda bottle



Preparation Activities

As the homework questions are discussed set up the two teacher demonstrations that will be done (see #18 Discussion Material for the Homework Questions for **Characteristics of Chemical Changes Lab**).

Introductory Activities (15 minutes)

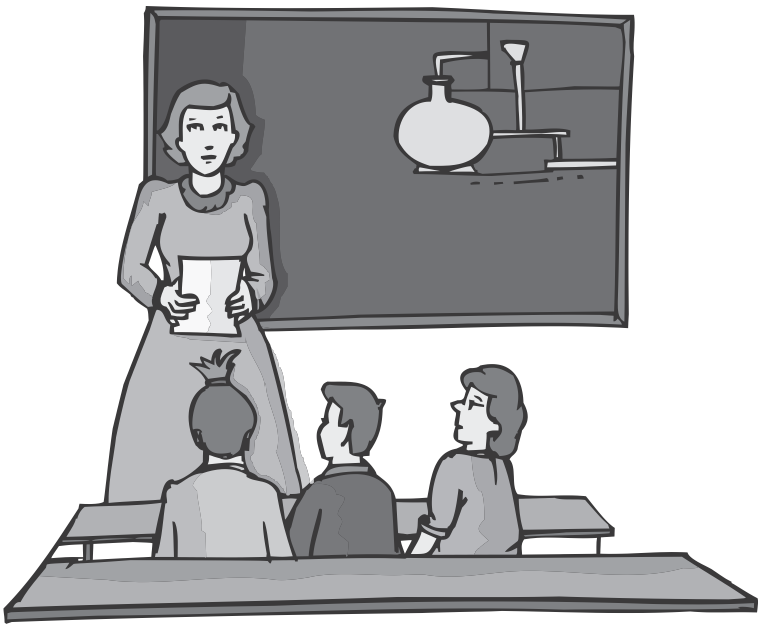
- Remember to have students examine their shoebox, iron powder and steel wool setups.
- Instruct students to copy the class results to their **Class Results Chart**.
- While they are copying the results, have them place their homework lab questions 1 & 2 on their desk.
- Check for completeness, not necessarily correctness. This homework assignment can be evaluated on three levels: incomplete, satisfactory, and thorough and accurate.

Pre-assessment

N/A

Teaching and Learning Activities (105 minutes)

1. Begin a discussion of the results by highlighting any discrepancies on the board between student groups and any inaccuracies in their results. Repeat in front of the whole class any of the reactions that triggered discrepancies, or what you know to be inaccuracies. If there is a significant problem with any of the reactions, have the students, themselves, go back and repeat the reaction (Day 1).



2. After reviewing and clarifying the class results for consistency and allowing time for the students to correct their **Class Results Chart**, have a discussion about the evidence that led them to believe the reactions in #1 were chemical changes (e.g., heat was liberated, a gas was produced, a white precipitate was formed-the latter indicating new substances were produced, etc.). Review each reaction (Day 1).

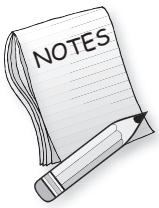
3. After #18 is reached, carry out the two demonstrations (Day 1).

4. Assign students to work in pairs to answer the remaining questions (see Discussion Material for the **Homework Questions for Characteristics of Chemical Changes Lab** below) (Day 2 and 3).

5. Look at what happened to the limewater overnight in the Teacher Demonstration #1 (yeast plus limewater). Review with students what happened in reactions #18, #8 and Teacher Demonstration #2. They should realize that all these reactions involved carbon and that the product was carbon dioxide.

6. Review the answers to questions #3 –17 (Day 3).

7. During this discussion of the answers to the questions begin to bring students to understand that during chemical reactions the structures of the reactants get broken apart and rearranged to form new substances. Some sort of analogy might help students. For example, you could say, "It is similar to a set of Legos that have been formed into small houses by one child and then another child comes along and breaks the Legos apart and decides to build one, large train station instead. The same parts are used but the product, the train station, does not have any of the characteristics of the original houses except the material, the Legos or the "elements" from which all substances are made. **SEARCHLIGHT**: During this discussion, be on the lookout for students who seem to have a deeper understanding of chemistry. Encourage them to complete the extension activity at the end of this lesson.



8. Collect their homework lab questions for further analysis regarding students' understandings, so that any misunderstandings can be addressed on the following day (Day 3).

Products and Assignments

- Students' **Questions for the Characteristics of Chemical Changes Lab** (Day 3).
- Students' Extension **Questions for the Characteristics of Chemical Changes Lab** (AID) (Day 3).

Extension Activities

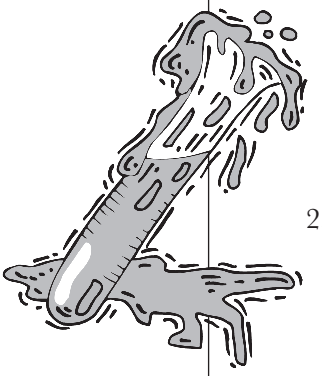
Invite students who need a further challenge to do the **Extension Questions for the Characteristics of Chemical Changes Lab** (Day 3).

Post Assessment

N/A

Debriefing and Reflection Opportunities (15 minutes)

1. Although the three days are essentially a clarification of student understanding, make sure on the last day of this lesson that a focused discussion occurs on how students would now answer the guiding questions, "What are some of the characteristics of chemical changes?" and "Do chemical and physical changes occur everywhere, all the time and between all types and states of matter?" (Day 3)
2. Elicit examples from as many students as possible to ensure their understanding.



Name_____ Date_____

Discussion Material for the Homework Questions for Characteristics of Chemical Changes Lab

1. Which reactions do you think represent chemical changes? Identify them by number. Give at least one reason for each reaction as to why you think it represents a chemical change.

   #1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 17-23

   #1: The banana and tomato are changing color. (Ethylene is produced by the banana as it ripens. This causes the tomato inside to ripen faster than the one outside).

   #2: 5 -It formed a new product, probably rust.

   #6: A gas was released.

   #7: A gas was released and the temperature went up. The product was not like the original reactants.

   #8: A gas was formed that is heavier than air because we could pour it. The product was not like the original reactants.

   #10: The match tip went from red to black, indicating that a new product was formed during the reaction.

   #12: A gas is formed (oxygen) as bubbles were seen. Based on the name hydrogen peroxide I would guess that it is oxygen or hydrogen. It is unimportant at this time to know exactly what the products are of a reaction. Students must begin to realize that they are not in any way like the reactants and, in fact, are new substances.

   #13: A white solid is formed, and it looks different than the original reactants. It is magnesium hydroxide, made from the magnesium in Epsom's salt (magnesium sulfate) and the hydroxide in ammonia water.

   #14: A white solid is formed, and it looks different than the original reactants. It is aluminum hydroxide, made from the aluminum in alum and the hydroxide in ammonia water.

   #17: The reaction is unusual, and that is why it is included. It has characteristics of both physical and chemical changes. This reaction produces a physical change because the Lifesaver gets crushed into smaller particles; however, the light production is often considered an indicator of the chemical change. It is perfectly reasonable that students might be uncomfortable with this apparently conflicting information. You can leave the subject, as it is, emphasizing the fact that students need to realize that not everything is science has clear answers or can be understood easily. If you choose to, you can continue the discussion of this particular reaction by telling students that several different processes can make light. For instance, fireflies produce light by chemical reactions and a flowing of particles, which produce electricity, produces light from light bulbs. In the case of the Lifesaver, light production comes from mechanical stress that causes the sugar particles in the Lifesaver to gain energy and then lose it again as light.

   #18: A white solid is formed and it looks different than the original reactants.

Do not tell students until after the demonstrations that the white solid in this reaction is calcium carbonate (limestone) made from the calcium in limewater, and the carbon and oxygen in carbon dioxide that comes

from your mouth when you exhale. Instead continue to pique their curiosity as to what the gas is by doing the following two demonstrations:

TEACHER DEMONSTRATION # 1:

Take a soda bottle and fill it half full with water; add 15 ml of yeast. Shake the bottle using your thumb as a cork. Put the tubing in the bottle and seal the opening with clay. Put the other end of the tubing through the top of a glass filled half way with limewater. Poke the tubing through the plastic wrap. Let it sit until tomorrow. Bubbles should be seen forming in the bottle and then flowing through the tubing turning the limewater milky. The yeast is an organism that uses sugar and oxygen to produce energy it needs and carbon dioxide as a waste product, much like what occurs in human digestion.

TEACHER DEMONSTRATION #2:

Take some clear limewater that is in a covered beaker. Repeat reaction #8. Pour the gas produced from reaction #8 into the limewater and the same white solid is formed that the students saw when they exhaled.

After the demonstrations, students should see that the gas is the same in all three cases and that the common ingredient to all three is the carbon in the gas they exhaled, the carbon in the baking soda (sodium bicarbonate) that reacted with the vinegar and finally demonstration #2 in which the carbon dioxide gas was produced via another mechanism - yeast digesting sugars, much the same way humans do it, producing carbon dioxide as a waste product of the process.

#19: A gas is produced, as bubbles were seen. In addition, the temperature of the reaction went up indicating that heat was released during the chemical reaction between bleach (sodium hypochlorite) and water. The gas produced is oxygen.

#20: A gas is produced, as bubbles were seen, and the red coloring faded. The oxygen assists in the degradation of the stain by breaking down the stain's chemical structure through a chemical oxidation process.

#21: A white solid is formed thus showing how two liquids can produce a substance in a different state of matter. The ammonia can violently react with the bleach.

#22: Ash results from the reaction between fire and the oxygen in air. The product definitely does not look anything like the reactants. The term combustion can be introduced at this time. Mention the burning process reduces the paper that is made from cellulose, a carbon compound found in plants. Tell students it is similar to burning trees in that the product is ash. Ask them if anyone knows how paper is made

#23: The reaction also produces bubbles of a gas that happens to be hydrogen. The "popping" sound that was made when the glowing splint was lowered into the gas is a characteristic result for the test for hydrogen gas. Oxygen gas makes a glowing splint glow brighter. The hydrogen combines with the oxygen in the air to form an explosion. Ask students what they know about the Hindenburg. Talk about the similarity between this reaction and what happened to the Hindenburg dirigible when the hydrogen gas caught fire.

2. Which reactions do you think represent physical changes? Identify them by number. Give one reason why you think they are physical changes and not chemical changes.

#9, 11 and #15: No new substances were produced and the original substances could be retrieved by physical means. The baking soda just dissolved in the water. If the water had been evaporated away, the baking soda would be visible again. The alcohol and water could be separated by distillation. This process involves boiling them; each would boil at a different temperature and could be collected separately. The ice and baby food jar just made the water vapor in the air inside the jar cool down and condense but it was still water, just in a different form.

3. Which reaction(s), if any, at first appeared to be a physical change but after time showed evidence of being a chemical change?

   #16: At first it looked like there was a chemical change, but the next day the silica gel was back to its original form.

4. Identify as many reasons as you can as to how a chemical change can be distinguished from a physical change.
   - New substance(s) are formed.
   - Heat change occurs.
   - A gas might be produced, which indicates a new substance was formed.
   - Color changes may occur, which indicates a new substance was formed.
   - Light or sound can be produced, which indicates a change in energy. These types of changes are associated with the production of new substances.

5. Why do you think you find the silica, the chemical found in #16, in boxes holding electronics, in boxes holding new shoes, etc.?

   It absorbs moisture and keeps the shoes dry.

6. What could be in your breath to cause the reaction in #18 to occur?

   Carbon dioxide

7. What conclusion can you draw about when happens to substances when they react with more than one type of substance? Use the results of reactions #7, 9, 13 and 14 to help you?

   Substances do not react in the same way when they react with different substances. As a result, different products are formed.

8. What do you think kept the water from rising up the tube initially when you inverted the test tube with the iron filings in reaction # 2?

   The air pressure inside the tube prevented the water from initially rising.

9. What does what happened to the water level in reactions #2, 3 & 4 after several days suggest to you?

   It indicates that some of the air (oxygen) was used up in a reaction between it and the iron powder.

10. Is there any evidence of a chemical change in reactions #2, 3 & 4? If so what is the evidence?

    Yes, there is evidence. The iron powder turns color. The water moves up the tube because some part of the air is being used in the chemical reaction.

11. What fraction of the total test tube or vial volume was filled with water, 1/2, 1/3, 3/4, etc. in reactions 2, 3 & 4?

    The fraction filled by water was 1/5.

12. What is the percentage of oxygen in air?

    The percentage of oxygen in air is 20%.

13. What are the two main gases that make up the mixture of air?

    Oxygen and nitrogen

14. What might have been used up from the air in reactions #2, 3 & 4?

    Oxygen

15. What do you caused the differences between the tomato inside the shoebox and the tomato outside the box?

    Something was released by the ripening banana (ethylene) to hasten the ripening of the green tomato inside the box.

16. Is watching a banana ripen more exciting than watching grass grow? Explain your answer and use the words "chemical change" in your explanation.

    Yes, because there is a chemical reaction in which change is quickly obvious. Although there are chemical changes going on as grass grows (photosynthesis), it is not as fast or as visible.

17. a) How does the color of the light produced by the crushing of the Lifesaver compare to the color of the Lifesaver itself?

    The Lifesaver is white, and the light was blue.

    b) How could you justify this change as a physical change?

    The Lifesaver is crushed into smaller particles, but it is still a Lifesaver.

    c) How could you justify this change as a chemical change?

    Light is produced, which is a sign of a chemical change and there was a color change in that the light was blue and the original reactant, the Lifesaver, was white.

Extensions Questions for the Characteristics of Chemical Changes Lab

1. Look on the label of the Epsom's salt container and write down the name of the active ingredient.

   Magnesium sulfate

2. Ammonia is a gas at room temperature and when it is dissolved in water you get household ammonia that is sold in the grocery stores. The name of the compound formed when ammonia dissolves in water is ammonia hydroxide. When you mixed Epsom salt and ammonia, you got a cloudy liquid form which settled out a white substance. This cloudy substance is actually produced and marketed as "Milk of Magnesia." Look on the label of the "Milk of Magnesia" container and figure out the name of the white, milky product in your reaction and write it below. (It turns out that most all sulfates are soluble, which is why magnesium sulfate, Milk of Magnesia exists as a solution):

   Magnesium hydroxide

3. If the formula for Epsom's salt was MgSO4 and ammonia hydroxide was NH4OH, what do you think the formula for the "milky" substance is?

   $Mg(OH)_2$

4. Reaction #6 and #9 both produced gases. Look at the label on the baking soda and Alka-Seltzer boxes. What is the common ingredient? Look up the formula of this substance in the dictionary and write it here.

   Sodium hydrogen carbonate, $NaHCO_3$

5. Redo reaction # 9 and light a match and put the flame into the cup while the reaction is taking place. What happens to the flame?

   It goes out.

6. Based on this result and the fact that oxygen makes a flame glow brighter, hydrogen makes a glowing splint pop and the formula you found in item # 4 above, what do you think this gas is?

   Carbon dioxide

7. How does a safety match work? What is the chemical or chemicals responsible for a safety match being able to ignite so easily upon striking it? Why is the tip of a match coated red?

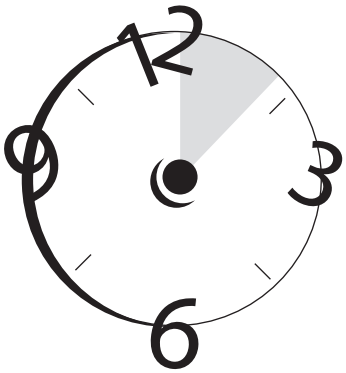
   The striker pads of match covers/boxes have red phosphorous, in two forms P_2S_5 and P_4S_3. These compounds react with oxygen when friction is applied and burst into flames. For instance, one of the reactions is $2P_2S_5 + 15O_2 \rightarrow 2P_2O_5 + 10SO_2$. Matches are coated with chemicals to prevent them from igniting easily and must be struck against a surface such as the ones on match covers and boxes in order to ignite easily.

8. How can so many different substances come from so few ingredients called elements, like carbon, magnesium, and iron?

   So many different substances can come from so few elements because elements can combined in many different arrangements, thus creating new substances. In addition to having different types of elements, different compounds can contain the same types of elements but their quantity can vary, thus providing many more unique substances.

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

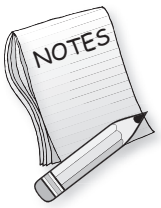
The purpose of this lesson is to highlight the fact that characteristics of products formed during a chemical reaction have nothing to do with the properties of the original substances. Students need to understand that when new products are formed, their properties and possible effects on the environment cannot be predicted based on the nature of the reactants that were used to produce them. Students will begin to realize that the study of chemical changes are important, as the potential effects of new products on ecosystems should be understood ahead of time, not after some unwanted consequences occur.

Guiding Questions

1. Do the physical and chemical properties of reactants have anything to do with the physical and chemical properties of the products of a chemical reaction?

BIG IDEA

What's so Special About Chemical Changes?



Content Goals

Universal Themes

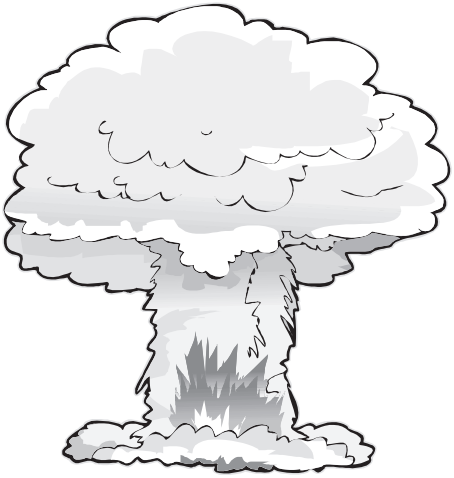
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- Chemical change produces new substances that have properties that are different than the original reactants.
- Chemical changes involve a rearrangement of reactant structures.

Concepts

- Chemical change
- Physical properties
- Chemical properties
- Reactant
- Product
- Rearrangement of reactant structures



Teacher Information

- Iron and sulfur react to form iron sulfide.
- Sodium reacts violently with water.
- Chlorine gas is toxic.
- Sodium and chlorine react to form a harmless substance, sodium chloride, better known as table salt.
- Magnesium in a flashcube burns with oxygen and forms a white powder of magnesium oxide.

Skills

- Identify characteristics
- Describe characteristics

- Analyze
- Compare and contrast

Materials and Resources

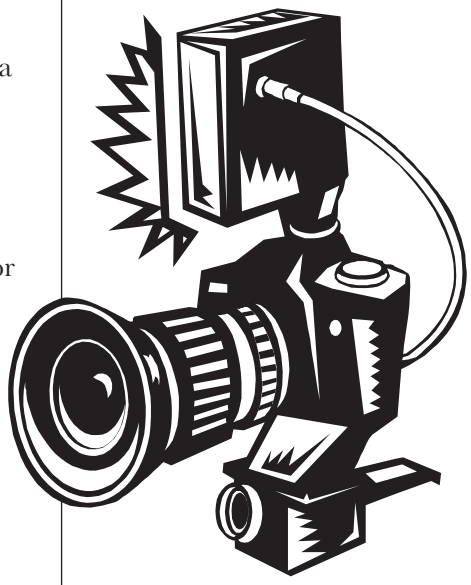
1. The following books offer pictures and information that could be used to enhance this lesson: The Eyewitness chemistry book has pictures of elements like iron and sulfur reacting to form iron sulfide. The pictures vividly depict the fact that the physical properties of reactants can in no way be used to predict the nature of the products of the reaction. These books are also used as reference material for later lessons.
    - The Newmark, A. (2000). Eyewitness books: Chemistry. London: Dorling Kindersley (DK) Publishing.
    - Newton, D. (1999). Chemical elements from carbon to krypton. Volumes 1 (A-F), 2 (G-O), and 3 (P-Z). Detroit, Michigan: UXL.
2. Pictures (see p. 5) or video clips of sodium reacting with water http://www.theodoregray.com/PeriodicTable Click on the element "sodium" and then click on the words "sodium party" and browse through the pictures and videos accordingly.
3. Picture of chlorine gas. If you do not have one, go to http://www.google.com, click on Images and put in chlorine gas.
4. Article on the deadly nature of chlorine gas http://www.emedicine.com/emerg/topic851.htm
5. Salt shaker or baggie containing salt
6. Picture of a camera flash bulb. Pictures can be found on the web at camera sites such as www.porterscamera.com

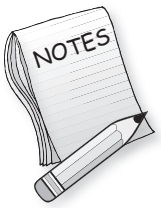
Preparation Activities

1. Copy the article related to chlorine gas for each student.
2. Copy the **Table of the Properties of Reactants and Products** for each student.

Introductory Activities (20 minutes)

- Instruct students to read and discuss the article "Chlorine Gas" emphasizing chlorine's properties and toxic nature.
- Show them photographs and/or the video clip of sodium reacting



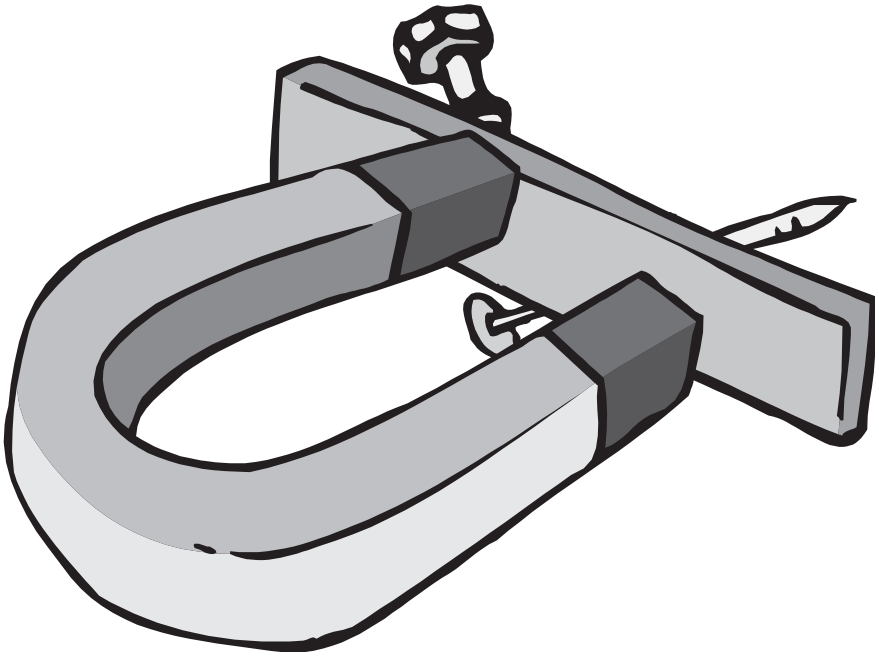


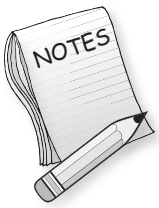
violently with water. http://www.theodoregray.com/PeriodicTable/Stories/011.2/Videos/SodiumLake01.MOV
Explain to them that the reaction produces a gas called hydrogen and lots of energy, which actually sets fire to the hydrogen gas. In the video students see a ball of sodium "sizzling" across the water. The energy released in the reaction is high enough to melt sodium and turn it into a tiny ball of liquid.

- Discuss the fact that sodium is one of the most reactive pure materials in the world. Tell students it reacts with air and must be stored as an oil, like kerosene, to prevent it from reacting with the air.
- Ask students if they know what is formed when sodium reacts with chlorine.
- In case they do not know that table salt is the answer, hold up a shaker or baggie of table salt.
- Question students about table salt's properties. They should discuss such properties as it is a white solid that is harmless, does not react with air and dissolves in water.
- Show them pictures of sodium and chlorine, the two elements that make up salt. Continue the discussion of their properties.

- Show them a photograph of sodium in its elemental state. If you do not have one, go to http://www.google.com, click on Images and put in the element sodium.
- Assign students to review the article on chlorine that follows and identify five properties of chlorine gas. The article was modified from one written by Dr. Eli Segal, MD and is posted on the following web site: http://www.emedicine.com/emerg/topic851.htm.
- Compare the properties of the three substances, sodium, chlorine and salt emphasizing the fact that properties of the reactants in no way predict the properties of the product.

- Share with students that you understand their first inclination might be to believe that products must have some relationship to the substances from which they are made because their own personal experiences. Families and the physical and behavioral similarities of children to their parents might serve as a basis or their thinking that products must have resemblance to reactants in some way. Assure them that chemical reactions are in no way similar to the heredity process.
- Show them page 20 in the *Eyewitness books: Chemistry*. Iron filings are shown in a mixture of yellow sulfur. The book also displays a picture of these two reactants being heated with a Bunsen burner forming the product iron sulfide. Finally, the book depicts a hand holding a magnet toward the iron sulfide with no evidence of any magnetic properties. Ask students what happened to the magnetism that iron, one of the two main ingredients, brought with it to this reaction. Students should make the connection that





the properties of iron sulfide are not dependent or related in any way to the properties of the original substances used in the reaction and there is no reason to assume that iron sulfide would be magnetic or yellowish in color for that matter. Remind them that the physical and chemical properties of reactants in a mixture remain intact and that distinguishes mixtures as physical changes as compared to chemical changes.

Chlorine Gas

Chlorine gas is a pulmonary irritant with intermediate water solubility that causes acute damage in the upper and lower respiratory tract. Chlorine gas was first used as a chemical weapon at Ypres, France, in 1915. Of the 70,552 American soldiers poisoned with various gasses in World War I, 1,843 were exposed to chlorine gas.

Chlorine is a greenish-yellow, noncombustible gas at room temperature and atmospheric pressure. The intermediate water solubility of chlorine accounts for its effect on the upper airway and the lower respiratory tract. In addition, the density of the gas is greater than that of air, causing it to remain near ground level and increasing exposure time.

Chlorine is moderately soluble in water and reacts in combination to form hypochlorous (HOCl) and hydrochloric (HCl) acids. The immediate effects of chlorine gas toxicity include acute inflammation of the conjunctivae, nose, pharynx, larynx, trachea, and bronchi resulting in pulmonary congestion. The eyes are seldom damaged severely by chlorine gas toxicity; however, burns and corneal abrasions have occurred.

In the U. S. chlorine gas is one of the most common single, irritant, inhalation exposures, occupationally and environmentally. In 1983, an estimated 191,000 US workers were at risk of exposure to chlorine in various forms. In a recent study of 323 cases of inhalation exposures reported to poison control centers, mixing bleach with other products caused the largest single source of exposure (21%).

Possible sources of exposure to chlorine gas are as follows:

- Industrial bleaching operations
- Sewage treatment
- Transportation releases

o Swimming pool chlorination tablet accidents
o Storage tank failure
o Chemical warfare

Adverse effects of inappropriate mixtures of household cleaners usually are caused by prolonged exposure to an irritant gas in a poorly ventilated area. The most common mixtures of cleaning agents are sodium hypochlorite (bleach) with acids or ammonia. Potential irritants released from such mixtures are chlorine gas, chloramines, and ammonia gas.

Pre-assessment

N/A

Teaching and Learning Activities (20 minutes)

1. Pair students.

2. Return students' **Questions for the Characteristics of Chemical Changes Lab**.

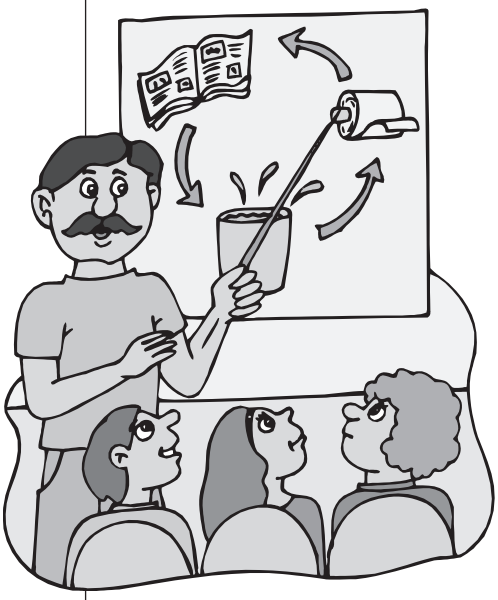
3. Review any major problems with the students' answers.

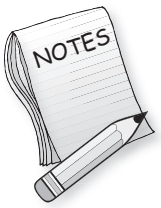
4. Distribute the **Table of the Properties of Reactants and Products** to each student.

5. Direct students to use them complete the table using the **Characteristics of Chemical Changes** lab activities as a reference.

6. Do the first two examples with them. In the first example show them a picture of a flash on top of a camera. Describe what goes on inside the flashcube when it goes off. Fill in an example of the table on the board. Instruct students to fill in their tables as well.

7. Repeat this procedure for the reaction #3.





8. Advise students to work with their partners to complete this table.

9. If there is extra time, you can select more reactions from the **Characteristics of Chemical Changes** lab for students to analyze.

Products and Assignments

Students' **Table of the Properties of Reactants and Products**

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

1. Review the answers to the table emphasizing the fact that the states of matter and colors of original reactants are not related to the products' states of matter or colors.
2. Ask students the guiding question, "Do the physical and chemical properties of reactants have anything to do with the physical and chemical properties of the products of a chemical reaction?"
3. Students should conclude that there is no predictable relationship between the physical and chemical properties of reactants and products in chemical reactions.

Name _____ Date_____

Table of the Properties of Reactants and Products

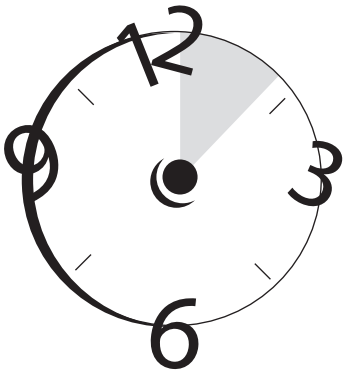
Reaction #	Property Examined	Reactant 1	Reactant 2	Product
Reaction ex.		**Magnesium**	**Oxygen**	**Magnesium oxide**
	States of Matter	Solid	Gas	Solid
	Color	Silver	Clear	White
Reaction #3		**Iron**	**Oxygen**	**Iron oxide (rust)**
	States of Matter	Solid	Gas	Solid
	Color	Brownish	Clear	Red
Reaction # 6		**Alka-Seltzer tablet**	**Water**	**Carbon dioxide**
	States of Matter			
	Color			
Reaction # 12		**Hydrogen peroxide**	**Water**	**Oxygen or hydrogen gas**
	States of Matter			
	Color			
Reaction # 13		**Ammonia water (ammonium hydroxide)**	**Epsom Salt (Magnesium sulfate)**	**Magnesium hydroxide**
	States of Matter			
	Color			
Reaction #18		**Breath (carbon dioxide)**	**Limewater (calcium hydroxide)**	**Calcium carbonate**
	States of Matter			
	Color			

Answers to the Properties of Reactants and Products Table

Reaction #	Property Examined	Reactant 1	Reactant 2	Product
Reaction		**Magnesium**	**Oxygen**	**Magnesium oxide**
Example	**States of Matter**	**Solid**	**Gas**	**Solid**
	Color	Silver	Clear	White
Reaction #3		**Iron**	**Oxygen**	**Iron oxide (rust)**
	States of Matter	Solid	Gas	Solid
	Color	Brownish	Clear	Red
Reaction # 6		**Alka-Seltzer tablet**	**Water**	**Carbon dioxide**
	States of Matter	Solid	Liquid	Gas
	Color	White	Clear	Clear
Reaction # 12		**Hydrogen peroxide**	**Water**	**Oxygen or hydrogen gas**
	States of Matter	Liquid	Liquid	Gas
	Color	Clear	Clear	Clear
Reaction # 13		**Ammonia water (ammonium hydroxide)**	**Epsom Salt (Magnesium sulfate)**	**Magnesium hydroxide**
	States of Matter	Liquid	Solid	Solid
	Color	Clear	White	White
Reaction #18		**Breath (carbon dioxide)**	**Limewater (calcium hydroxide)**	**Calcium carbonate**
	States of Matter	Gas	Liquid	Solid
	Color	Clear	Clear	White

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

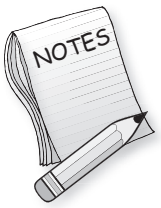
In this lesson students will be assessed on their current understandings of chemical and physical changes.

Guiding Questions

- Can I recognize physical and chemical changes in my life?
- Can I recognize the different characteristics of physical and chemical changes?

BIG IDEA

What Do We Know About Physical and Chemical Changes?



Content Goals

Universal Themes

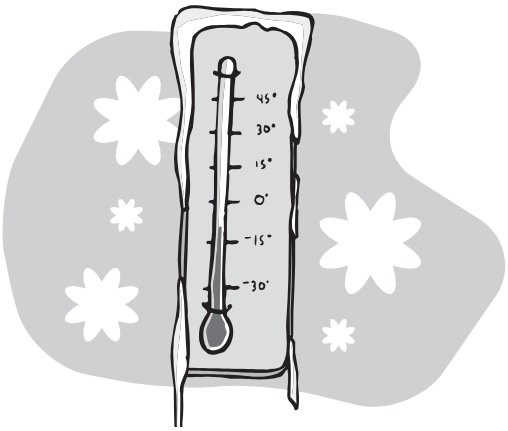
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- There are differences between chemical and physical changes.
- Chemical changes produce solids, liquids and/or gases.
- Chemical change produces new substances that have properties that are different than the original reactants.
- Chemical changes involve a rearrangement of reactant structures.
- Chemical changes have certain attributes such as producing new substances, temperature changes and gas or light production.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.
- Mixtures are made up of and are examples of different states of matter.
- Solutions are mixtures that contain substances that are dissolved.

Concepts

- States of matter
- Chemical change
- Physical change
- Mixture
- Solution
- Solute
- Solvent
- Reactant
- Product
- Temperature change
- Color change
- Rearrangement of reactant structures



Teacher Information
N/A

Skills
- Identify characteristics
- Analyze
- Compare and contrast
- Categorize
- Draw conclusions

Materials and Resources
1. Two pictures that show chemical and physical changes, labeled "A" and "B"
2. Copies of the assessment, **What Do I Know about Physical and Chemical Changes?**

Preparation Activities
Copy the assessment **What Do I Know about Physical and Chemical Changes?** for each student.

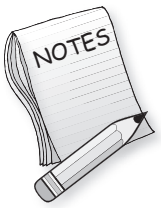
Introductory Activities (2 minutes)
Explain to students that they will be taking an assessment on the lessons thus far in this unit.

Pre-assessment
N/A

Teaching and Learning Activities (43 minutes)
Administer assessment, **What Do I Know about Physical and Chemical Changes?** to students.

Products and Assignments
Student assessments

Extension Activities
N/A



Post Assessment

Assessment given today serves as a post assessment for the previous lessons in this module.

Debriefing and Reflection Opportunities

N/A

Name _____ Date _____

What Do I Know about Physical and Chemical Changes?

1. Choose one of the two pictures below, and identify three different physical and chemical changes that are occurring in the picture.

A. Picture with fog or snow melting

B. Fourth of July, Centennial Celebration fireworks

Name _____ Date _____

What Do I Know about Physical and Chemical Changes?

2. The flash in a flashbulb is a reaction between a magnesium metal coil and oxygen gas. A white powder is left in the glass bulb after the flash goes off. What do you think happened? Explain your answer.

3. When a Class B fire (grease or gasoline) occurs, a fire extinguisher holding liquid carbon dioxide is used. Explain what happens to the carbon dioxide when it comes out of the extinguisher. Is this a chemical or physical change?

4. When a cup of tea is made, what two states of matter are involved? What is the solute and what is solvent?

5. How do you know that putting salt in water is a physical change and not a chemical change?

6. Can you think of one human-made chemical change that has been detrimental to our environment?

7. Can you think of one physical change that humans have done to our environment that has been detrimental?

8. Do you think gold can be turned into liquid? Explain.

9. During the fall, when leaves turn color, do you think this is a physical or chemical change, and why do you have this opinion?

10. Do you think when silver tarnishes and turns black, it is a physical or chemical change? Explain your opinion.

11. When you rub tarnished silver with a cloth very little happens. What do you think silver polish does? Is this a physical or chemical change?

12. The Statue of Liberty is made mainly of copper, which is red. What do you think happened to cause the Statue of Liberty to change to the color green?

13. "All solutions are mixtures but not all mixtures are solutions." Explain this statement using examples.

14. Cider is a juice that can ferment (some of the sugar in it is changed to another substance). After the reaction, it does not taste as sweet and it is called "hard cider."

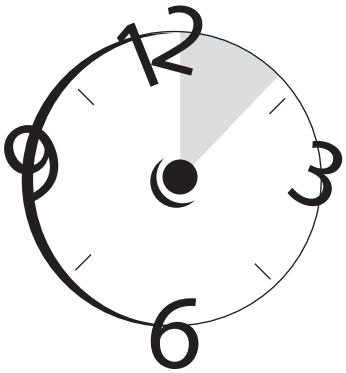
a) What kind of change do you think occurred here? Explain your opinion.

b) When you freeze hard cider, you get slush. What states of matter were evident?

15. Do you think it is possible for two gases to react and form a liquid? Explain your answer.

Physical and Chemical Changes

Parallel: Core
Time Allocation 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

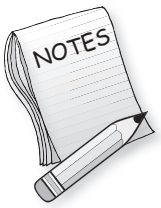
In this lesson, students will review the results of the assessment of their understandings of chemical and physical changes.

Guiding Questions

- Do I recognize physical and chemical changes in my life?
- Do I recognize the different characteristic of physical and chemical changes?

BIG IDEA

What Do We Know About Physical and Chemical Changes?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Chemical and physical changes occur everywhere, all the time and between all types and states of matter.
- Chemical changes produce solids, liquids and/or gases.
- Chemical change produces new substances that have properties that are different than the original reactants.
- Chemical changes involve a rearrangement of reactant structures.
- Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.
- There are differences between chemical and physical changes.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.
- Mixtures are made up of different states of matter.
- Solutions are mixtures that contain substances that are dissolved.

Concepts

- States of matter
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- Solution
- Solute
- Solvent
- Reactant
- Product
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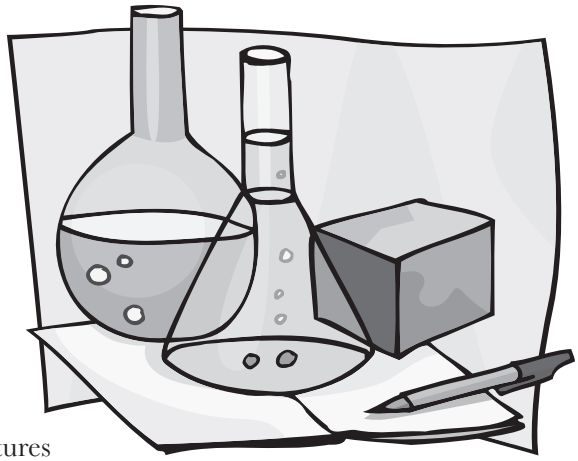


Teacher Information
N/A

Skills
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Categorize
- Explain
- Draw conclusions

Materials and Resources
Assessment results for the **What Do I Know about Physical and Chemical Changes?** test

Preparation Activities
Copy the answers to **What Do I Know about Physical and Chemical Changes?**

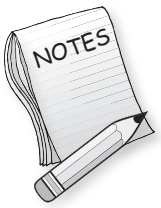
Introductory Activities (2 minutes)
Explain to students that the class today will be a survey of the answers to the assessment they took in the previous lesson.

Pre-assessment
N/A

Teaching and Learning Activities (43 minutes)
Review the answers to the assessment using the answers to **What Do I Know about Physical and Chemical Changes?** on the last three pages of this lesson.

Products and Assignments
N/A

Extension Activities
N/A



Post Assessment

N/A

Debriefing and Reflection Opportunities

A thorough review of the assessment and its correct answers serves as a debriefing.

Answers to What Do I Know about Physical and Chemical Changes?

1. Choose one of the two pictures below and identify three different physical and chemical changes that are occurring in the picture.

A. Picture with fog or snow melting

Analyze the picture you chose and identify changes.

B. Fourth of July, Centennial Celebration fireworks (perhaps the "Tall Ships")

Analyze the picture you chose and identify changes.

2. The flash in a flashbulb is a reaction between a magnesium metal coil and oxygen gas. A white powder is left in the glass bulb after the flash goes off. What do you think happened? Explain your answer.

A chemical change took place and a new substance that was white was produced. The color change was noted and a white powder was formed that did not exist before. The powder shows that a new product was formed, which is characteristic of chemical reactions.

3. When a Class B fire (grease or gasoline) occurs, a fire extinguisher holding liquid carbon dioxide is used. Explain what happens to the carbon dioxide when it comes out of the extinguisher. Is this a chemical or physical change?

When the carbon dioxide comes out of the extinguisher, it is a physical change because it still is carbon dioxide. It just turns from liquid to gas.

4. When a cup of tea is made, what two states of matter are involved? What is the solute and what is solvent?

A solid and a liquid are involved. The solute is the tea from the tea bag and the solvent is the water.

5. How do you know that putting salt in water is a physical change and not a chemical change?

When the water evaporates, the salt would be left behind and would still be salt. There is no chemical change because no new substance is produced.

6. Can you think of one human-made chemical change that has been detrimental to our environment?

We have introduced plastics that do not degrade quickly. The production and transportation of oil has led to oil spills that have damaged our environment. Aerosol cans release chemicals that damage our ozone. The burning of fossil fuels produces gases that cause the "greenhouse effect." The production of consumer goods in factories releases gases that combine with water to produce acid rain.

7. Can you think of one physical change that man has done to our environment that has been detrimental?

One example is clear cutting of trees. Building in areas like marshes is another example.

8. Do you think gold can be turned into liquid? Explain.

Yes, all substances can be in solid, liquid or gaseous states. It needs to be heated to a high enough temperature to melt it.

9. During the fall, when leaves turn color, do you think this is a physical or chemical change and why do you have this opinion?

It is a chemical change because color change is one of the characteristics of chemical changes and also because you cannot get the leaf back to its original color by physical means.

10. Do you think when silver tarnishes and turns black it is a physical or chemical change? Explain your opinion?

It is a chemical change because of the color change, and it looks like a new substance is deposited on top of the silver.

11. When you rub tarnished silver with a cloth very little happens. What do you think silver polish does? Is this a physical or chemical change?

The polish causes black tarnish to go away. In other words, it chemically destroys the tarnish. I think it is a chemical change because just rubbing the tarnish does little. A chemical substance, polish, had to be added in order to clean the silver, so it must be some chemical reaction between the polish and the tarnish that gets rid of the black tarnish.

12. The Statue of Liberty is made mainly of copper, which is red. What do you think happened to cause the Statue of Liberty to change to the color green?

A chemical change must occur to the red copper.

13. "All solutions are mixtures but not all mixtures are solutions." Explain this statement using examples.

A solution is a mixture that is alike everywhere no matter where you sample it. Salt in water is a solution. However, there are mixtures like salt and pepper where the salt may not be evenly mixed with the pepper, and if you sampled it, you may taste more pepper one time and more salt another time, depending on where you took the sample. Another example of something that is a mixture but not a solution is chocolate chip cookies where the ingredients are not mixed evenly. There may be more chips in one part of the cookie than in another part. Therefore, we can conclude that some mixtures are not solutions.

14. Cider is a juice that can ferment (some of the sugar in it is changed to another substance). After the reaction, it does not taste as sweet and it is called "hard cider."

a) What kind of change do you think occurred here? Explain your opinion.

A chemical change took place because a new substance that is not as sweet as sugar was produced.

b) When you freeze hard cider, you get slush. What states of matter were evident?

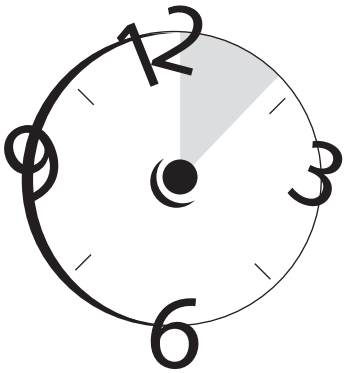
A solid and a liquid were involved.

15. Do you think it is possible for two gases to react and form a liquid? Explain your answer.

Yes, it is possible. A product's states of matter or properties are not dependent on the states of the reactants of their respective properties.

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

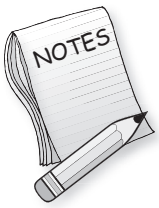
Now that students are more aware of the differences between physical and chemical changes, it is time to examine the specific restructuring processes involved in both physical and chemical changes. Students in this lesson will begin to deepen their understanding of what actually happens when substances mix to form solutions. To clarify the process by which substances dissolve, the teacher will conduct three demonstrations. These demonstrations should serve as visual anchors for the students as they assimilate the concept of dissolving.

Guiding Questions

- What happens when solutions form?
- Why does one plus one not add up to two when talking about solutions?

BIG IDEA

What's so Special About Solutions?



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Most matter in nature is found mixed with other matter.
- Solutions are mixtures that contain substances that are dissolved.
- Mixtures are made up of different states of matter.
- When a substance dissolves in another substance, its particles go in-between the other's particles.

Concepts

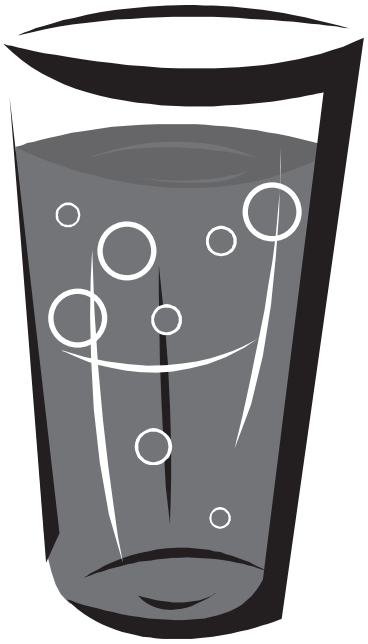
- Physical change
- Mixture
- Solution
- Dissolve
- Solute
- Solvent

Teacher Information

When the salt is added to the soda, the salt particles push the carbon dioxide gas particles out of the way, causing them to rush to the surface of the baby food jar. This forms foam on the top of the liquid. The process of replacing a gas with another substance is called *effervescence*.

Skills

- Describe characteristics
- Analyze
- Compare and contrast



Materials and Resources

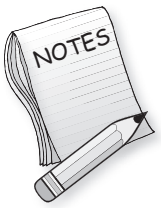
1. Kool-Aid pack or powdered drink mix
2. Glass of water
3. Toothpicks with flat ends
4. Pictures of solutions
5. One 500 ml graduated cylinder or 1 quart glass jar (masking tape and pen are necessary if the quart jar is used)
6. Sugar 240 ml (about 1 cup)
7. Water 240 ml. (about 1 cup)
8. Rubbing alcohol 240 ml (about 1 cup)
9. Food coloring (2 drops)
10. Bottle of soda
11. Small baby food jar
12. Tablespoon
13. Table salt (1 tablespoon for teacher demonstration)
14. Thin wire for stirring purposes

Preparation Activities

1. Post some pictures of solutions on the board that students may not think of, such as steel (mixture of iron and carbon), brass (mixture of two solids, copper and zinc) and bronze (mixture of two solids, copper and tin).
2. Try item #8 from the Teaching and Learning Activities below ahead of time.

Introductory Activities (10 minutes)

- As you begin the class, fill a glass half full with water. Gently shake the flat end of a toothpick that has Kool-Aid or other powdered fruit drink over the glass. As the streamers of color travel down through the water, begin your discussion of the dissolving process. Ask them what substance in the combination is the solvent (water) and what substance is the solute (powder).
- Talk about the particles of solid powder breaking apart into smaller and smaller particles and spreading thoroughly throughout the water particles.



- Ask students, "If you took a sample of Kool-Aid or soda from different parts of the liquids would they taste any differently?" Ask similar questions regarding the sampling of air or steel (if students mention that air does vary because of pollutants, accept the fact that air might not be a solution in all locations, as it might be contaminated with particulate matter that is not dissolved evenly throughout the air sample). Remind students that the different parts of a solution are identical. You can use the term homogeneous. However, the term is not what is important here. It is the idea that solutions have substances equally distributed throughout.
- Have a bottle of soda and ask students the following questions: "Is this a mixture?" "What is it a mixture of?" "Is it a solution?" Review the idea that mixtures such as this solution of liquid and gas can be between different states of matter or between the same states of matter, such as cranberry and orange juice mixed.
- Ask them what substance in the soda is the solvent (water) and what substances are the solutes (carbon dioxide gas and various ingredients like sugar or artificial sweetener).
- Ask students, "Is air is a mixture? A solution?" Have students explain why it is both. Identify the states of matter involved (several gases: oxygen, nitrogen and other gases [argon]).
- Ask students, "Is blood is a mixture? A solution?" Students should realize that blood is a solution. It contains fats, salts, sugars and proteins dissolved in water.
- Refer to the pictures of solutions on the board and discuss the solutions represented in them.

Pre-assessment

N/A

Teaching and Learning Activities (32 minutes)

1. Pose the question, "What do you predict the total volume of 240 ml (1 cup) of sugar combined with 240 ml (1 cup) of water to be?" Put the suggestions on the board and make everyone commit to one of them by writing a choice in their science notebooks.

2. Conduct the first demonstration. Add 240 ml of water to a 500 ml graduated cylinder or glass jar. (If a glass jar is used, put a piece of masking tape on the outside. Pour in one cup of water and mark the tape at the one cup level. Add a second cup of water and mark the two cup level. If the graduated cylinder is used, it will already have the measurement lines on it.)

3. Empty and dry the measuring cylinder or jar.

4. Add 240 ml of sugar to the empty cylinder or glass jar. Make sure the top of the sugar is at the 240 ml (1 cup) mark.

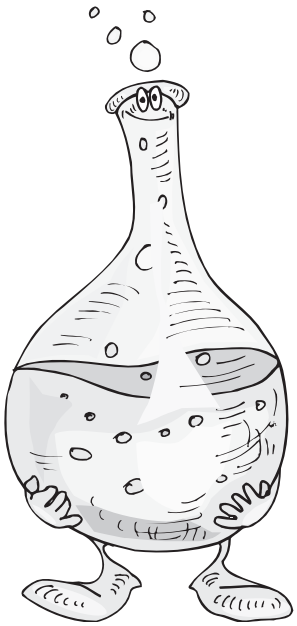
5. Add 240 ml of water of water and stir.

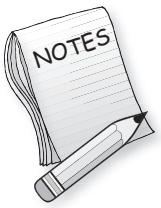
6. Have a student read the final combined volume. They will report that it is less than the 480 ml (2 cup) mark.

7. Empty the jar and conduct the second demonstration. Add 240 ml (1 cup) of water into the jar. Add one or two drops of food coloring. Add 240 ml (1 cup) of rubbing alcohol to the jar. Have a student report on the combined height. Again, it will be below the 480 ml mark.

8. For the third demonstrations, fill a glass full of water until it forms a rounded bubble-like top. Ask students what will happen when you add the salt. Some students might say the water will spill over the glass. Make all students commit to an answer. Sprinkle the salt gently onto the water and use a thin wire to stir it in. The salt should dissolve and the water should not spill over the top.

9. Talk about when "one plus one is less than two." Have students answer the questions as to where the water went in the first demonstration, where the alcohol went in the second and where the salt went in the third demonstration. They should realize that the water went in-between the sugar particles and that the salt went in-between the water molecules, respectively. Similarly, the alcohol went in between the water particles. They should come to realize there are spaces in-between the particles of substances, which can be filled by particles of other substances. This means that one and one can be less than two!





10. Fill the jar one-half full with the soda. Add 5 ml of salt. Discuss what is seen with the class. Ask students what they think might be happening to cause all the bubbling over of the soda. Mention that the salt particles push the carbon dioxide gas particles out of the way causing them to rush to the surface of the baby food jar. This forms foam on the top of the liquid; this process, replacing a gas with another substance, is called *effervescence*.

Products and Assignments

N/A

Extension Activities

N/A

Post Assessment

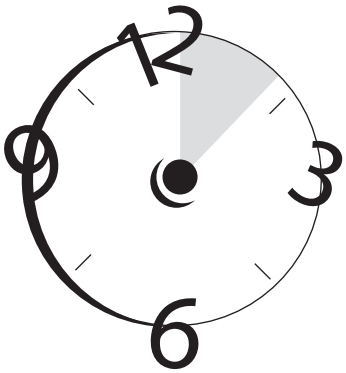
N/A

Debriefing and Reflection Opportunities (3 minutes)

Discuss when "one plus one is less than two." Invite students to answer the questions as to where the water went in the first demonstration. They should realize that it went in-between the sugar particles. Similarly, they should realize that the alcohol and salt substances went in between the water particles in the second and third demonstrations, respectively. They should come to realize there are spaces in-between the particles of substances, which can be filled by particles of other substances. This means that one and one can be less than two!

Physical and Chemical Changes

Parallel: Core
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

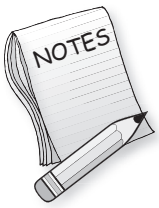
Students in this lesson will explore the different factors that affect the rate of physical and chemical changes. They will discover that temperature, surface area and concentration are three common factors that influence reactions between substances.

Guiding Questions

- What are some of the factors that influence the behavior of physical changes such as dissolving?
- What are some of the factors that influence the behavior of chemical changes such as the yellowing of newspaper?

BIG IDEA

What Factors Affect Rates of Reactions?



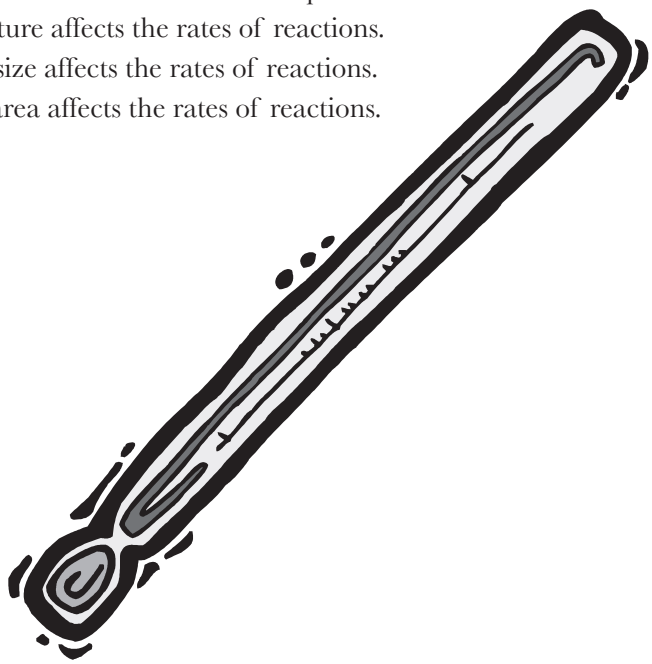
Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Some of the interactions between matter are predictable.
- Changing temperature affects the rates of reactions.
- Changing particle size affects the rates of reactions.
- Changing surface area affects the rates of reactions.



Concepts

- Chemical change
- Physical change
- Mixture
- Solution
- Solute
- Solvent
- Solubility
- Temperature
- Surface area
- Concentration
- Reaction rate

Teacher Information

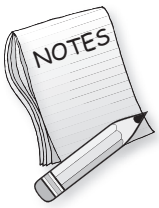
- Temperature increases the solubility of solids in liquids.
- Temperature decreases the solubility of gases in liquids.
- Making particle size of a solute smaller increases the speed of dissolution and vice versa.
- Increasing concentration increases reaction rates and visa versa.
- Students should plot the volume of solution 1 on the x-axis, as it is the independent variable in Experiment E and should plot time on the y-axis, as it is the dependent variable.

Skills

- Describe characteristics
- Analyze
- Compare and contrast
- Identify patterns

Materials and Resources

1. Two newspapers
2. Ice water
3. Room temperature water
4. Hot plate
5. Hot water (preferably boiling)
6. Kool-Aid or some other powdered drink mix
7. Bottles of soda with caps on (2 per group)
8. Bottle opener (preferably 1 per group)
9. Small balloon
10. Sugar cubes (8 per group)
11. Stirring rods or spoons (2 per group)
12. Spoon or something to smash sugar cubes
13. Light sticks (2 per group)
14. 100 ml graduated cylinders (1 for each group)
15. 150 ml beakers or glass containers (2 per group)
16. White paper (1 sheet per group)
17. Graph paper (1 sheet per group)
18. Clock or watch with a second hand
19. Solution 1 (120 ml for each group) is made with 4 g of potassium iodate (KIO3).
    - KIO3 is an oxidizer and considered hazardous. It can be purchased from *Frey Scientific*, P.O. Box 8101, Mansfield, Ohio 44901-8101, or ordered via the Web at www.freyscientific.com. The solid potassium iodate is item #15584268 (6mm) and costs $7.35 plus 8% shipping and handling. There is an additional charge for hazardous chemical of $15 for one - three chemicals and $24 for four or more chemicals. There is free shipping on Internet orders, excluding hazardous materials. Another option is to order a 1 molar solution of potassium iodate and then dilute it to make the required .02 Molar solution described below.



The Item # is 15579807 for 500 ml at $5.80 plus shipping and handling. It is not a hazardous material. 20. Solution 2 (90 ml for each group) is made with 4 g of soluble starch, 2 g of sodium metabisulfite (Na2S2O5) and 5 ml of sulfuric acid (1 Molar H2SO4).

- Soluble starch, sodium metabisulfite and sulfuric acid can be ordered from *Frey Scientific*. These are items # 15580371 (100 g $8.95) and #15580050, (100g, $5.45), respectively. Be careful to keep the sodium metabisulfite dry, as it is very hygroscopic.
- 1 Molar H2SO4 can be purchased from *Science Kit & Boreal Laboratories*, P.O. Box 5003, Tonawanda, NY 93403-5059, or online at www.sciencekit.com . The part is 97098-07 1 Liter at $9.00 plus about 10% shipping and handling and charges for hazardous material.

Preparation Activities

1. Make Solution 1 (.02 Molar KIO3) for Experiment E by taking 4.3 g of potassium iodate (KIO3) and filling it up to the 1-liter mark or using 200 ml of the potassium iodate solution and adding water to it until the total volume is 1000 ml, or one liter. This will be the same concentration as adding 4.3 grams of solid potassium iodate up to the one liter mark with water.
2. Make Solution 2 for Experiment E by first making a starch paste using 4 grams of soluble starch and dissolving it slowly in 900 ml of boiling water. Boil for several minutes and allow the solution to cool. Add enough additional water to bring the final volume up to 995 ml. **Just before Solution 2 is to be used**, add .2 grams of Na2S2O5 and 5 ml of 1 Molar sulfuric acid.
3. Copy lab, **Factors Affecting Rates of Reaction** for each student.
4. Copy handout, for **Questions for the Factors Affecting Rates of Reactions** for each student.

Introductory Activities (5 minutes)

- Take the two newspapers, one from the closet and one from the sunlit windowsill. Ask students whether the coloring change is a physical or chemical change. They should say chemical. Make them support their answer (e.g., because we cannot get the newspaper back to its original condition).
- Ask students why the one from the windowsill is yellow and the other is not? The students might say that the sunlight caused the newspaper to

"age." However, other personal experiences might tell them that color fades because of the sunlight such as fabric on furniture. Why does the newspaper that has been in the sunlight gain color instead? Kids may even say that the sun is yellow and the newspaper "sucks in the yellow color," which of course is incorrect but may seem logical to students.

- Query students about what the possible factors are that could influence this change. They should be able to list sunlight, moonlight, air and moisture.
- Question them about which factors are different for the two locations, in the closet and on the windowsill. They should realize that the only major difference in the two cases was the amount of sunlight. Because the sun alone generally causes fading, it must be reacting with something else to add color. The logical thing is the air and from within it, oxygen gas.
- Ask students if they think the newspaper would have turned yellow after a longer period of time. Ask them if they have seen old newspapers in their garages or attics. Students should answer, "Yes. The paper does turn yellow." Ask them what role sunlight actually has in this reaction (speeds up the reaction).
- Lead students to understand that sunlight helps oxygen to recombine with the paper bringing it back to its yellowish, original state. The original materials used to make paper are yellow and bleach is used in the paper making process to whiten paper by removing oxygen. The oxygen from the air reverses this process and brings paper back to it original yellow color while the sunlight speeds up this chemical reaction rate.
- Inform them they will be conducting several experiments in an effort to determine what other factors affect the rates of chemical reactions.

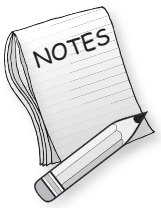
Pre-assessment

N/A

Teaching and Learning Activities (40 minutes)

1. Distribute and briefly review the instructions for **Factors Affecting Rates of Reaction.**

2. Distribute and briefly review the instructions for **Questions for the Factors Affecting Rates of Reactions.**



3. Pair students and instruct them to perform the lab.

4. Remind students that for homework they are to make a graph for Experiment E.

Products and Assignments
N/A

Extension Activities
N/A

Post Assessment
N/A

Debriefing and Reflection Opportunities
Debriefing will occur in Lesson 18.

Name _____Date _____

Factors Affecting Rates of Reactions

Experiment A:

1. Place 100 ml of cold water into a beaker with ice cubes.
2. Place 100 ml of room temperature water into a beaker.
3. Place 100 ml of boiling temperature water into a beaker.
4. Drops a pinch of drink powder into each of the three beakers at the same time.
5. Time how long it takes for each pinch of powder to completely diffuse (spread) thoroughly throughout the water.

Time for cold _____ Time for room temperature_____ Time for hot_____

Experiment B:

1. Place a bottle of soda with its cap on in an ice bath.
2. Place a second bottle of soda in a bath of hot water.
3. Let them sit for 2 minutes.
4. Remove the caps from both at the same time. Document your observations.

Observations:

Experiment C:

1. Smash four sugar cubes on a piece of paper.
2. Place four cubes of sugar into a glass half filled with water at the same time as you place the smashed cubes into a glass half filled with water.
3. Stir both and note the time it takes for all the sugar to dissolve in both situations.

Time for 4 cubes_____ Time for smashed sugar cubes_____

Experiment D:

1. Take two light sticks and place one in ice cold water and the other in hot water.
2. Observe.

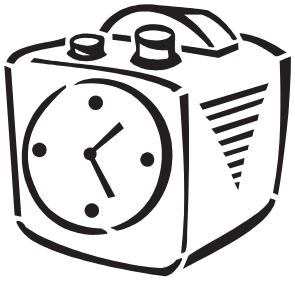
Observations:

REACTIONS AND INTERACTIONS

Name _____ Date _____

Experiment E

1. Take 120 ml of Solution 1 to your desk
2. Measure 60 ml of Solution 1 and place it in a separate container.
3. Add 10 ml of distilled water to Solution 1 to dilute it a bit.
4. Place 30 ml of Solution 2 on a piece of white paper. Pour the 70 ml of diluted solution into the container holding Solution 2.
5. Note the time it takes for the reaction to occur.



TIME_____

6. Clean and dry the containers.
7. Measure 40 ml Solution 1 and place it in the cleaned container.
8. Add 30 ml of distilled water to Solution 1, diluting it even more.
9. Place 30 ml of Solution 2 on a piece of white paper. Pour the 70 ml of diluted solution into the container holding Solution 2.
10. Note the time it takes for the reaction to occur.

TIME_____

11. Clean and dry the containers.
12. Measure 20 ml of Solution 1 and place it in a clean container.
13. Add 50 ml of distilled water to Solution 1 to dilute it still further.
14. Place 30 ml of Solution 2 on a piece of white paper. Pour the 70 ml of diluted solution into the container holding Solution 2.
15. Note the time it takes for the reaction to occur.

TIME_____

16. Clean and dry the containers.
17. Make a graph of the results for homework. One axis should be used to plot time and the other axis should be used to plot the volume of solution 1.

Name _____ Date _____

Questions for the Factors Affecting Rates of Reactions

1. Based on the results of Experiment A, what is the effect of temperature on the rate at which a solid dissolves?

2. Based on the results of Experiment B, what is the effect of temperature on the solubility of gases like carbon dioxide in liquids?

3. Sometimes on a hot summer day, large quantities of dead fish can be seen floating on the surface of the water in lakes and along ocean water edges. These are called "fish kills."

a) What gas, dissolved in water, is important for fish to be able to live?

b) Knowing what you do about the solubility of gases in liquids (#2 above) and that temperature has an effect on gas solubility, what do you think happens to the dissolved oxygen in lakes or oceans when the temperature gets very hot during the summer time? Do you think that it might affect the fish that live in these waters? If so, how do you think they are affected?

4. Using Experiment C as evidence, what is your conclusion about the relationship between a substance's ability to dissolve quickly and the size of its particles (amount of surface area)?

5. Explain what you think was happening in Experiment D that can account for the fact that the two light sticks behaved differently in the two water baths.

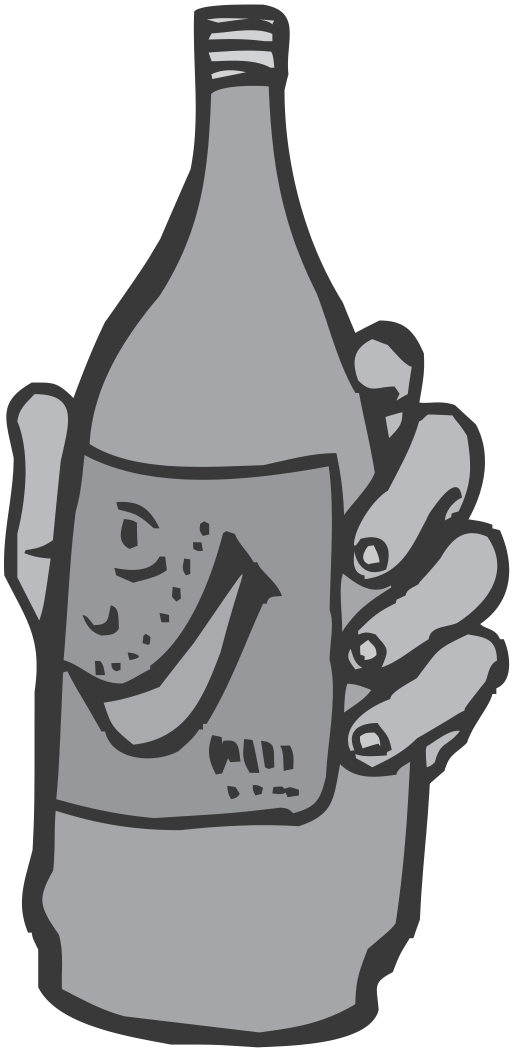
6. What was the total, final volume in all three parts of Experiment E?

7. Explain why Solution 1 was getting more and more diluted each time it was prepared for reaction with Solution 2. In other words, what was being done to make it less concentrated?

8. What happened to the reaction time between Solution 1 and Solution 2, as Solution 1 became less concentrated?

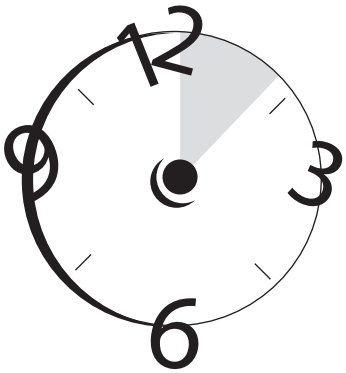
9. Complete the following sentence: As the concentration of a solution goes down, the reaction between it and another solution gets (faster or slower).

EXTRA CREDIT: We all know soda goes flat after it stands open for awhile and no matter how long we wait, the carbonation (fizz) will not return. How do you think soda gets the carbon dioxide in it in the first place at the soda manufacturing plants?



Physical and Chemical Changes

Parallel: Core
Time Allocation: 1 hour, 30 minutes
Required Materials and Resources on Page 230



Lesson Overview

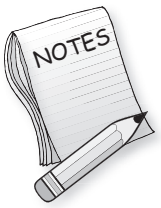
Using the results from various simple experiments as evidence, students will discover some of the factors that affect the rate of physical and chemical changes. They will conclude that temperature, surface area and concentration are three common factors that affect reactions between substances. They will discuss the importance of these factors in real world events and products, such as fish kills and carbonated beverages, respectively.

Guiding Questions

- Why should I care about the factors that affect the behavior of reactions?

BIG IDEA

What Factors Affect Rates of Reactions?



Content Goals

Universal Theme

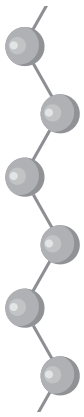
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

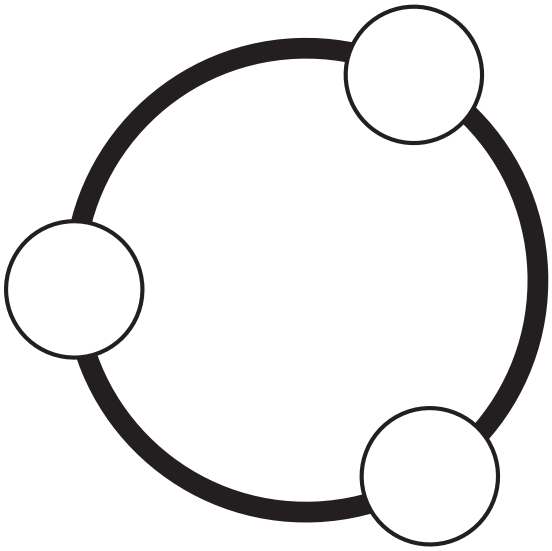
Principles and Generalizations

- Some of the interactions between matter are predictable.
- Changing temperature affects the rates of reactions.
- Changing particle size affects the rates of reactions.
- Changing surface area affects the rates of reactions.
- Changing concentration affects the rates of reactions.

Concepts

- Chemical change
- Mixture
- Solution
- Dissolve
- Solute
- Solvent
- Solubility
- Temperature
- Surface area
- Concentration
- Reaction rate





Teacher Information

- Temperature increases the solubility of solids in liquids.
- Temperature decreases the solubility of gases in liquids.
- Making particle size of a solute smaller increases the speed of dissolution.
- Increasing the surface area increases the rates of reactions and vice versa.
- Changing the concentration affects the rates of reactions.

Skills

- Describe characteristics
- Analyze
- Compare and contrast
- Identify patterns

Materials and Resources

1. Answers for the **Questions for the Factors Affecting Rates of Reactions** (included in this lesson)
2. *Starburst* candy (1 2.07 oz package per group)
3. Sample Answers for the ***Starburst* Surface Activity** (last page in this lesson)

Preparation Activities

1. Copy the ***Starburst* Surface Activity**.
2. Copy answers for the **Questions for the Factors Affecting Rates of Reactions**.
3. Copy **Sample Answers for the Starburst Surface Activity**.

Introductory Activities (5 minutes)

- Collect the students' graphs that they did for homework (Lesson 17) (Day 1).
- Distribute and review the lab activity, ***Starburst* Surface Activity** (Day 2).

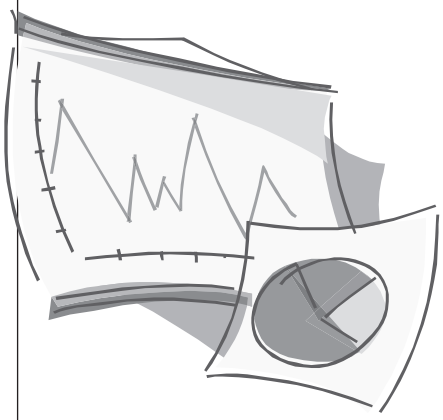
Pre-assessment

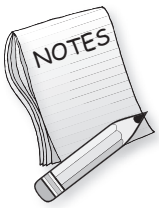
N/A

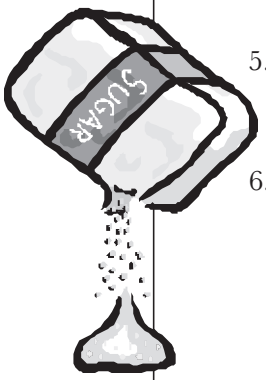
Teaching and Learning Activities (55 minutes)

1. Direct students to work with their partners on answering the **Questions for the Factors Affecting Rates of Reactions**. Each student should fill in answers on their own sheet (Day 1).

2. After you have circulated and are sure students are on task, take a few minutes to review the homework graphs to see if students' plots resulted in a linear relationship that indicated the lower the concentration the longer the reaction time (Day 1).







3. Review the graph results with students by using one of the student's graphs that is done well as an example for discussion. Ask students which variable was independent (volume of Solution 1, as it was under their control) and where it should be plotted (x-axis). Ask students what the dependent variable was (time, as it was not under their control) and where it should have been plotted (y-axis) (Day 1).

4. Explain to students that this is a convention that has been agreed upon by scientists so that communication of experimental results is more effective. Scientists have agreed upon locations for the variables being controlled and studied (Day 1).

5. Conduct a class discussion regarding the answers to the lab questions (Day 1).

6. When question #4 is reached, students probably will be quick to understand the idea that smaller particles will go into solution more quickly. Talk to them about the fact that we purposely had the same amount of sugar, as we smashed only four cubes. Talk about not having too many things vary at once (variables). Discuss the fact that we wanted to let the size of the particles change, and we had that as our independent variable to see if made a difference in the rate of solution dissolution. We found out that the rate depended on the size of the sugar particles. The smaller sugar particles dissolved faster than the larger cubes. Discuss the fact that if we had not kept the quantity of the sugar the same in both cases, we would not have been able to determine whether the rate of dissolving was being influenced by the size of the particles or the amount of sugar being dissolved (Day 1).

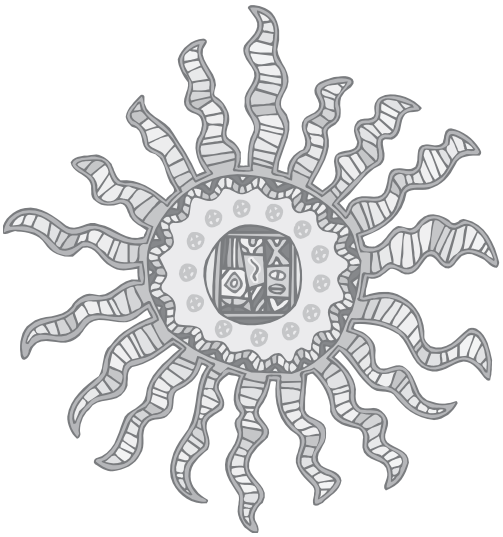
7. Continue with question #4 from the point of view that surface area of the sugar particles was changed when the cubes were broken into smaller pieces. This concept may be a bit more difficult for students to grasp (Day 1).

8. Tell students to complete the Starburst Surface Area activity below (Day 2).

9. Address the guiding question, "Why should we care about the factors that affect the behavior of reactions?" by first helping students realize that they

all conducted the same experiments and that all the interactions between the reactants produced the same results. Emphasize that there is nothing arbitrary in the way chemicals behave. As a result of this fact, tell them that scientists can use information gained through experimentation and analysis to predict how other physical and chemical changes behave. For instance, if your experiment tells you that carbon dioxide gas leaves soda at an increased rate if the temperature of the soda is increased, then you could use that information to predict that oxygen gas will leave lake and ocean waters at a faster rate on hot days than on cool days (Day 2).

10. Collect the Questions for the **Factors Affecting Rates of Reactions** from each student to ensure the work was completed (Day 2).



Products and Assignments

- Students' graphs
- Students' Questions for the **Factors Affecting Rates of Reactions**

Extension Activities

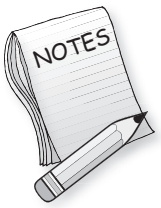
N/A

Post Assessment

N/A

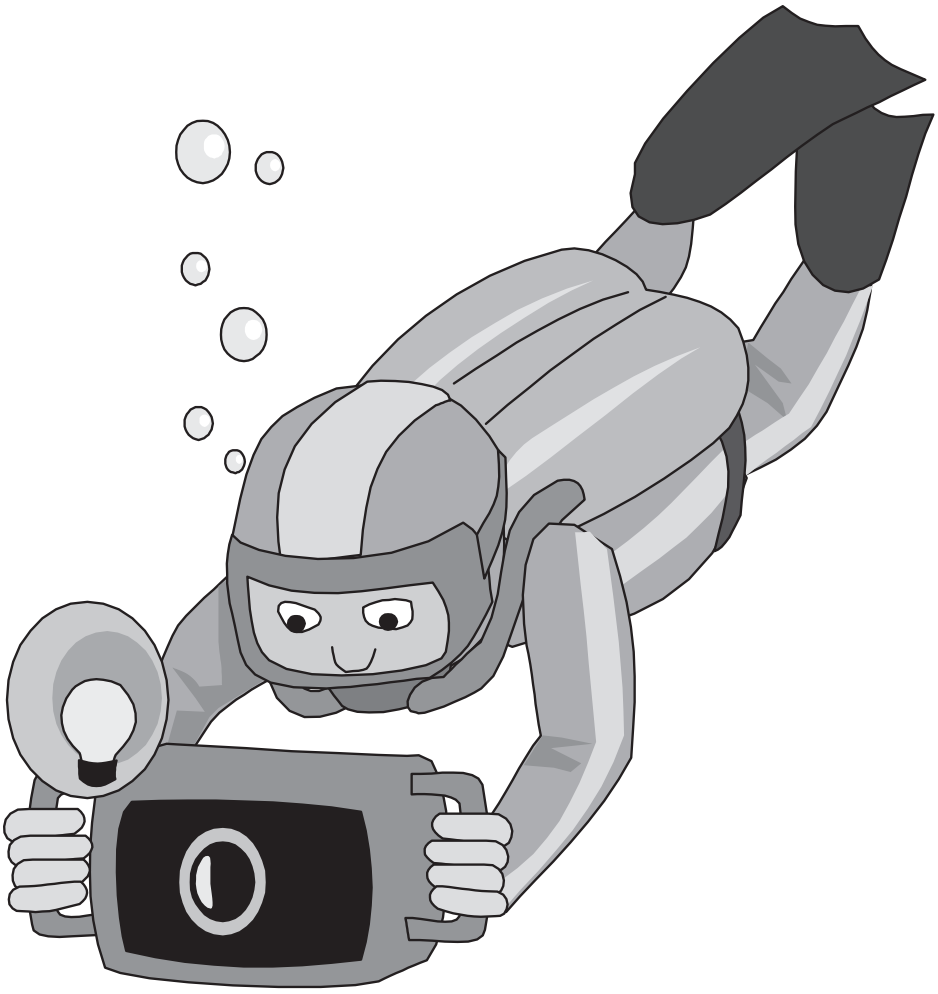
Debriefing and Reflection Opportunities (15 minutes)

1. Make sure a discussion of the implications of solubility occurs. In addition to the discussion of summertime fish kills in question #3, talk about the heated water that is pumped into the oceans by nuclear energy plants, such as the Millstone plant in Connecticut. Discuss the impact on the local fish of the heat plumes.
2. Explain the "bends," and introduce the idea that pressure is another factor that affects the solubility (an interaction) of gases in liquids. During a deep-sea dive the pressure gets higher the deeper a diver goes. The deeper the

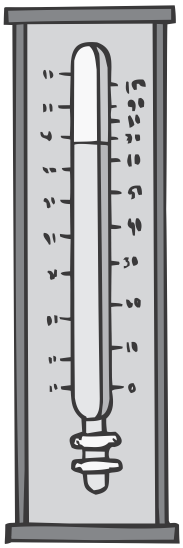


diver goes, the more the nitrogen from his or her breathing dissolves in the blood. The problem arises when the diver resurfaces and this dissolved gas rapidly expands, as the pressure drops and forms bubbles in the blood known as the bends.

3. Finally, the connection can be made to the extra credit question. Invite a student(s) to explain the answer and relate it to the preceding discussion of the bends and divers. (The answer is that the carbon dioxide in carbonated beverages is forced into solution using pressure, just as nitrogen is forced by water pressure into a person's blood, as he or she dives deeper and deeper.)



Answers to the Questions for the Factors Affecting Rates of Reactions



1. Based on the results of Experiment A, what is the effect of temperature on the rate at which a solid dissolves?

As the temperature increases, the rate at which a solid dissolves increases as well.

2. Based on the results of Experiment B, what is the effect of temperature on the solubility of gases like carbon dioxide in liquids?

The effect of temperature on the solubility of gases like carbon dioxide, in liquids is that as temperature increases, the solubility of a gas in the liquid goes down.

3. Sometimes on a hot summer day large quantities of dead fish can be seen floating on the surface of the water in lakes and along ocean water edges. These are called "fish kills."

a) What gas, dissolved in water, is important for fish to be able to live?

Oxygen is essential for fish to survive.

b) Knowing what you do about the solubility of gases in liquids (#2 above) and that temperature has an effect on gas solubility, what do you think happens to the dissolved oxygen in lakes or oceans when the temperature gets very hot during the summer time? Do you think that it might affect the fish that live in these waters? If so, how do you think they are affected?

The dissolved oxygen goes down. Yes, I think fish will die as a result of being deprived of oxygen, which they need to survive.

4. Using Experiment C as evidence, what is your conclusion about the relationship between a substance's ability to dissolve quickly and the size of its particles (amount of surface area)?

The smaller the size of the particles (more surface area) the more quickly substances will dissolve or react with one another.

5. Explain what you think was happening in Experiment D that can account for the fact that the two light sticks behaved differently in the two water baths.

The light stick in the hot water was brighter than the other light stick. The chemical reaction that is producing light inside the light stick must be going faster in the hot water than the cold water.

6. What was the total, final volume in all three parts of Experiment E?

The final volume was 100 ml.

7. Explain why the Solution 1 was getting more and more diluted each time it was prepared for reaction with Solution 2. In other words, what was being done to make it less concentrated?

We were adding more distilled water to less Solution 1, thus it was getting weaker (less and less concentrated).

8. What happened to the reaction time between Solution 1 and Solution 2 as Solution 1 became less concentrated?

It took longer to react.

9. Complete the following sentence: As the concentration of a solution goes down, the reaction between it and another solution gets (faster or slower).

EXTRA CREDIT: We all know soda goes flat after it stands open for awhile and no matter how long we wait, the carbonation (fizz) will not return. How do you think soda gets the carbon dioxide in it in the first place at the soda manufacturing plants?

It had to be forced in by pressure, which is why soda pops when you open it. Some of the pressurized gas comes out right as soon as you remove the cap.

Name _____ Date _____

Starburst Surface Activity

1. Take a pack of Starbursts and measure the length and width of each of the 6 surfaces. Record these measurements in centimeters below:

Length: ____cm X Width: ____cm = Surface area 1 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 2 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 4 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 5 = _____cm squared

Length: ____cm X Width: ____ cm = Surface area 6 = _____cm squared

2. Calculate the surface area of the whole pack by adding the six surface areas together = _____cm squared

3. Take one starburst out of the pack and measure the length and width of each of its 6 surfaces. Record these measurements in millimeters below:

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

Length: ____cm X Width: ____cm = Surface area 3 = _____cm squared

4. Calculate the surface area of the single Starburst by adding the 6 surface areas = _____cm squared

5. Calculate the surface area of the all 12 of the single *Starburst* candies by multiplying the surface area of one of them X 12, as shown in #4 above = _____ cm squared

6. Which has more surface area, the *Starburst* in a pack or as smaller pieces? _____

Sample Answers for the *Starburst* Surface Activity

1. Take a pack of *Starburst* and measure the length and width of all 6 sides of the pack. Record these measurements in millimeters below:

Length: __13__cm X Width: _2_cm = Surface area 1 = __26_____cm squared

Length: __13__cm X Width: _2_cm = Surface area 2 = __26_____cm squared

Length: __13__cm X Width: _2_cm = Surface area 3 = __26_____cm squared

Length: __13___ cm X Width: _2_cm = Surface area 4 = __26_____cm squared

Length: __ 2__cm X Width: _2_cm = Surface area 1 = ___4____cm squared

Length: __13__cm X Width: _2_cm = Surface area 1 = ___4_____cm squared

2. Calculate the surface area of the whole pack by adding the 6 surface areas = ____116____cm squared

3. Take one starburst out of the pack and measure the length and width of each of its 6 surfaces. Record these measurements in millimeters below:

Length: _2_cm X Width __2_cm = Surface area 1 = _____4___cm squared

Length: _2_cm X Width _2_cm = Surface area 2 = _____4___cm squared

Length: _1_cm X Width _2_cm = Surface area 3 = _____2___cm squared

Length: _1_cm X Width _2_cm = Surface area 4 = _____2___cm squared

Length: _1_cm X Width _2_cm = Surface area 5 = _____2___cm squared

Length: _1_cm X Width _2_cm = Surface area 6 = _____2___cm squared

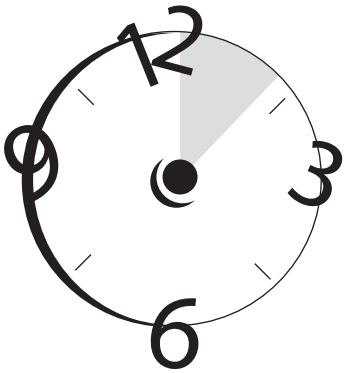
4. Calculate the surface area of the single *Starburst* by adding the 6 surface areas = __16_cm squared

5. Calculate the surface area of the all 12 of the single *Starbursts* candies by multiplying the surface area of one of them X 12, as shown in #4 above = __192__ cm squared

6. Which has more surface area, the *Starbursts* in a pack or as smaller pieces? __Smaller pieces____

Physical and Chemical Changes

Practice/Identity
Time Allocation: 1 hour, 50 minutes
Required Materials and Resources on Page 230



Lesson Overview

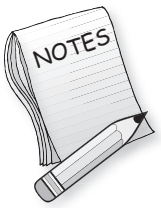
Students will perform some simple chemical tests on substances in order to experience the work that analytical chemists do for a living. After compiling results from various tests on different solid substances that have been mixed together, they will use the data from this work to test an unknown sample that has one or more of the substances mixed together. In addition, they will determine what some of the components are in certain household products. This experience will give them the opportunity to apply critical thinking skills in the exploration of substances they see in their daily lives. They will also have the chance to reflect on their reactions to doing the work of a chemist and consider if this career could be a possibility for them.

Guiding Questions

- How can I use analytical techniques to determine what might be found in common household products?
- What is it like to do work similar to the work of analytical chemists?
- Would I like to be a chemist?

BIG IDEA

Using Reactions to Predict Substance Identity.



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Some of the interactions between matter are predictable.
- Some interactions of matter form mixtures.
- Mixtures are examples of physical changes.
- Although substances may look the same physically, they can be distinguished by their reactivity with other substances.

Concepts

- Chemical change
- Mixture
- Reactant
- Product
- Acid
- Base
- Neutral
- Salt

Teacher Information

- Salts are made from acids and bases. Cream of tartar ($KC_2H_3(COOH)_2$) is a salt made from tartaric acid and potassium hydroxide (base). Tartaric acid is found in wines, and it can crystallize out on corks and walls of vessels as potassium bitartarate, (cream of tartar) also known as "winestone."
- Double acting baking powder is a base. It is made from sodium bicarbonate, cornstarch and other materials that produce acid when the baking powder comes in contact with water.

- Baking soda is a base. It is pure sodium bicarbonate.
- Vinegar is an acid made with acetic acid.
- When mixed, acids and bases form salts.
- Baking soda and vinegar react to form carbon dioxide and a salt.
- The commercial product, Fruit-Fresh® contains ascorbic acid – an antioxidant (a source of Vitamin C) and dextrose – a natural sugar.

Skills

- Plan procedures
- Collect data
- Analyze data
- Identify patterns
- Draw conclusions

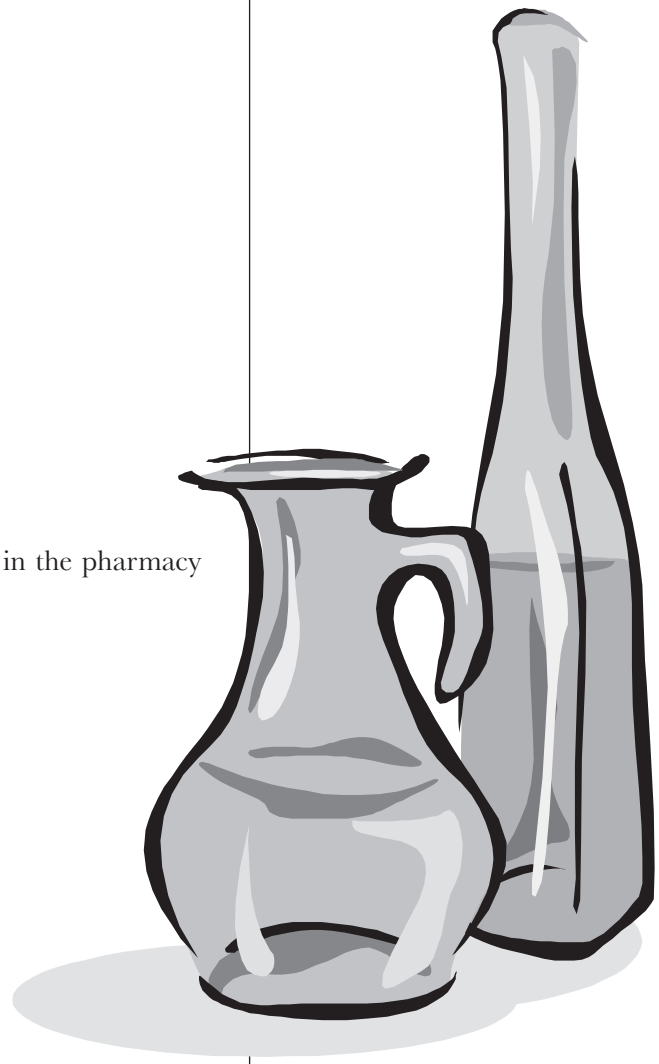
Materials and Resources

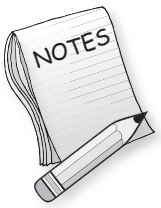
Day 1

1. Water
2. Baking soda (Powder 1 – a base)
3. Cornstarch (Powder 2 – a starch)
4. Cream of tartar (Powder 3 – a salt)
5. Teaspoon or 10 ml graduated cylinder (1 per group)
6. Stirring rods
7. Vinegar (household will work fine)
8. Tincture of iodine (can be purchased at a grocery store in the pharmacy section)
9. Plastic spoons
10. Plastic cups (3 per group)
11. Baggies® for unknown samples
12. Marker for labeling Baggies® (1 per group)

Day 2

1. Fruit-Fresh® powder
2. Pancake mix
3. Cake mix
4. Tooth powder
5. Antacid tablets





6. Baking powder
7. Talcum powder

Preparation Activities

1. Make up unknown samples of the powders by using one, two or three of the powders together. Prepare one sample per lab group). Label the samples and keep a record of the powders put in each of the unknown Baggies®.
2. Place the powders out on a table with plastic spoons that can be used to dispense the powders.
3. Copy the **Qualitative Analysis of Cooking Powders** lab for each student.
4. Copy the **Qualitative Analysis of Household Substances** lab for each student.
5. Correct all lab results before the second day of this lesson. Students will need to have accurate test results in order to analyze household substances on the second day of this lesson (Day 1).

Introductory Activities (5 minutes – Day 1 and 5 minutes – Day 2)

- Return the **Questions for the Factors Affecting Rates of Reaction Lab** to each student.
- Share with students that they will be practicing their qualitative analysis skills in efforts to determine the composition of some mixtures. Explain that qualitative analysis is an aspect of scientific work that requires scientists to use tests that they have devised that allow them to deduce what is present in a mixture of substances. Advise them that the emphasis is not on the measurement of things, quantitative analysis, but rather on the characteristics or qualities of substances that point to their uniqueness (Day 1).
- Distribute and review the **Qualitative Analysis of Cooking Powders** lab (Day 1).
- Return the students' work from the **Qualitative Analysis of Cooking Powder**s lab (Day 2).

Pre-assessment

N/A

Teaching and Learning Activities (20 minutes - Day 1, 40 minutes - Day 2)

1. Pair students and have them conduct the lab (Day 1).

2. Explain to them that they must show you their procedures for analyzing the unknowns. Tell them you will be checking for completeness, not the logic or accuracy of the plan. If there are problems with their plan, they will discover these as they proceed and learn by "trial and error," if necessary, just like real analytical chemists do (Day 1).

3. Debrief with students at the conclusion of the lab activity by putting their results on the board for the **Qualitative Analysis of Cooking Powders** in a Class Data Table similar to the one on the next page.

4. If there are any discrepancies, throw out the outliers and try to determine through discussion with the groups producing the errant data what might have caused a problem during their analysis work.

5. Collect the **Qualitative Analysis of Cooking Powders** lab (see Debriefing and Reflection Opportunities below) (Day 1).

6. Share with students that today they will have a chance to use these tests again on some household products to determine if the labels accurately reflect the contents (Day 2).

7. Instruct students to take samples of each of the household substances you have supplied and test them for the presence of baking soda, cornstarch and/or cream of tartar (Day 2).

8. Direct them to fill in the **Qualitative Analysis of Household Substances** table as they go along with their work (Day 2).

9. Remind them to use the test results from yesterday's work (Day 2).

10. Collect the **Qualitative Analysis of Household Substances** lab activity results (Day 2).

Class Data Table

	Vinegar Observations		Tincture of Iodine Observations		Baking Soda Observations	
Group 1	Powder 1		Powder 1		Powder 1	
	Powder 2		Powder 2		Powder 2	
	Powder 3		Powder 3		Powder 3	
Group 2	Powder 1		Powder 1		Powder 1	
	Powder 2		Powder 2		Powder 2	
	Powder 3		Powder 3		Powder 3	
Group 3	Powder 1		Powder 1		Powder 1	
	Powder 2		Powder 2		Powder 2	
	Powder 3		Powder 3		Powder 3	
Group 4	Powder 1		Powder 1		Powder 1	
	Powder 2		Powder 2		Powder 2	
	Powder 3		Powder 3		Powder 3	
Group 5	Powder 1		Powder 1		Powder 1	
	Powder 2		Powder 2		Powder 2	
	Powder 3		Powder 3		Powder 3	

Products and Assignments

- Students' **Qualitative Analysis of Cooking Powders** lab results (Day 1)
- Students' **Qualitative Analysis of Household Substances** lab results (Day 2)

Extension Activities

Survey students' parents to see if any of them work in a laboratory in which analyses of chemicals are conducted. Ask them if they would be willing to come to your class and share some of the aspects of their work experiences, including what factors influenced them to pursue the career they did.

Post Assessment

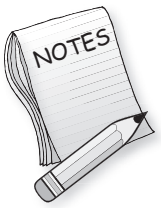
N/A

Debriefing and Reflection Opportunities
(40 minutes -- 20 minutes Day 1, 20 minutes Day 2)

Day 1

1. Tell the students the identity of each of the powders.
2. Go over what the test results should have been for the Qualitative Analysis of Cooking Powders lab.

TEST SUBSTANCE	RESULTS ON POW. #1	RESULTS ON POW. #2	RESULTS ON POW. #3
VINEGAR	Bubbles Chemical change Heat released	No change	No change
TINCTURE OF IODINE	No change	Powder turned dark brownish black	No change
BAKING SODA	No change	No change	No change



3. Tell them that the simple test for all starches including cornstarch is to use tincture of iodine, which turns brown. Explain that tincture of iodine is just a solution of iodine and alcohol (homogeneous mixture and thus alike throughout) and that the word 'tincture" means something that colors or dyes something else, in this case starch.
4. Inform them that cream of tartar is a type of salt different than table salt (sodium chloride) and that salts do not react with any of the test substances.
5. Make sure that students know that vinegar is acidic (sour tasting). Tell them that the Latin word for sour is "acidus" which is where our word for acid comes. It can be used to test for basic substances and in this case it reacted with baking soda that is a basic substance. Tell students that they can recognize this because bases often feel slippery.
6. Instruct students to put some baking soda in-between their fingers and moisten it and they should feel its slippery texture.
7. It is not important that students know exactly what acids or bases supply (hydrogen and hydroxide ions) but that students realize they are different (opposites so to speak) and that when they come together a reaction takes place.
8. Point out that when vinegar was added to the baking soda in cup 1, bubbles were seen (carbon dioxide), which is a sign of a chemical reaction.
9. Mention the fact that we have acids in our stomach, hence the expression "sour stomach."
10. Ask them if they have heard of "antacids."
11. Invite them to suggest what they think antacids do for people that take them. Without expecting students to understand the chemical differences between acids and bases, students probably know from experience that acids are involved in stomach indigestion problems and that people take antacids to counter their effects. They also probably have heard of the concept of bases as well through conversations if nothing else.
12. Query students, "What is the opposite of an acid that could counter (neutralize) it?" They should say "a base" and realize that antacids contain some sort of basic substance.
13. Inform students that one of the powders we tested today is found in many antacids. Ask them which one they think it is. They should be able to select baking soda because neither cornstarch nor cream of tartar reacted with the vinegar during the previous day's lab activity.

14. Share with students that tomorrow they will have a chance to use these tests again on some household products to determine if the labels accurately reflect the contents.

Day 2

1. Invite a couple of lab pairs to share their results on the household substances tests. Ask them if there were any products that did not list an ingredient on the label. Discuss the reasons why it is important that all ingredients be listed on product labels.
2. Explore with students how this science detective work was satisfying. Encourage them to think of some of their personal qualities that assisted them in doing the work. (Look for qualities such as curiosity, persistence, keen observation skills, skepticism, etc.) What personal qualities do they have that would help them in their work as a chemist?
3. Going further, ask students to think about how they would like to make a contribution to society in their future occupation. Do they feel that they could make a difference by being a chemist?
4. Invite them to reflect on these questions in their journals.
5. Make information available about the occupation of chemist for those students who seem especially interested. By going to the website for the Occupational Outlook Handbook (http://www.bls.gov/oco/ocos049.htm), they can find information about the nature of the work, job outlook, earnings, and training and other qualifications for the job.

REACTIONS AND INTERACTIONS

Name _____ Date _____

Qualitative Analysis of Cooking Powders

1. Look at the three powders. Can you tell them apart by appearance?

2. Fill three cups each full of water.
3. Put a 1/2 teaspoon (2-3 ml) of power 1 into each of three cups. Stir until the powder is dissolved completely.
4. Take 2-3 ml of vinegar and add it to the first cup that holds Powder 1.
5. Record the results for the interaction with Powder 1 in the table below. Include any evidence of a chemical change. **Remember to feel the glass for any heat change**.
6. Add a few drops of tincture of iodine to second cup. Record the results of this interaction with Powder 1 in the table below. Include any evidence of a chemical change.
7. Put a 1/2 teaspoon (2-3 ml) of baking soda into the last of the three cups.
8. Record the results for the interaction with Powder 1 in the table below. Include any evidence of a chemical change.
9. Empty and rinse the three cups.
10. Repeat steps 2-10 except in Step #3 use Powder 2. In other words add 1/2 teaspoon (2-3 ml) of Powder 2 to each of the three cups.
11. Repeat steps 2-10 except in Step #3 use Powder 3. In other words add 1/2 teaspoon (2-3 ml) of Powder 3 to each of the three cups.
12. Get a "powder unknown" and use the results below to help you determine what powder(s) are in your unknown sample.
13. Turn in this page in with the identity of the powder(s) for your unknown written below.

TEST SUBSTANCE	RESULTS ON POWDER #1	RESULTS ON POWDER #2	RESULTS ON POWDER #3
VINEGAR			
TINCTURE OF IODINE			
BAKING SODA			

UNKNOWN #_____

CONTENTS: _____

Name _____ Date _____

Qualitative Analysis of Household Substances

1. Take a small sample of each of the household substances that are in the front of the room.
2. Test each household substance for the presence of any of the three powders we tested for yesterday. They were baking soda, cornstarch and cream of tartar.
3. Fill in Table 1 with the test results by writing the substance found in the box next to the appropriate test substance. For instance, if the Fruit-Fresh® produces bubbles when the vinegar is added, then that is an indication that baking soda might be present in Fruit-Fresh®, as baking soda and vinegar produce carbon dioxide gas.
4. For every one of the three substances tested, use Table 2 to indicate what was found.
5. Read the label for each household product that you found contained one or more of the three test substances, baking soda, cream of tartar, and cornstarch.
6. If one of the test substances (baking soda, cornstarch, cream of tartar) was identified on the label of household product and was found to be present in your lab test in Table 2, place a check mark in the "Yes" box. If a substance identified to be present through the test results is not also listed on the label, place a check in the "No" box.

Table 1

TEST SUBSTANCE	Fruit-Fresh®	Baking Powder	Talcum Powder	Antacid	Pancake mix	Cake mix	Tooth Powder
VINEGAR							
TINCTURE OF IODINE							
BAKING SODA							

Name _____ Date _____

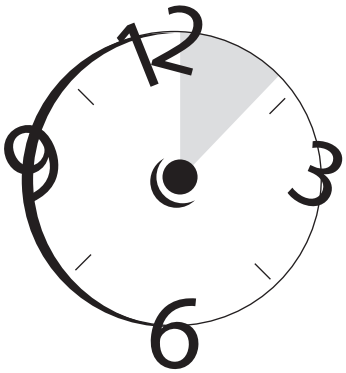
Qualitative Analysis of Household Substances

Table 2

Household Substance	Name of one of the Three Tests Ingredients Found	Was the Ingredient Found Via Testing Also Found on the Label?	
		Yes	No
Fruit-Fresh®			
Baking powder			
Talcum Powder			
Antacid			
Pancake Mix			
Cake Mix			
Tooth Powder			

Getting to Know and Appreciate the Elements and their "Families"

Core/Aid
Time Allocation: 45 minutes
Required Materials and Resources on Page 230



Lesson Overview

The lesson starts with a review of the previous day's lab results, in which the characteristics of chemical changes are emphasized one final time. The idea that products of a reaction can be analyzed and actually have physical and chemical properties distinctly independent of the properties of the reactants from which they were made, is also stressed. The purpose of this is to lead students into a discussion of the process of rearrangement that occurs during chemical reactions that produce new substances whose properties are not linked to those of the reactants.

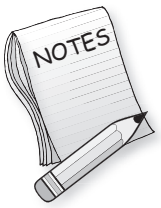
In order to understand the rearrangement process that occurs during chemical reactions, students must develop an understanding of what the chemical makeup is of substances themselves. Students will begin the process of understanding the building blocks of matter, elements and the resulting compounds they can produce.

Guiding Questions

- How do scientists learn about elements and their compounds?
- How can so many compounds be made from so few elements?

BIG IDEA

Elements and Compounds



Content Goals

Universal Themes

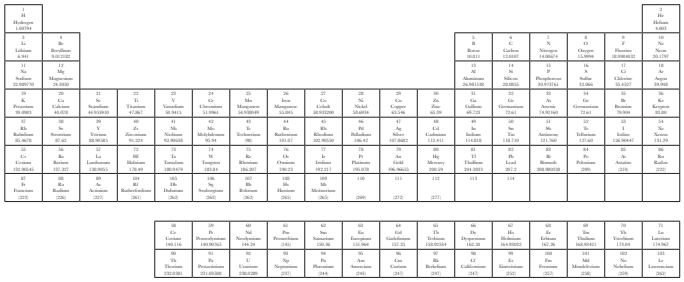
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characteristics of change.

Principles and Generalizations

- Matter is made of elements that can be by themselves or joined to form compounds.
- Although substances may look physically the same, they can be distinguished by their reactivity with other substances.
- Compounds are made from combining different elements in different arrangements.
- Many compounds can be produced from a much smaller number of basic kinds of materials, elements.
- Matter can be acidic, basic or neutral.

Concepts

- Reactant
- Product
- Acid
- Base
- Chemical properties
- Physical properties
- Chemical change
- Element
- Compound



Teacher Information

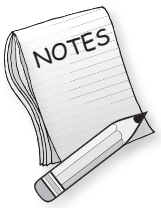
- Magnesium metal burns in air to form a white powder called magnesium oxide (MgO). When two pure elements form a compound, the product has entirely different physical properties than the reactants.

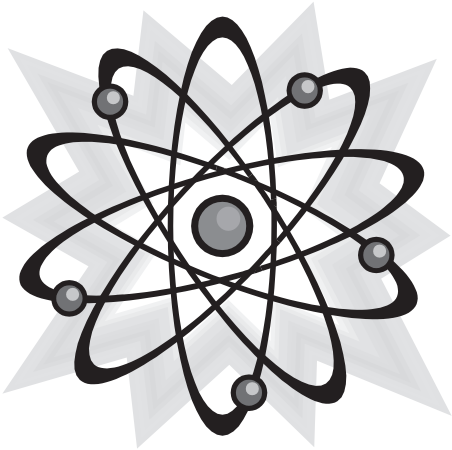
Skills

- Describe characteristics
- Analyze
- Compare and contrast
- Draw conclusions

Materials and Resources

1. Magnesium metal, metal tongs and ceramic wire gauze can be obtained from most high school science departments, or ordered from *Frey Scientific*, P.O. Box 8101, Mansfield, Ohio 44901-8101, or ordered via the Web at www.freyscientific.com. The items numbers are as follows: magnesium ribbon (hazardous material), # 15573162 at $10.35, stainless steel tongs, # 15574149, and ceramic gauze (6" x 6") #15584325, $9.75, plus an 8% shipping and handling fee. Additional charges of $15 for 1-3 hazardous chemicals and $24 for 4 or more hazardous chemicals are charged.
2. Matches
3. Use any of the following references for pictures of elements, compounds and the equipment used by previous generations of scientists as they went about their research into the nature of elements and compounds:
    - Challoner, J. (1996). *Eyewitness visual dictionaries: The visual dictionary of chemistry*. London: Dorling Kindersley (DK) Publishing.
    - Cooper, C. (2000). *Eyewitness books: Chemistry*. London: Dorling Kindersley (DK) Publishing.
    - Mewmark, A. (1993). *Eyewitness books: Chemistry. London:* Dorling Kindersley (DK) Publishing.
    - Sherwood, M. (Ed.). (1986). *Chemistry today*. Chicago: The World Book Encyclopedia of Science.
    - Stwertka, A. (1996). *A guide to the elements*. New York: Oxford University Press.
    - Newton, D. (1999). *Chemical elements from carbon to krypton*. Volumes 1 (A-F), 2 (G-O) and 3 (P-Z). Detroit, Michigan: UXL.
4. Use Internet sites, if needed, to assist students in their research on the elements such as:
    - http://www.esc20.net/etprojects/formats/webquests/misc99/elements/Default.htm
    - http://web.buddyproject.org/web017/web017/
5. Poster board or oak tag for element neck tags





6. Markers
7. Scissors
8. Glue
9. Rulers
10. Stencils

Preparation Activities

1. (Optional or you can have students do it as part of the Extension Activities below). Prepare a poster on the element carbon (Family IV), as an exemplar for the element project. Carbon is one of the most important compounds in living things. It will show students how to depict the information they gather during their research. The benchmark will serve as an excellent exemplar of the project format and the level of quality expected from students.
2. This poster could later be used again as an introduction to the exploration of plastics.
3. Note: This lesson can be stopped and continued the next day at any time. The length of class discussion will depend on the students involved.
4. Copy the Instructions for the Poster Project, **What's My Element's Story?** for each student.

Introductory Activities (15-20 minutes)

- Conduct a class review of the results from the **Qualitative Analysis of Household Substances Lab** activity. Have students from different groups contribute to a data table that has been put on the board similar to the one the students had to complete as part of the lab activity.
- Ask students whether the tests they used caused physical or chemical changes and to provide evidence for their choices.
- Ask students which substances appear to be basic in nature. Students will suggest that double acting baking powder is basic in nature, as it reacted with vinegar in a similar way to the baking soda (Powder 1 in the **Qualitative Analysis of Household Substances Lab**). The students should conclude that it contained sodium bicarbonate, which it does, as the label confirms this ingredient. In addition, the baking powder turned the tincture of iodine brown, indicating it contains starch, which is also confirmed by the label that lists cornstarch as an ingredient.
- Discuss the accuracy of labels from the students' point of view. Were the labels accurate, based on the results of their tests?

Getting to Know and Appreciate The Elements and their "Families"

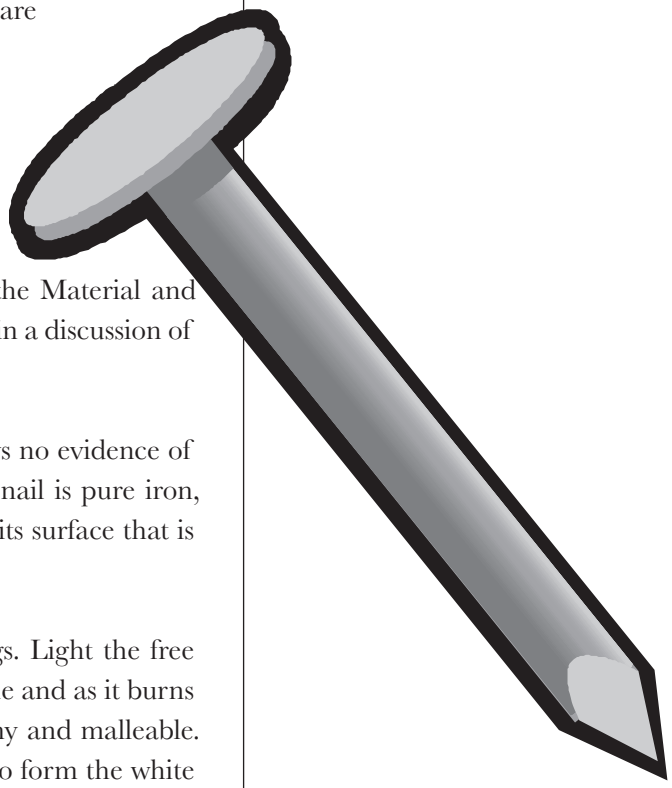
Pre-assessment

N/A

Teaching and Learning Activities (23–28 minutes)

1. Invite students to explain what they think is happening in all of these chemical reactions to the original reactants. They should recognize by now that there has to be some breaking apart of the original materials and a reorganization of parts, thus producing new substances with entirely different physical and chemical properties than the reactants possess. **SEARCHLIGHT**: Be aware of students who seem to have rich knowledge about chemistry and/or deeper insight into the concept being taught. See the extension activity for those students who seem ready and interested in further exploration of elements and/or organic chemistry.

2 Brainstorm with the class what they already know about elements addressing such questions as: What is an element? Where are they found? Why are they important? Are there different ones? How do you know? What are they made of? What are they good for?

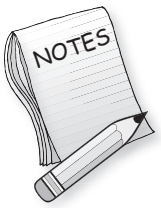


3. Ask students if they know what a compound is.

4. You can use some books (e.g., *Eyewitness Books*, listed in the Material and Resources section above) or video clips to engage students in a discussion of the nature and discovery of the elements.

5. Hold up an iron nail that has been sanded so that it shows no evidence of rust and a nail that is rusted. Tell students that the iron nail is pure iron, an element, and the other nail has a compound, rust, on its surface that is composed of two elements, iron and oxygen.

6. Take a strip of magnesium and hold it in a pair of tongs. Light the free end with a match. A white powder should drop to the table and as it burns discuss the fact that magnesium is an element that is shiny and malleable. It combines with another element in the air, oxygen gas, to form the white powder they see falling, which is magnesium oxide. Ask students how the

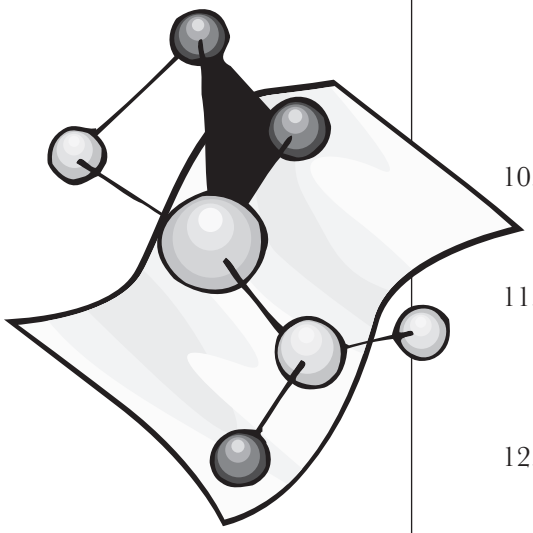


reactants and products are different physically (e.g., silver, flexible, metallic, versus white and powdery). Ask students if they think the product would burn like the original reactant can? They should recognize that they cannot predict the chemical properties (e.g., flammability) of a new product based on the chemical properties of the reactants.

7. Instruct students that they will be doing a research project for the purpose of "getting to know and appreciate the elements and their families."

8. Assign each student one of the following 24 elements (lithium sodium potassium (from Family I), beryllium, magnesium, calcium (from Family II), copper, silver and gold (from Transition Metals), boron, aluminum, gallium (from Family III), silicon, germanium (from Family IV), nitrogen, phosphorous, arsenic (from Family V), sulfur, selenium (from Family VI), fluorine, chlorine, bromine (from Family VII), helium, neon (from Family VIII). If you do not have 24 students, you can eliminate gold, arsenic or bromine in any order. If you have more than 24 students, you can add elements from each of these families. It is important for later activities that you assign at least two elements, preferably three, from each of the nine groups/families of elements, Families 1-8 and the Transition Metals.

9. Assign students who need a further challenge to research a second element, one of the three most important elements in living things: oxygen (from Family VI), hydrogen (characteristics of Family I and Family VII), or carbon (from family IV). If the teacher does not do the latter, then assign the element carbon as a benchmark poster (AID).



10. Apprise students that a poster presentation will be the assessment tool that is used to evaluate their understandings and research efforts.

11. Inform students they can start their posters at home and that they are due in four days (Lesson #26). They will have some class time in the next few days to work on the poster after they have gathered some of their research information.
12. Advise students that they can sign out some of the supplies they need to work on their posters, if necessary.

13. Distribute and review the instructions for the poster project, **My Element's Story**.

14. Circulate and go over the rubric for the poster project, **My Element's Story**.

15. Instruct students that for homework each student is to look up the symbol for his or her element and make a neck tag (oak tag or construction paper, with string and reinforcement tabs for the holes). It should be 8" by 8" in size and sturdy enough to be worn for several activities in future.

Products and Assignments

N/A

Extension Activities

Those students who have demonstrated exceptional ability to do independent research should do a second poster that focuses on the three most important elements to living things, carbon, oxygen and hydrogen. Tell these students that their research must include the element's role in living things and thus will include some aspect of organic chemistry (AID).

Post Assessment

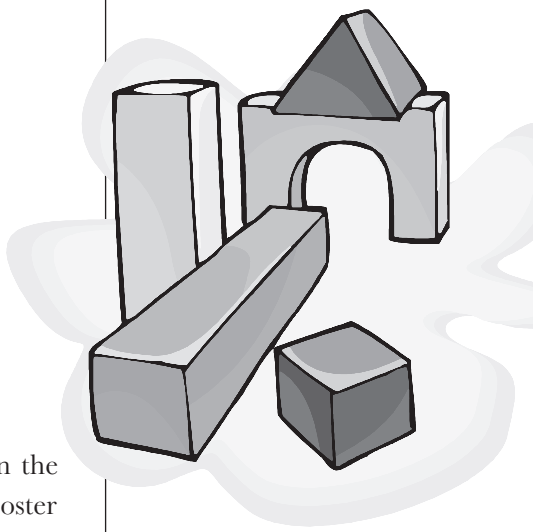
N/A

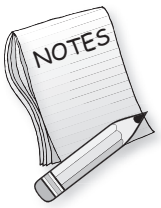
Debriefing and Reflection Opportunities (2 minutes)

Remind students that the building blocks of all matter are the elements, and that it is important to understand the physical and chemical properties of these elements, as they help explain why they form the compounds they do. Invite questions and comments from the class.

Instructions for the Poster Project, What's My Element's Story?

1. Each student will create a poster on poster board that is sized within the following dimensions: width range 15"-22"; length range 22"-25"; poster should depict the information gathered during research.
2. No free-hand writing will be permitted on the poster. The information must be **typed** or **written using stencils**.





3. The following information must be included on the poster:
   (a) The name and symbol of the element
   (b) 2-3 physical properties
   (c) 1-2 chemical properties
   (d) Discovery of the element (at minimum of 3 historical facts, who, when and where)
   (e) Occurrence in nature of the element
   (f) Extraction or production method
   (g) Use(s) and compounds of the element.
   (h) Health effects for animals or plants, if information is available.
4. The research notes will be turned in with the poster.
5. Pictures, drawings, diagrams or graphs should be included if possible as they add visual appeal and deepen understanding.
6. A bibliography of resources must be included using proper MLA format.
7. The poster will be assessed using a rubric that evaluates the quality of the content, the fact that all required components on the poster are included, thoroughness of research notes, neatness, visual appeal, spelling accuracy and a complete and correctly formatted bibliography.

Name _____ Date _____

Poster Rubric

Criteria	1	2	3	4	Your Score
Quality of Science Content	Information is cursory or incorrect. Little understanding of content is evident from presentation.	Some solid information presented; however, some information is incorrect or cursory.	Information is clear and correct throughout most of presentation.	Information is well presented, clear and correct throughout.	1 2 3 4
Criteria	Much of the required criteria required is missing or contains insufficient information.	Some of the criteria are missing, and the lack of sufficient research is evident in some of the required areas.	Although the eight criteria were addressed, they could have been addressed more thoroughly as a result of more extensive research.	All of the eight criteria were completely and thoroughly addressed.	1 2 3 4
Graphics	Images do not connect to text and/or are not relevant and do not deepen understanding of the "element's story."	Images are not always relevant and thus do not provide additional insight as to the "element's story." Text citations are not always present.	Images are mostly relevant and add to the understanding of the "element's story." Text citations are usually present and identify the images.	Images are relevant, and complement the text. Each image is cited in the text and identified. The number of images is appropriate, and they enhance the understanding of the "element's story."	1 2 3 4
Mechanics	Text contains many spelling/grammar errors. Sentences seem disconnected, and there is carelessness throughout.	Text contains some spelling/grammar errors. Little logical structure or flow to sentences. Evidence of carelessness in writing.	Grammar and spelling are nearly flawless. Logical sequence apparent. Some wording is careless with inconsistency in style.	Grammar and spelling are flawless and the flow provides a logical pathway of ideas. Consistent and engaging style is present throughout.	1 2 3 4

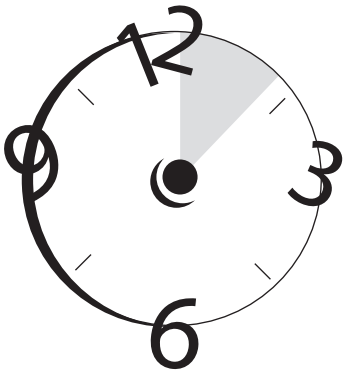
Criteria	1	2	3	4	Your Score
Following directions	Many of the directions, such as having correct poster size, keeping complete research notes, attaching research notes, avoiding handwriting on the poster, etc., were not followed and only some deadlines were met.	Many of the directions, such as having correct poster size, keeping complete research notes, attaching research notes, avoiding handwriting on the poster, etc., were not followed or deadlines were not met.	One or more of the directions, such as having correct poster size, keeping complete research notes, attaching research notes, avoiding hand-writing on the poster, etc., were not followed or deadlines were not met.	All of the directions, such as having correct poster size, keeping complete research notes, attaching research notes, avoiding hand-writing on the poster, etc. were followed, and deadlines were met.	1 2 3 4
Poster Design	The poster is either cluttered or too empty. There is no text/image balance. No attention is paid to variation in design.	Some parts of the poster are either cluttered or empty. Inconsistent attention is paid to sizing of graphics, placement of graphics and text, and text wrapping.	Most of the poster contains well-placed objects, with thoughtful text/image balance and logical text wrapping.	Objects and test on the poster are well placed and sized. Poster is not cluttered or too empty. Logical text wrapping is present.	1 2 3 4
Quality of Bibliography	The bibliography is incomplete and contains errors in format.	The bibliography is incomplete or contains errors in format.	The bibliography is complete but contains a few errors in format.	The bibliography is complete and contains no errors in format.	1 2 3 4

Getting to Know and Appreciate the Elements and their "Families"

Core/Aid

Time Allocation: 1 hour, 30 minutes

Required Materials and Resources on Page 230



Lesson Overview

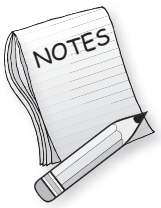
Students will investigate the nature, discovery, uses, impact and history of the elements. They will also research some of the compounds that can be made from their assigned elements. The research activity will culminate in a poster presentation.

Guiding Questions

- What is an element's story?
- Do elements have families, too?

BIG IDEA

Introduction to the Elements



Content Goals

Universal Themes

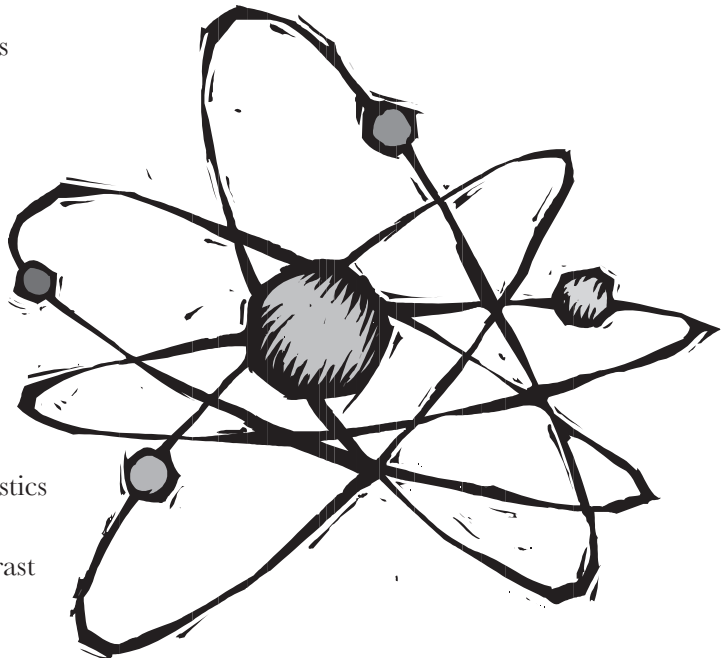
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.

Principles and Generalizations

- Matter is made of elements that can be by themselves or joined to form compounds.
- Compounds are made from combining different elements in different arrangements.
- Many products can be produced from a much smaller number of basic kinds of materials.
- Different elements have different physical and chemical properties.
- Different compounds have different physical and chemical properties.

Concepts

- Physical properties
- Chemical properties
- Chemical reactivity
- Product
- Reactant
- Element
- Compound



Teacher Information

N/A

Skills

- Describe characteristics
- Analyze
- Compare and contrast

Materials and Resources

1. Use any of the following references for pictures of elements, compounds and the equipment used by previous generations of scientists as they went about their research into the nature of elements and compounds:
    - Challoner, J. (1996). *Eyewitness visual dictionaries: The visual dictionary of chemistry*. London: Dorling Kindersley (DK) Publishing.
    - Cooper, C. (2000). *Eyewitness books: Chemistry*. London: Dorling Kindersley (DK) Publishing.
    - Mewmark, A. (1993). *Eyewitness books: Chemistry*. London: Dorling Kindersley (DK) Publishing.
    - Sherwood, M. (Ed.). (1986). *Chemistry today*. Chicago: The World Book Encyclopedia of Science.
    - Stwertka, A. (1996). *A guide to the elements*. New York: Oxford University Press.
    - Newton, D. (1999). *Chemical elements from carbon to krypton*. Volumes 1 (A-F), 2 (G-O) and 3 (P-Z). Detroit, Michigan: UXL.
2. Use Internet sites, if needed, to assist students in their research on the elements such as:
    - http://web.buddyproject.org/web017/web017/
    - http://www.theodoregray.com/PeriodicTable Click on the element "sodium" and then click on the words "sodium party" and browse through the pictures and videos accordingly.

Preparation Activities

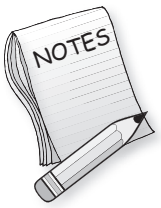
Gather resources for research on the properties of elements, their uses, history (discovery) and source(s).

Introductory Activities

Collect element name tags.

Pre-assessment

N/A



Teaching and Learning Activities (1 hour, 30 minutes)

1. Take the students to the library, computer lab etc. to begin the research process. (Day 1)

2. Students should finish the research on the elements and start their poster work. (Day 2)

3. Remind students to work on their posters at home. Tell students that they are due in two days. Tell students that they can sign out some of the supplies they need to work on their posters at home if necessary (Day 2).

4. Circulate and provide scaffolding when necessary.

Products and Assignments

Element name tags

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

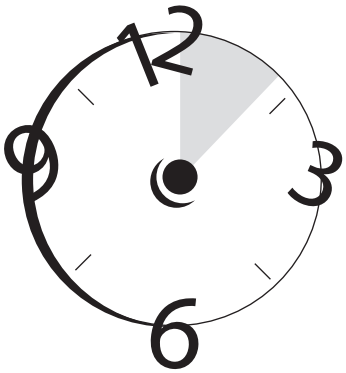
N/A

Getting to Know and Appreciate the Elements and their "Families"

Core

Time Allocation: 1 hour, 30 minutes

Required Materials and Resources on Page 230



Lesson Overview

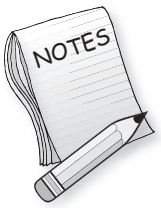
Students will discover that elements can be grouped based on some similarities in properties into "families." They will become familiar with the concept of periodicity of elements by participating in a kinesthetic activity. In addition, students will begin to understand the benefits of creating a periodic table, especially its use as a tool for prediction and explanation.

Guiding Questions

- How can so many compounds be made from so few elements?
- How do scientists learn about elements and their compounds?
- Why do scientists group elements based on their chemical properties?

BIG IDEA

Elements' Families and Periodicity



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.

Principles and Generalizations

- Matter is made of elements that can be by themselves or joined to form compounds.
- Tables can be used to organize large amounts of information and therefore make data more manageable.
- Different elements have different physical and chemical properties.
- Elements can be grouped by their chemical properties.
- Reactivity is an example of a chemical property of elements.
- Elements can be categorized into metals, non-metals and semi-metals.
- Groups of elements have similarities much like families.

Concepts

- Physical properties
- Chemical properties
- Chemical reactivity
- Product
- Reactant
- Element
- Compound
- Metal
- Non-metal
- Semi-metal
- Noble gas
- Reactive gas
- "Families" of elements
- Periodicity

Getting to Know and Appreciate The Elements and their "Families"

Teacher Information

- Most metals are ductile.
- Most metals have luster or shininess.
- Most metals conduct electricity.
- Most metals are heavy for their size (have a high density).
- Most metals are malleable, which means they can be hammered into sheets.
- Selenium exists in several allotropic forms (elements that exist in different structures and as a result have different physical and chemical properties).
- The word "period" as it is used in reference to the periodic table means a completion of a cycle.
- The word "periodicity" as it is used in reference to the periodic table means the quality of re-occurring.

Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Identify patterns
- Categorize

Materials and Resources

A large periodic table is needed as a graphic organizer for this lesson.

Preparation Activities

N/A

Introductory Activities

N/A

Pre-assessment

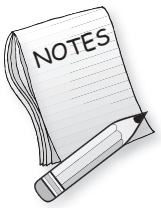
N/A

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorous 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Iron Manganese 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Ge Germanium 72.61	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.905985	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.96655	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.980038	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (265)	110 (269)	111 (272)	112 (277)	113	114				

58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (247)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

Teaching and Learning Activities (1 hour, 30 minutes)

1. Invite students to put on their oak tag signs around their neck (Day 1).



2. Put the students in small groups of elements that are from the same family or group on the periodic table, which means groups of three or four (see Lesson #22 for the families/groups). Do not tell the students how you are grouping them. They will discover this on their own (Day 1).

3. Instruct the student who researched hydrogen that he or she is to spend half his or her time in two groups (make sure he or she goes to the group of elements from Family I and Family VII).

4. In these groups students will discuss their research findings and derive a list of similar attributes that all their elements share (e.g., tin and lead are both solids at room temperature; tin and lead are found in ores) (Day 1).

5. As part of a class discussion, generate a list of similarities from each group of students and put them on the board under columns labeled Group 1, Group 2, etc., starting with the lithium, sodium and potassium group, thus mirroring the families in the periodic table.

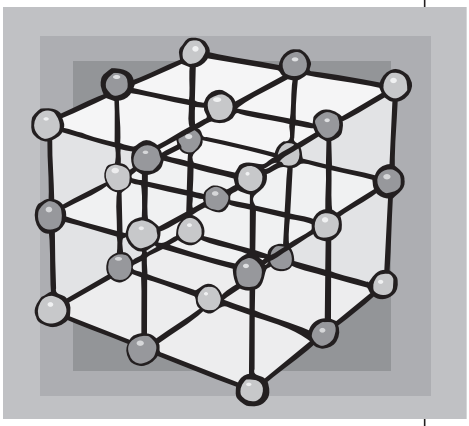
6. Bring up representatives from each of the major families and have each member of the group identify one or two major characteristics of that group (e.g., the alkali metals would say they react vigorously with water and are solid at room temperature) (Day 1).

7. Direct students to copy this information (Day 1).

8. Select two groups for comparison (e.g., Group 1 (alkali metals) lithium, sodium and potassium and another metal group, copper, gold and silver, and compare and contrast their characteristics, encouraging students to realize that there are more similarities within a group than between groups (Day 1).

9. Ask the students from Family I, "Why do you think you were put together as a Family I?" They should indicate that they have similar physical and/or chemical properties by giving examples of these properties (Day 1).

10. Question the students from the Transition Metals, "Why do you think you were put together as a group?" They should indicate that they have similar



physical and/or chemical properties by giving examples of these properties (Day 1).

11. Inform students that these groups are called "families" in the science field, except for a group of substances that have a special name, "Transition Metals" and that there are reasons for this distinction that they will learn about in later years, as they study the actual make-up/parts of the elements themselves. Tell these students to sit (Day 1).

12. Point out that the student groups were formed based on the fact that the members of each group have similar properties (Day 1).

13. Direct Family I, VII and hydrogen to come to the front of the room (Day 1).

14. Ask hydrogen to explain why he or she was called to the front of the room. That student should realize that he or she has properties of both families (Day 1).

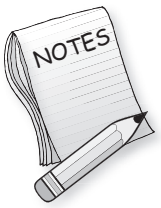
15. Instruct students to order themselves so that the heaviest element is facing the students seated in the class with lighter ones lined up behind them. Hydrogen can stand in between both families but farthest back, as he or she is the lightest member of either family (Day 1).

16. Show them a copy of the periodic table (Day 1).

17. Invite students to share what they think the periodic table does for scientists (a graphic organizer- a tool that organizes a large amount of information in a logical way that allows scientists to predict properties and reactions because of its organizational structure) (Day 1).

18. Point out the location of the eight groups or families and the Transition Metals (Day 1).

19. Continue to remind students that families have similar physical and chemical properties and this reality is reflected in the organizational structure of the periodic table (Day 1).



20. Ask the three students who researched lithium, sodium and potassium, "In Family I, what did you discover about your reactivity? Who is most reactive and who is the least?" (Potassium should answer that he or she is the most reactive and lithium should answer that he or she is the least reactive.) Ask, "In Family VII, who is most reactive and who is the least?" (Fluorine should know he or she is the most reactive element of the three and bromine should respond as being the least.) (Day 1).

21. Referring to the periodic table, while the students stand one in front of the other in their respective families in the front of the room, thus mirroring its structure, ask the class, "What is the trend in reactivity as you go down Family I?" (Day 1).

22. Students should realize that as you get larger and go down the family, reactivity goes up.

23. Ask students, "What is the trend in reactivity as you go down Family VII?" Students should recognize that as you get larger and go down the family, reactivity goes down (Day 1).

24. Inform students that the periodic table can be used to examine trends and then the trends can use used to predict the characteristics of the elements without looking up the specifics of the element. For instance, tell students if in fact the most reactive solid is found in Family I, which element would it be? Have one student volunteer come up to the periodic table and identify it. (Francium is the element at the bottom of Family I, as the trend dictated that the heavier the element, the more reactive it was (Day 1).

25. Ask students, "What is the least reactive element from Family VII?" Have one student volunteer come up to the periodic table and identify it. (Astatine should be identified as it again follows the trend for that family, reactivity falls as you go down Family VII, which is opposite to the trend seen in Family I.) (Day 1).

26. Have the class members carry out the following activities by moving to certain parts of the room depending on the characteristics of their respective elements. All students must be wearing their element nametags (Day 2).

Getting to Know and Appreciate The Elements and their "Families"

(a) Explain that all the elements that are solids at room temperature should go to the left side of the room. Record the results on the board. Instruct students to record this information in their science notebooks when they return to their seats.

(b) Inform students that whoever is a gas at room temperature should go to the right side of the room. Record the results on the board.

(c) Summon students to return to their seats, and instruct them to record this information in their science notebooks.

(d) Using the periodic table, show students that the solids are located on the left-hand side of the periodic table and the gases seem to be mostly found on the right-hand side of the table.

(e) Invite the class to describe a metal. Put their descriptors (e.g., solid at room temperature, shiny, malleable, ductile, conducts electricity) on the board. Record the results on the board.

(f) Instruct students to record this information in their science notebooks.

(g) Invite the class members who have most of the characteristics of a metal to stand on the left side of the front of the room in family groups lined one behind another (lithium, sodium, potassium (Family I), beryllium, magnesium and calcium (Family II), copper, silver and gold (from Transition Metals), aluminum and gallium (Family III) should come forward.

(h) Record the results on the board. Tell students to record this information in their science notebooks, making sure they describe this group as "metals."

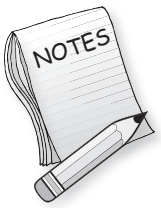
(i) Tell students that the names of Family I and II are called the "Alkali Metals" and the "Alkaline Earth Metals," respectively. Change the Group 1 and 2 names on the board to reflect these new identities.

(j) Instruct students to add this name above the group heading in their notebooks.

(k) Inform students that aluminum and gallium are from what is called the "Boron Family." Change Group 3's name to Boron Family.

(l) Tell students to add this name above the group heading in their notebooks.

(m) Direct the students that have characteristics of non-metals to go to the right side of the room (the members of families VII and VIII and carbon, nitrogen, phosphorous, oxygen and sulfur should move to the right).



(n) Note the results on the board. Tell students to record this information in their science notebooks, making sure they describe this group as "non-metals."

(o) Inform students that carbon heads Group 4 and the name of the family is referred to as the "Carbon Family." Change Group 4's name to Carbon Family.

(p) Instruct students to add this name above the group heading in their notebooks.

(q) Call upon any of the remaining elements that are unsure of their "identity" to stand in the middle of the room, even if they are from families that have elements that are sure of their metallic or non-metallic nature (boron, silicon, germanium, arsenic and selenium should come to the middle of the room.).

(r) Make sure that the students who are representing phosphorous and sulfur recognize that they have properties more like non-metals than metals. Point out that they have little luster, no malleability, and no ductility and do not conduct electricity or heat well. They should not be standing with these elements, metalloids, that have some of the properties of metals (e.g., metalloids conduct heat and electricity better than non-metals; germanium is used in transistors and silicon is used in solar cells; selenium and silicon can be shiny, depending on the allotropic form; selenium and silicon are semiconductors).

(s) Copy the results on the board. Remind students to record this information in their science notebooks.

(t) Inform students that this group is called the "metalloids" and they come from families III, IV and V.

(u) From the non-metal group, ask all the non-reactive gases at room temperature to step to the furthest right of the front of the room. This group will consist of helium and neon.

(v) Note the results on the board and have students record this information in their science notebooks.

(w) Point out to students that these two elements are from the same family. Describe this group as the "noble gases," (in some texts they are called "rare gases"). Tell students this is Group 8. Change the name of Group 8 on the board to "Noble Gases" and have students add this name above the group heading in their notebooks.

Getting to Know and Appreciate The Elements and their "Families"

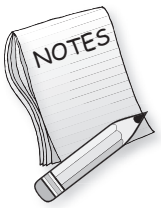
(x) Direct the remaining elements (hydrogen, oxygen, nitrogen, phosphorous, fluorine, chlorine and bromine) to separate into families based on similar properties and behaviors found during their research.

(y) Apprise students that through examination of other properties we find that fluorine, chlorine and bromine, a liquid at room temperature, are more closely related to each other than to other gases included in this larger group of non-metal gases at room temperature. Inform them that this group is called the "Halogen Family." Change the name of Group 7 on the board to "Halogen Family" and advise students to add this name above the group heading in their notebooks.

(z) Remind students that hydrogen reacts in ways that are similar to both families, and as a result, it is separated on the periodic table. Point this out on the table itself.

- Hydrogen has already been discussed as an element with a unique combination of Family I and Family VII, metal and non-metal families, yet as a gas, it does not fall into the "metalloid" group.
- Advise students that nitrogen heads group 5, and thus, this family, which included phosphorous, is called the "Nitrogen Family." Change the name of Group 5 on the board to "Nitrogen Family." Instruct them to add this name above the group heading in their notebooks.
- Share with students that oxygen heads group 6, and thus, this family, which includes sulfur, is called the "Oxygen Family." (In case students ask why some families do not have special names, you can tell them that they some do, but they are not commonly used in most textbooks (e.g., the oxygen family is also known as the "Chalcogen Family." The name comes from the Greek word *chalkos* meaning "ore." Both oxygen and sulfur are found in most ores). Change the name of Group 6 on the board to "Oxygen Family." Instruct students to add this name above the group heading in their notebooks.

27. Invite students to look at the elements from the point of view of state of matter at room temperature going across the periodic table. Ask them how things change? They should see that the elements go from active solids to inactive gases in each row (Day 2).



28. Point out that at the end of every row, we come back to a solid which starts the next row. We have a pattern here that is referred to as a period. The word "period" means a completion of a cycle. Tell students it is similar to using a "period" at the end of a sentence as it signals that another sentence is coming. In the periodic table the end of a row is a period because a new row or period will start (Day 2).

29. Inform students this periodicity, the quality of re-occurring, (which can be seen as you go down from one period to the next, you find an element similar to the one above it in the previous period) is the reason they call this table the "periodic table" (Day 2).

30. Discuss the fact that as we go through the table, going from heavy element to heavier element, the numbers 1-109 are used as the identifiers for each element. (It is not necessary to tell students at this time that this number represents the number of protons in the element's nucleus.)

Products and Assignments

Students' posters (Day 2)

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

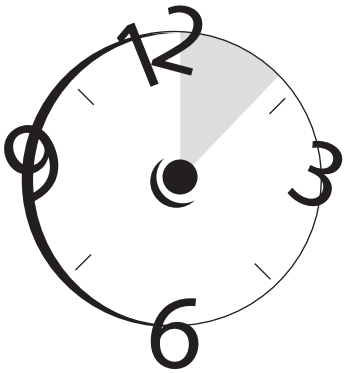
N/A

Getting to Know and Appreciate the Elements and their "Families"

Core

Time Allocation: 1 hour, 30 minutes

Required Materials and Resources on Page 230



Lesson Overview

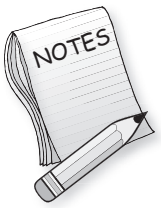
In this lesson students will explore the chemical reactivity of elements in order to deepen their understandings of the concept of periodicity. The intent of these reactions is to be able to determine if certain substances are more reactive than others are and whether they can be categorized based on their reactivity. Metals and nonmetals will be used to demonstrate the differences in their reactivity with basic substances like weak acids and air.

Guiding Question

- Can chemical reactivity of elements be used to differentiate groups of elements?

BIG IDEA

Elements' Reactivity and Families



Content Goals

Universal Themes

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Matter varies in its ability to chemically react with other matter.
- The nature of matter can be explored through scientific investigations.
- Different elements have different physical and chemical properties.
- Elements can be grouped together depending on their physical and chemical properties.
- Reactivity is an example of a chemical property of elements.
- Elements can be categorized into metals, non-metals and semi-metals.
- Elements vary in their chemical reactivity.

Concepts

- Chemical properties
- Chemical reactivity
- Element
- Compound
- Scientific investigation

Teacher Information

Carbon comes in various forms that have different structures or arrangement of the carbon atoms. Two of these are graphite and diamond.

Skills

- Identify characteristics
- Describe characteristics

Getting to Know and Appreciate The Elements and their "Families"

- Analyze
- Compare and contrast
- Identify patterns
- Categorize

Materials and Resources

1. Iron nail (make sure it is not a stainless steel nail)
2. Sandpaper (to shine up the nail before the experiment)
3. Penny
4. Graphite (break a pencil tip or buy some replacement sticks for a graphite pencil)
5. Vinegar

Preparation Activities

1. Gather materials for the lab.
2. Copy **Instructions for the Reactivity of Substances** Lab for all students.
3. Copy **Questions for the Reactivity of Substances Lab** for all students.

Introductory Activities (25 minutes)

- Distribute and review **Instructions for the Reactivity of Substances Lab**.
- Distribute and review the **Questions for the Reactivity of Substances Lab**.

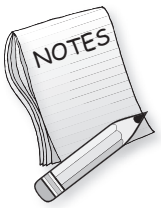
Pre-assessment

N/A

Teaching and Learning Activities (50 – 55 minutes)

1. Direct students to conduct the lab (Day1).

2. Advise students that there will be a class discussion the next day, as the lab materials must sit over night (Day 1).



3. Collect the posters. Have students put their posters around the room to provide opportunities for students to appreciate and learn from the work of others over time (Day 1). Organize the posters in families so that you end up with a partial periodic table of "element posters" (Day 1).

4. Have a student from each of the eight families review their posters (Day 1).

5. Examine some of the properties of elements within one family to show similarities within families (e.g., all of the elements from Family I react violently with water, whereas all of the elements of Family VIII are basically unreactive).

6. Examine the melting and boiling point of elements from Family I and VII in order to show differences between them (e.g., Family I have higher melting and boiling points than those of Family VII halogens do (Day 1).

7. Discuss the results of the experiment by bringing together two sets of lab groups to make foursomes. The groups of four will compare results and begin to answer the questions for the lab. Students need to recognize that it is important to compare results to ensure their validity. Circulate to each group assisting them with the analysis and conclusions based on the lab results (Day 2).

8. Have the larger groups of four put their agreed upon (individually revised if necessary) results on the board (Day 2).

9. Check to make sure that their results should show that three of the elements had high reactivity, copper, iron and silver, and carbon in its graphite and diamond forms is unreactive (Day 2).

10. Invite students to suggest what group they would put three of them in. Students should recognize these as metals. Therefore carbon is a non-metal (Day 2).

11. Ask students, "Why is the statement, all non-metals are non-reactive, incorrect?" They should realize that most non-metals are non-reactive with the exceptions of the halogen family that consists of reactive gases (Day 2).

12. Collect students' answers to the lab questions for the lab (Day 2).

Products and Assignments

- Students' posters (Day 1)
- Students' answers to the lab questions for the lab (Day 2).

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (10- 15 minutes)

1. Examine some of the properties of elements within one family to show similarities within families (e.g., all of the elements from Family I react violently with water, whereas all of the elements of Family VIII are basically unreactive).
2. Examine the melting and boiling point of elements from Family I and VII in order to show differences between them (e.g., Family I have higher melting and boiling points than those of Family VII halogens do) (Day 1).
3. Review the fact that elements as well as families of elements can vary in their chemical properties, such as reactivity (Day 2).

Instructions for Reactivity of Substances Lab

1. Each student will wear safety glasses throughout this lab.
2. Each group will go to the stations around the room and carry out the reactions as instructed at the site.
3. Each student will identify the states of matter included in the reaction and record and discuss his or her observations. Each station is equipped with a thermometer except for the match and soda stations.
4. Each student will think and discuss whether what he or she saw was a chemical or physical change and why.
5. The lab partners will discuss all the questions at the end of the lab sheet, and then each partner will answer the questions on his or her own lab sheet.

REACTIONS AND INTERACTIONS

Name _____ Date _____

DATA COLLECTION TABLE

Reactants	Observations/Experience	Evidence of a reaction? Y or N
1. Copper penny and vinegar (leave overnight)	Today: Next day:	Today: Next day:
2. Carbon graphite in vinegar (leave overnight)		
3. Iron nail in vinegar (leave overnight)	Today: Next day:	Today: Next day:
4. From your experience, what will happen to an iron nail that sits in air for an extended period of time?		

Name _____ Date _____

DATA COLLECTION TABLE

Reactants	Observations/Experience	Evidence of a reaction? Y or N
5. From your experience, what will happen to a piece of pencil tip (graphite, which is a form of carbon) that sits in air for an extended period of time?		
6. From your experience, what will happen to a diamond (which is another form of carbon) that sits in air for an extended period of time?		
7. From experience what happens when silver is exposed to air for an extended period of time?		

Name _____ Date _____

Questions for Reactivity of Substances Lab

1. Which substances react relatively with air and which do not?

2. Which substances reacted with vinegar easily and which did not?

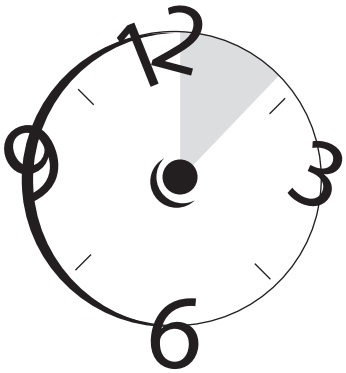
3. Based on the data above, put the four elements into two categories and give the categories names.

Getting to Know and Appreciate the Elements and their "Families"

Connections/AID

Time Allocation: 1 hour, 30 minutes

Required Materials and Resources on Page 230



Lesson Overview

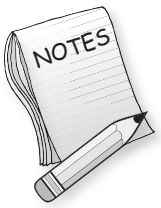
In this lesson, students will have an opportunity to take their understanding of an element and its family members and combine it with their perception of the characteristics of a hero. Using a creative story format, they will demonstrate their insight into seemingly disparate disciplines, science and language arts. AID opportunities allow students with exceptional creativity to present their story to another class, publish it in a local newspaper or create a visual representation of it.

Guiding Questions

Can my perception of heroes be used to convey my understandings of the nature of some element?

BIG IDEA

Element Heroes



Content Goals

Universal Theme

Models are tentative schemes or structures that correspond to real objects, events, or classes of events and that have explanatory power.

Principles and Generalizations

- Scientists communicate knowledge about matter in clear and varied ways.
- Matter is made of elements that can be used by themselves, or joined to form compounds.
- Compounds are made from combining different elements in different arrangements.
- Different elements have different physical and chemical properties.
- Different compounds have different physical and chemical properties.
- Groups of elements have similarities much like families.

Concepts

- Matter
- Element
- Compound
- Physical properties
- Chemical properties
- "Families" of elements

Teacher Information

- A tragic hero/heroine has the following characteristics:
    - o a position of authority
    - o a tragic flaw that leads to his/her demise
    - o a goal
    - o freedom to make choices
- A tragic hero/heroine is a sympathetic character.
- The audience must be able to see the tragic hero's/heroine's future before he or she does in a story that involves such a character.

Classic Tragic Hero

Getting to Know and Appreciate The Elements and their "Families"

Skills

- Describe characteristics
- Compare and contrast
- Write creatively
- Use analogies or metaphors
- (Optional) Use computer technology to enhance communication

Materials and Resources

- Resources on tragic and romantic heroes/heroines
- Access to computers if possible.

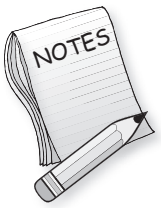
Preparation Activities

If possible, work with a teacher of literature who has taught about tragic and romantic heroes and heroines.

Introductory Activities (20 minutes)

- Share with students that they will be writing a story about an element that is a hero. In their creative stories, they will have to integrate the aspects of heroism and characteristics of tragic or romantic heroes/heroines with the facts they have learned about their particular element's "personality" and "family" (Day 1).
- Advise students to make sure to include characters (in addition to the hero/heroine), setting, and plot (Day 1).
- Inform students that their story should include a beginning, middle, and ending.
    - o The beginning establishes the setting, introduces the hero/heroine, and sets up the conflict. Remind them that a conflict is a problem or opposing force that must be confronted. Depending upon the type of hero/heroine, the hero/heroine either solves the conflict or the conflict overcomes the hero/heroine. Remember, without a conflict, there is no story.

    - o The body or middle of the story is the main section, and here the student should develop the conflict as well as the character of the hero/heroine. In this section the plot or action reaches it highest point, and we begin to see how the hero/heroine will



fare. The hero's/heroine's qualities will be reflected by his/her actions, as well as how he or she interacts with other characters.

o The ending or conclusion should explain the conflict's resolution one way or another and clarify how its resolution affected the hero/heroine and any other important characters.

- Ask students what makes someone a hero/heroine. They should talk about a person who is willing to sacrifice himself or herself for others or for a cause. A hero or heroine has to face various adversities (Day 1).
- Remind students about the two types of heroes/heroines, tragic and romantic. Give examples of both. Romeo in *Romeo and Juliet*, the Wizard in *Wizard of Oz* , Mufasa in *The Lion King*, and the Beast in *Beauty and the Beast* were tragic heroes, whereas the Spaniard in the *Gladiator* and Frodo Baggins in *Lord of the Rings* are romantic heroes. Ask them to explain the difference between a romantic and tragic hero (Day 1).

Pre-assessment

N/A

Teaching and Learning Activities

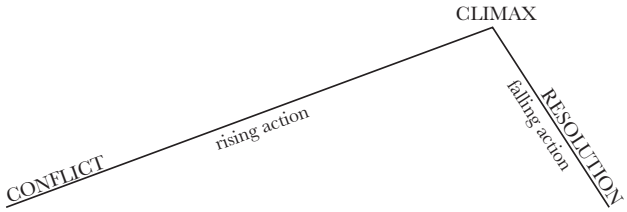
1. Distribute and review **Instructions for the Creative Story, Elements of Heroism** (Day 1).

2. Circulate and go over the **Rubric for the Creative Story about the Elements of Heroism** (Day 1).

3. Instruct students to begin writing their creative story, the **Elements of Heroism** (Day 1).

4. If computers are available, save and print out each student's work at the end of the day (Day 1).

5. Direct students to work on their creative stories for homework. They must complete at least one new paragraph (mark student papers as they leave the class) (Day 1).



6. Advise students to work in pairs, exchange their creative stories, and do some peer editing (Day 2).

7. Instruct students to finish their stories using the rest of the second day (Day 2).

8. Circulate from group to group assisting students in the editing process (Day 2).

9. Instruct students to write their final drafts of the creative stories for homework (Day 2).

10. Advise students to bring their stories home for homework. Have a parent read the story and work with them on editing and/or clarifying the story if necessary (Day 2).

Products and Assignments

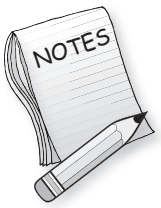
Collect and assess the creative story assignment, using the **Rubric for the Creative Story**, **Elements of Heroism**, and work with a teacher of literature to assess those categories that pertain to understandings aspects of romantic or tragic heroes, creativity, writing style and grammar. It will also be an assessment for the accuracy and thoroughness of its science content (Day 2).

Extension Activities

(AID) After assessing the stories, ask the students who demonstrated the deepest understanding of both the science and English content, and whose work exhibited exceptional creativity, elaboration, or connections to do one of the following:

- o (Option 1) Arrange for these students to go to another classroom (e.g., lower grade, a class that is studying creative writing, even at the high school level) and read their story.
- o (Option 2) Arrange for these students to have their stories published in a town or district newspaper.
- o (Option 3) For students who have artistic aptitude, tell them to create a visual representation of their story. Work with an art teacher to assist the students in conveying the overall heroic aspect of the story in their artwork. Again, find an authentic audience to display both the story and the art piece.

REACTIONS AND INTERACTIONS



Post Assessment

N/A

Debriefing and Reflection Opportunities

After assessing the students' work, ask permission to display the stories around the room, so that the rest of the class members have the benefit of reading each other's work.

Instructions for the Creative Story, Elements of Heroism

1. Using the properties, history, uses and source of an element that you researched, write a story in which the element is personified as either a tragic or romantic hero/heroine.

2. The story should be written from the element's point of view incorporating the chemical and historical aspects of the element as "he" or "she" proceeds through the adventure.

3. Remember to address the important aspects of heroism and its tragic or romantic aspects.

4. The story must be typed and be a minimum of two pages.

5. The story will be evaluated using the **Rubric for the Creative Story about Elements of Heroism.**

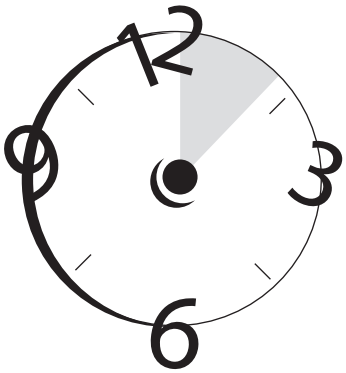
Name _____Date _____

Rubric for the Creative Story about the Elements of Heroism

Criteria	1	2	3	4	Your Score
Focus	The story addresses topic of tragic or romantic "hero elements," but loses focus by including irrelevant ideas.	The story is focused on topic and includes a few loosely related ideas.	The story is focused on the topic and includes relevant ideas.	The story is focused, purposeful and reflects clear insight and ideas.	1 2 3 4
Quality of Science Content	The science content is incomplete or contains misunderstandings or inaccuracies	The science content is briefly explained and contains some misunderstandings or inaccuracies	The science content is explained sufficiently, with little or no inaccuracies	The science content is complete, accurate and explained thoroughly. It is elaborated in such a way that conceptual understanding on the part of the reader is ensured	1 2 3 4
Understanding of Literature Content	Apparent misunderstanding of material on heroes	Limited understanding of material displayed by vague, unclear language or ideas	Fairly clear understanding of material as evidenced by adequate expression of ideas	Clear understanding of material displayed by clear, concrete language and complex ideas	1 2 3 4
Mechanics	Frequent errors in spelling, grammar and punctuation	Grammar or punctuation errors, but the spelling is accurate	Occasional grammatical errors and questionable word choice	Story is nearly error-free, which reflects clear understanding and thorough proofreading	1 2 3 4
Structural Organization	Story lacks logical progression of ideas.	Story includes brief skeleton (introduction, body, and conclusion) but lacks transitions.	Story includes logical progression of ideas aided by clear transitions.	Story is powerfully organized and fully developed.	1 2 3 4
Support	Few to no solid supporting ideas or evidence for the story content	Story lacks sufficient support details and is loosely developed.	Story includes some supporting ideas and/ or evidence for the story content.	Story includes developed details and provides superior support for the story content.	1 2 3 4

Getting to Know and Appreciate the Elements and their "Families"

Connections
Time Allocation: 3 hours
Required Materials and Resources on Page 230



Lesson Overview

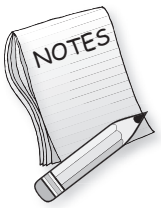
In addition to using the information previously gathered regarding the properties and behaviors of elements, students will have an opportunity to explore the historical and social contexts in which a particular scientific discovery or innovation occurred. Students will research and document some aspect of an element's history, either its discovery or its importance to society in terms of its uses. As a result of this activity, students will better understand that scientists and their discoveries are inexorably linked to the world in which they exist. Students will develop an appreciation for the process of scientific discovery that includes an understanding that scientific exploration does not occur in isolation.

Guiding Questions

- What is an element's story?
- How do scientists learn about elements and their compounds?
- Are scientific discoveries and innovations influenced by the historical and social context in which they occur?

BIG IDEA

Newspaper Front Page Elements



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- The natural world is composed of systems, which are organized groups of related objects that together form a whole.

Principles and Generalizations

- The study of matter, the subsequent technology and the social and historical context in which this study takes place are interdependent.
- Matter is made of elements.
- Different elements have different physical and chemical properties.
- Different compounds have different physical and chemical properties.
- Scientific discoveries and inventions have beneficial and detrimental consequences.

Concepts

- Element
- Compound
- Physical properties
- Chemical properties
- Commercial product
- Intended consequences
- Unintended consequences
- Social context
- Historical context

Teacher Information

- In the journalism field "copy" is the term used for the material that will be set up for printing.
- In the journalism field "by-line" is the second line under a newspaper article's title or main heading that includes the writer's name.

Getting to Know and Appreciate The Elements and their "Families"

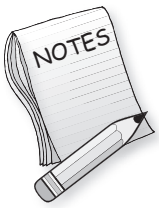
- Sodium tripolyphosphate ($Na_5P_3O_{10}$) is found in detergents.
- Sodium metaborate ($NaBO_2$) is used in herbicides

Skills

- Identify characteristics
- Compare and contrast
- See relationships
- Brainstorm
- Plan
- Organize
- Write
- Demonstrate originality
- (Optional) Use computer technology to enhance communication

Materials and Resources

1. Collect resources related to journalism (e.g., copies of different newspaper front pages, lists of terms used in the newspaper industry, such as "copy", "by-line", etc.) for students to use in their efforts to simulate the front page of a newspaper.
2. Collect resources on the elements/compounds that the students will be researching containing information about their discovery, history and uses. The following three volumes would supply all the initial information students would need about the uses of the element, especially the useful compounds it forms:
   - Newton, D. (1999). *Chemical elements from carbon to krypton*. Volumes 1 (A-F), 2 (G-O) and 3 (P-Z). Detroit, Michigan: UXL.
3. Stencils
4. Rulers
5. Magic markers
6. Scissors
7. White paper
8. (Optional) Computers
9. (Optional) Publishing software (e.g., Microsoft Publisher, Adobe PageMaker). If this software is not available, the articles can be typed using regular word processing software and made into columnar format.



Preparation Activities

1. Gather the information resources for the list of possible elements from which students can choose. These elements are ones the students have already researched. Include an important compound for each element in case students would rather write about the history of the compound's discovery or significant use (see list below). The list contains only a few examples of compounds and students can choose any compound that contains one of their elements but it cannot be a compound that was already discussed in class (e.g., magnesium hydroxide, iron oxide (rust), magnesium sulfate (milk of magnesia), acetic acid (vinegar), potassium bitartrate (cream of tartar), etc.). This list should help constrain the amount of informational resources you must provide for students (Day 1).
2. Make copies of **Tips for Journalistic Writing** handout.
3. Secure poster board for each student or have students purchase them ahead of time (Day 2).
4. Arrange for access to a computer laboratory (Day 2-4).
5. Create a template to be used by each group for a front page if computers are to be used. It should contain an area for the newspaper title and multiple columns into which students can insert the articles that have been typed using a word processing program.

Introductory Activities (25 minutes)

- (Optional) Advise students that they can use Internet sites below if needed in their research on their element/compound (Day 1-4):
  http://web.buddyproject.org/web017/web017/
  http://www.theodoregray.com/PeriodicTable Click on the element "sodium" and then click on the words "sodium party" and browse through the pictures and videos accordingly.
- Share with the students that they will be creating a newspaper front page in which they will feature a historical event associated with one of the elements, or its important compounds that was already researched by one of the group members (Day 1).
- In addition, inform students that they will have to do research and write about three other historical events that occurred during the same period of time as when their group's element or compound "made history" (Day 1).
- Advise students that they are to work on this project at home (e.g., research, typing, and stenciling) each of the next three nights (Day 1).

- Distribute examples of real newspaper front pages (Day 1).
- Briefly discuss the nature of journalistic writing (Day 1) and how it varies from creative and short story writing. Distribute **Tips for Journalistic Writing**.
- Discuss some of the vocabulary such as "copy," "by-line" and "editorial" (Day 1).
- Circulate and review Instructions for the Worthy "Elements" of News Project with students (Day 1).
- Distribute and review the Newspaper Front Page Self-Assessment Rubric and the Newspaper Front Page Teacher-Assessment Rubric (Day 1).
- Break the students into groups of two or three. Advise them that each student is to research and type at least one article. Instruct them that they will be asked to document their contributions to the project at a later time.
- Distribute the **Element and Compound List for Featured Article** sheet to the groups of students.
- Advise students to use the list to select an element or compound to use for the basis of the featured article and report this information to you. No two groups can feature the same element or compound.

Pre-assessment

N/A

Teaching and Learning Activities (155 minutes)

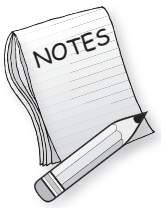
1. Distribute the resources to each group as appropriate to begin the research process.

2. Take students to the library to complete their research (Day 2).

3. If possible, have students use the computer lab to begin the writing process for their feature article (Day 2).

4. Instruct students to write and type on the computer one more article for homework.

5. Collect the two articles, review them, give students feedback regarding



the accuracy of the content and the grammar and have them make the edits (Days 2 and 3).

6. Direct students to work on writing and typing the rest of the articles (Days 2, 3 and 4).

7. If publishing software is available, have students import the articles into pages. If not, have students create columns in the word processing software by using tables without borders or shading.

8. Remind students to find appropriate graphics to use in their newspaper front page (Day 1).

9. Instruct students to create a title for their newspaper (Day 1).

10. Remind students to work on this project for homework and to make sure each member leaves each day knowing his/her responsibility for the evening's homework (Days 1, 2 & 3).

Products and Assignments

Students' poster projects

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

The students will view each other's work on a bulletin board display in the future.

Tips for Journalistic Writing

1. Use 3rd person point of view (avoid "you" or "I").

2. Determine which of the 5W's and 1 H (who, what, where, when, why and how) need to be included in the lead (which are essential).

3. Select the key thought and put it first; emphasize this thought in the first five or six words by using a few, colorful words that will spark the reader's interest.

4. Use the inverted pyramid style (key facts first, followed by the less important ones).

5. Limit a newspaper paragraph to one topic, or one aspect of a topic.

6. Keep paragraphs short. They make stories visually attractive due to narrow newspaper columns.

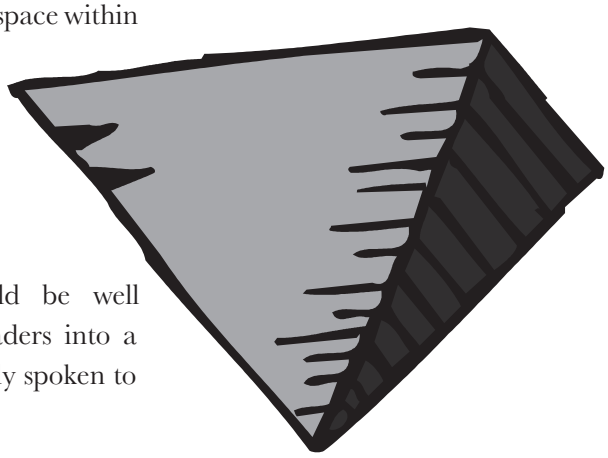
7. Make the appearance of a story more appealing by using white space within and around it.

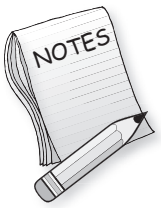
8. Limit paragraphs to 75 words.

9. Start paragraphs with significant words.

10. Enliven stories with direct quotations. Quotations should be well chosen and should enhance an article. Quotations draw readers into a story, and consequently, readers feel as if they are being directly spoken to (quotes typically are used in alternate paragraphs).

11. Do not add any kind of editorializing. Stick to the facts and avoid giving opinions.





Headline Do's

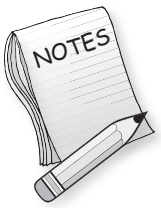
- Limit the number of words - 6 to 10, generally.
- Use a smaller point size as you work down the page (the most important stories are highest on the page, and have the largest headlines).
- Make sure the headline "touches" the byline, or first paragraph, of its article (don't put a photo between them).
- Give the most general, overall focus/summary of the story.
- Remember that the headline may be the only reason the reader decides to read the story.
- Avoid headlines that can have more than one interpretation.
- Use strong, active verbs. ("to be" verbs are generally understood, but not written out).
- Use present tense verbs.
- Express a complete thought. Headlines usually read like simple sentences.
- Use a secondary headline – or subhead – to convey an additional idea of a story.
- Substitute a comma for the word "and."
- Capitalize only the first word and proper nouns and adjectives.
- Write a headline that is grammatically correct. Make sure a headline has a subject and verb.

Headline Do Not's

- Mislead the reader about the content of the article.
- Avoid downplay, exaggeration and sensationalism.
- Use the name of the school unless it's absolutely necessary.
- Use the verbs "participate" or "experience."
- Use labels or phrases for headlines.
- Put a period at the end of a headline.
- Use names, unless very well recognized. Use grades or positions instead.
- Use abbreviations or slang.
- Trivialize a serious story with the inappropriate use of puns or other word play.
- Separate words that belong together in a phrase. (All words in infinitives and prepositional phrases should be on one line.)
- Capitalize every word or every important word.
- Use "a," "an" or "the."

Element and Compound List for Featured Article

1. Sodium (sodium hydroxide, sodium citrate, sodium nitrite)
2. Potassium (e.g., potassium nitrate)
3. Magnesium
4. Calcium (e.g., calcium chloride)
5. Copper
6. Silver (e.g., silver chloride)
7. Gold
8. Boron (e.g., sodium metaborate)
9. Aluminum (e.g., aluminum sulfate)
10. Gallium
11. Silicon (e.g., silicon dioxide)
12. Nitrogen (e.g., nitrous oxide, nitric oxide,
13. Phosphorous (e.g., sodium tripolyphosphate)
14. Arsenic
15. Sulfur (e.g., sulfuric acid, hydrogen sulfide)
16. Bromine (e.g., potassium bromide)
17. Fluorine (e.g., hydrogen fluoride)
18. Chlorine (e.g., potassium chloride)
19. Helium
20. Hydrogen (e.g., hydrogen peroxide, potassium hydroxide)



Name _____ Date_____

Instructions for the "Worthy Elements of News" Project

In an effort to provide you with a better understanding of the context in which science takes place, you will be researching the historical and social context of the discovery or significant use(s) of an element or a compound. Each group will create a newspaper front page with the featured story being about the discovery or importance of an element or compound. Students will use word processing or preferably publishing software, if available, to produce the articles for the newspaper front page. The general project requirements are as follows:

1. Each group of students will create a title for their newspaper and follow proper journalistic format for the items on a newspaper's front page, using the examples supplied by the teacher.
2. Each newspaper front page must contain a feature article about the element or compound. It must include information about its discovery **or** importance. The previous research done by one of your group members on an element may assist you with this feature article.
3. Each group will research **three other historical events** that occurred during the year of the element's or compound's discovery.
4. Each of the other **three non-science articles** must come from a different subject area, such as politics, economics, health, environment, sports, or entertainment. Each of these will be included on the front page of the newspaper.
5. Each student will be required to write a paragraph describing his contribution to the group project. Each member of the group must validate the other group members' contributions by signing the bottom of each other's paragraphs.

Specific Project Requirements are:

1. The newspaper itself must be titled in large print, so that the title covers a significant portion of the total front-page width, as it does in a real newspaper.
2. No free-hand writing will be permitted on the poster, including the title. The information must be **typed or written using stencils**.
3. The articles (**six** in total) will be laid out on poster board that is sized within the following dimensions: width range: 15”-22”; length range: 22”-25”.
4. There will be **four** columns to the newspaper and no more than _” between columns or between articles. The title of each of the articles must be bigger than the print used in the article itself.
5. The article fonts should be easy to read (e.g., Times Roman) and the size should vary, as it does in real newspapers but not be too small, so it is not too difficult to read.
6. The newspaper must contain three or four pictures.
7. Appropriate newspaper format, such as by-lines, is to be followed (use real newspapers as your model).
8. A typed bibliography is required.
9. The project is due _____.
10. Each student in the group must attach a Newspaper Front Page Self-Assessment Rubric to the back of the poster board.

Parent or Guardian’s Signature _____ Date _____

Name _____ Date _____

Newspaper Front Page Self-Assessment Rubric

Criteria	1	2	3	4	Your Score
Quality of Content in Featured Article	The science content of the featured science article is incomplete or contains misunderstandings or inaccuracies.	The science content of the featured science article is briefly explained, and contains some misunderstandings or inaccuracies.	The content of the featured science article addresses the scientific discovery or innovation in a thorough manner. The science content is explained sufficiently and with little or no inaccuracies.	The content of the featured science article is complete, accurate and explained thoroughly. It is elaborated in such a way that conceptual understanding on the part of the reader is ensured.	1 2 3 4
Quality of Content of Three Additional Articles	The content of the three other articles is incomplete, inaccurate or insignificant.	The content of the three other articles is either incomplete or has some inaccuracies.	The content of the three other articles is historically accurate and significant.	The content of the three other articles is historically accurate, thorough, interesting and significant.	1 2 3 4
Significance of the Featured Article	The article does not focus on a significant scientific event or innovation in history.	The significance of the scientific event or innovation in history is questionable.	The scientific event or innovation has historical significance.	The scientific event or innovation has great historical significance and the article is interesting to read.	1 2 3 4
Journalistic Quality of Articles	Articles are inappropriately informal and confusing to read. No attempt has been made to engage the reader with a good lead or a clear and logical presentation of facts or concepts.	Articles lack some necessary elements of a newspaper article: a good lead, clear presentation of facts, and/or an appropriately formal writing style.	Articles have good leads, logical and clear presentation of facts, and formal writing style.	Articles have good leads, logical and clear presentation of facts, and an appropriately formal writing style. Articles are interesting to read and hold reader's attention.	1 2 3 4
Graphics	Graphics do not clearly support or relate to the text.	Graphics sometimes support and/or relate to the text.	Graphics usually support and/or relate to the text.	Graphics consistently support and/or relate to the text.	1 2 3 4
Layout	Design is messy and unattractive. It does not make good use of available space. There is poor balance of text and graphics.	Design is inconsistent. Some parts are attractive and space-efficient, but other parts are not. Inconsistent or poor balance between text and graphics is evident.	Design is mostly attractive and space efficient. Good balance of text and graphics exists, for the most part.	Design is attractive and space-efficient. Excellent balance of text and graphics exists throughout.	1 2 3 4

Name _____ Date _____

Newspaper Front Page Self-Assessment Rubric

Criteria	1	2	3	4	Your Score
Mechanics	Text contains many spelling/grammar errors. Sentences seem disconnected, and there is carelessness throughout.	Text contains some spelling/grammar errors. There is little logical structure or flow to sentences, and evidence of carelessness in writing.	Grammar and spelling are nearly flawless. Logical sequence apparent. Some wording is careless and style is inconsistent.	Grammar and spelling are flawless and the flow provides a logical pathway of ideas. There is consistent and engaging style throughout.	1 2 3 4
Supplementary Features (e.g. graphs, letters, classified ads, print ads, etc.)	No supplementary features are included.	A few supplementary features are included.	Many supplementary features are included.	Many outstanding supplementary features are included.	1 2 3 4

Name _____ Date _____

Newspaper Front Page Self-Assessment Rubric

The first three criteria have a weighting factor of five. The last five criteria have a weighting factor of two. My final score is as follows:

Score for Item #1_____x 5 =

Item #2_____x 5 =

Item #3_____x 5 =

Item #4_____x 2 =

Item #5_____x 2 =

Item #6_____x 2 =

Item #7_____x 2 =

Item #8_____x 2 =

Total Score_____

Name _____ Date _____

Newspaper Front Page Teacher-Assessment Rubric

Criteria	1	2	3	4	Your Score
Quality of Content of Featured Article	The science content of the featured science article is incomplete or contains misunderstandings or inaccuracies.	The science content of the featured science article is briefly explained and contains some misunderstandings or inaccuracies.	The content of the featured science article addresses the scientific discovery or innovation in a thorough manner. The science content is explained sufficiently and with little or no inaccuracies.	The content of the featured science article is complete, accurate and explained thoroughly. It is elaborated in such a way that conceptual understanding on the part of the reader is ensured.	1 2 3 4
Quality of Content of Three Additional Articles	The content of the three other articles is incomplete, inaccurate or insignificant.	The content of the three other articles is either incomplete or has some inaccuracies.	The content of the three other articles was historically accurate and significant.	The content of the three other articles was historically accurate, thorough, interesting and significant.	1 2 3 4
Significance of the Featured Article	The article does not focus on a significant scientific event or innovation in history.	The significance of the scientific event or innovation in history is questionable.	The scientific event or innovation has historical significance.	The scientific event or innovation has great historical significance and the article is interesting to read.	1 2 3 4
Journalistic Quality of Articles	Articles are inappropriately informal and confusing to read. No attempt has been made to engage the reader with a good lead or a clear and logical presentation of facts or concepts.	Article lacks some necessary elements of a newspaper article: a good lead, clear presentation of facts, and/or an appropriately formal writing style.	Articles have good leads, logical and clear presentation of facts, and formal writing style.	Articles have good leads, logical and clear presentation of facts, and an appropriately formal writing style. Articles are interesting to read and hold reader's attention.	1 2 3 4
Graphics	Graphics do not clearly support or relate to the text.	Graphics sometimes support and/or relate to the text.	Graphics usually support and/or relate to the text.	Graphics consistently support and/or relate to the text.	1 2 3 4
Layout	Design is messy and unattractive. It does not make good use of available space. There is poor balance of text and graphics.	Design is inconsistent. Some parts are attractive and space-efficient, but other parts are not. Inconsistent or poor balance between text and graphics is evident.	Design is mostly attractive and space efficient. Good balance of text and graphics exists, for the most part.	Design is attractive and space-efficient. Excellent balance of text and graphics exists throughout.	1 2 3 4

REACTIONS AND INTERACTIONS

Name _____ Date _____

Newspaper Front Page Teacher-Assessment Rubric

Criteria	1	2	3	4	Your Score
Mechanics	Text contains many spelling/grammar errors. Sentences seem disconnected, and there is carelessness throughout.	Text contains some spelling/grammar errors. There is little logical structure or flow to sentences and evidence of carelessness in writing.	Grammar and spelling are nearly flawless. Logical sequence is apparent. Some wording is careless, and style is inconsistent.	Grammar and spelling are flawless and the flow provides a logical pathway of ideas. There is consistent and engaging style throughout.	1 2 3 4
Supplementary Features (e.g. graphs, letters, classified ads, print ads, etc.)	No supplementary features are included.	A few supplementary features are included.	Many supplementary features are included.	Many outstanding supplementary features are included.	1 2 3 4

Newspaper Front Page Teacher-Assessment Rubric

The first three criteria have a weighting factor of five. The last five criteria have a weighting factor of two. Your final score is as follows:

Score for Item #1_____x 5 =

Item #2_____x 5 =

Item #3_____x 5 =

Item #4_____x 2 =

Item #5_____x 2 =

Item #6_____x 2 =

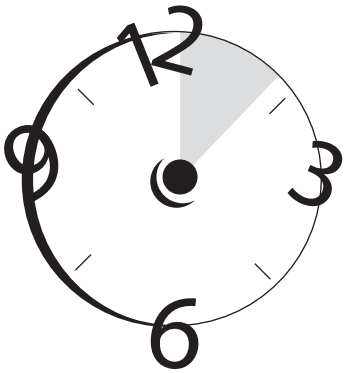
Item #7_____x 2 =

Item #8_____x 2 =

Total Score_____

Post Assessment

Core
Time Allocation: 50 minutes
Required Materials and Resources on Page 230



Lesson Overview

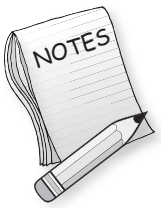
In this lesson students will take the final assessment. After the assessment is completed, students will hang their newspaper front page posters in the assigned areas.

Guiding Questions

- What did I learn about physical and chemical reactions and interactions?
- What did I learn about mixtures, elements and compounds?

BIG IDEA

What Did I Learn about Physical and Chemical Interactions?



Content Goals

Universal Themes

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- The interactions between matter cause physical or chemical changes.
- There are differences between physical and chemical changes.
- Matter is made of elements that can be by themselves or joined to form compounds.
- Compounds are made from combining different elements in different arrangements
- Matter has physical and chemical properties.
- Different elements have different physical and chemical properties.
- Different compounds have different physical and chemical properties.
- Groups of elements have similarities much like families.
- The study of matter, the subsequent technology and the social and historical context in which this study takes place are interdependent.

Concepts

- Matter
- Chemical change
- Physical change
- Mixture
- Solution
- Dissolving
- Physical properties
- Chemical properties
- Element

- Compound
- "Families" of elements
- Periodicity
- Interdependence of science, technology and society
- Environmental and social consequences

Teacher Information
N/A

Skills
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- See relationships
- Draw conclusions

Materials and Resources
Reactions and Interactions Unit Post Assessment.

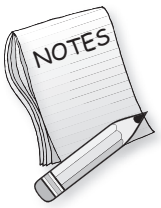
Preparation Activities
Copy **Reactions and Interactions Unit Post Assessment** for each student.

Introductory Activities
Explain to students that the final assessment will be used by you to measure their knowledge about this unit. Emphasize that they should make their best effort on the assessment.

Pre-assessment
N/A

Teaching and Learning Activities (50 minutes)
Distribute the **Reactions and Interactions Unit Post Assessment** to each student.

REACTIONS AND INTERACTIONS



Products and Assignments
Students' assessment results

Extension Activities
N/A

Post Assessment
Students' post assessments

Debriefing and Reflection Opportunities
N/A

Name _____ Date _____

Reactions and Interactions Unit Post Assessment

1. Describe two examples of chemical changes?

2. Identify one chemical change that is beneficial and indicate why or how it is beneficial.

3. Identify one chemical change that is detrimental and indicate why or how it is detrimental.

4.

A) What are some differences between chemical and physical changes?

B) When we see a change occur in our daily lives or in the environment why should we if care if it is physical or chemical?

5. Name two elements and two compounds and describe how they are useful to us.

Name _____ Date _____

6. Describe what happens when a solid dissolves in a liquid?

7. Why are environmental accidents that form mixtures generally easier to clean up than those that cause chemical changes like fires?

8. If you were given three containers each holding a blue solid powder, how would you go about determining if the containers held the same or different powders?

9. If you were told that a compound called pyrite was shiny and contained "gold specs," could you assume that it contains the element gold? Please explain your answer.

10. Why are science, technology and society interdependent?

11.

A) What do elements in a “family” have in common?

B) What is the advantage of grouping elements in a family on the periodic table?

12. Why do you think matter matters?

“Curriculum Map”

Author: Fie Budzinsky
Curriculum Map: Reactions and Interactions
Grade Level: 7-8

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
The interactions between matter cause physical or chemical changes.	Pre-assessment CORE 50 minutes	• There are differences between physical and chemical changes. • Matter is made of elements that can be by themselves or joined to form compounds. • Compounds are made from combining different elements in different arrangements. • Matter has physical and chemical properties. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties. • Groups of elements have similarities much like families. • The study of matter, the subsequent technology and the social and historical context in which this study takes place are interdependent.	• Matter • Chemical change • Physical change • Mixture • Solution • Dissolving • Physical properties • Chemical properties • Element • Compound • "Families" of elements • Periodicity • Interdependence of science, technology and society • Environmental and social consequences	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • See relationships • Draw conclusions	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• What do I know about physical and chemical reactions? • What do I know about mixtures, elements and compounds?
1. The interactions between matter cause physical or chemical changes.	Lesson 1 Core/AID 45 minutes	• There are differences between physical and chemical changes. • Chemical changes occur everywhere, all the time and between all states of matter. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Scientific discoveries and inventions may have both beneficial and detrimental consequences.	• Matter • Interaction • Reaction • Physical change • Mixture • Chemical change • Product • Temperature • Gas • Light • Environmental consequence	• Make observations • Identify characteristics • Describe characteristics • Analyze • Compare and contrast • See relationships • Draw conclusions • Draw • Create	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Why does matter matter? • What do you already know about chemical and physical changes? • Can you recognize a physical versus a chemical change? • What are some of the differences between physical and chemical changes? • Do chemical changes occur everywhere, all the time and between all states of matter? • What are some of the detrimental environmental consequences of chemical reactions?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
2. The interactions between matter cause physical or chemical changes.	CORE 45 minutes	• There are differences between physical and chemical changes. • Chemical and physical changes occur everywhere, all the time and between all states of matter. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Scientific discoveries and inventions may have both beneficial and detrimental consequences.	• Matter • Interaction • Reaction • Physical change • Mixture • Chemical change • Product • Temperature • Gas • Light • Environmental and social consequences	• Make observations • Identify characteristics • Describe characteristics • Analyze • Compare and contrast • See relationships • Draw conclusions • Draw • Create	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Can I recognize a physical versus a chemical change? • What are some of the differences between physical and chemical changes? • Do chemical changes occur everywhere, all the time and between all states of matter? • What are some of the detrimental environmental consequences of chemical reactions?
3. The interactions between matter cause physical or chemical changes.	CORE 45 minutes	• There are differences between physical and chemical changes. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Substances involved in a physical change can be reversed through physical means. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes.	• Matter • States of matter • Interaction • Reaction • Chemical reaction • Chemical change • Physical change • Mixture	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Identify patterns • Categorize	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
4. The interactions between matter cause physical or chemical changes.	CORE 45 minutes	• There are differences between physical and chemical changes. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Substances involved in a physical change can be reversed through physical means. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes.	• Matter • Interaction • Reaction • Chemical reaction • Chemical change • Physical change • Mixture	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Identify patterns • Categorize	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes?
5. The interactions between matter cause physical or chemical changes.	CORE 45 minutes	• There are differences between physical and chemical changes. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes. • Substances involved in a physical change can be reversed through physical means. • Mixtures are made up of different states of matter. • Mixtures can be divided into types. • Solutions are mixtures that contain substances that are dissolved.	• States of matter • Chemical reaction • Chemical change • Physical change • Mixture • Solution • Dissolve • Solute • Solvent	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Identify patterns • Categorize	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• How do I recognize the difference between those interactions between matter that can be reversed through physical means, physical changes, and those that produce new substances, chemical changes? • How are different types of mixtures part of my life? • What can cause mix-ups regarding mixtures?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
6. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE/ AID 45 minutes	• There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes.	• States of Matter • Chemical change • Physical change • Mixture • Reactant • Product • Heterogeneous • Saturation • Suspension (G & T) • Colloid (G & T) • Emulsion (G & T)	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • See relationships • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• How much did I learn about mixtures? • What does chemistry have to do with the ripening of fruit?
7. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE 45 minutes	• There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that have properties that are different than the original reactants.	• States of Matter • Chemical change • Physical change • Reactant • Product	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• What are some of the characteristics of chemical changes?
8 & 9. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE/ AID 1 hour, 30 minutes	• There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.	• States of Matter • Chemical change • Physical change • Reactant • Product • Rearrangement of reactant structures	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• What are some of the characteristics of chemical changes?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
10. 11. & 12. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE/ AID 2 hours, 15 minutes Core/AID	• There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that can be identified and have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production.	• States of Matter • Chemical change • Physical change • Reactant • Product • Temperature change • Light production • Color change • Rearrangement of reactant structures	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Categorize • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• What are some of the characteristics of chemical changes? • Do chemical and physical changes occur everywhere, all the time and between all types and states of matter? • How can so many different substances come from so few ingredients? (AID)
13. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE 45 minutes	• Chemical change produces new substances that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures.	• Chemical change • Physical properties • Chemical properties • Reactant • Product • Rearrangement of reactant structures	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Do the physical and chemical properties of reactants have anything to do with the physical and chemical properties of the products of a chemical reaction?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
14. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE 45 minutes	• There are differences between physical and chemical changes. • Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas or light production. • Some interactions of matter form mixtures. • Mixtures are examples of physical changes. • Mixtures are made up of different states of matter. • Solutions are mixtures that contain substances that are dissolved.	• States of Matter • Chemical change • Physical change • Mixture • Solution • Solute • Solvent • Reactant • Product • Temperature change • Color change • Rearrangement of reactant structures	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Categorize • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Can I recognize physical and chemical changes in my life? • Can I recognize the different characteristic of physical and chemical changes?
15. Chemical and physical changes occur everywhere, all the time and between all types and states of matter.	CORE 45 minutes	• Chemical changes produce solids, liquids and/or gases. • Chemical change produces new substances that have properties that are different than the original reactants. • Chemical changes involve a rearrangement of reactant structures. • Chemical changes have certain attributes such as producing new substances, temperature changes, and gas and light production. • There are differences between chemical and physical changes • Some interactions of matter form mixtures. • Mixtures are examples of physical changes. • Mixtures are made up of different states of matter. • Solutions are mixtures that contain substances that are dissolved.	• States of Matter • Chemical change • Physical change • Mixture • Solution • Solute • Solvent • Reactant • Product • Temperature change • Color change • Rearrangement of reactant structures	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Categorize • Explain • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Do I recognize physical and chemical changes in my life? • Do I recognize the different characteristic of physical and chemical changes?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
16. Most matter in nature is found mixed with other matter.	CORE 45 minutes	• Solutions are mixtures that contain substances that are dissolved. • Mixtures are made up of different states of matter • When a substance dissolves in another substance, its particles go in-between the other's particles.	• Physical change • Mixture • Solution • Dissolve • Solute • Solvent	• Describe characteristics • Analyze • Compare and contrast	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes • Properties of some objects and processes are characterized by change.	• What happens when solutions form? • Why does one plus one, not add up to two when talking about solutions?
17. Some of the interactions between matter are predictable.	CORE 45 minutes	• Changing temperature affects the rates of reactions • Changing particle size affects the rates of reactions. • Changing surface area affects the rates of reactions.	• Chemical change • Physical change • Mixture • Solution • Solute • Solvent • Solubility • Temperature • Surface area • Concentration • Reaction rate	• Describe characteristics • Analyze • Compare and contrast • Identify patterns	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes • Properties of some objects and processes are characterized by change.	• What are some of the factors that influence physical changes such as dissolving? • What are some of the factors that influence chemical changes such as the yellowing of newspaper?
18. & 19. Some of the interactions between matter are predictable.	CORE 1 hour, 30 minutes	• Changing temperature affects the rates of reactions • Changing particle size affects the rates of reactions. • Changing surface area affects the rates of reactions. • Changing concentration affects the rates of reactions.	• Chemical change • Mixture • Solution • Dissolve • Solute • Solvent • Solubility • Temperature • Surface area • Concentration • Reaction rate	• Describe characteristics • Analyze • Compare and contrast • Identify patterns	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Why should I care about the factors that affect the behavior of reactions?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
20. & 21. Some of the interactions between matter are predictable.	PRACTICE/ IDENTITY 1 hour, 50 minutes	• Some interactions of matter form mixtures. • Mixtures are examples of physical changes. • Although substances may look the same physically, they can be distinguished by their reactivity with other substances.	• Chemical change • Mixture • Reactant • Product • Acid • Base • Neutral • Salt	• Plan procedures • Collect data • Analyze data • Identify patterns • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• How can I use analytical techniques to determine what might be found in common household products? • What is it like to do work similar to the work of analytical chemists? • Would I like to be a chemist?
22. Matter is made of elements that can be by themselves or joined to form compounds.	CORE/AID 45 minutes	• Although substances may look physically the same, they can be distinguished by their reactivity with other substances. • Compounds are made from combining different elements in different arrangements. • Many products can be produced from a much smaller number of basic kinds of materials, elements. • Matter can be acidic, basic or neutral.	• Reactant • Product • Acid • Base • Chemical properties • Physical properties • Chemical change • Element • Compound	• Describe characteristics • Analyze • Compare and contrast • Draw conclusions	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• How do scientists learn about elements and their compounds? • How can so many compounds be made from so few elements?
23. & 24. Matter is made of elements that can be by themselves or joined to form compounds.	CORE/AID 1 hour, 30 minutes	• Compounds are made from combining different elements in different arrangements. • Many products can be produced from a much smaller number of basic kinds of materials. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties.	• Physical properties • Chemical properties • Chemical reactivity • Reactant • Product • Element • Compound	• Describe characteristics • Analyze • Compare and contrast	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes.	• What is an element's story? • Do elements have families, too?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
25. & 26. Matter is made of elements that can be by themselves or joined to form compounds.	CORE 1 hour, 30 minutes	• Tables can be used to organize large amounts of information and therefore make data more manageable. • Different elements have different physical and chemical properties. • Elements can be grouped by their chemical properties. • Reactivity is an example of a chemical property of elements. • Elements can be categorized into metals, non-metals and semi-metals. • Groups of elements have similarities much like families.	• Physical properties • Chemical properties • Chemical reactivity • Product • Reactant • Element • Compound • Metal • Non-metal • Semi-metal • Noble gas • Reactive gas • "Families" of elements • Periodicity	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Identify patterns • Categorize	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes.	• How can so many compounds be made from so few elements? • How do scientists learn about elements and their compounds? • Why do scientists group elements based on their chemical properties?
27. & 28. Matter varies in its ability to chemically react with other matter.	CORE 1 hour, 30 minutes	• The nature of matter can be explored through scientific investigations. • Different elements have different physical and chemical properties. • Elements can be grouped together depending on their physical and chemical properties. • Reactivity is an example of a chemical property of elements. • Elements can be categorized into metals, non-metals and semi-metals. • Elements vary in their chemical reactivity	• Chemical properties • Chemical reactivity • Element • Compound • Scientific investigation	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • Identify patterns • Categorize	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• Can chemical reactivity of elements be used to differentiate groups of elements?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
29. & 30. Scientists communicate knowledge about the nature of matter in clear and varied ways.	CONNECTIONS/ AID 1 hour, 30 minutes	• Matter is made of elements that can be used by themselves or joined to form compounds. • Compounds are made from combining different elements in different arrangements. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties. • Groups of elements have similarities much like families.	• Matter • Element • Compound • Physical properties • Chemical properties • "Families" of elements	• Describe characteristics • Compare and contrast • Write creatively • Use analogies or metaphors • (Optional) Use computer technology to enhance communication	• Models are tentative schemes or structures that correspond to real objects, events or classes of events, and that have explanatory power.	• Can my perception of heroes be used to convey my understandings of the nature of some element?
31. 32., 33. & 34. The study of matter, the subsequent technology and the social and historical context in which this study takes place are interdependent.	CONNECTIONS 3 hours	• Matter is made of elements. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties. • Scientific discoveries and inventions have beneficial and detrimental consequences.	• Element • Compound • Physical properties • Chemical properties • Commercial product • Intended consequences • Unintended consequences • Social context • Historical context	• Identify characteristics • Compare and contrast • See relationships • Brainstorm • Plan • Organize • Write • Demonstrate originality • (Optional) Use computer technology to enhance communication	• Scientific evidence consists of observations and date on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • The natural world is composed of systems, which are organized groups of related objects that together form a whole.	• What is an element's story? • How do scientists learn about elements and their compounds? • Are scientific discoveries and innovations influenced by the historical and social context in which they occur?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
35. Post Assessment	CORE 50 minutes	• The interactions between matter cause physical or chemical changes. • There are differences between physical and chemical changes. • Matter is made of elements that can be by themselves or joined to form compounds. • Compounds are made from combining different elements in different arrangements. • Matter has physical and chemical properties. • Different elements have different physical and chemical properties. • Different compounds have different physical and chemical properties. • Groups of elements have similarities much like families. • The study of matter, the subsequent technology, and the social and historical context in which this study takes place are interdependent.	• Matter • Chemical change • Physical change • Mixture • Solution • Dissolving • Physical properties • Chemical properties • Element • Compound • "Families" of elements • Periodicity • Interdependence of science, technology and society • Environmental and social consequences	• Identify characteristics • Describe characteristics • Analyze • Compare and contrast • See relationships • Draw conclusions	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change.	• What did I learn about physical and chemical reactions and interactions? • What did I learn about mixtures, elements and compounds?

“Materials Chart”

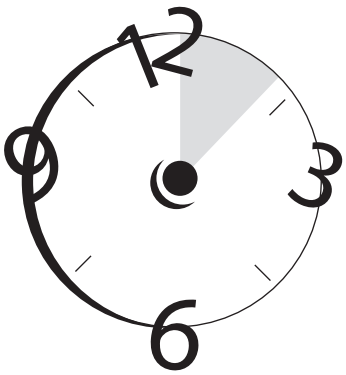
Lesson	Primary Materials	Additional Materials (Supplied by Teacher)
Pre-assessment	**Reactions and Interactions Unit Pre-assessment** (included with lesson)	
1		10-12 pictures from various sources that show physical and chemical changes—each picture should contain at least one negative consequence of physical or chemical change to the environment pictures of common places and activities that illustrate physical or chemical changes
2	N/A	
3	Plastic sandwich bags (1 per group), bar magnet (1 per group) (see lesson 3 for ordering information), white tissues (1 per group), water, cooking oil (25 ml per group), food coloring (1 dispenser per group), sugar (1 pinch per group), eyedropper (1 per group), watch glass or small beaker (1 per group), 10-ml graduated cylinder (1 per group), 100-ml graduated cylinder (1 per group), beaker (500 ml) or large quart jar (1 per group), small beaker or clear plastic cup (1 per group), baking soda (1 TB per group, citric acid (1 TB per group) 500 g (see lesson 3 for ordering information), plastic tablespoons (1 per group), paper towels (2 sheets per group), hand lens (1 per group), (optional) filter funnel and filter paper or watch glass or small glass plate to evaporate water from the cereal	Two new pictures that contain a mixture, representing a physical change and also at least one chemical change; baby food jars with lids (2 per group), box of iron-fortified cereal with raisins
4	What is the **Nature of the Interaction? Lab Activity** (included in Lesson 4)	
5	Tincture of iodine (optional as an example of a solution), piece of steel (optional as an example of a solution, glass container big enough to hold gumballs or marbles, small gum balls or marbles	Small pieces of candy like Skittles, access to the Internet
6	Construction paper, scissors, white lined paper, glue sticks (1 per pair of students), metric rulers, black marker, (1 per pair of students)	Shoe box, overripe bananas (1 per group), green tomatoes (2 per group)
7	Water, iron powder (see ordering information in Lesson 7), test tube or plastic vials (1 per group), glass beaker or drinking glass (3 per group), steel wool pads without soap (2 per group), pencil, rubber band, flat dish (2 per group), vinegar (large jug), small thermometers to fit in capped jar (1 per group)	

Lesson	Primary Materials	Additional Materials (Supplied by Teacher)
8/9	See Lesson 8/9 for ordering information for chemicals. Crushed chalk or shells, *Alka-Seltzer* tablets and packaging (1 tablet per group), baking soda and labeled box, vinegar, candle (1 for every 2 groups), box of safety matches, bucket of water and/or sand for front of room, rubbing alcohol, hydrogen peroxide, Epsom's salt, milk of magnesia, ammonia hydroxide, alum, ice, baggie (1 per group), silica, limewater, straw (1 per group), thermometer (1 per group), powdered bleach (1 tsp. per group), liquid bleach, stirring rods (1 per group), plastic spoons for taking reactants, graduated cylinders or measuring cups, (optional) zinc pieces and 6 Molar hydrochloric acid, wooden splint, test tube	Baby food jar or canning jar with lid (1 per group), hot plate (1 per group but can be done with one for entire class)
10/11/12	Baking soda and labeled box (1 tsp.), vinegar (about 60 ml), glass jar with a lid, tubing (1 1/2/ feet), beaker (1/2 filled with limewater (calcium hydroxide and covered with plastic wrap), powered yeast (1/2 package), sugar (1 tsp.)	Empty soda bottle, modeling clay to seal off the soda bottle
13	Salt shaker or baggie with salt • The following books offer pictures and information that will enhance the lesson: The Newmark, A. (2000). *Eyewitness books: Chemistry*. London: Dorling Kindersley (DK) Publishing. • Newton, D. (1999). *Chemical elements from carbon to krypton*. Volumes 1 (A-F), 2 (G-O), and 3 (P-Z). Detroit, Michigan: UXL.	Internet access to get pictures or video clips of sodium reacting with water as well as a picture and article on chlorine gas and a picture of a camera flash bulb
14	Assessment: **What Do I Know about Physical and Chemical Changes?** (included in Lesson 14)	Two pictures that show chemical and physical changes
15	Assessment results from Lesson 14	
16	*Kool-Aid* pack or powdered drink mix, glass of water, toothpicks with flat ends, one 500 ml. graduated cylinder or one quart glass jar, sugar (240 ml), water (240 ml), rubbing alcohol (240 ml), food coloring, tablespoon, table salt (1 TB), thin wire for stirring	Pictures of solutions, bottle of soda, small baby food jar
17	Ice water, room temperature water, hot water (preferably boiling), *Kool-Aid* or some other powdered drink mix, bottles of soda with caps on (2 per group), sugar cubes (8 per group), stirring rods or spoons (2 per group), spoon to smash sugar cubes, light sticks (2 per group), 100 ml. graduated cylinders (1 for each group), 150 ml beakers or glass containers (2 per group), white paper (1 sheet per group) graph paper (1 sheet per group), clock or watch with second hand, Solution 1 (120 ml for each group) made with 4 g. of potassium iodate, Solution 2 (90 ml for each group) made with 4 g. of soluble starch, 2 g of sodium metabisulfite and 5 ml of sulfuric acid – See Lesson 17 for ordering information.	Two newspapers, hot plate, bottle opener (1 per group), small balloon,

Lesson	Primary Materials	Additional Materials (Supplied by Teacher)
18/19		*Starburst* candy
20/21	Water, baking soda, cornstarch, cream of tartar, teaspoon, stirring rods, vinegar, tincture of iodine, plastic spoons, plastic cups (3 per group), plastic bags for unknown samples, marker, *Fruit-Fresh* powder, pancake mix, cake mix, tooth powder, antacid tablets, baking powder, talcum powder	
22	Magnesium metal, metal tongs, ceramic wire gauze, matches, poster board or oak tag, markers, scissors, glue, rulers, stencils, and any of the following references for pictures of elements, compounds and the equipment used by previous generations of scientists as they went about their research into the nature of elements and compounds: • Challoner, J. (1996). *Eyewitness visual dictionaries: The Visual dictionary of chemistry*. London: Dorling Kindersley (DK) Publishing. • Cooper, C. (2000). *Eyewitness books: Chemistry*. London: Dorling Kindersley (DK) Publishing. • Mewmark, A. (1993). *Eyewitness books: Chemistry*. London: Dorling Kindersley (DK) Publishing. • Sherwood, M. (Ed.). (1986). *Chemistry today*. Chicago: The World Book Encyclopedia of Science. • Stwertka, A. (1996). *A guide to the elements*. New York: Oxford University Press. • Newton, D. (1999). *Chemical elements from carbon to krypton*. Volumes 1 (A-F), 2 (G-O) and 3 (P-Z). Detroit, Michigan: UXL.	Internet access
23/24	Reference books from Lesson 22	Internet access
25/26	Large periodic table to be used as a graphic organizer	
27/28	Iron nail, sandpaper, penny, graphite, vinegar	
29/30	Resources on tragic and romantic heroes/heroines	Internet access
31/32/33/34	Resources on elements/compounds that students will be researching -- the following three volumes would supply all of the initial information students would need: Newton, D. (1999). *Chemical elements from carbon to krypton*. Volumes 1 (A-F) 2 (G-O), and 3 (P-Z). Detroit Michigan: UXL. Stencils, rulers, magic markers, scissors, white paper	Resources related to journalism for students to use in their efforts to simulate the front page of a newspaper, computer access, publishing software (optional)
35	**Reactions and Interactions Unit Post Assessment** (included in Lesson 35)	

Physical and Chemical Changes

Core/Identity
Time Allocation: 1 hour, 30 minutes
(2 days)



Lesson Overview

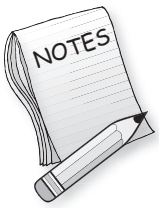
Students in this lesson will be introduced to a special type of mixture called a suspension. After exploring some examples of suspensions, students will write their own procedure to determine whether some foods are solutions or suspensions.

Guiding Questions

- How are different types of mixtures part of our lives?
- What makes mixtures a cause for mix-up?

BIG IDEA

Get into the Mix when it Comes to Mixtures!



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Most matter in nature is found mixed with other matter.
- Mixtures are made up of different states of matter.
- Mixtures can be divided into types.
- Suspensions are a special type of mixtures.
- Some mixtures have materials suspended temporarily and some have materials suspended permanently.

Concepts

- States of matter
- Physical change
- Mixture
- Suspension

Teacher Information

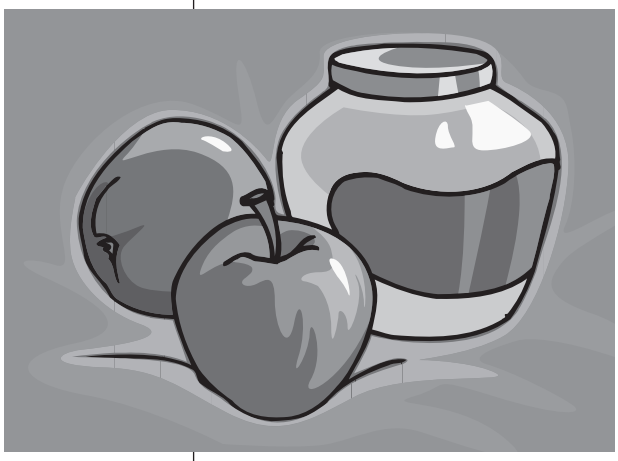
- A suspension is a mixture in which a solid is dispersed in another fluid but is not dissolved. A suspension often is temporary as the particles are large and eventually settle out of the other substance.
- It is helpful to know whether a substance is a solution or a suspension because if it is the latter, it could be separated by filtration. Substances in solutions cannot be separated using filtration. They can be separated using a process like distillation that uses the characteristic properties of boiling or freezing points to separate substances that make up a solution.

Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Categorize

Materials and Resources

1. Flour (one tablespoon per group)
2. Water
3. Clear plastic cup or small beaker (one per group)
4. Borscht (beet soup)
5. Split pea soup
6. Tomato sauce
7. Apple sauce
8. Pulp-free orange juice
9. Kitchen strainer (one per group)
10. Coffee filters (five per group)



Preparation Activities

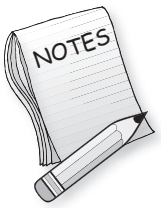
1. Make copies of the lab activity, **What Makes Mixtures Cause for Mix-up? – Part 1**
2. Make copies of the lab activity, **What Makes Mixtures Cause for Mix-up? – Part 2**
3. Shop and gather the necessary materials.

Introductory Activities (3 minutes)

1. Put students into lab groups, preferably in pairs.
2. Tell students that they will be investigating two types of mixtures and then be designing an experiment to identify mixture types.

Pre-assessment

N/A



Teaching and Learning Activities (1 hour, 17 minutes)

1. Tell students to complete both parts of the lab activity **What Makes Mixtures a Cause for Mix-up?** (Day 1)

2. Remind students to get their procedures checked before completing Part 2 of the lab activity (Day 1 or 2).

3. Upon completion of the lab exploration distribute the questions for **What Makes Mixtures Cause for Mix-up?** lab activity (Day 2).

4. Advise students to work with their partners to answer questions #1 & 2 (see **Answers to Questions for What Makes Mixtures a Cause for Mix-up?** below) (Day 2).

5. After going over #1 and #2, ask students how they know the flour and water is not a solution (answer: the flour and water eventually separated) (Day 2).

6. Ask students if anyone know what this type of mixture is called (answer: a suspension) (Day 2).

7. Inform students that in suspensions, the substances being mixed do not dissolve (Day 2).

8. Ask students if they think there is anything suspended in blood. Some students might know that blood cells and blood platelets are suspended in blood (Day 2).

9. Direct students to work with their partner to finish the questions and if they do not complete them in class, they are to complete them at home for homework (Day 2).

Products and Assignments

N/A

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (10 minutes)

- Reinforce the idea that mixtures are a big part of students' everyday lives and that solutions and suspensions are two of the various types of mixtures. Remind students that all mixtures can be separated by physical means. Share with them that in nature most matter is found mixed with other matter. Advise students that understanding the types and nature of mixtures allows scientists and researchers to design and produce products that meet the myriad demands of consumers. Strengthen the idea that with some understanding of mixtures, students can become more informed consumers and citizens, as it relates to the impact these mixtures have on the environment.
- Invite students to share their examples of how different types of mixtures are part of their lives.
- Encourage students to explain how mixtures can be a cause for mix-up.

What Makes Mixtures a Cause for Mix-up? – Part 1

Name _____ Date _____

Instructions	States of matter	Observation	What do you think happened? (Chemical or physical change)	Why do you think so?
1. a) Fill a clear plastic cup or small beaker 3/4 full of water. b) Add 1 tablespoon of flour. c) Mix the substances together. Write down what you see today and what you see tomorrow.		Today: Next day:	Today: Next day:	Today: Next day:
2. a) Shake a jar of borscht. Watch it for 2 minutes and write down you observations. b) *Decant* the *supernatant* liquid through a strainer into a plastic cup. c) Define the italicized words		Observations: *Decant:* *Supernatant:*		
3. a) Rinse out the strainer. b) Place a coffee filter in it and pour the liquid from Step #2 above through the strainer/filter paper combination. Taste the filtered liquid.				

What Makes Mixtures a Cause for Mix-up? -Part 2

Name _____ Date _____

Write a procedure below to determine whether the following substances: tomato sauce, orange juice, pea soup and applesauce are solutions or suspensions:

1.

After checking the procedure with the teacher, proceed to carry out the procedure. Answer the following questions:

1. Which of the substances were solutions and which were suspensions? What evidence did you use to make your decisions?

2. Why do you think it might be helpful to know if a substance is a solution or a suspension?

Name _____Date _____

Questions for the "What Makes Mixtures a Cause for Mix-up?" Lab Activity

1. Is the combination of flour and water a physical or chemical change and what evidence do you have to support your conclusion?

2. Would you call flour and water a mixture or not, especially after letting it sit over night? Explain your answer.

3. What did what you observed in the strainer in Step #2 tell you about the size of the particles in this mixture?

4. Are the particles in the filter paper smaller or larger than the filter paper?

5. Are the particles in the filter paper smaller or larger than the first red particles caught by the strainer in Step #2?

6. What did the liquid taste like? What do you think may be dissolved in the liquid?

7. Write down the ingredients from the label of borscht soup below:

8. What evidence do you have that the ingredients listed on the label are actually present in the borscht?

Name _____ Date _____

Answers to Questions for the "What Makes Mixtures a Cause for Mix-up?" Lab Activity

1. Is the combination of flour and water a physical or chemical change and what evidence do you have to support your conclusion?

The flour and water combination is a physical change, as no new substances were produced.

2. Would you call flour and water a mixture or not, especially after letting it sit overnight? Explain your answer.

The flour and water formed a temporary mixture and then over night the flour settled out.

3. What did what you observed in the strainer in Step #2 tell you about the size of the particles in this mixture?

The size of the particles varies.

4. Are the particles in the filter paper smaller or larger than the filter paper?

The particles in the filter paper are larger than the filter paper

5. Are the particles in the filter paper smaller or larger than the first red particles caught by the strainer in Step #2?

The particles are smaller than the first red particles

6. What did the liquid taste like? What do you think may be dissolved in the liquid?

It tasted sweet. Maybe sugar is dissolved in the liquid.

7. Write down the ingredients from the label of borscht soup below:

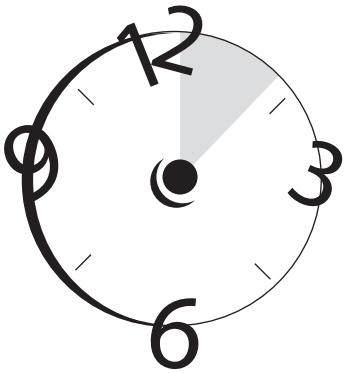
The label said,

8. What evidence do you have that the ingredients listed on the label are actually present in the borscht?

Sugar was listed on the label, and the borscht tasted sweet.

Physical and Chemical Changes

Core
Time Allocation: 45 minutes



Lesson Overview

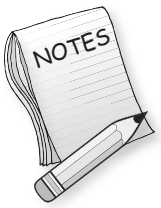
Students in this lesson will be introduced to special types of mixtures called colloids and to the concept of emulsification. They will identify which substances are solutions and which are colloids using the Tyndall effect.

Guiding Questions

- How are different types of mixtures part of our lives?
- What makes mixtures cause for mix-up?

BIG IDEA

Get into the Mix when it Comes to Mixtures!



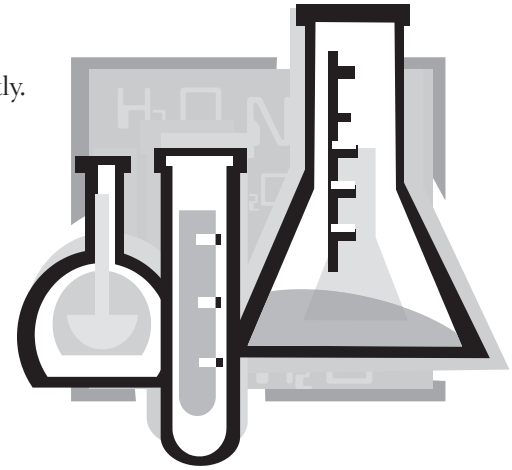
Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Most matter in nature is found mixed with other matter.
- Mixtures are made up of different states of matter.
- Mixtures can be divided into types.
- Suspensions and colloids are special types of mixtures.
- Some mixtures have materials suspended temporarily and some have materials suspended permanently.



Concepts

- States of matter
- Physical change
- Mixture
- Suspension
- Colloid
- Tyndall effect

Teacher Information

- A colloid is similar to a suspension in that it has particles that are small enough to stay mixed with the other substance, but they do not actually dissolve in the other substance.
- Tyndall effect was named after the British scientist John Tyndall. It is the ability for a mixture to scatter light. Unlike solutions, colloids with their tiny suspended particles can scatter light beams.

Skills

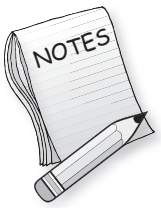
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Categorize

Materials and Resources

1. Pen flashlight (one per group or student)
2. Black construction paper (one sheet per group or student)
3. Glass or jar (one per group or student)
4. (Optional) For better viewing of the Tyndall effect a cardboard box can be turned upside down and used to house the glass of substance being analyzed. Use a pencil point to make a small hole in the **end** of the box through which the light beam will pass. The height of the hole should be one-half the height of the glass or jar being used. Cut a second hole, a 2.5-cm viewing hole, on the **side** of the box, about 8-cm from the corner of the box and the same height as the pencil hole. Place a glass filled with the substance to be tested inside the box, shine a flashlight beam through the tiny hole and view the liquid through the viewing hole on the end of the box.
5. Cranberry juice
6. Syrup (clear)
7. Orange drink
8. Coffee
9. Tea
10. Vinegar (distilled)
11. Cider
12. Egg white
13. Milk
14. Toothpaste
15. Suntan lotion

Preparation Activities

N/A



Introductory Activities (10 minutes)

- Collect both parts of the previous days' lab, **What Makes Mixtures a Cause for Mix-up?** and the answers to the questions from the assignment, **Questions for the "What Makes Mixtures a Cause for Mix-up?" Lab Activity.**
- Review with students the answers to questions #3-8.

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Instruct students to complete the **What Makes Mixtures Cause for Mix-up?** - Part 3 lab activity.

2. Upon completion of the lab exploration, ask students which group of substances when viewed from the side showed the light beam.

3. Ask students why they think the light showed in one group of substances and not in the other. (Answer: The substances that scattered the beam have something in them - tiny particles that scatter light).

4. Inform students that mixtures with this ability are called colloids. Colloids can scatter beams of light in the same way that one can see a beam of sunlight in a dusty room or when headlight beams show through fog at night. Share with students that fog is a colloid in which tiny droplets of water are suspended in air. The water droplets are suspended and are large enough to reflect light but not heavy enough to fall out of the mixture, as occurs in suspensions.

5. Explain to students that a colloid is similar to a suspension in that the particles do not dissolve, but they are small enough to stay mixed with the other substance indefinitely.

6. Show some examples of household colloids, such as milk, toothpaste and suntan lotion. Explain that each of these is a colloid in which the particles do not separate on standing.

7. Inform students that colloids are mixtures between different states of matter. Ask them what the two states of matter are in the following colloids:
   a) smoke (solid and gas)
   b) fog (liquid and gas)
   c) whipped cream (gas and liquid)
   d) paint (solid and liquid)
   e) spray paint (solid and gas)
   f) ketchup (solid and liquid)
   g) butter (solid and liquid)

8. Collect students' lab-results sheets and analyze for completion and accuracy.

Products and Assignments

- Students' **What Makes Mixtures a Cause for Mix-up? - Part 3** results
- Answers to questions, **Questions for the What Makes Mixtures a Cause for Mix-up? Lab Activity.**

Extension Activities

N/A

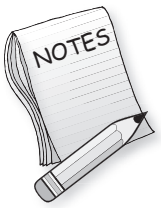
Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

1. Reinforce the idea that in nature most matter is found mixed with other matter and that mixtures are a big part of students' everyday lives. Share with students that understanding the types and nature of mixtures allows scientists and researchers to design and produce products that meet the myriad demands of consumers. Strengthen the idea that with some understanding of mixtures, students can become more informed consumers.

2. Encourage students to ask questions or give examples.



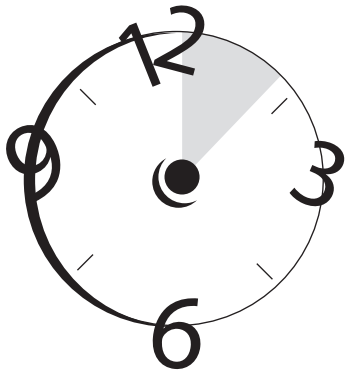
Name _____ Date _____

What makes mixtures a cause for mix-up?

Instructions	Observation	Colloid or solution
1 a) Fill a glass 1/2 full with each of the substances listed in the second column and place it against the black construction paper. b) Shine a flashlight beam through it. c) Look at the beam from the side and write down whether the beam is visible or not. d) In the third column identify the substance as a colloid or a solution.	Cranberry juice Syrup (clear) Orange drink Coffee Tea Vinegar (distilled) Cider Egg white Milk	

Physical and Chemical Changes

Core
Time Allocation: 45 minutes



Lesson Overview

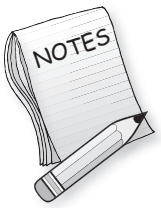
Students in this lesson will be introduced to the concept of emulsification. They will create and examine emulsions and emulsifying agents using a lab activity, **Eating and Emulsions - What's the Connection? - Part 1**.

Guiding Question

Why would we want to force two substances to mix that naturally do not mix?

BIG IDEA

Get into the Mix When it Comes to Mixtures!



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Most matter in nature is found mixed with other matter.
- Mixtures are made up of different states of matter.
- Mixtures can be divided into types.
- Suspensions, colloids and emulsions are special types of mixtures.
- Some mixtures have materials suspended temporarily, and some have materials suspended permanently.

Concepts

- States of matter
- Physical change
- Mixture
- Immiscible
- Suspension
- Emulsion
- Emulsifying agent
- Foam

Teacher Information

- An emulsion is a stabilized suspension of two immiscible liquids (e.g., mayonnaise). The dispersed phase droplet size ranges from 0.1 - 10 μm. Important oil-in-water food emulsions, ones in which oil or fat is the dispersed phase and water is the continuous phase, include milk, cream, ice cream, salad dressings, cake batters, flavor emulsions, meat emulsions, and cream liqueurs. Examples of food water-in-oil emulsions are butter and margarine.
- An emulsifying agent is the substance that keeps two immiscible substances apart, preventing them from coming together and creating

two separate layers (e.g., egg yolks in mayonnaise or soap detergent, as it interacts with the non-polar grease in clothes, and the polar water in which the clothes are washed).

- Foam is a gas dispersed in a liquid where the gas bubbles are the discrete phase. There are many food foams including whipped creams, ice cream, carbonated soft drinks, mousses, meringues, and the head of a beer. Foam is likewise unstable and needs a stabilizing agent to form the gas bubble membrane.

Skills

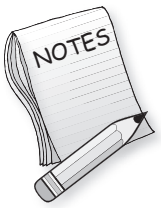
- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Categorize
- Draw conclusions

Materials and Resources

1. Website – This site is a good site for information on emulsions. http://www.courses.psu.edu. Put the key word "Emulsion" into the keyword search.
2. Quart jars with lids (1 per group or student)
3. Stirring rods or stick (1 per group or student)
4. Pint jar or 500 ml beaker (1 per group or student)
5. Oil (1/2 cup [~120 ml] per group or student)
6. Water (3/4 cup [180 ml] per group or student)
7. Food coloring (1 dispenser per group or student)

Preparation Activities

1. Make copies of the **Eating and Emulsions - What's the Connection? - Part 1** lab activity.
2. Make copies of the **Questions for the Eating and Emulsions - What's the Connection? - Part 1** lab activity.
3. Review for yourself the answers to the **Questions for the Eating and Emulsions - What's the Connection? - Part 1** lab activity.



Introductory Activities (5 minutes)

- Distribute and review the **Eating and Emulsions - What's the Connection? - Part 1** lab activity.
- Distribute the **Questions for the Eating and Emulsions - What's the Connection? - Part 1** lab activity.

Pre-assessment

N/A

Teaching and Learning Activities (40 minutes)

1. Instruct students to complete the lab activity **Eating and Emulsions - What's the Connection? - Part 1**.

2. Circulate while students are working on lab activity.

3. Inform students that they should answer the questions for **Eating and Emulsions - What's the Connection? - Part 1**, and finish them for homework.

Products and Assignments

N/A

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

Next day's lesson will be the debriefing.

Eating and Emulsions - What's the Connection? Part 1

Name _____ Date _____

Instructions	Observation
1. a) Take a 1-quart jar and fill it 1/2 full with water. b) Add 5 drops of food coloring and stir. c) Slowly add 1/4 cup of oil. Observe. d) Secure the lid and shake the jar vigorously. e) Observe today and tomorrow.	Today: Next day:
2. a) Pour 60 ml of water into a pint jar or a 500-ml beaker. b) Slowly add 60 ml of cooking oil to the water in the jar or beaker. c) Use an eyedropper to add 5 drops of food coloring to the jar or beaker. Observe. d) Use a stirring rod to push down one of the drops until it touches the top of the water level.	

Questions for the Eating and Emulsions - What's the Connection? - Part 1 Lab Activity

Name _____ Date _____

1. Which substance is less dense, oil or water, and how do you know?

2. In step #1, how many layers formed initially? Explain how you think the layers are different.

3. Why do you think the shaking allowed the substances to mix more easily? (What did it do to the size of the oil particles?)

4. How many layers were present on the second day of observations for step #1 in the lab activity?

5. What happened to the food coloring drop that you pushed down into the water layer?

6. Based on what happened to the food coloring drop when it touched the surface of the water layer, what conclusions can you draw about its solubility in water? In oil?

7. What do you think the expression "likes dissolve in likes" means?

Answers for the Eating and Emulsions - What's the Connection? – Part 1 Lab Activity

Name _____ Date _____

1. Which substance is less dense, oil or water and how do you know?

Oil is less dense, as it floats on top of the water layer.

2. In Step 1, how many layers formed initially? Explain how you think the layers are different.

Three layers formed. The denser bottom layer was water with some trapped bubbles of oil. The center layer appeared to have more oil bubbles mixed with water. The top layer was mostly oil with some trapped bubbles of water in it.

3. Why do you think the shaking allowed the substances to mix more easily? (What did it do to the size of the oil particles?)

The shaking made the oil turn into tiny drops that could then mix with the water more easily.

4. How many layers were present on the second day of observations for Step #1 in the lab activity?

Two layers were present: the oil and water, completely separated.

5. What happened to the food-coloring drop that you pushed down into the water layer?

It disappeared (dissolved) into the water.

6. Based on what happened to the food-coloring drop when it touched the surface of the water layer, what conclusions can you draw about its solubility in water? In oil?

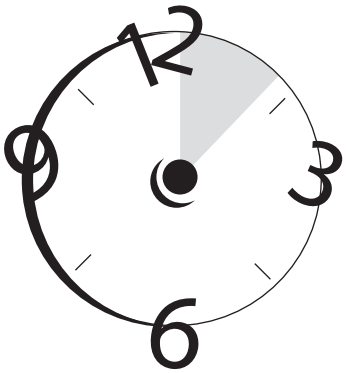
It is soluble in water and not soluble in oil.

7. What do you think the expression "likes dissolve in likes" means?

It means that a substance will dissolve in another substance if both substances have similar chemical structures. A substance that has a different chemical structure than the solvent, in which you are trying to dissolve it, will not dissolve. The two substances then are said to be immiscible. More specifically, and not for teaching purposes, solubility depends on polarity. Polar substances like water and alcohol can form solutions, whereas a non-polar substance, like oil, cannot dissolve in water.

Physical and Chemical Changes

Core
Time Allocation: 45 minutes



Lesson Overview

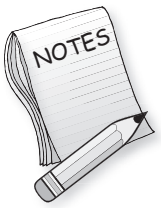
Students in this lesson will continue their exploration of mixtures by investigating emulsions. They will create and examine an emulsion and an emulsifying agent using a lab activity, **Eating and Emulsions - What's the Connection? - Part 2**.

Guiding Questions

Why would we want to force two substances to mix that naturally do not mix?

BIG IDEA

Get into the Mix when it Comes to Mixtures!



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.

Principles and Generalizations

- Most matter in nature is found mixed with other matter.
- Mixtures are made up of different states of matter.
- Mixtures can be divided into types.
- Suspensions, colloids and emulsions are special types of mixtures.
- Some mixtures have materials suspended temporarily, and some have materials suspended permanently.

Concepts

- States of matter
- Physical change
- Mixture
- Immiscible
- Suspension
- Emulsion
- Emulsifying agent

Teacher Information

N/A

Skills

- Identify characteristics
- Describe characteristics
- Analyze
- Compare and contrast
- Categorize
- Draw Conclusions

Materials and Resources

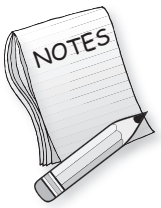
1. Eggs (room temperature) (2 per group or student)
2. Vinegar (room temperature) (3 tablespoons or 15 ml per group or student)
3. Salt (1/2 teaspoon per group or student)
4. Prepared mustard (1/4 teaspoon per group or student)
5. Salad oil (room temperature) (1 cup or 240 ml per group or student)
6. Small bowl (1 per group or student)
7. Egg beater (1 per group or student)
8. Teaspoon (1 per group or student)

Preparation Activities

1. Make copies of the **Eating and Emulsions - What's the Connection? - Part 2** lab activity.
2. Make copies of the **Questions for the Eating and Emulsions - What's the Connection? – Part 2** lab activity.

Introductory Activities (10 minutes)

- Collect the results and answers to the questions for the **Eating and Emulsions - What's the Connection? - Part 1** lab activity.
- Review the results, emphasizing the idea that shaking substances that are immiscible temporarily suspends one in the other.
- Share with students that if we could suspend a substance in another by using a third substance to do it we would then have a mixture called an emulsion.
- Explain to them that the previous day's work mixing oil and water did not produce an emulsion because the layers soon separated.
- Inform students that emulsions are essentially stabilized suspensions in which one substance is so small that it can be suspended in the other with the assistance of another substance referred to as an emulsifying agent. The emulsifying agent keeps the original two types of liquids mixed with one another, preventing them from uniting with their own kind and forming separate immiscible layers.
- Distribute and review the **Eating and Emulsions - What's the Connection? - Part 2** lab activity.



Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Instruct students to complete the lab activity **Eating and Emulsions - What's the Connection? - Part 2**.

2. Direct them to answer the lab questions.

3. After the completion of the lab, have student answer and discuss the two questions at the bottom of the lab.

4. Share with students that mayonnaise is just one type of emulsion, as it blends two states of matter, vinegar (water and acetic acid) and oil.

5. Inform students that emulsions are an important part of the food industry and that there are other examples of emulsions that they can find using the Internet.

6. Encourage students to consider creating a poster display of the information they find, so that other students and staff can benefit from their increased appreciation that the interactions of matter really matter to us all (see Extension Activities).

Products and Assignments

Students' **Eating and Emulsions - What's the Connection? - Part 1** lab results.

Extension Activities

1. Use the Internet to find other foods that use emulsifying agents.
2. Invite students to prepare a poster that can be displayed in the classroom(s), describing what emulsions and emulsifying agents are, including examples of food products that are emulsions.

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

- Inform students that mayonnaise is just one type of emulsion, as it blends two states of matter, vinegar (water and acetic acid) and oil. Explain to them that emulsions are an important part of the food industry and that there are other examples of emulsions that they found using the Internet.
- Query students as to why we would want to force two substances to mix that naturally do not mix.
- Encourage students to explore the topic and to create a poster display of the information they find, so that other students and staff can benefit from their increased appreciation that the interactions of matter, really matter to us all!

Eating and Emulsions - What's the Connection? Part 2
Making Mayonnaise

Name _____ Date _____

Instructions	Observations
1. a) Put egg yolks, mustard and salt and one teaspoon of vinegar in a bowl. b) Beat until egg yolks are sticky and thoroughly mixed with the water that is in the vinegar. c) Add oil drop by drop beating the mixture constantly. If you add the oil too fast, it will come together and the mayonnaise will curdle. d) If the mayonnaise curdles, take another egg yolk and add the curdled mayonnaise to the egg yolk, not the other way around. e) Once you see that the oil is being blended in nicely and the mixture is thickening (usually after the addition of 1/3 cup), you can add the remaining 2/3-cup of oil in a slightly faster manner, beating all the time.	

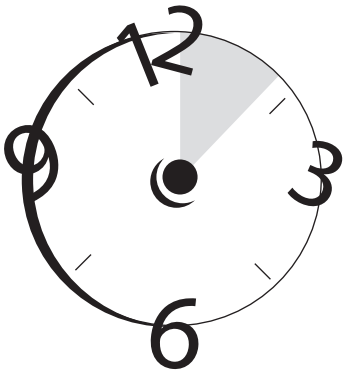
1. What is the emulsifying agent in this mixture?

2. Describe what the role of the emulsifying agent is in this mixture. If a drawing will help convey your understanding, feel free to include one. Do not forget to label the items in your drawing.

Getting to Know and Appreciate the Elements and their "Families"

Connections (Science, Society and the Dramatic Arts)

Time Allocation: 4 hours, 30 minutes



Lesson Overview

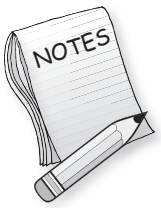
In addition to using the information previously gathered regarding the properties and behaviors of elements, students will have an opportunity during this activity to portray some aspect of an element's history, either its discovery or its importance to society in terms of its uses. This activity will serve to reinforce one of the important benchmarks for science literacy that states, "Important contributions to the advancement of science, mathematics and technology have been made by different kinds of people, in different cultures, at different times" (AAAS, 1993, p.17). As a result of this activity, students will better understand that scientists and their discoveries are inexorably linked to the world in which they live.

Guiding Questions

- What is my element's story?
- How do scientists learn about elements and their compounds?
- Are scientific discoveries and innovations influenced by the historical and social context in which they occur?

BIG IDEA

Elements on Stage



Content Goals

Universal Themes

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- The natural world is composed of systems, which are organized groups of related objects that together form a whole.

Principles and Generalizations

- Matter is made of elements that can be by themselves or joined to form compounds.
- Compounds are made of elements.
- Different elements have different physical and chemical properties.
- The nature of matter can be explored through scientific investigations.
- Scientists ask and explore questions about the nature of matter.
- Scientific work cannot be separated from the historical and social context in which it occurs.
- Scientific discoveries and inventions can have beneficial or detrimental consequences.

Concepts

- Element
- Compound
- Physical properties
- Chemical properties
- Commercial products
- Interdependence of science, technology and society
- Environmental or social consequence

Teacher Information

N/A

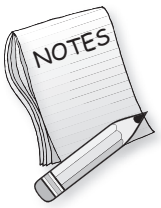
Skills

- Brainstorm
- Plan

- Organize
- Write
- Summarize
- Demonstrate originality and creativity
- Identify characteristics
- Compare and contrast
- Analyze
- See relationships

Materials and Resources

1. Use the following references to gather ideas on how to go about science productions and other activities with students.
    - Budzinsky, F. (1995). Chemistry on Stage - A Strategy for integrating science and the dramatic arts. *School Science and Mathematics*, 406-410.
    - Spain, R. S., (1992). Role-playing reactions: Identifying with the elements. *The Science Teacher*, 59(9), 38-40.
2. Have the books used for the research on the elements available
    - Challoner, J. (1996). *Eyewitness visual dictionaries: The visual dictionary of chemistry.* London: Dorling Kindersley (DK) Publishing.
    - Cooper, C. (2000). *Eyewitness books: Chemistry.* London: Dorling Kindersley (DK) Publishing.
    - Mewmark, A. (1993). Eyewitness books: *Chemistry.* London: Dorling Kindersley (DK) Publishing.
    - Sherwood, M. (Ed.). (1986). *Chemistry today.* Chicago: The World Book Encyclopedia of Science.
    - Stwertka, A. (1996). *A guide to the elements.* New York: Oxford University Press.
    - Newton, D. (1999). *Chemical elements from carbon to krypton.* Volumes 1 (A-F), 2 (G-O) and 3 (P-Z). Detroit, Michigan: UXL.
3. Use Internet sites if needed to assist students in their research on the elements such as: http://web.buddyproject.org/web017/web017/ http://www.theodoregray.com/PeriodicTable Click on the element "sodium" and then click on the words "sodium party" and browse through the pictures and videos accordingly.
4. Each volume of the *Chemical Elements from Carbon to Krypton* book has a timeline of when each element was discovered and by whom.



Preparation Activities

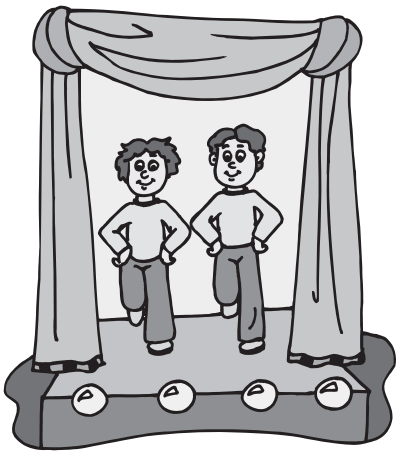
1. Make copies of the **Instructions for the Chemistry-on-Stage Project, Chemistry-on-Stage Teacher Rubric** and **Chemistry-on-Stage Student Rubric.**
2. Try to arrange an authentic environment like an auditorium for the student product. The production day could include programs, intermission and even food sales. Invitations to the production can be extended to the press, parents, faculty, administration and other classes. If this arrangement is not possible, the live or videotaped performances can take place in the classroom.
3. As a result of the time needed to plan and write at home, make parents aware of the project and the degree of student responsibility and independence required. Therefore, after handing out and reviewing the project, students should bring the instruction sheet for the project home as a homework assignment to obtain a signature from a parent or guardian.
4. Reserve the auditorium and begin to design a program with the students' names and characters (optional).
5. Arrange for a video projector if necessary.
6. If possible, try and arrange with your science colleagues to have an extended class period the day of the productions. It enhances the entire activity if all the skits can be done in one day, which means a minimum of 90 minutes.

Introductory Activities (10 minutes)

- Tell the students that they will be creating skits that portray some significant aspect about the element they explored and its family members.
- Inform students that they will have a choice of videotaping the skit or putting on a live production.
- Advise students that some of the work on this project will be after school hours.
- Distribute and review the Instructions for the **Chemistry-on-Stage Project** assignment with students.
- Distribute and review the **Chemistry-on-Stage Teacher Rubric and Chemistry-on-Stage Student Rubric**.

Pre-assessment

N/A



Teaching and Learning Activities

1. After the introduction, have students get with the "family members" or their "close relatives" (e.g., Family I and II, alkalai metals and alkaline earth metals) and begin discussing the plot for the skit (Day 1). The size of these groups will depend on the number of students you have.

2. Remind students to focus their skit around the discovery of at least one of the elements in the family and its importance to society (past or future, which leaves the "creative door open" to changes in time within the skit, such as flashbacks).

3. Advise students that they will have four days to work on their skits and scripts. Tell them they might have to get together after school to do some additional work.

4. Go from group to group helping students incorporate the science content with the history of the times as students work on their scripts. (Days 1-4).

5. Use rubrics for evaluation of the various aspects of students' performances. These evaluations will be done by other students and you. (Days 5 & 6).

Products and Assignments

- The skit scripts
- Evaluations of the other **Chemistry-on-Stage** performances
- Teacher evaluations of the **Chemistry-on-Stage** project using the **Chemistry-on-Stage Teacher Rubric.**

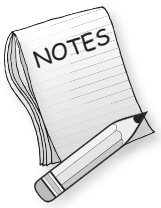
Extension Activities

N/A

Post Assessment

N/A

REACTIONS AND INTERACTIONS



Debriefing and Reflection Opportunities

Students will discuss ways to improve the project with the teacher after the performances are completed.

Name _____ Date_____

Instructions for the Chemistry-on-Stage Project

In an effort to provide students with a better understanding of the context in which science takes place, they will be planning and performing a skit in which some significant aspects of an element's history and uses are portrayed. As a result of a project that integrates the arts and science, opportunities are provided for students to demonstrate creativity and originality, as they choose methods that best communicate to an audience of their peers how scientific discoveries actually occur. Along with their other "elemental" family members (groups of two or three), students will write a script, secure costumes and props and perform or videotape a 10-minute skit. Each group of students will submit a beginning script (rough draft) that addresses the following requirements:

1. Include some important historical information (e.g., who or how was it discovered) about the element or compound of which it is a part. The object of the skit is to help the audience understand that science is not always predictable and that scientific discovery involves curiosity, mistakes and frustrations. It is to help viewers understand that scientific exploration can be tedious, can involve serendipity, is not always linear and sometimes is disrupted by human frailties.
2. Include some information about the element's family members. What do they have in common? Is there any other family member that is not on stage (it does not have to be an element previously assigned to students) that has some "different aspects" to his/her personality that may cause some "friction" in the family. For instance, during a skit that might be designed by the two or three students who researched the elements from the alkali family (lithium, sodium and potassium) their brother "Frank Francium" might be continually getting into fights at school because he cannot control his temper. It seems some of the siblings from the Waters family provoke him more than others and the school principal is trying to find out just what the underlying problem is that causes Frank to react so violently.
3. Include a use or two of the element and/or one of its compounds - "its job."
4. The skit must be historically accurate. If any other characters are used besides the elements, such as the English scientist Sir Humphry Davy, the discoverer of sodium in 1807, they must be portrayed with personalities, idiosyncrasies and talents that are historically accurate.
5. Props used should add "historical flavor" to the performance.
6. Type the script. A rough draft is due _____
7. I will be meeting with each group to review the draft after school. Schedule an appointment with me by _____.
8. Make a list of props you may need. It will be posted so that staff members and classmates can assist you in obtaining what you need. The list is due _____.
9. The final draft of the script is due _____.
10. Any research notes in addition to the ones used for the "*What's my element's story?*" project should be included, so that appropriate credit can be given for the additional work.
11. The *Chemistry-on-Stage* project will be assessed on the quality of the content, the level of completion of the

requirements, originality, effort and adherence to deadlines using the attached rubric.

12. Each student will be given a self-evaluation sheet and a sheet to evaluate the other students' performances. These assessment tools, plus my evaluation using the attached "Chemistry-on-Stage" rubric will all be part of the grading process.

I have read this project assignment on _____
(Date)

Parent or Guardian's Signature _____
(Signature)

Name_____ Date _____

Chemistry-on-Stage Teacher Rubric

Criteria	1	2	3	4	Your Score
Quality of Science Content	Science content is unclear, and information is disconnected.	Science content is clear, but supporting information is disconnected.	Science content is clear, and supporting information is relatively connected.	Presentation of science content with an abundance of relevant and interesting information is exceptional.	1 2 3 4
Understanding of Material	Student has an apparent misunderstanding of material.	Student has a limited understanding of material displayed by vague, unclear language.	Student has a clear understanding of material as evidenced by accuracy in information and attempts at explaining connections between science concepts.	Student has a thorough and deep understanding of material, as evidenced by language that is clear and that include explanations and connections between science concepts.	1 2 3 4
Understanding of Historical Context	Little to no understanding of historical context is evidenced from student's writing.	Some understanding of historical context is evidenced from student's writing, but student does not always reason scientifically.	Firm understanding of historical context is evidenced from student's writing.	Complete understanding of historical context is evidenced from student's writing. Student provides a level of detail and depth that exceeds requirements.	1 2 3 4
Effort	Student actively avoids jobs when possible, complains about others, or has large set of excuses for not contributing properly.	Student reluctantly does jobs when asked. The student seeks easiest duties in group. The student sometimes works to completion.	Student willingly takes on jobs when asked, works to completion, and will work long hours when required.	Student volunteers for jobs no matter how difficult, always works to completion, and is willing to work long hours.	1 2 3 4
Intellectual Contribution	Student has little or no grasp of context and sees task as isolated with no connection to past or future ideas.	Student is aware of overall context, but makes no connections on own. He/she can recite connections of others but rarely can support them.	Student usually understands overall context of task and asks questions about context. He/she makes connections on own and "gets" those others make.	Student understands overall context of the task. He/she contributes ideas and proposals and extends connections to ideas past and future.	1 2 3 4
Engagement	Student waits for direction, knows little of what is going on or objectives. He/she cannot describe where group is in process.	Student seeks direction, but does not initiate action. He/she sees objectives as poorly defined external requirements. He/she may know where group is.	Student sometimes initiates action and always works well with direction. He/she generally knows the specific objectives and where group is.	Student enthusiastically initiates action and personalizes the task and takes ownership of the objectives. He/she always knows where group is.	1 2 3 4

Criteria	1	2	3	4	Your Score
Planning	Student has no plan notion of the magnitude of the work. He/she is always late or scrambling to complete and is often a "no show" for group work session.	Student's plan is dominated by an early postponement and deadline related push. He/she may be a "no show" at start of task and he/she rarely meets deadlines.	Student makes plan, but does not always follow it. He/she may need help allotting time. He/she usually meets all deadlines.	Student conceptualizes task and plans execution as a rational, sequenced process. He/she always meets deadlines and overcomes problems.	1 2 3 4
Collaboration	Student is unable to work cooperatively with partners to complete the activity. He/she requires continual intervention by teacher.	Student simply follows directions of partner(s) and makes little effort to actively contribute.	Student is able to work cooperatively with partners to complete the activity, but may not be receptive to partners' ideas.	Student works cooperatively with partners to complete the activity, emerging as an effective collaborator who supports the ideas and suggestions of his/her peers.	1 2 3 4
Attention to Audience	Student did not attempt to engage audience.	Student made little attempt to engage audience.	Student engaged audience and held their attention most of the time by remaining on topic and presenting facts with enthusiasm.	Student engaged audience and held their attention throughout with creative articulation, enthusiasm, and a clearly focused presentation.	1 2 3 4
Clarity	Student had no apparent logical order of presentation; focus was unclear.	Student's content is loosely connected; transitions lack clarity	Student's sequence of information is well-organized for the most part, but more clarity with transitions is needed	Student's development of information is clear through use of specific and appropriate examples; transitions are clear and create a succinct and even flow.	1 2 3 4
Creativity	Student's delivery is repetitive with little or no variety in presentation techniques	Student's presents material with little interpretation or originality	Student showed some apparent originality through use of original interpretation of presented materials	Student's presentation and interpretation showed exceptional originality.	1 2 3 4
Speaking Skills	Speaker used a monotone; he/she seemed uninterested in material	Speaker had little eye contact, fast speaking rate and little expression. He/she mumbled.	Student presented clear articulation of ideas, but he/she apparently lacks confidence with material	Speaker showed exceptional confidence with material through poise, clear articulation, eye contact, and enthusiasm	1 2 3 4

Criteria	1	2	3	4	Your Score
Presentation Length	Presentation length greatly exceeded or fell short of allotted time.	Presentation length exceeded or fell short of allotted time.	Presentation remained close to the allotted time.	Presentation was within the allotted time	1 2 3 4

Name_____ Date _____

Chemistry-on-Stage Teacher Score Sheet

The first three criteria have a weighting factor of 10. The next 4 criteria have a weighting factor of 8. Criteria #9-12 carry a weight of 6 points and the last criteria carries a weight of 4 points. Your final score is as follows:

Score for

Item #1_____ x 10 =

Item #2_____ x 10 =

Item #3_____ x 10 =

Item #4_____ x 10 =

Item #5_____ x 8 =

Item #6_____ x 8 =

Item #7_____ x 8=

Item #8_____ x 8=

Item #9_____ x 6=

Item #10_____ x 6=

Item #11_____ x 6 =

Item #12_____ x 6=

Item #13_____ x 4= _____

Total Score_____

Name_____ Date _____

Chemistry-on-Stage Student Rubric

Criteria	1	2	3	4	Your Score
Quality of Science Content	Science content is unclear, and information is disconnected.	Science content is clear, but supporting information is disconnected.	Science content is clear, and supporting information is relatively connected.	Presentation of science content with an abundance of relevant and interesting information is exceptional.	1 2 3 4
Understanding of Material	Student has an apparent misunderstanding of material.	Student has a limited understanding of material displayed by vague, unclear language.	Student has a clear understanding of material as evidenced by accuracy in information and attempts at explaining connections between science concepts.	Student has a thorough and deep understanding of material, as evidenced by language that is clear and that include explanations and connections between science concepts.	1 2 3 4
Understanding of Historical Context	Little to no understanding of historical context is evidenced from student's writing.	Some understanding of historical context is evidenced from student's writing, but student does not always reason scientifically.	Firm understanding of historical context is evidenced from student's writing.	Complete understanding of historical context is evidenced from student's writing. Student provides a level of detail and depth that exceeds requirements.	1 2 3 4
Attention to Audience	Speaker did not attempt to engage audience	Speaker made little attempt to engage audience	Speaker engaged audience and held their attention most of the time by remaining on topic and presenting facts with enthusiasm	Speaker engaged audience and held their attention throughout with creative articulation, enthusiasm, and a clearly focused presentation	1 2 3 4

Criteria	1	2	3	4	Your Score
Clarity	Presentation has no apparent logical order and an unclear focus	Content is loosely connected; transitions lack clarity	Sequence of information is well-organized for the most part, but more clarity with transitions is needed	Development of information is clear through use of specific and appropriate examples; transitions are clear and create a succinct and even flow	
Creativity	Delivery is repetitive with little or no variety in presentation techniques	Material presented with little interpretation or originality	Some apparent originality displayed through use of original interpretation of presented materials	Exceptional originality of presented material and interpretation is displayed.	1 2 3 4
Speaking Skills	Speaker uses a monotone and seems uninterested in material	Speaker has Little eye contact, fast speaking rate, and little expression. He/she mumbled.	Speaker has clear articulation of ideas, but apparently lacks confidence with material.	Speaker displays exceptional confidence with material through poise, clear articulation, eye contact, and enthusiasm.	1 2 3 4

Name_____ Date _____

Chemistry-on-Stage Student Score Sheet

The first three criteria have a weighting factor of 20. The next 4 criteria have a weighting factor of 10. The final score is as follows:

Score for

Item #1_____ x 20 =

Item #2_____ x 20 =

Item #3_____ x 20 =

Item #4_____ x 10 =

Item #5_____ x 10 =

Item #6_____ x 10 =

Item #7_____ x 10= _____

Total Score_____