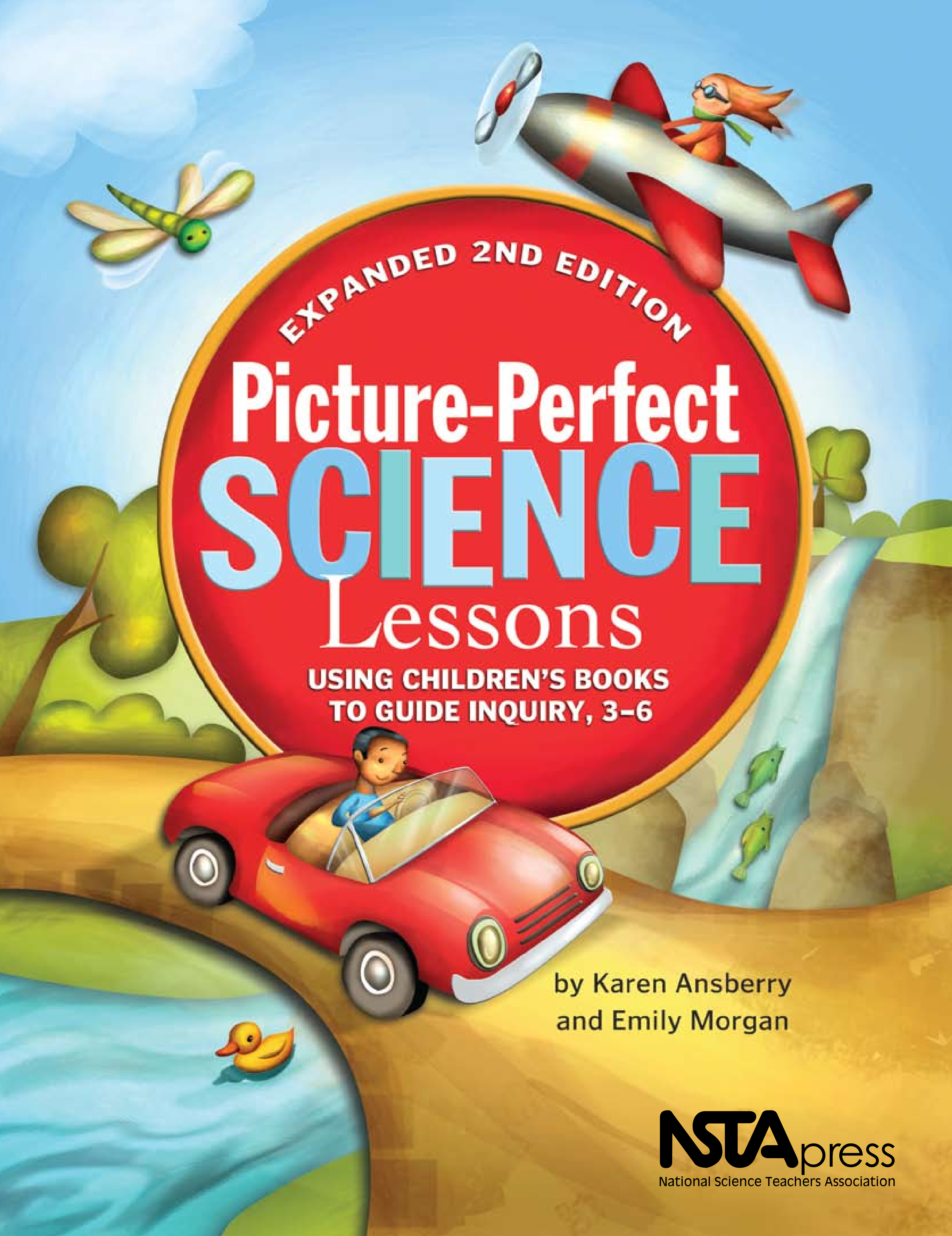

EXPANDED 2ND EDITION

Picture-Perfect SCIENCE Lessons

USING CHILDREN'S BOOKS TO GUIDE INQUIRY, 3–6

by Karen Ansberry
and Emily Morgan

NSTA press
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Contents

Foreword

I had the good fortune to meet the authors of *Picture-Perfect Science Lessons,* Karen Ansberry and Emily Morgan, in the fall of 2003 at a workshop I facilitated on inquiry-based science. At that event, we had a lively discussion about the nature of science and how the teachers in attendance might impart their love of science to elementary-age children. The authors then took me aside and told me of their plans to write a book for teachers (and parents, too) using children's literature to engage children in scientific inquiry. I have always believed that children in the elementary grades would experience more science if elementary teachers were provided with better ways to integrate literacy and science. So, of course, I was intrigued.

As I reviewed this manuscript, I was reminded of one of my favorite "picture books" as an adult—*The Sense of Wonder,* by Rachel Carson. In that book, Ms. Carson expresses her love of learning and how she helped her young nephew discover the wonders of nature. As she expressed,

> *I sincerely believe that for the child, and for the parent seeking to guide him, it is not half so important to know as to feel. If facts are the seeds that later produce knowledge and wisdom, then the emotions and the impressions of the senses are the fertile soil in which the seeds must grow. The years of early childhood are the time to prepare the soil. Once the emotions have been aroused—a sense of the beautiful, the excitement of the new and the unknown, a feeling of sympathy, pity, admiration or love—then we wish for knowledge about the object of our emotional response. Once found, it has lasting meaning. It is more important to pave the way for the child to want to know than to put him on a diet of facts he is not ready to assimilate.* (Carson 1956)

Rachel Carson used the natural environment to instill in her nephew the wonders of nature and scientific inquiry, but I believe, along with the authors, that picture books can have a similar emotional effect on children and inspire their wonder and their curiosity. Then, when teachers and parents couple scientific inquiry experiences with the content of the picture books, science really comes to life for children. *Picture-Perfect Science Lessons* provides an ideal framework that encourages children to read first; explore objects, organisms, and events related to what they've read; discern relationships, patterns, and explanations in the world around them; and then read more to gather more information, which will lead to new questions worth investigating.

In addition, *Picture-Perfect Science Lessons* is the perfect antidote to leaving science behind in the elementary classroom. As elementary teachers struggle to increase the basic literacy of all students, they often cannot find the time to include science in the curriculum, or they are discouraged from teaching science when literacy scores decline. Teachers need resources such as *Picture-Perfect Science Lessons* to genuinely integrate science and literacy. There is no doubt that inquiry-based science experiences motivate children to learn. Through this book, teachers have the best of both worlds—they will have the resources to motivate children to read and to "do science." What could be better?

As one of the developers of the BSCS 5E Instructional Model, I was gratified to learn that the authors intended to use the "5Es" to structure their learning experiences for children and teachers. These authors, as with many teachers across the country, had become acquainted with the 5Es and used the model extensively to promote learning in their own classrooms; however, they did not know the origin of the model until we had a conversation about BSCS and the 5Es. This book helps set the record straight—the 5E Instructional Model was indeed developed at BSCS in the late 1980s in conjunction with an elementary curriculum project and thus is appropriately titled "The BSCS 5E Instructional Model" in this book. The authors' iterative use of the BSCS 5Es is appropriate because the model is meant to be fluid, where one exploration leads to a partial explanation that invites further exploration before a child has a grasp of a complete scientific explanation for a phenomenon. As the authors mention, the final E—evaluate—is applied more formally at the end of a unit of study, but the BSCS 5E model by no means implies that teachers and students do not evaluate, or assess, student learning as the students progress through the model. Ongoing assessment is an integral part of the philosophy of the BSCS 5Es and the authors appropriately weave formative assessment into each lesson.

Once you place your toe into the waters of this book, I guarantee that you will dive right in! Whether you are a teacher, a parent, or both, you will enjoy this inviting approach to inquiry-based science. If you follow the methods outlined in *Picture-Perfect Science Lessons*, you and the children with whom you interact will have no choice but to learn science concepts through reading and scientific inquiry.

I don't know about you, but I'm rather curious about those sheep in a jeep. Enjoy!

Nancy M. Landes
Senior Science Educator
Center for Professional Development
Biological Sciences Curriculum Study

Reference

Carson, R. 1956. *The sense of wonder.* Berkeley, CA: The Nature Company. (Copyright renewed 1984 by Roger Christie. Text copyright 1956 by Rachel Carson.)

Preface

A class of fifth-grade students laughs as their teacher reads Jeanne Willis's *Dr. Xargle's Book of Earthlets.* Students are listening to the alien professor, Dr. Xargle, teach his pupils about Earthlets (human babies): "Earthlets are born without fangs. At first, they drink only milk, through a hole in their faces called a mouth. When they finish the milk, they are patted and squeezed so they won't explode." The fifth-grade class giggles at this outrageous lesson as Dr. Xargle continues to lecture. Students then begin sorting cards containing some of the alien professor's "observations" of Earthlets. The teacher asks her students, "Which of Dr. Xargle's comments are truly observations?" Students review their cards and realize that many of his comments are not observations but rather hilariously incorrect inferences. They re-sort their cards into two groups: observations and inferences. This amusing picture book and word sorting activity guide students into hands-on inquiry where they make observations about sealed mystery samples Dr. Xargle collected from Earth. Eventually students develop inferences about what the mystery samples might be. Through this exciting lesson, students construct their own understanding of the difference between an observation and an inference, how scientists use observations and inferences, and how to make good observations and inferences.

What Is Picture-Perfect Science?

This scenario describes how a children's picture book can help guide students through an engaging, hands-on inquiry lesson. *Picture-Perfect Science Lessons* contains 20 science lessons for students in grades 3 through 6, with embedded reading comprehension strategies to help them learn to read and read to learn while engaged in inquiry-based science. To help you teach according to the National Science Education Standards, the lessons are written in an easy-to-follow format for teaching inquiry-based science: the Biological Sciences Curriculum Study 5E Instructional Model (Bybee 1997, used with permission from BSCS). This learning cycle model allows students to construct their own understanding of scientific concepts as they cycle through the following phases: Engage, Explore, Explain, Elaborate, and Evaluate. Although *Picture-Perfect Science Lessons* is primarily a book for teaching science, reading comprehension strategies are embedded in each lesson. These essential strategies can be modeled throughout while keeping the focus of the lessons on science.

Use This Book Within Your Science Curriculum

We wrote *Picture-Perfect Science Lessons* to supplement, not replace, an existing science program. Although each lesson stands alone as a carefully planned learning cycle based on clearly defined science objectives, the lessons are intended to be integrated into a more complete unit of instruction in which concepts can be more fully developed. The lessons are not designed to be taught sequentially. We want you to use *Picture-Perfect Science Lessons* where appropriate within your school's current science curriculum to support, enrich, and extend it. And we want you to adapt the lessons to fit your school's curriculum, your students' needs, and your own teaching style.

Special Features

1. Ready-to-Use Lessons With Assessments

Each lesson contains engagement activities, hands-on explorations, student pages, suggestions for student and teacher explanations, opportunities for elaboration, assessment suggestions, and annotated bibliographies of more books to read on the topic. Assessments range from poster sessions with rubrics to teacher checkpoint labs to formal multiple choice and extended response quizzes.

2. Reading Comprehension Strategies

Reading comprehension strategies based on the book *Strategies That Work* (Harvey and Goudvis 2000) and specific activities to enhance comprehension are embedded throughout the lessons and clearly marked with an icon. Chapter 2 describes how to model these strategies while reading aloud to students.

3. Standards-Based Objectives

All lesson objectives were adapted from *National Science Education Standards* (NRC 1996) and are clearly identified at the beginning of each lesson. Because we wrote *Picture-Perfect Science Lessons* for students in grades 3 though 6, we used two grade ranges of the Standards: K–4 and 5–8. Chapter 5 outlines the National Science Education Standards for those grade ranges and shows the correlation between the lessons and the Standards.

4. Science as Inquiry

As we said, the lessons in *Picture-Perfect Science Lessons* are structured as guided inquiries following the 5E Model. Guiding questions are embedded throughout each lesson and marked with an icon ?. The questioning process is the cornerstone of good teaching. A teacher who asks thoughtful questions arouses students' curiosity, promotes critical-thinking skills, creates links between ideas, provides challenges, gets immediate feedback on student learning, and helps guide students through the inquiry process. Each lesson includes an "Inquiry Place," a section at the end of the lesson that suggests ideas for developing open inquiries. Chapters 3 and 4 explore science as inquiry and the BSCS 5E Instructional Model.

References

Bybee, R. W. 1997. *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann.

Harvey, S., and A. Goudvis. 2000. *Strategies that work: Teaching comprehension to enhance understanding.* York, ME: Stenhouse Publishers.

National Research Council. 1996. *National science education standards.* Washington, DC: National Academies Press.

Children's Book Cited

Willis, J. 2003. *Dr. Xargle's book of Earthlets*. London, UK: Anderson Press Ltd.

Editors' Note: *Picture-Perfect Science Lessons* builds on the texts of 38 children's picture books to teach science. Some of these books feature animals that have been anthropomorphized—sheep crash a jeep, a hermit crab builds his house. While we recognize that many scientists and educators believe that personification, teleology, animism, and anthropomorphism promote misconceptions among young children, others believe that removing these elements would leave children's literature severely underpopulated. Furthermore, backers of these techniques not only see little harm in their use but also argue that they facilitate learning.

Because *Picture-Perfect Science Lessons* specifically and carefully supports scientific inquiry—"The Changing Moon" lesson, for instance, teaches students how to weed out misconceptions by asking them to point out inaccurate depictions of the Moon—we, like our authors, feel the question remains open.

Acknowledgments

We would like to give special thanks to science consultant Carol Collins for sharing her expertise in teaching inquiry-based science, for giving us many wonderful opportunities to share *Picture-Perfect Science Lessons* with teachers, and for continuing to support and encourage our efforts.

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About the Authors

Karen Ansberry is an elementary science curriculum leader and a former fifth- and sixth-grade science teacher at Mason City Schools, in Mason, Ohio. She has a bachelor of science in biology from Xavier University and a master of arts in teaching from Miami University. Karen lives in historic Lebanon, Ohio, with her husband, daughter, twin boys, two dogs, and two cats.

Emily Morgan is the science leader for the High AIMS Consortium in Cincinnati, Ohio. She is a former elementary science lab teacher at Mason City Schools in Mason, Ohio, and a seventh-grade science teacher at Northridge Local Schools in Dayton, Ohio. She has a bachelor of science in elementary education from Wright State University and a master of science in education from the University of Dayton. Emily lives in West Chester, Ohio, with her husband, son, dog, and two cats.

Karen and Emily, along with language arts consultant Susan Livingston, received a Toyota Tapestry grant for their Picture-Perfect Science grant proposal in 2002. Since then, they have enjoyed facilitating teacher workshops at elementary schools, universities, and professional conferences across the country. They are also the authors of *More Picture-Perfect Science Lessons: Using Children's Books to Guide Inquiry, K–4.*

Karen Ansberry, right, and Emily Morgan developed *Picture-Perfect Science Lessons* based on their workshops supported by a Toyota Tapestry grant.

About the Picture-Perfect Science Program

The Picture-Perfect Science program originated from Emily Morgan's and Karen Ansberry's shared interest in using children's literature to make science more engaging. In Emily's 2001 master's thesis study involving 350 of her third-grade science lab students at Western Row Elementary, she found that students who used science trade books instead of the textbook scored significantly higher on district science performance assessments than students who used the textbook only. Convinced of the benefits of using picture books to engage students in science inquiry and to increase science understanding, Karen and Emily began collaborating with Susan Livingston, the elementary language arts curriculum leader for the Mason City Schools in Ohio, in an effort to integrate literacy strategies into inquiry-based science lessons. They received grants from the Ohio Department of Education (2001) and Toyota Tapestry (2002) to train all third-grade through sixth-grade science teachers, and in 2003 they also trained seventh- and eighth-grade science teachers with district support. The program has been presented both locally and nationally, including at the National Science Teachers Association national conferences.

For more information on Picture-Perfect Science teacher workshops, go to *www.pictureperfectscience.com.*

Lessons by Grade

Chapter		Grade	Picture Books
6	Earthlets	3–6	*Dr. Xargle's Book of Earthlets* *Seven Blind Mice*
7	Name That Shell!	3–4	*Seashells by the Seashore* *A House for Hermit Crab*
8	Rice Is Life	3–6	*Rice Is Life* *Rice*
9	What's Poppin'?	5–6	*Popcorn!*
10	Mystery Pellets	3–6	*White Owl, Barn Owl* *Butternut Hollow Pond*
11	Close Encounters of the Symbiotic Kind	4–6	*What's Eating You? Parasites—The Inside Story* *Weird Friends: Unlikely Allies in the Animal Kingdom*
12	Turtle Hurdles	3–4	*Turtle Watch* *Turtle, Turtle, Watch Out!*
13	Oil Spill!	3–6	*Prince William* *Oil Spill!*
14	Sheep in a Jeep	3–4	*Sheep in a Jeep*
15	Sounds of Science	3–4	*Sound* *The Remarkable Farkle McBride*
16	Chemical Change Café	3–6	*Pancakes, Pancakes!*
17	The Changing Moon	3–6	*Rise the Moon* *The Moon Book* *Papa, Please Get the Moon for Me*
18	Day and Night	3–6	*Somewhere in the World Right Now*
19	Grand Canyon	3–6	*Erosion* *Grand Canyon: A Trail Through Time*
20	Brainstorms: From Idea to Invention	5–6	*Imaginative Inventions* *Girls Think of Everything: Stories of Ingenious Inventions by Women*

Chapter		Grade	Picture Books
21	Bugs!	3–4	*The Perfect Pet* *Bugs Are Insects* *Ant, Ant, Ant! (An Insect Chant)*
22	Batteries Included	4–6	*Electrical Circuits* *Too Many Toys*
23	The Secrets of Flight	3–6	*How People Learned to Fly* *Kids' Paper Airplane Book*
24	Down the Drain	3–6	*Down the Drain: Conserving Water* *A Cool Drink of Water*
25	If I Built a Car	4–6	*If I Built a Car* *Inventing the Automobile*

Activity-specific safety guidelines are highlighted throughout the lessons. For a more thorough discussion of safety procedures, see *The NSTA Ready-Reference Guide to Safer Science* or *Exploring Safely.* The National Science Teachers Association has also created a convenient *Safety in the Elementary Science Classroom* flipchart. This colorful and student-friendly safety resource can be hung on the wall for easy reference or a quick refresher.

Resources

Kwan, T., and J. Texley. 2002. *Exploring safely: A guide for elementary teachers.* Arlington, VA: NSTA Press.

National Science Teachers Association (NSTA). 2003. *Safety in the elementary science classroom* flipchart. Arlington, VA: NSTA Press.

Roy, K. R. 2007. *The NSTA ready-reference guide to safer science.* Arlington, VA: NSTA Press.

Chemical Change Café

Description

Learners explore the differences between chemical and physical changes by observing a variety of changes in matter. Learners observe the chemical change of cooking pancakes and identify new menu items for the Chemical Change Café.

Suggested Grade Levels: 3–6

Lesson Objectives Connecting to the Standards

Content Standard A: Scientific Inquiry

K–4: Use data (observations) to construct a reasonable explanation.

5–8: Develop descriptions, explanations, and predictions using evidence.

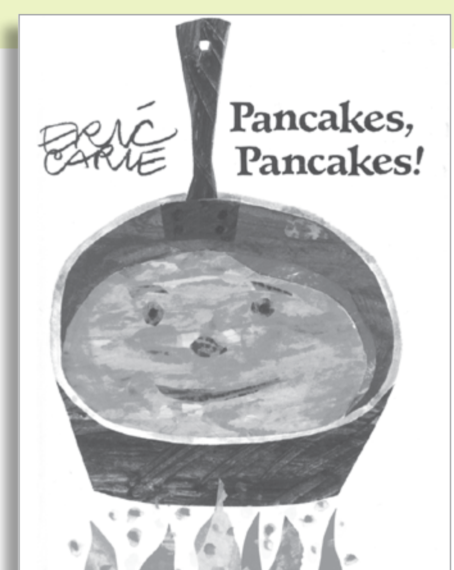
Content Standard B: Physical Science

K–4: Understand that objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances.

5–8: Understand that substances react chemically in characteristic ways with other substances to form new substances with different characteristic properties.

Featured Picture Book

Title	***Pancakes, Pancakes!***
Author	**Eric Carle**
Illustrator	**Eric Carle**
Publisher	**Aladdin**
Year	**2005**
Genre	**Story**
Summary	**By cutting and grinding the wheat for flour, Jack starts from scratch to help make his breakfast pancake.**



Time Needed

This lesson will take several class periods. Suggested scheduling is as follows:

Day 1: **Engage** with changing paper, and **Explore** with Observing Changes in Matter lab stations

Day 2: **Explain** with Chemical Changes article, Frayer Model, and *Pancakes, Pancakes!* read aloud

Day 3: **Elaborate** with Chemical Change Café

Day 4: **Evaluate** with New Menu Items

Materials

For Changing Paper Demonstration

- Piece of paper
- Glass jar
- Matches (for teacher use only)

For Observing Changes in Matter Lab Stations

SAFETY

Station 1: Before this activity, check with your school nurse to see if any students have latex allergies. Students who are allergic to latex should not do the activity at Station 1.

Station 3: Before this activity, demonstrate for students the safe way to smell any chemical by "wafting."

- A red plastic cup and a green plastic cup with the bottoms taped together (1 per team)
- Station 1
  - 7 pieces of bubble wrap
- Station 2
  - Small cup of vinegar
  - Small cup of baking soda
  - Wax paper (1 piece per group)
  - Spoon
  - Pipette
- Station 3
  - Cup of fresh milk covered with foil (labeled "fresh")
  - Cup of sour milk covered with foil (labeled "sour")
- Station 4
  - Lump of clay
- Station 5
  - New steel wool
  - Rusted steel wool in water (leave in water for at least 24 hours)
- Station 6
  - Resealable plastic sandwich bags (1 per team)
  - 2 teaspoons
  - 25 ml graduated cylinder
  - Small cup of cream of tartar
  - Small cup of baking soda
  - Room temperature water
  - 3 thermometers (labeled "1," "2," and "3")
- Station 7
  - Two 25 ml graduated cylinders
  - Clear plastic cups (1 per group)
  - Cup of whole milk
  - Cup of vinegar

For Chemical Change Café

SAFETY

Before using this activity, check your school's policy on eating as part of a science lab activity. Some schools forbid it, and commercial labs can be fined for even the appearance of eating. Make sure your students know they should never taste anything in a lab activity. *Exploring Safely: A Guide for Elementary Teachers* recommends, "Nothing should be tasted or eaten as part of science lab work" (Kwan and Texley 2002). Also check with your school nurse to see if any students have dietary restrictions.

- Box of "just add water" pancake mix (1 per group)
- Metric measuring cups for food preparation (1 per group)
- Water
- Wire whisks or spoons (1 per group)
- Mixing bowls (1 per group)
- Electric griddle or hot plate with a pancake pan (for teacher use only)
- Spatula
- Paper plates
- Forks
- Bottles of pancake syrup

Student Pages

- Observing Changes in Matter
- Chemical Changes article
- Chemical Change Frayer Model
- Chemical Change Café Menu
- New Menu Items

Background

A *chemical change* occurs when a substance changes into a new substance with new properties. For example, when you add baking soda to vinegar, a gas bubbles up. The gas, carbon dioxide, has different properties from the baking soda and the vinegar. This is a chemical reaction, which is just another way of saying chemical change. The opposite of a chemical change is a *physical change*. A physical change is a change in matter that might change the form or appearance of a substance but does not produce any new substances. For example, when you chop a piece of wood, its appearance changes, but it is not a new substance. It is still wood. When you put water in the freezer, it turns to ice, but it is still water, just in a different form. Observing any of the following when you combine two or more substances can give you clues that a chemical change has occurred:

- Gas is produced (bubbles).
- Temperature changes.

- Odor changes.
- Color changes.
- A solid forms when two liquids are combined (precipitate).
- Light is emitted.

Although any of these phenomena may be evidence of a chemical change after combining substances, sometimes a physical change can have similar results. For example, boiling water causes bubbles to appear. The bubbles contain water vapor—liquid water that has physically changed into a gas—so no *new* substance is produced. Another example is mixing paint. Although the resulting color may be different from the original colors, the chemical properties of the paint are the same. No new substance has been produced—it's still paint!

A common misconception about distinguishing between physical and chemical changes is that with a physical change, you can "change it back." That is not always true. For example, after you tear a piece of paper into a thousand pieces, you can't return it to its original form. But tearing paper is a physical change because the small pieces are still the same substance as the whole piece of paper was. And in fact, there are some chemical changes that can be reversed. So the best defining characteristic of a chemical change is the presence of a new substance or substances that are entirely different from the starting substances. Sometimes it is really difficult to distinguish between a chemical change and a physical change (in some cases scientists don't even agree!), but the important idea is that matter can be changed in different ways.

The National Science Education Standards state that students in grades K–4 should understand that objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Students in grades 5–8 should understand that substances react chemically with other substances to form new substances with different characteristic properties. It can be tempting to introduce atoms and molecules to explain these changes, but the Standards suggest that this terminology is premature for students in grades 5–8 and can distract from the understanding that can be gained from merely observing and describing such changes.

engage

Changing Paper

Show students a piece of blank paper. Ask

? What can I do to change this piece of paper?

Students may suggest folding it, rolling it up, cutting it, tearing it, writing on it, and crumpling it up into a ball. Try all of the students' suggestions, and after each one, ask

? Is it still paper? (yes)

Then roll up the piece of paper, and put it in a large glass jar. Strike a match, light the paper on fire, and let the students watch it burn. After the paper has finished burning, ask students

? Is it still paper? How do you know? (No, it is a different substance with new properties.)

explore

Observing Changes in Matter Lab Stations

In advance, set up seven separate locations in the room as lab stations. Number each station, and supply all of the necessary materials for the Observing Changes in Matter activity to be done at that station. Put students in groups of two to four, and give each student the Observing Changes in Matter student page. Tell students they will have a red-green cup to signal the teacher. While they are working, they should keep the green side on top. If they need help, or if they are finished and ready to move to the next station, they should put the red side on top.

Each team will begin at a different station and will visit all seven stations during the lab. Students will complete the activities at each station and record their observations on the student page. They will learn what "P" and "C" mean later. Each member of the group is responsible for writing responses. When all teams are finished (all red cups are up), students may rotate to the next numbered station.

"Wafting" fresh and sour milk in the lab

SAFETY

Demonstrate for students the safe way to smell any chemical by "wafting" (Station 3). Remind students that they should never taste anything during a laboratory activity.

explain

Chemical Changes Article

Pairs Read

Pass out the Chemical Changes article. Tell students this article will help them learn more about the changes they observed. Have students take turns reading aloud from the article. While one person reads a paragraph, the other listens and makes comments ("I think ..."), asks questions ("I wonder ..."), or shares new learnings ("I didn't know ..."). Students can use the information they learn from this article on the Chemical Change Frayer Model student page.

Frayer Model

The Frayer Model is a tool to help students develop their vocabularies by studying concepts in a relational manner. Students write a particular word in the middle of a box and proceed to list characteristics, examples, nonexamples, and a definition in other quadrants of the box. They can proceed by using the examples and characteristics to help them formulate a definition or, conversely, by using the definition to determine examples and nonexamples.

In this case, have students use the preceding article to formulate a definition for "chemical change" in their own words in the top left box of the Chemical Change Frayer Model. Then have students write some characteristics of chemical changes in the top right box. Have students work in pairs to come up with exam-

Physical and Chemical Changes in *Pancakes, Pancakes!*

Physical Changes	**Chemical Changes**
Cutting wheat	Burning wood for a fire
Separating grain from chaff	Cooking the pancake
Grinding wheat	
Squirting milk in the pail	
Churning butter	
Melting butter	
Chopping wood	
Breaking an egg	
Stirring the batter	

ples and nonexamples from their own lives. As you observe students working, encourage them to use their previous experiences as a basis for their chemical change examples. Students can then present and explain their models to other groups. As they present to each other, informally assess their understanding of the concept and clarify as necessary.

After the reading and the Frayer Model activity, point out that with a chemical change, the change happens without any external assistance. For example, water can get hot in a physical change if there is an external source of heat. Materials can change color in a physical change if there is an external source of color—paint, for example.

Refer back to the paper you used in the Engage phase. Ask students

? Which of the changes that I made to the paper demonstrated a chemical change? Why? (Burning the paper was a chemical change because when the change was complete, there was a new substance formed: black ash.)

With this new information students have learned from the article, have them go back to the Observing Changes in Matter student page they completed in the Explore phase and identify each change as physical or chemical by circling "P" or "C."

Answers

The physical changes in the Observing Changes in Matter exploration were

Station 1: Popping the bubble wrap

Station 4: Forming clay into different shapes

The chemical changes in the Observing Changes in Matter exploration were

Station 2: Vinegar and baking soda reaction (gas bubbles produced)

Station 3: Souring milk (change in odor)

Station 5: Rusted steel wool (change in color and odor)

Station 6: Cream of tartar, baking soda, and water reaction (change in temperature)

Station 7: Vinegar and milk reaction (precipitate formed)

SAFETY

In *Safety in the Elementary (K-6) Science Classroom: Second Edition,* the American Chemical Society (2001) gives the following safety rules for working with hot plates:

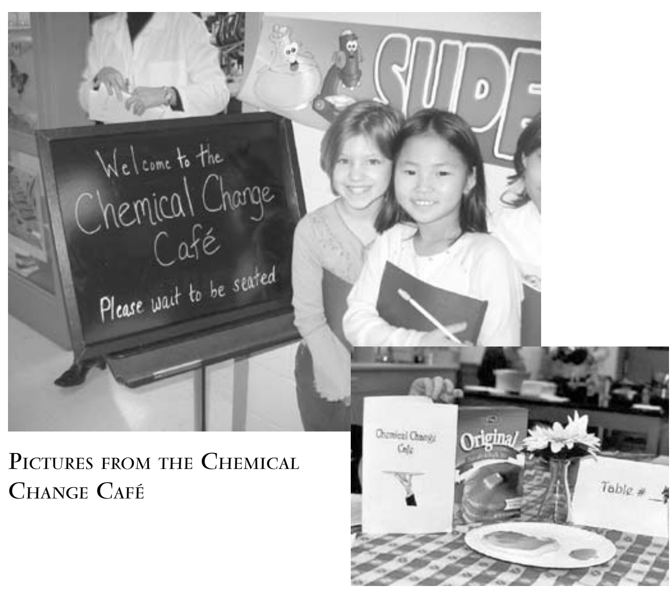
1. When working around a heat source, tie back long hair and secure loose clothing.
2. The area surrounding a heat source should be clean and have no combustible materials nearby.
3. When using a hot plate, locate it so that a child cannot pull it off the worktop or trip over the power cord.
4. Never leave the room while the hot plate is plugged in, whether or not it is in use; never allow students near an in-use hot plate if the teacher is not immediately beside the students.
5. Be certain that hot plates have been unplugged and are cool before handling. Check for residual heat by placing a few drops of water on the hot plate surface.

In addition, read the safety box included in the Materials List for the Chemical Change Café.

Explain

Pancakes, Pancakes!

Introduce the author and illustrator of *Pancakes, Pancakes!* Ask students if they have read any other books by Eric Carle (information about him can be found at *www.eric-carle.com*).



PICTURES FROM THE CHEMICAL CHANGE CAFÉ

Determining Importance

Tell students that as you read the story aloud, they should listen for examples of chemical and physical changes that occur in the story. Have students signal (raise their hands) when they hear examples. Have them classify the change as chemical or physical and provide justification.

Elaborate

Chemical Change Café

The day after reading *Pancakes, Pancakes!* convert your classroom into the Chemical Change Café. Set up a hot plate with a pancake pan or an electric griddle for your use only. Locate the cooking area away from any high traffic areas in your classroom. Provide a box of "just add water" pancake mix, metric measuring cup, spoon or whisk, and container of water for each table of students.

Greet students at the door, divide them into groups, and distribute the menus. All supplies should be on the desks, and students

will follow directions on the menu to make the batter. Invite groups to bring their prepared batter to the cooking area, and they can observe changes as you cook the pancakes according to the package directions. On the menus, students should draw and describe the pancakes before and after they are cooked and explain why cooking pancakes is a chemical change.

Student Procedure for Chemical Change Café (Making Pancakes)

- Please mix 250 ml of pancake mix with 175 ml of water and stir until smooth.
- Please raise your hand to notify the chef that you are ready to have your batter cooked.
- Watch as the batter is changed into a light and fluffy pancake.
- Add a little syrup.
- Enjoy!

Evaluate

New Menu Items

As a final evaluation of student understanding of chemical versus physical changes, have students complete the New Menu Items student page.

The following items can be added to the Chemical Change Café menu because they are turned into new substances with new properties:

1 Toast
3 Scrambled eggs
6 Buttermilk biscuits
8 Cottage cheese
10 Toasted marshmallows

The other items cannot be served at the Chemical Change Café because they undergo only physical changes in their preparation.

Inquiry Place

Have students brainstorm testable questions such as

- ? How does temperature affect the rate of a chemical change?
- ? Will steel wool rust faster in water, salt water, or vinegar?
- ? How can you make a sugar cube undergo a physical change? A chemical change?

Have students select a question to investigate as a class, or groups of students can vote on the question they want to investigate as teams. After they make their predictions, they can design an experiment to test their predictions. Students can present their findings at a poster session.

More Books to Read

Cole, J. 1995. *The Magic School Bus gets baked in a cake: A book about kitchen chemistry.* New York: Scholastic Books.
Summary: Ms. Frizzle's class takes the Magic School Bus to the local bakery to find out about the chemistry of baking.

Stille, D. 2006. *Chemical change: From fireworks to rust.* Mankato, MN: Compass Point Books.
Summary: This book for grades 5–7 describes chemical changes and highlights some of the commercial and consumer products that result from chemical changes, such as plastics and dyes.

Stille, D. 2006. *Physical change: Reshaping matter.* Mankato, MN: Compass Point Books.
Summary: This book for grades 5–7 describes the physical changes of matter, including melting, freezing, suspensions, boiling, and condensing.

References

American Chemical Society (ACS). 2001. *Safety in the elementary (K–6) science classroom: Second edition.* Washington, DC: ACS.

Kwan, T., and J. Texley. 2002. *Exploring safely: A guide for elementary teachers*. Arlington, VA: NSTA Press

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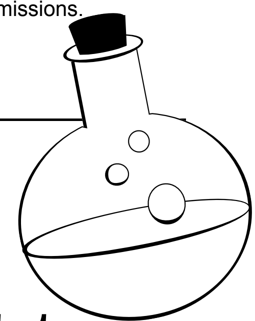

Observing Changes in Matter

Follow the directions below and record your observations at each station. Use all of your senses, except taste, to make your observations. You will decide whether each change is *physical* (P) or *chemical* (C) later in this lesson.

Station 1 P or C

- Observe the bubble wrap. Record your observations.

____

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- Pop the bubbles with your fingers.
- Observe the bubble wrap again. How has it changed?

____

____

Station 2 P or C

- Observe the cup of baking soda and the cup of vinegar, and record your observations.

____

____

- Put a small spoonful of baking soda on the wax paper.
- Put 5 drops of vinegar on the baking soda.
- Observe what is on the wax paper. How has it changed?

____

____

Name: ______________________________

Observing Changes in Matter cont.

Station 3 P or C

- Take the foil off the fresh milk and observe.
- Smell the fresh milk by "wafting." Put the foil back on.

____

____

- Take the foil off the sour milk and observe.
- Smell the sour milk by "wafting." Put the foil back on.
- How has the milk changed?

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Station 4 P or C

- Observe the clay, and record your observations.

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- Form the clay into a different shape.
- Observe the clay again. How has it changed?

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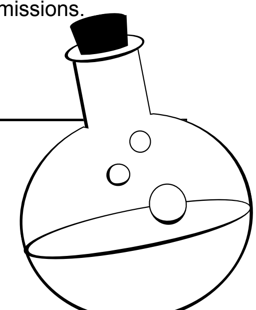

Observing Changes in Matter cont.

Station 5 P or C

- Observe the new steel wool, and record your observations.

____

____

- Observe the steel wool that has been in water.
- Describe the differences between the new steel wool and the wet steel wool.

____

____

Station 6 P or C

- Put 1 teaspoon of cream of tartar and 1 teaspoon of baking soda in a sandwich bag.
- Observe the cream of tartar and baking soda.
- Record the temperature of the mixture with thermometer 1.

____

- Observe the water in the cup.
- Record its temperature with thermometer 2.

____

- Add 10 ml of water to the cream of tartar and baking soda mixture in the sandwich bag.
- Feel the outside of the bag.

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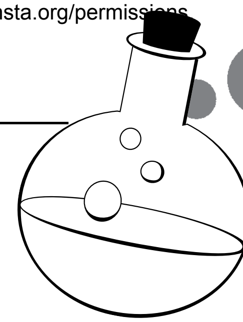

Observing Changes in Matter cont.

- Record the temperature of the "stuff" inside the bag with thermometer 3.

____

- How have the water and cream of tartar and baking soda changed?

____

____

Station 7 P or C

- Observe the milk, and record your observations.

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- Observe the vinegar, and record your observations.

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- Pour 20 ml of milk into a clear plastic cup.
- Pour 10 ml of vinegar into the milk, stir once, and let it sit for 1 min.
- Observe the "stuff" in the cup. How have the milk and vinegar changed?

____

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Name: ______________________________

Chemical Changes

Changing Matter

Every day we see changes in the matter around us. Sometimes there is a change in the appearance of matter and other times the change results in an entirely new substance.

Chemical Changes

A **chemical change** is a change in matter that produces new substances. For example, when a piece of wood is burned, it is no longer wood. It is changed into an entirely new substance with new properties. The wood changes from a hard solid into various gases, smoke, and a pile of ash. When cake batter is cooked, the ingredients form a new substance with a different smell, color, texture, and taste.

Physical Changes

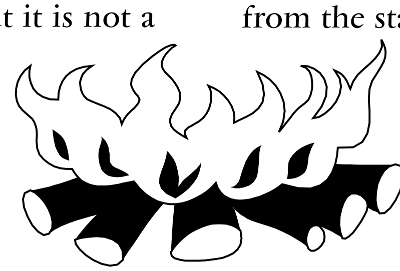
The opposite of a chemical change is a **physical change**. A physical change is a change in matter that might change the form or appearance of a substance, but does not produce any new substances. For example, when you tear a piece of paper, its appearance changes, but it is not a new substance. It is still paper. When you put water in the freezer, it turns to ice, but it is still water, just in a different form.

Evidence of a Chemical Change

You can use your senses to detect chemical changes. Here are some characteristics that can help you determine if a chemical change has occurred:

- Gas produced (bubbles)
- Change in temperature
- Change in odor
- Change in color
- A solid formed when combining two liquids (precipitate)
- Light emitted

Any one of these characteristics is evidence that a chemical change has occurred. But sometimes a physical change can have similar results. The key characteristic of a chemical change is the presence of a new substance or substances that are entirely different from the starting substances.



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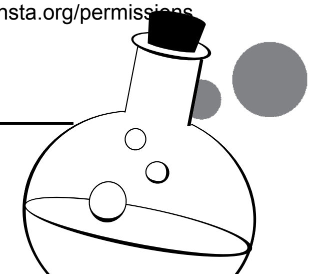


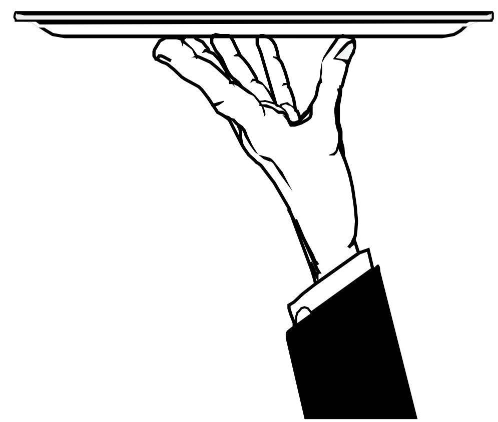
Chemical Change

Frayer Model

Definition	Characteristics
Chemical Change	
Examples	Nonexamples

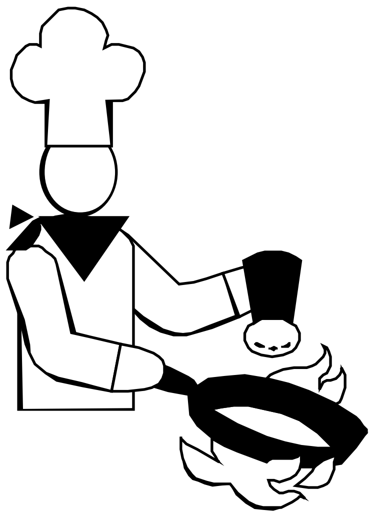
Is cooking pancakes a physical or chemical change? What is your evidence?

Chemical Change Café



Menu

Today's Special



Pancakes

- Please mix **250 ml of pancake mix** with **175 ml of water** and stir until smooth.
- Please raise your hand to notify the chef that you are ready to have your batter cooked.
- Watch as the batter is changed into a light and fluffy pancake.
- Add a little syrup.
- Enjoy!

Draw and describe the pancakes before cooking.

Draw and describe the pancakes after cooking.

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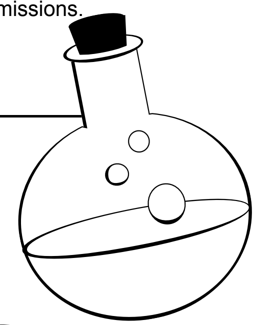

New Menu Items

The Chemical Change Café would like to add some new items to the menu. Only food that has been prepared through a chemical change can be featured on our menu. Put a check mark next to each item that can be added to the menu at the Chemical Change Café.

❑ **1** Toast

We begin with a plain white piece of bread and heat it until it turns brown and produces a delightful smell.

Is making toast a chemical change? Why or why not?

____

____

❑ **2** Orange Juice

Lovely fresh oranges are hand squeezed until the delicious juice drips into your glass.

Is making orange juice a chemical change? Why or why not?

____

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❑ **3** Scrambled Eggs

Grade A eggs are cooked until they are light, fluffy, and yellow.

Is making scrambled eggs a chemical change? Why or why not?

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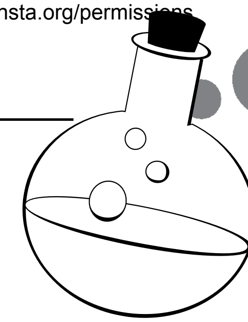

New Menu Items cont.

❑ **4** Strawberry Smoothie

We begin with strawberries, ice, sugar, and milk. We blend them together to make a thick, delicious drink.

Is making a strawberry smoothie a chemical change? Why or why not?

____

____

❑ **5** Trail Mix

We mix together the finest fresh nuts and dried fruits to create this tasty blend.

Is making trail mix a chemical change? Why or why not?

____

____

❑ **6** Buttermilk Biscuits

Creamy buttermilk, baking powder, flour, butter, and salt are mixed together and baked until gas bubbles cause them to rise. The batter turns into flaky, golden brown biscuits. The aroma of the baked biscuits is delightful.

Is making buttermilk biscuits a chemical change? Why or why not?

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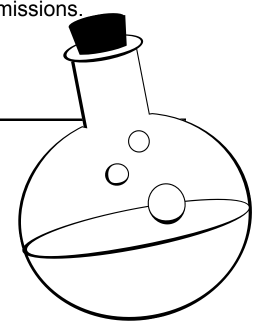

New Menu Items cont.

❑ **7** Orange-sicles

We freeze our finest fresh orange juice until the orange liquid becomes a tasty, frozen solid.

Is making orange-sicles a chemical change? Why or why not?

____

____

❑ **8** Cottage Cheese

Fresh milk is combined with special enzymes until the milk becomes thick and clumpy with a completely new taste and smell.

Is making cottage cheese a chemical change? Why or why not?

____

____

❑ **9** Fruit Salad

Fresh pineapple, strawberries, kiwi, and blueberries are sliced and mixed together to make this sweet treat.

Is making fruit salad a chemical change? Why or why not?

____

____

❑ **10** Toasted Marshmallows

Fluffy white marshmallows are toasted over an open flame until they begin to turn golden brown and smell heavenly.

Is making toasted marshmallows a chemical change? Why or why not?

____

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Index

*Page numbers in **boldface** type refer to figures or tables. Those followed by "n" refer to footnotes.*