Smithsonian Science for the Classroom

HOW CAN WE IDENTIFY MATERIALS BASED ON THEIR PROPERTIES?

Grade 5 - Physical Science

TRAINER GUIDE

CURRICULUM PROFESSIONAL DEVELOPMENT

Smithsonian
Science Education Center

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How Can We Identify Materials Based on Their Properties?

Grade 5—Physical Science

Trainer Guide

INTRODUCTION

In 2019, the US Department of Education awarded the Smithsonian Science Education Center an early-phase Education Innovation and Research (EIR) grant to support the development, implementation, and initial evaluation of evidence-based innovations to improve student achievement. The project, called Smithsonian Science for North and South Carolina Classrooms (PR# U411C190055), took place between October 2019 and September 2024 in third-, fourth-, and fifth-grade classrooms in North and South Carolina.

Between 2020 and 2023, participating teachers in implementation schools received curriculum professional development tied to two Smithsonian Science for the Classroom curriculum modules and content and pedagogy professional development tied to the content of each module to implement in their classrooms. The Center for Research in Educational Policy (CREP) at the University of Memphis evaluated the impact of these modules and professional development on student achievement using standardized assessments, classroom observations, and teacher focus groups.

This guide was developed as a support for trainers leading curriculum professional development for fifth grade teachers implementing the Smithsonian Science for the Classroom Physical Science module *How Can We Identify Materials Based on Their Properties?*

RESOURCES

- Teacher Guide (TG)
- Student Activity Guide (SAG)
- Smithsonian Science Stories Literacy Series: *What's Cooking* (Reader)
- Carolina Science Online (CSO): Carolinascienceonline.com

HOW TO USE THIS TRAINER GUIDE

This guide shares important ideas and strategies for effectively introducing a Smithsonian Science for the Classroom (SSftC) module with educators, when used in conjunction with the corresponding Teacher Guide. The Teacher Guide contains essential details needed to implement the module in the classroom, while this Trainer Guide outlines how to conduct professional development for that module; therefore, the two guides should be used in tandem.

The professional development plan for each section is outlined in a table at the start of each session. Within each section, there is another table. The first column shows the part of the lesson being addressed, and corresponding page numbers within the Teacher Guide, Student Activity Guide, and Reader. The second column provides the trainer with additional direction in concise bullet points.

ROOM SETUP

To set up a classroom for this workshop:

- Move tables or desks so groups of three or four participants can work together.
- Set module materials out on side tables where they can be easily accessed.
- Locate the nearest restrooms and evacuation routes.

WORKSHOP OVERVIEW

This trainer guide provides direction on facilitating the curriculum sessions highlighted in the table below.

Day 1		Day 2	
10 a.m.	Welcome Session	**10 a.m.** Curriculum Session 3	Focus Questions 3-4 (Lessons 8-12)*
11 a.m. Curriculum Session 1	Introduction and Lesson 1	**12 p.m.**	Lunch
12 p.m.	Lunch	**12:45 p.m.** Curriculum Session 4	Focus Question 5 (Lessons 13-15)
12:45 p.m. Curriculum Session 2	Focus Questions 1-3 (Lessons 2-7)	**3 p.m.**	Closing Session
3:30 p.m.	Adjourn	**3:30 p.m.**	Adjourn

**Depending on the workshop design, this section may be led by participants if they have adequate time to prepare.*

Note: Statements in italics are intended to provide supporting information to facilitators.

SESSION 1:

Introduction and Lesson 1

In this session, the trainer leads lessons as a facilitator (wearing their "teacher hat") while teachers act as learners (wearing their "student hats").

Goal: The trainer facilitates the first lesson as an exemplar and introduces the concept storyline of the G5 Physical Science module. Participants experience Lesson 1 as learners and debrief the lesson as teachers.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Housekeeping and Introductions	10 minutes	
Lesson 1	30 minutes	
SSftC Features and CSO	15 minutes	
Concept Storyline	5 minutes	

	Key Points
Housekeeping and Introductions	**Introductions** Welcome participants to your session. Remind them that this professional learning workshop is meant to orient teachers to a new Smithsonian Science for the Classroom curriculum module. At times they will be asked to wear their "student hat" and experience lessons as their students will, and at other times they'll reflect on the material wearing their "teacher hat." **Icebreaker Activity** Participants introduce themselves through an icebreaker activity. **Housekeeping** Preview the agenda. Verify the safety protocols in the classroom and locate the nearest restrooms, fire exit, and tornado shelter.

	Key Points
	Establish the Tone for the Day Divide participants into small groups and ask them to think about what they want to achieve today. What norms do they think will encourage a positive learning environment? Introduce group norm ideas: • Be brave • Be present • Ask questions • Be respectful Have each small group discuss the suggested norms and add to the group list of norms. Once everyone has added their ideas, ask if there are any changes, additions, or modifications that need to be made. When the discussion is finished, this will be the social contract the group abides by for the next two days.
	General Safety This module requires the use of chemicals and open flame. While the risk of injury is low, there should be clear safety guidelines and expectations. These guidelines will vary depending on the situation, but some useful examples can be found in the Stay Safe! contract included in the curriculum, chemistry lab rules, and general classroom safety expectations. Safety guidelines should be discussed before every lesson. Examples of safety guidelines: • Pull hair back • No tasting anything • Wear protective eyewear from start to finish • If something spills, report it immediately to get help cleaning it up • Listen closely to instructions • No running in the classroom

Lesson 1: Sweet and Salty

Properties can be used to identify materials.

30 minutes

Students use appropriate methods and tools to identify similarities and differences between sugar and salt. They represent their observations in a box and a T chart to identify a pattern.

Group discussion among participants is very important for these lessons. Strategies for supporting group discussions can be found in Appendix 1. Strategies for furthering discussion through questioning/guiding thought can be found in Appendix 2.

On CSO, navigate to Lesson 1 using the numbers at the top of the screen.

Resource/Page #	Lesson 1
Overview TG: p. 83	Objectives: • Use appropriate methods and tools to answer the question, "Can we tell salt and sugar apart using just our senses?" • Use a box and a T chart to represent observations of salt and sugar and identify similarities and differences. Lesson Background Information: • Materials have physical and chemical properties. • Physical properties are explored using the primary senses and do not require altering chemical makeup. Class Periods: 1 (1 class period = about 35 minutes)

Resource/Page #	Lesson 1
Materials & Preparation TG: p. 84-86	Materials: • Safety goggles • Student test trays • Containers of sugar and salt • Unknown Solid chart • Blank box and T chart for class recording Printed Materials: • Lesson 1 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Gather test tray materials (Small sample cups with samples, permanent marker, small spoons, toothpicks, and hand lenses). • Label containers.
Procedure: Getting Started TG: p. 87	***Getting Started*** • Introduce unknown jars of salt and sugar and ask participants how they can tell the solids apart. • Have participants share ideas with their shoulder partner.
Procedure: Activity TG: p. 87-91	***Activity*** • Have one participant from each group of four pick up their test trays and label the cups and spoons to limit cross contamination. • Facilitate a discussion on safety rules, including wearing goggles, tying back hair, paying attention to the directions and your surroundings, etc. • In this lesson participants will be using their senses to identify similarities and differences between the solids. Collect ideas about how participants might use their senses. For safety reasons, participants will not be using taste and will only touch the materials with a toothpick. • Give groups time to explore their materials and record anything they notice.

Resource/Page #	Lesson 1
Procedure: Bringing It All Together TG: p. 91–93	***Bringing It All Together*** • Have participants share observations and complete the box and the T chart. • Use guiding questions to help participants verbalize the differences and similarities they have noticed. • Have participants complete Notebook Sheet 1 as a pre-assessment.
Assessment, Enrichment & Extension TG: p. 94–96	Briefly review, as time allows: • Assessment Rubrics: Pre-Assessment • Extension: Close Up (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Smithsonian Science for the Classroom Features and Carolina Science Online

15 minutes

	Key Points
TG	Hand out TGs. Briefly review the physical items that accompany a module: • Teacher Guide (1) • Student Activity Guides (8) • Smithsonian Science Stories (16) • Materials (for 32 students)

	Key Points
CSO	CSO is the virtual platform that hosts the Teacher Guide, digital copies of the student readers, digital readers in Spanish, and other digital resources for the module. **Set Up a Carolina Science Online Account** Before training, you should receive an email directing you to create your teacher login on CSO (www.carolinascienceonline.com). On the main page, hover over the "Teacher login" button. "Create a Teacher account" will appear as an option. Enter the required information. Make sure you choose a password you can remember. Return to the main page and log in. At the top of the page, click "redeem code." Enter the code that was emailed to you. The account is now ready to use. On the main page, all the titles available to you will be in bright colors. Click on the module you need. The module will open in the "Module Overview" tab. The "Home" button on the top left of the screen will take you back to the main screen with all the available titles. "Bookmarks" will open your bookmarks folder. You can bookmark any of the digital resources on CSO by clicking on the star underneath the resource. "Assignments" shows all assignments you have created using CSO digital resources. You can add a digital resource to Assignments by clicking "add to assignment" on any CSO digital resource.

	Key Points
TG and CSO TG: p. 1-17	Navigate to the "Curriculum Overview" section in the TG, which is also found under the "Module Overview" tab in CSO. This section provides an introduction to the curriculum and the research-based methods integrated into Smithsonian Science for the Classroom.
TG: p. 20-21	**Concepts and Practices Storyline** Modules are broken down into areas that each revolve around a single focus question. The focus questions build a storyline that provides a coherent experience that builds toward solving a problem. The storylines are carefully integrated with the 5E model and each lesson is identified as to where it fits in the model. This module has five focus questions with the final focus question being the Science Challenge.
TG: p. 22-24	**Prerequisite Concepts and Practices** The items listed are the skills and knowledge students will lean on to incorporate new skills and content learning. Each set of concepts and practices identifies where the prerequisites should have been taught.
TG: p. 24-28	**Module Background Information** This section provides background information for the teacher. It covers content that is not directly discussed in the module but may prove useful in understanding where content or practices are headed. It also provides information that is a fundamental building block for the content and practices used in the module.
TG: p. 29-34	**Common Misconceptions** Students may express misconceptions throughout the lesson. This section provides a list of common misconceptions identified in research for both content and practices, an explanation of the misconception, and a possible example of how it may come up. The number after the misconception refers to which reference the misconception is described in. next page →

	Key Points
	Throughout the module, misconception callouts will be highlighted using the Good Thinking! bubble. Good Thinking! is a YouTube video series created by the Smithsonian Science Education Center that is focused on misconceptions and learning.
TG: p. 34-41	**Materials Management and Safety** This section provides information on materials that will be provided with the module kit, needed but not supplied materials, safety concerns, and a safety contract for students. Under the "Materials Lists" section you will need to click on the hyperlink to download the materials lists. These lists show you everything that will be included in the module kit and items teachers will need to supply. The lists also show how much of each material is needed and in which lesson. In the "Safety" section, there are callouts for specific concerns for this module and a link to a Stay Safe! contract. The contract lists expectations for students to keep themselves and others safe during science investigations. It has lines for both students and guardians to sign.
TG: p. 46-47	Navigate to the "NGSS Alignment and Planner" tab in CSO. **Module Alignment to NGSS** These modules are aligned to the Next Generation Science Standards, which teachers can use as an additional tool to identify student objectives and goals for learning. next page →

	Key Points
TG: p. 48-77	**Lesson Planners** The lesson planners highlight everything that will happen in a lesson, such as: • Focus Question • Step of 5E model • Number of class periods needed • Vocabulary that will be introduced • Student objectives • Misconceptions: more information can be found in the "Module Overview" tab or TG p. 29-34 • Disciplinary core ideas: content focus • Science and engineering practices • Crosscutting concepts: ideas that are multidisciplinary • ELA and math connections: numbers reference the Common Core Standards • Extensions: additional lessons that are not necessary to move forward in the module
TG: p. 80-81	In the TG, review the callout icons itemized in the Guide to Module Investigations: • NGSS • Common Core • Misconceptions • Digital Resource • ELL Strategy • Teacher Tips and Tech Tips • Guiding Questions • Safety Notes • Class Period Break
Readers and CSO	All the written materials (Readers, Student Activity Guides, Notebook Sheets) are available digitally on CSO. Navigate to the Readers under the "Digital Resources" tab in CSO. There are multiple versions. The on-grade reader cover has a matchstick with the round end pointing up. The below-grade reader cover has a matchstick with the round end pointing down. The Spanish reader is only available on grade. next page →

	Key Points
	The on-grade reader exists in two forms on CSO. One is an interactive book and the other is an e-book. The other readers are only available in the e-book format. Both formats have tools for students. In the interactive book, students can highlight and make notes using the tools in the toolbar. In the e-book format, students can use the text-to-talk feature by highlighting the text and selecting the speaking icon.
Support and CSO	Carolina Science Online provides a number of supports to teachers, including: • Teacher Resource videos: These videos provide an overview of the focus questions and show any lessons with a potentially tricky setup. They're available under the "Digital Resources" tab. • Tutorial videos: For help using CSO's features, choose "Support" from the vertical toolbar on the left side of the homepage. • Get Ready! Professional Learning: These short videos offer information on demand and teacher tips about the program. They can be found at: https://www.smithsonianstc.com/ssftc-get-ready-campaign-172N7-44857Z.html

Concept Storyline

Grade 5 Physical Science: *How Can We Identify Materials Based on Their Properties?*

5 minutes

	Concept Storyline
TG and CSO TG: p. 20–21	**Concepts and Practices Storyline** Return to the "Concepts and Practices Storyline" tab and walk through the module's structure. This module has five focus questions, with the final focus question being the Science Challenge. Explain each focus question with its objectives, as below: next page →

	Concept Storyline
	FQ#1: How can we use our senses to compare materials? (Lessons 1-3) *Students use their senses to compare properties of six solids, including sugar and cornstarch. They read about how sugar and cornstarch are made by plants and used as food by animals.* FQ#2: What happens when materials are mixed with water? (Lessons 4-6) *Students learn that dissolving and evaporation can be explained by particles. They compare how six solids behave when mixed with water.* FQ#3: How do heating and cooling affect materials? (Lessons 7-9) *Students learn that melting points can be used to identify solids. They look at the effect of heat on six solids.* FQ#4: Does mixing materials together form a new material? (Lessons 10-12) *Students record what happens when six solids are mixed with either iodine or vinegar. They read about how carbon dioxide and water combine to produce sugar and oxygen in a plant. They weigh cornstarch and iodine before and after mixing and conclude that weight is conserved in any change.* FQ#5: How can we identify unknown kitchen materials? (Lessons 13-15) *Students apply what they have learned about properties to identify four unknown solids.*

Assessment	There are four types of assessment throughout the module.
	• Pre-Assessment (Lesson 1)
	• Formative Assessment (Lessons 2-12)
	• Summative Assessment (Lessons 13-15)
	  • Written Summative Assessment
	  • Performance Summative Assessment
	• Self-Assessment (SAG): Stop & Check

SESSION 2:

Lessons 2–7

The trainer introduces Lessons 2 and 3 (Focus Question 1), Lessons 4–6 (Focus Question 2), and Lesson 7 (Focus Question 3).

Goal: The trainer facilitates Lessons 2–7, with participants experiencing the lessons as students and debriefing each focus question as teachers.

At various points in the training, there may be differing ideas presented by participants, especially when introducing claims and evidence. For strategies on handling differing opinions, please see Appendix 4.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Lesson 2	25 minutes	Gather cups, fill with powders, restock testing tray, label spoons
Lesson 3	20 minutes	Hand out Readers
Group Roles	5 minutes	Make sure Group Roles poster is visible
Short break	10 minutes	
Lesson 4	25 minutes	Reset testing trays, make sure balances turn on
Lesson 5	20 minutes	Find prepared dehydrated sugar trays and distribute
Short break	10 minutes	
Lesson 6	25 minutes	Reset testing trays
Lesson 7	25 minutes	Set up heating stations, weigh out beeswax and coconut oil

Lesson 2: Four New Solids

Sugar, salt, cornstarch, baking powder, baking soda, and alum can be compared using just our senses.

25 minutes

Students use appropriate methods and tools to identify similarities and differences between alum, cornstarch, baking powder, and baking soda. They represent their observations in a table and argue from evidence that six solids can be identified using just our senses.

On CSO, navigate to Lesson 2 using the numbers at the top of the screen.

Resource/Page #	Lesson 2
Overview TG: p. 97	Objectives: • Use appropriate methods and tools to answer the question, "Can we identify six solids using just our senses?" • Use a table to represent observations of four solids to identify similarities and differences. • Argue from evidence that six solids can be identified using just our senses. Lesson Background Information: • Participants will compare four white solids: cornstarch, baking soda, baking powder, and alum. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 98–100	Materials: • Safety goggles • Testing trays set up for four solids • Containers of alum, baking soda, baking powder, and cornstarch • Chart of solids • Reader Printed Materials: • Lesson 2 Notebook Sheet A • Lesson 2 Notebook Sheet B Digital Materials: • N/A next page →

Resource/Page #	Lesson 2
	The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information. To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Gather and fill four containers labeled 3-6 with alum, baking soda, baking powder, and cornstarch. • Restock used items from the testing tray (toothpicks, extra powders, etc.). • Collect and label small spoons for the new samples.
Procedure: Getting Started TG: p. 100	***Getting Started*** • Quickly review Lesson 1, focusing on what participants observed and what methods they used to collect their observations.
Procedure: Activity TG: p. 101–103	***Activity*** • Review safety rules and have participants put on safety gear. • Have one participant from each group of four retrieve materials. • Review how to use the senses to safely gather information about solids. • Give groups 20 minutes to collect and record observations about the new solids.
Procedure: Bringing It All Together TG: p. 103–105 Reader: p. 9–12	***Bringing It All Together*** • Have participants create and share claims about which solids they can identify using just their senses. Make sure participants support their claim using their observations of the solids as evidence. next page →

Resource/Page #	Lesson 2

	• The Reader *What's Cooking* has multiple versions. They all have the same readings but in multiple forms:
	  • On-Grade Readers: 16 physical copies shipped with your supplies, with Lexile scores for fifth grade
	  • CSO Readers: All CSO readers can be assigned to students using the CSO system
	  1. Spanish reader: on-grade reader in Spanish has notes and text-to-speech
	  2. Student reader: digital copy of on-grade reader with note-taking and text-to-speech
	  3. Below-grade reader: the same information but simpler sentence structure, to decrease the Lexile score by about 100 points
	  4. Smithsonian Science Stories: *What's Cooking* Student Reader: e-book version of the on-grade reader with annotation toolbar
	• Read reading 2, "All About Alum" from the Reader.
	
	Reading Summary
	This reading describes the uses and properties of alum. Alum is a chemical that, when mixed with water, forms an acid. This acid can be used to preserve foods such as pickles; kill bacteria when used for wound treatment, toothpaste, or deodorant; or limit the amount of ink paper will absorb. Alum can be distinguished by its crystal shape, which is like two pyramids attached at the base.

Assessment, Enrichment & Extension TG: p. 105–106	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Comparing Solids (Literacy)

Resource/Page #	Lesson 2
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 3: Plant Products

Sugar and cornstarch can be obtained from plants.

20 minutes

Students argue from evidence obtained from a text that the sugar and cornstarch we eat is made by plants.

On CSO, navigate to Lesson 3 using the numbers at the top of the screen.

Resource/Page #	Lesson 3
Overview TG: p. 107	Objectives: • Obtain information from a text to answer the question, "Where do the sugar and cornstarch we eat come from?" • Argue from evidence that the sugar and cornstarch we eat are both made by plants. Lesson Background Information: • Plants make sugar, which is water-soluble, to use as energy. • To store the excess sugar, it is changed into a starch, which is not water-soluble. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 108	Materials: • Reader • Class table labeled, "Food we eat containing sugar vs. Food we eat containing starch" Printed Materials: • Lesson 3 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* There is no extra preparation for this lesson.

Resource/Page #	Lesson 3
Procedure: Getting Started TG: p. 108–109	***Getting Started*** • Remind participants of their observations about sugar and cornstarch from Lessons 1 and 2. • Have participants discuss and share what foods they eat that contain sugar and/or cornstarch. • Ask participants if they know where the sugar and cornstarch we eat comes from.
Procedure: Activity TG: p. 109–110 Reader: p. 13	***Activity*** • Have participants read reading 3, "Sweet Corn," from the Reader. • As a class, debrief the reading, covering the main points and key ideas. • Have participants reread "Sweet Corn" and complete the Lesson 3 Notebook Sheet. **Reading Summary** This reading introduces the parts of the corn kernel and the food products that can be created from it. The parts of the kernel (corn seed) are the bran (outer shell), endosperm (majority of volume, which acts as food for the germ), and the germ (the part of the seed that grows). Some foods that can be created from corn are cornstarch (from the endosperm), cornmeal, corn flour, cereals, and corn syrup. Corn is a common food source for animals and humans. Corn was originally grown for food by Native Americans, who planted the corn with beans and squash on small mounds. The mounds helped protect the plants, while the beans helped keep nutrients in the soil and the squash protected against weeds.
Procedure: Bringing It All Together TG: p. 111	***Bringing It All Together*** • Have participants create a claim supported by evidence from their reading that answers the question, "Where do the sugar and cornstarch we eat come from?" • In their notebooks, have participants write down answers to the focus question, "How can we use our senses to compare materials?"

Resource/Page #	Lesson 3
Assessment, Enrichment & Extension TG: p. 112-113	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Family Favorites (Home, Community, Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Many of the lessons use group roles to assign specific jobs. For strategies on using group roles effectively, please see Appendix 3.

Group Roles

5 minutes

Starting in Lesson 4, students will be assigned group roles. The assignments and a possible rotation system can be found in Appendix 3. Group roles are a common tool to build teamwork skills such as turn taking, communication, and responsibility for individual and group needs. Additionally, having a specific role can increase student involvement and confidence by ensuring they know what is expected of them in a given situation. You can learn more about collaborative groups and group roles in the Zero Barriers in STEM Education Accessibility and Inclusion Workbook found at https://ssec.si.edu/zero-barriers.

Lesson 4: Sugar Water

When sugar is dissolved in water, there is no change in weight.

25 minutes

Students represent in a table the weight in grams of sugar and water before and after mixing. They draw a graph to show that the weight of sugar and water after mixing is the same as before.

On CSO, navigate to Lesson 4 using the numbers at the top of the screen.

Resource/Page #	Lesson 4
Overview TG: p. 115	Objectives: • Use a table to represent data on weight in grams of sugar and water before and after mixing. • Graph the weight in grams of sugar, water, and a sugar solution to provide evidence that the weight of sugar and water is the same before and after mixing. Lesson Background Information: • When materials are mixed, the total weight of the materials remains the same. Class Periods: 2 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 116–118	Materials: • Testing tray for each group • Graduated cups • Small (1.25-ounce) plastic cups • Large (7-ounce) plastic cups • Pipet • Electric balance • SAG Printed Materials: • Lesson 4 Notebook Sheet A • Lesson 4 Notebook Sheet B Digital Materials: • Hummingbird video file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 4
	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Reset the testing tray with six sample cups, small (1.25-ounce) plastic cup, large (7-ounce) plastic cup, pipet, toothpicks, six small spoons, permanent marker, and weighing dish. • Give each group one electric balance. • Give each group writing implements in at least two different colors.
Procedure: Getting Started TG: p. 118–119	***Getting Started*** • Play the video of the hummingbird eating. • Have participants discuss what the hummingbird is eating, why, and why they cannot see the sugar in the liquid feeder.
Procedure: Activity TG: p. 119–124 SAG: p. 1–4	***Activity*** • Have participants predict what will happen to the weight of the sugar and water after they are mixed. • Assign group roles and have each group collect their materials. • Demonstrate how to add water to a graduated cup using the pipet and how to weigh spoonfuls of sugar in the small cup. • Make sure participants have materials and safety gear before having them follow steps 3–10 in the SAG to weigh the water and sugar separately and again after they're mixed. • Before cleaning up, have each group pour some sugar water solution in a weighing dish to be observed in Lesson 5. • Have participants follow steps 11–13 in the SAG to analyze the data they have collected by creating bar graphs and discussing how the results compare to their predictions.

Resource/Page #	Lesson 4
Procedure: Bringing It All Together TG: p. 124	***Bringing It All Together*** • Have participants share their graphs and group discussions. • Introduce the words "dissolve" and "solution" to explain why the sugar cannot be seen in the water.
Assessment, Enrichment & Extension TG: p. 124–126	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Sweet Fractions (Math and Technology)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 5: What We Can't See

Dissolving and evaporation can be explained by particles.

20 minutes

Students draw a model to show what happens to the very small particles of water and sugar during dissolving and evaporation. They use the model to explain why the weight of sugar and water after mixing is the same as before.

On CSO, navigate to Lesson 5 using the numbers at the top of the screen.

Resource/Page #	Lesson 5
Overview TG: p. 127	Objectives: • Develop a model showing what happens to the very small particles of sugar and water when sugar dissolves in water and a sugar solution evaporates. • Use a model to explain why the weight of sugar and water is the same before and after mixing. Lesson Background Information: • Models can take many forms, including drawings, physical models, games, and computer simulations. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 128-129	Materials: • Weighing dish with sugar solution from Lesson 4, dehydrated • Water • Sugar • Colored pencils or markers Printed Materials: • N/A Digital Materials: • Particle Models file • Sugar Simulation *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 5
	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Collect the weighing dishes from Lesson 4. • Gather near an Internet device, if possible. • Gather two writing implements of different colors.
Procedure: Getting Started TG: p. 129–130	***Getting Started*** • Place participants in the same groups as in Lesson 4. • Have participants observe the dehydrated solution in the weighing dish and make suggestions about what has changed and not changed regarding the dish.
Procedure: Activity TG: p. 130–133	***Activity*** • Project the Particle Models file and have participants draw a model of water and sugar in a cup. • Go to Model 2 in the file and have participants draw a model of the dehydrated sugar solution in the weighing dish. • Have groups share their models. • Have groups explore the Sugar Simulation and the model it uses to represent sugar, water, and the changes the solution goes through. • Have groups revise their earlier models showing the sugar and water solutions.
Procedure: Bringing It All Together TG: p. 133–135	***Bringing It All Together*** • Review the Sugar Simulation with the group, discussing what each element represents and what happened to the sugar and water as changes were made. • Have participants make predictions about what happened to the weight of the solutions as the changes were made.

Resource/Page #	Lesson 5
Assessment, Enrichment & Extension TG: p. 136-137	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extensions: Invisible Air (Literacy and Social Studies) and Gallery Walk (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 6: Chemists Make Solutions

Solids can be compared based on how they mix with water.

25 minutes

Students carry out an investigation using a fair test to collect data on how six solids mix with water. They argue from evidence that six solids can be identified based on similarities and differences in how they mix with water.

On CSO, navigate to Lesson 6 using the numbers at the top of the screen.

Resource/Page #	Lesson 6
Overview TG: p. 139	Objectives: • Carry out an investigation that uses a fair test to answer the question, "What happens to six solids when they are mixed with water?" • Use a table to represent observations of mixing six solids with water to identify similarities and differences. • Argue from evidence that six solids can be identified by how they mix with water. Lesson Background Information: • Some solids will dissolve in water, including salt and sugar, while others will not, such as cornstarch. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 140–141	Materials: • Testing tray for each group • SAG • Water for each group • Graduated cups • Safety goggles • Reader Printed Materials: • Lesson 6 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 6
	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Collect each group's testing tray and refill any needed supplies. • Gather six graduated cups.
Procedure: Getting Started TG: p. 142 Reader: p. 25	***Getting Started*** • Read the first page of reading 5, "What's the Solution," in the Reader. This reading defines what a solution is and identifies other solutions students might know. • Ask participants what other solutions they know about.
Procedure: Activity TG: p. 142–145 SAG: p. 5–7	***Activity*** • Have participants put on their safety goggles and enact any other safety measures. • Discuss with participants how to make each test a fair test by using the same amount of water and solids, and the same method. • Have participants complete steps 1–3 in the SAG, then have each group collect a cup of water. • Participants should then follow steps 4–8 in the SAG to mix their solids with water and take notes about what happens. • When groups finish collecting their notes, have them clean their areas.
Procedure: Bringing It All Together TG: p. 146–147	***Bringing It All Together*** • Have participants share their observations from their tests.
Assessment, Enrichment & Extension TG: p. 147–149	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: What's the Solution? (Literacy)

Resource/Page #	Lesson 6
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 7: Lip Balm

A mixture of coconut oil and beeswax melts more easily than beeswax alone.

25 minutes

Students represent in a table observations and the melting point in degrees Celsius of beeswax and a mixture of beeswax and coconut oil. They interpret the data to explain why lip balm is a mixture of beeswax and coconut oil.

On CSO, navigate to Lesson 7 using the numbers at the top of the screen.

Resource/Page #	Lesson 7
Overview TG: p. 151	Objectives: • Carry out an investigation to explain why lip balm is a mixture of beeswax and coconut oil. • Use a table to represent observations and melting points in degrees Celsius and interpret data to explain why lip balm is a mixture of beeswax and coconut oil. Lesson Background Information: • As heat is added to a solid, the particles begin to vibrate faster. • When the particles are vibrating fast enough, the solid will become a liquid. The temperature at which a solid becomes a liquid is called the melting point. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 152-155	Materials: • Heating stations • Thermometers • Beeswax • Coconut oil (warming the coconut oil bottle in warm water will make it easier to distribute) • Weighing dish • SAG Printed Materials: • Lesson 7 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 7

	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should:
	• Create a heating station by filling the bottom of a pie pan with sand and placing a tea light in the middle of the pan.
	• Collect materials:
	  • Thermometer
	  • 6g coconut oil
	  • 1g beeswax
	  • Weighing dish
	  • 1 clothespin
	  • 2 craft sticks

Procedure: Getting Started TG: p. 155-156	***Getting Started*** • Discuss safety measures with participants. This lesson requires the use of an open candle flame. • Introduce beeswax and coconut oil to participants and have them hold the small cups of each in their hands and observe what happens. • Have the whole group share observations.
Procedure: Activity TG: p. 156-161 SAG: p. 8-13	***Activity*** • Demonstrate how to hold the weighing dish over the flame to melt the different materials. • Divide participants into groups of four and have them follow steps 1-3 in the SAG and gather their materials. • Demonstrate how to melt the materials and measure the temperature at which the materials melt. • Have the groups follow steps 4-7 in the SAG to melt and measure the temperature of the beeswax. • Have participants complete steps 8-15 in the SAG to combine beeswax and coconut oil to determine the temperature at which the mixture melts. • Have groups clean up their area.

Resource/Page #	Lesson 7
Procedure: Bringing It All Together TG: p. 161-162	***Bringing It All Together*** • Ask groups to share their observations about the melting point temperatures. • Have participants make a claim about why lip balm is a mixture of coconut oil and beeswax, with supporting evidence from their observations.
Assessment, Enrichment & Extension TG: p. 162-164	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Writing vs. Video and What Is Beeswax Good For? (Literacy and Technology)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

SESSION 3:

Lessons 8–12

The trainer introduces Lessons 8–12 (Focus Questions 3 and 4).

Goal: The trainer facilitates Lessons 8–12, with participants experiencing the lessons as learners and debriefing each focus question as teachers.

At various points in the training, there may be differing ideas presented by participants, especially when introducing claims and evidence. For strategies on handling differing opinions, please see Appendix 4.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Lesson 8	20 minutes	Hand out Readers
Lesson 9	25 minutes	Reset testing trays, set up heating stations
Short break	10 minutes	
Lesson 10	25 minutes	Reset testing trays, hand out vinegar and iodine bottles
Lesson 11	20 minutes	Hand out Readers
Lesson 12	20 minutes	Reset testing trays, hand out iodine bottles, make sure balances work

Lesson 8: Melting and Freezing Points

Mixtures have different melting points and freezing points from pure materials.

20 minutes

Students obtain evidence from a text to construct an explanation that adding something to a pure material causes the melting point and freezing point to change.

On CSO, navigate to Lesson 8 using the numbers at the top of the screen.

Resource/Page #	Lesson 8
Overview TG: p. 165	Objectives: • Obtain evidence from a text that mixtures can have different melting points and freezing points than pure materials. • Analyze and interpret data to explain that adding salt to water causes the freezing point of water to be lowered. Lesson Background Information: • Melting point is a physical property that can change depending on impurities in a material. • Melting point and freezing point are usually the same. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 166	Materials: • Reader Printed Materials: • Lesson 8 Notebook Sheet Digital Materials: • Salting Roads file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* This lesson does not require additional preparation.
Procedure: Getting Started TG: p. 166-167	***Getting Started*** • Ask participants about the melting points they explored in Lesson 7. • Open the Salting Roads file and ask for observations and ideas about what is happening and why.

Resource/Page #	Lesson 8
Procedure: Activity TG: p. 167–168 Reader: p. 33–38	***Activity*** • Have pairs read reading 6, "What's the Point," in the Reader. • Briefly discuss the main points of the reading before handing out the notebook sheet. • Give participants time to review the reading and write down their thoughts on the notebook sheet. **Reading Summary** Chemical engineers are scientists who use and identify materials in many ways, including the melting point of materials. The melting point is the temperature at which a solid becomes a liquid. Different materials have different melting points, and this fact can be used to help identify the material. The melting point of materials like beeswax can also be used to determine how pure the material is. The freezing point is the temperature at which a liquid becomes a solid. Chemicals such as salt and ethylene glycol can be added to a liquid to lower the freezing point. Some animals have special proteins that act as antifreeze within their body to keep their cells from freezing in very cold temperatures.
Procedure: Bringing It All Together TG: p. 168–169	***Bringing It All Together*** • Have a group discussion on how melting and freezing points can change, using evidence from the reading.
Assessment, Enrichment & Extension TG: p. 169–171	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: The Wrong Beeswax (Literacy) and DIY Ice Cream (Literacy and Technology)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 9: Cooking with Fire

Solids can be compared based on how they respond to heat.

25 minutes

Students carry out an investigation using a fair test to collect data on how different solids respond to heat. Students argue from evidence that six solids can be identified based on similarities and differences in how they respond to heat.

On CSO, navigate to Lesson 9 using the numbers at the top of the screen.

Resource/Page #	Lesson 9
Overview TG: p. 173	Objectives: • Carry out an investigation that uses a fair test to answer the question, "What happens to six solids when they are heated?" • Use a table to represent observations gathered when heating six solids, to identify similarities and differences. • Argue from evidence that six solids can be identified by how they respond to heat. Lesson Background Information: • Sugar, alum, and baking powder will undergo chemical changes when exposed to the heat from a candle. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 174-175	Materials: • Heating station for each group • Testing tray for each group • Stopwatch or timer Printed Materials: • Lesson 9 Notebook Sheet Digital Materials: • N/A *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 9
	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Refill any solids needed for the testing tray. • Collect a heating station and check the candle. • Determine how to time melting using a clock, timer, or stopwatch.
Procedure: Getting Started TG: p. 176	***Getting Started*** • Let participants know they will be heating the six solids to observe their reactions. Ask for predictions about the solids' reactions.
Procedure: Activity TG: p. 176–179 SAG: p. 14–17	***Activity*** • Review safety requirements and have participants prepare their stations. • Have participants complete steps 1–4 in the SAG to set up their test mats. • Remind participants how to test the materials fairly by making sure they use the same measurements and the same procedure. • Have participants complete steps 5–7 in the SAG to heat each solid and record their observations.
Procedure: Bringing It All Together TG: p. 179–180	***Bringing It All Together*** • Have the group share their observations. • Have participants make a claim about which solids could be identified by heating them, using evidence from their observations.
Assessment, Enrichment & Extension TG: p. 180–182	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Candy Chemistry (Literacy and Technology)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 10: Making Something New

Bubbles or a change in color can be observed when six solids are mixed with vinegar or iodine.

25 minutes

Students carry out an investigation using a fair test to collect data on how six solids mix with vinegar and iodine. Students argue from evidence that something new being formed can cause a color change or bubbles.

On CSO, navigate to Lesson 10 using the numbers at the top of the screen.

Resource/Page #	Lesson 10
Overview TG: p. 183	Objectives: • Carry out an investigation using a fair test to answer the question, "Which solids mix with iodine and vinegar to form a new material?" • Use a table to represent observations after adding vinegar and iodine to six solids, to identify cause-and-effect relationships. • Argue from evidence that a color change and bubbles can mean that a new material is formed. Lesson Background Information: • Indicators of chemical reactions include gas formation, change in color, change in odor, formation of a solid, and change in temperature (without added heat). Class Periods: 2 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 184–187	Materials: • Testing tray for each group • Dropper bottle of iodine for each group • Dropper bottle of vinegar for each group • Safety goggles • Small plastic cups • SAG Printed Materials: • Lesson 10 Notebook Sheet A • Lesson 10 Notebook Sheet B next page →

Resource/Page #	Lesson 10
	Digital Materials: • Muffins Rising video file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Refill any solids needed on the testing tray. • Collect 12 small (1.25-ounce) plastic cups, 12 toothpicks, 1 dropper bottle of iodine, and 1 dropper bottle of vinegar.
Procedure: Getting Started TG: p. 187–188	***Getting Started*** • Review what happened to the six solids when introduced to heat. • Play the Muffins Rising video and ask for observations. • During the following lessons, participants will be exploring the question, "Does mixing materials together form a new material?"
Procedure: Activity TG: p. 188–192 SAG: p. 18–21	***Activity*** • Discuss any safety concerns and remind participants of safety rules. • Have participants follow steps 1–3 in the SAG to collect their materials and prepare their areas. • Demonstrate how to add vinegar and iodine to the cups. Remind participants that they need to use the same amounts and the same procedure for each test to keep it a fair test. • Have participants follow steps 4–9 in the SAG to add vinegar to each of the solids. • Have participants complete step 10 in the SAG to add iodine to each solid. • Have groups clean up their areas.

Resource/Page #	Lesson 10
Procedure: Bringing It All Together TG: p. 192	***Bringing It All Together*** • Have groups make a claim about whether a new material was created when the iodine or vinegar was added to the solids, using evidence from their observations. • Groups will collect more evidence in the next lesson to refine their claim.
Assessment, Enrichment & Extension TG: p. 192–194	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: Iodine (Literacy, Technology, and Social Studies)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 11: Change Is All Around Us

Bubbles or a change in smell, color, or texture can be a sign that a new material has been made.

20 minutes

Students obtain information from a text that formation of a new material can cause bubbles or a change in color, smell, or texture. They use evidence from the text to construct an explanation that plants make sugar and oxygen from the chemical reaction of carbon dioxide and water.

On CSO, navigate to Lesson 11 using the numbers at the top of the screen.

Resource/Page #	Lesson 11
Overview TG: p. 195	Objectives: • Obtain evidence from a text that a change in taste, smell, color, texture, and bubbles is a sign that something new may have been made. • Make a claim that a gas being produced can explain cakes rising and bubbles from *Elodea*. Lesson Background Information: • Chemical reactions are very common. Examples include rust and photosynthesis. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 196	Materials: • Reader Printed Materials: • Lesson 11 Notebook Sheet Digital Materials: • *Elodea* video file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* No additional prep is required for this lesson.
Procedure: Getting Started TG: p. 196-197	***Getting Started*** • Review Lesson 3, focusing on the fact that plants make sugar. • Play the Elodea video and ask for observations.

Resource/Page #	Lesson 11
Procedure: Activity TG: p. 197-198 Reader: p. 39-44	***Activity*** • Have pairs read reading 7, "Something New," in the Reader. • Discuss the main points of the reading. • Hand out the Lesson 11 Notebook Sheet and have groups revise their claim from the end of Lesson 10. **Reading Summary** A chemical reaction is when two or more things are combined and a new substance is formed, as when water, air, and metal combine to make rust or burning paper makes smoke. Some signs of a chemical reaction could be a change in color, creation of gas/bubbles, or a change in smell.
Procedure: Bringing It All Together TG: p. 198-199	***Bringing It All Together*** • Have participants share any revised claims and ask for any questions.
Assessment, Enrichment & Extension TG: p. 199-201	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: The Green Lady (Science, Literacy, and Technology)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 12: A Weighty Matter

When something new is formed, there is no change in weight.

20 minutes

Students represent in a table the weight in grams of iodine and cornstarch before and after mixing. They draw a graph and compare data from different groups to conclude that the weight after mixing is the same as before.

On CSO, navigate to Lesson 12 using the numbers at the top of the screen.

Resource/Page #	Lesson 12
Overview TG: p. 203	Objectives: • Plan and carry out an investigation to answer the question, "How does the weight of the materials before and after mixing compare when a new material forms?" • Graph the weight in grams of cornstarch and iodine before and after mixing to provide evidence that when something new is formed, there is no change in weight. Lesson Background Information: • While chemical reactions result in a new material, the weight does not change. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 204–205	Materials: • SAG • Testing trays • Electric balance • Colored pencils or markers • Iodine bottles, with dropper Printed Materials: • Lesson 12 Notebook Sheet Digital Materials: • Iodine and Cornstarch Class Graph *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* next page →

Resource/Page #	Lesson 12
	To help participants better familiarize themselves with the lesson setup for implementation, the group will do some materials preparation during the workshop. For this lesson, each group should: • Refill any needed solids from the testing tray. • Collect a balance, two small cups, and a dropper bottle of iodine.
Procedure: Getting Started TG: p. 206	***Getting Started*** • Ask participants to revisit their Lesson 11 claims about whether mixing materials creates a new material. • Ask participants to look at their Lesson 4 notes to remind themselves what the weight change was when mixing water and sugar. • Ask participants to predict if there will be a weight change when iodine and cornstarch are mixed.
Procedure: Activity TG: p. 206–208 SAG: p. 22–25	***Activity*** • Remind participants of safety procedures and what a fair test is. Participants will need to decide for themselves how much of each material to use and how to maintain a fair test. • Have groups follow steps 1–4 in the SAG to collect their materials and discuss how much of each material they should use. A good base is six drops of iodine to one scoop of material, as used in Lesson 10. Groups can choose to use more or less, but may need help if they do not get results. • Hand out electric balances and remind participants how to tare them. • Have groups complete steps 5–15 in the SAG to test and weigh their mixtures. The Artist for each group should add their bar graphs to the class chart being displayed. • Have groups clean their area.

Resource/Page #	Lesson 12
Procedure: Bringing It All Together TG: p. 209	***Bringing It All Together*** • Ask groups to share observations from their experiments. Help the whole group identify patterns in their observations and the data. • Ask participants to share predictions about the weight change of beeswax when it is heated.
Assessment, Enrichment & Extension TG: p. 210–211	Briefly review, as time allows: • Assessment Rubrics: Formative Assessment • Extension: What's My Weight? (Math)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

SESSION 4:

Lessons 13–15

The trainer introduces Focus Question 5 (Lessons 13–15).

Goal: The trainer facilitates Lessons 13–15 with participants experiencing the lessons as learners and debriefing each focus question as teachers.

At various points in a training, there may be differing ideas presented by participants, especially when introducing claims and evidence. For strategies on handling differing opinions, please see Appendix 4.

AGENDA AND TIMING

Sections	Minutes	Materials/Notes
Lesson 13	30 minutes	Provide planning paper and markers to groups
Lesson 14	30 minutes	Reset testing trays, make sure balances work
Lesson 15	30 minutes	
Wrap Up	15 minutes	

Lesson 13: Kitchen Crisis Part 1

A model can be used to plan an investigation.

30 minutes

Students plan an investigation using a model to identify four unknown solids based on similarities and differences in properties.

On CSO, navigate to Lesson 13 using the numbers at the top of the screen.

Resource/Page #	Lesson 13
Overview TG: p. 213	Objectives: • Plan an investigation using a flow chart as a model to identify four unknown solids by their similarities and differences. Lesson Background Information: • A flow chart can be used to classify different things based on their similarities and differences. Class Periods: 1 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 214	Materials: • Chart paper • Permanent markers Printed Materials: • N/A Digital Materials: • Kitchen Crisis file • Flow Charts file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* No additional preparation is required for this lesson.
Procedure: Getting Started TG: p. 214–215	***Getting Started*** • Introduce the challenge of unlabeled containers in a kitchen using the Kitchen Crisis file.

Resource/Page #	Lesson 13
Procedure: Activity TG: p. 215-217	***Activity*** • Let participants know that they will need to come up with a series of tests to identify the different materials. Have participants suggest what tests they could use. • To help participants plan which tests they will use and in what order, introduce the Flow Charts file. • Have groups work to create a flow chart to determine what test to use and what order to test the solids to determine what each solid is.
Procedure: Bringing It All Together TG: p. 218	***Bringing It All Together*** • Have participants share their flow charts and talk about why they chose the different steps and order.
Assessment, Enrichment & Extension TG: p. 218-220	Briefly review, as time allows: • Assessment Rubrics: Performance Summative Assessment • Extension: Gallery Walk (Literacy) and Decision Time (Community and Home)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 14: Kitchen Crisis Part 2

Unknown solids can be identified by comparing properties.

30 minutes

Students carry out an investigation using a fair test to identify four unknown solids based on similarities and differences in properties.

On CSO, navigate to Lesson 14 using the numbers at the top of the screen.

Resource/Page #	Lesson 14
Overview TG: p. 221	Objectives: • Carry out an investigation that uses a fair test to answer the question, "How can we use properties to identify four unknown solids?" • Use a table to represent data on the properties of four solids to show similarities and differences. Lesson Background Information: • Groups need to be careful to keep the tests fair to ensure their results can support their claims. Class Periods: 2 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 222-225	Materials: • Electric balances • Heating stations • Weighing dishes • Vinegar • Iodine • Water • Toothpicks • Pipets • Four solids • Testing Flow Chart from Lesson 13 Printed Materials: • Lesson 14 Notebook Sheet Digital Materials: • Kitchen Crisis file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* There is no additional preparation required for this lesson, but groups will need to collect testing materials according to their Testing Flow Chart throughout the lesson.

Resource/Page #	Lesson 14
Procedure: Getting Started TG: p. 225-226	***Getting Started*** • Remind the group that they are testing solids to identify each for a chef. • Project slide 3 of the Kitchen Crisis file to let participants know which samples to collect. • Review the Testing Flow Charts groups made in Lesson 13 to determine what tests the participants should do and in what order.
Procedure: Activity TG: p. 226-229	***Activity*** • Remind groups of safety expectations and how to obtain testing materials they may need. • Have groups begin their tests. Depending on time, participants should be able to complete two to three tests on the first day of this lesson. • On the second day of this lesson, groups continue their testing according to their flow chart. • After finishing their tests, have participants complete the Lesson 14 Notebook Sheet.
Procedure: Bringing It All Together TG: p. 230	***Bringing It All Together*** • Have participants share their thoughts about how the testing went. • The next lesson will provide time for them to present their findings from their tests.
Assessment, Enrichment & Extension TG: p. 230-232	Briefly review, as time allows: • Assessment Rubrics: Performance Summative Assessment • Extension: Chemistry Detectives (Literacy)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Lesson 15: Kitchen Crisis Part 3

Scientists use evidence when communicating their findings.

30 minutes

Students communicate information and argue from evidence that four unknown solids can be identified based on similarities and differences in properties.

On CSO, navigate to Lesson 15 using the numbers on the top of the screen.

Resource/Page #	Lesson 15
Overview TG: p. 233	Objectives: • Communicate information about similarities and differences in the properties of four unknown solids. • Argue from evidence that four unknown solids can be identified based on how they respond to various tests. Lesson Background Information: • Students should support their claims with evidence from Lesson 14. Class Periods: 2 (1 class period = about 35 minutes)
Materials & Preparation TG: p. 234	Materials: • Presentation materials Printed Materials: • Lesson 15 Notebook Sheet A • Lesson 15 Notebook Sheet B Digital Materials: • Kitchen Crisis file *The materials listed here are a minimum list. Please visit CSO or the TG for more detailed information.* There is no additional preparation for this lesson.
Procedure: Getting Started TG: p. 234	***Getting Started*** • Share expectations for group presentations, including sharing claims about the identity of each solid, using evidence from their testing.

Resource/Page #	Lesson 15
Procedure: Activity TG: p. 235-236	***Activity*** • Assign group roles. • Share slide 4 of the digital file Kitchen Crisis to help participants create presentations. • Give groups time to create their presentations. • Have groups share their presentations and ask questions. • Have the whole group agree on which solid is in which container, and add labels to the jars.
Procedure: Bringing It All Together TG: p. 236-237	***Bringing It All Together*** • Have participants complete the written cumulative assessment using Lesson 15 Notebook Sheets A and B.
Assessment, Enrichment & Extension TG: p. 237-242	Briefly review, as time allows: • Assessment Rubrics: Performance Summative Assessment and Written Summative Assessment • Extension: Kitchen Helpers (Art) and Advertising Brochure (Literacy and Art)
Reflection	After experiencing the lesson, ask participants to put on their "teacher hat" to consider and discuss: • What student learning can you expect from this lesson? • Any potential challenges you might have in this lesson? • Any potential difficulties or misconceptions that students may struggle with in this lesson? • What strategies or supports can be applied?

Wrap Up

Take a few minutes to check in with the group before dismissing everyone.

15 minutes

	Key Points
Q&A	Invite participants to ask any final questions about materials, implementation, strategies, or anything else on their mind.
Continuing Support	If you are willing, provide your contact information for questions and concerns the participants may have in the future.

APPENDIX 1: GROUP DISCUSSION

The goal of group discussions is to provide an opportunity for shared learning by asking multiple people to propose connections between their individual experience and the new content of focus.

The facilitator has three primary jobs during group discussions:

1. Support individuals sharing.
   It may be unnerving for individuals to share their thoughts in a group. When facilitating group discussions, use the following techniques to boost individuals' confidence and likelihood of sharing their thoughts:
   - Pay attention to speakers.
   - Smile and nod at appropriate moments to nonverbally communicate that you are engaged.
   - Provide anonymous sharing opportunities using chart paper or sticky notes.
2. Manage group participation.
   It is important to have active and balanced participation from the group to gain as many perspectives as possible. While it is important to hear from everyone, not every person needs to comment on every question. Here are some techniques to help you manage participation of individuals during a group discussion:
   - Use small groups with a designated sharer/speaker.
     - Assigning roles: Change roles for each lesson.
   - When no one wants to speak up:
     - Use the silence. Generally someone will speak up within 15 seconds.
     - Make eye contact with someone you would like to hear from.
   - How to stop a monopolizing speaker:
     - Do not make eye contact with them.
     - Redirect comments and questions from monopolizers to others.
3. Support group thinking.
   - Record individual member suggestions or points in a central location.
   - Ask guiding questions to have the group highlight connections.
   - Summarize.

If you would like to see group discussions in practice, please visit:
TERC Inquiry Project videos: https://inquiryproject.terc.edu/prof_dev/library.cfm.html

APPENDIX 2: QUESTIONING/GUIDING THOUGHT

Questioning is a useful tool with many applications. For this application we will focus on questioning as a way to discover what people are thinking, encourage further thought, and develop group understanding.

The best questions to use are open-ended questions, which do not have a set answer and often require a sentence or more to answer. Questions like:

- What do you know about . . . ?
- Does anyone have anything to add?
- Why do you agree/disagree?

Generally the first level will be eliciting new ideas by asking questions about what people already know or can observe during the lesson:

- What did you observe?
- Has anyone ever encountered . . . ?
- What are some ways to introduce students to . . . ?

The second level is encouraging further thought by asking people to reflect on what has been said, to identify connections to the current topic:

- What do you mean by . . . ?
- Can you tell me more about . . . ?
- What is the evidence for/against . . . ?

The final level we will look at is creating a group understanding by coming to consensus on what has been discussed:

- What idea do you think best connects what everyone is saying?
- Can someone summarize for me?
- Based on what the group is saying, how would this affect . . . ?

Further suggestions for questioning:

- Give thinking time of three to five seconds after posing a question.
- Avoid saying “correct/incorrect.” Instead, let the group validate or clarify what someone is saying.
- Avoid the habit of only collecting one “correct” response and moving on. Always have at least two people answer a question, even if their answers are similar.
- Questioning can also be used to help keep time by letting people know how much longer the discussion can go on.
- Validate everyone’s input by thanking them for speaking up.

APPENDIX 3: GROUP ROLES

Each person in a group having a role can provide many positive outcomes. Some benefits of using group roles include:

- Increases participant motivation by having a unique role
- Models positive classroom behaviors
- Decreases the amount of time spent waiting for a group to decide or discuss who will do what
- If a job is assigned, it pushes participants to participate in different ways

Here are some ideas for how to begin using group roles:

- Change roles regularly to maintain interest.
- Try to give everyone a chance at each role.
- Have a system in place for assigning roles. Possible systems include:
    - Colored dots and frames—Give each person in the group a colored dot. Place a matching color frame around their role for the day. Change the frame placement as needed.
    - Numbers—Assign each member of the group a number (1-4). Place a sticky note with the corresponding number on their role for the day.
    - Badges—Give each person in the group a badge or card with their role for the day listed.
    - Desk tents—Give each person in a group a desk tent with their role for the day.

More information about group roles can be found at: https://ctl.wustl.edu/resources/using-roles-in-group-work

The chart here shows which roles are used in each lesson. The roles and rotation are based on having four members in each group. The numbers in each column suggest how to rotate roles.

	Lesson #									
Group Role	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**15**
Recorder	1			4						
Artist		2					1	3	4	2
Builder										
Tester			3	1	4	2				
Materials Manager	2		4	2	3	1	4			
Speaker		3						4	2	1
Gardener/ Zookeeper										
Questioner							2	1	3	4
Organizer	3	4	1	3	2	4	3	2	1	3
Messenger	4	1	2		1	3				

For these trainings, use the roles listed in each lesson, as described on the Group Roles poster.

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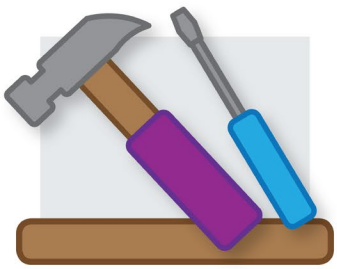
Scientists and Engineers in Our Classroom: Group Roles

Artist

Draws any sketches, diagrams, or graphs.

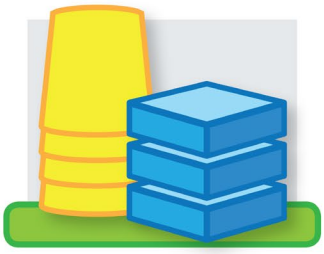


Builder

Takes the lead in putting together materials.

Gardener/Zookeeper

Makes sure live organisms are cared for and treated with respect.



Materials Manager

Collects, cleans up, and puts away materials neatly.

Messenger

Asks questions of the teacher for the group.

Organizer

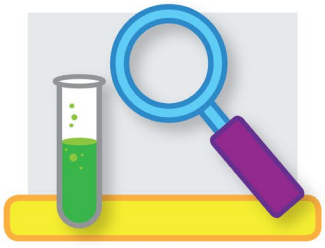
Makes sure group members work together and complete work on time.

Recorder

Writes down data, observations, and explanations.

Speaker

Shares the group's final work or ideas with the whole class.



Tester

Takes the lead in carrying out investigations and testing designs.

Questioner

Asks questions of group members to make sure all points of view are considered.

APPENDIX 4: MANAGING DIFFERING OPINIONS

At some point, it is highly likely that participants will have different opinions and thoughts. Working through these differences and coming to a point of mutual understanding is important to keep the group moving forward. This is also at the core of inquiry science and changing education practices.

Hearing different opinions and thoughts shows there is not always one "right" answer and there are multiple ways to interpret evidence. Often we are trying to come to consensus, which may require each participant to compromise or focus on where they agree and come back to the other areas.

To have meaningful conversations around different interpretations and ideas, it is important to build a culture of discussion and argumentation. At the beginning of the training, set group norms for how to interact when people do not agree, such as:

- Disagree with an idea, not the person.
- Use respectful language.
- Use phrases like "I disagree about . . ." or "I agree on . . ."
- Listen quietly to other people.
- Ask questions politely.
- Speak loudly and clearly.
- Always use evidence.

As with any other discussion, everyone needs to have the opportunity to be heard. Make sure you are allowing a variety of people to speak and that people are not cutting each other off.

Not every discussion of different opinions can come to a complete end every time. One way to table a discussion in order to move on is to take advantage of a parking lot or other idea repository. The chart on the next page lists a few ideas about when the parking lot should be used instead of having the discussion continue. Note: Every circumstance is different. These are suggested criteria, not hard rules.

Parking Lot	Keep Going
Requires input from people outside of training	Is specific to the current topic
Will be covered more in future lessons or sessions	Will likely be wrapped up in the session
Not related to the current topic	Multiple participants are highly engaged
Discussion becomes combative	Group has good evidence to come to consensus
Only one participant is speaking	

Sometimes the difference of opinions and ideas stems from a misconception. The Teacher Guide has a list of content and practice-based misconceptions that may come up in each module. Additionally, it is important to ask participants about what sources they are using, why they believe this information, or other questions to get at the root of their misconception while avoiding an accusatory or negative tone of voice. You can also use their peers' input to help clarify. If you must correct misconceptions to support learning later in the module, try using a supportive phrase such as, "Many people think that is true but the evidence so far supports . . ."

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