## The Evolution of the T2L Science Curriculum

Over the last four years, the Teach to Learn program created 20 NGSS-aligned science units in grades K-5 during our summer sessions. True to our plan, we piloted the units in North Adams Public Schools, and asked and received feedback from our science fellows and our participating teachers. This feedback served as a starting point for our revisions of the units. During year 2 (Summer of 2015), we revised units from year 1 (Summer/Fall 2014) and created new units to pilot. In year 3, we revised units from years 1 and 2 and created new units of curricula, using the same model for year 4. Our understanding of how to create rich and robust science curriculum grew, so by the summer of 2018, our final summer of curriculum development, we had created five exemplar units and established an exemplar unit template which is available in the T2L Toolkit.

We made a concerted effort to upgrade all the existing units with exemplar components. We were able to do much, but not all. So, as you explore different units, you will notice that some contain all elements of our exemplar units, while others contain only some. The fully realized exemplar units are noted on the cover page. We did revise all 20 units and brought them to a baseline of "exemplar" by including the Lessons-At-A-Glance and Science Talk elements.

Grade 5

# Matter and its Interactions



MCLA NAPS Williams

Teach To Learn

A collaboration between MCLA, Williams College, and North Adams Public Schools

Funded by NSF DUE-IUSE Award #1432591

T2L Curriculum Unit

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# Matter and Its Interactions

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## Physical Science/Grade 5

This unit explores appropriate scientific equipment use, the concept of matter and the 3 forms that it can take (solid, liquid, and gas) as well as the chemical and physical reactions that allow for phase changes and other transformations. This unit also introduces the Law of Conservation of Mass, as well as qualitative and quantitative analysis. Throughout the course of this unit, students will encounter new vocabulary and scientific principles that help to form the basis for further scientific thought and inquiry.

The lessons of this unit incorporate hands-on investigations, the use of technology, responding to journal prompts, recording data, and discussions with peers and teachers in order to facilitate a rich learning experience.

# Unit Creation and Revision History


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# Table of Contents



This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

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# UNIT PLAN

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr>
<td rowspan="4">5-LS2-1. Develop a model of a food web to describe the movement of matter among producers, primary and secondary consumers, decomposers, and the air and soil in the environment: a. show that plants produce sugars and plant materials; b. show that some animals eat plants for food and other animals eat the animals that eat plants; and c. show that some organisms, including fungi and bacteria, break down dead organisms and recycle some materials back to the air and soil. [Clarification Statement: Emphasis is on matter moving throughout the ecosystem. Waste includes matter in the form of gasses (such as air), liquids (such as water), or solids (such as minerals or nutrients).] [Assessment Boundary: Assessment does not include molecular explanations.]<br><br>5-PS3-1. Use a model to describe that the food animals digest: a. contains energy that was once energy from the sun, and b. provides energy and materials for body repair, growth, motion, body warmth, and reproduction. [Clarification Statement: Examples of models could include diagrams and flow charts.]</td>
<td colspan="2">Meaning</td>
</tr>
<tr>
<td>UNDERSTANDINGS U<br>Students will understand that<ul><li>Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model shows that gases are made from particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (5-PS1-1)</li><li>The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)</li></ul></td>
<td>ESSENTIAL QUESTIONS Q<ul><li>What structures allow plants and animals to survive?</li><li>Why are these structures important, and how did they aide in survival?</li></ul></td>
</tr>
<tr><td colspan="2">Student Learning Targets</td></tr>
<tr>
<td colspan="2">By the end of this unit, students will be able to say:<ul><li>I can follow rules for safe and appropriate use of scientific tools</li><li>I can identify the following tools and the purpose of each: microscope, scale, thermometer, beaker, and hand lens.</li><li>I can summarize an article about matter.</li><li>I can restate key points from an article.</li><li>I can identify evidence that supports the main idea of the text.</li><li>I can define matter and give examples of both matter and non-matter.</li></ul></td>
</tr>
</table>

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| | |
|---|---|
| [Assessment Boundary: Details of photosynthesis or respiration are not expected.]<br><br>**5-LS1-1. Support an argument with evidence that plants get the materials they need for growth and reproduction chiefly through a process in which they use air, water, and energy from the sun to produce sugars and plant materials.** [Assessment Boundary: The chemical formula or details about the process of photosynthesis is not expected.<br><br>***3-5 LS-2 Identify the structures in plants (leaves, roots, flowers, stem, bark, wood) that are responsible for food production, support, water transport, reproduction, growth, and protection.***<br><br>***3-5 LS.11 Describe how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within a food chain from producers (plants) to consumers to decomposers.***<br><br>**ELA Reading Standard**<br>2. Determine one or more main ideas of a text and explain how they are supported by key details; summarize a text. | • I can describe the three phases of matter (solid, liquid, or gas) and give examples of each.<br>• I can label drawings of different phases of matter by its properties of shape and volume.<br>• I can use the terms melting, evaporating, condensing, and freezing to describe phase changes<br>• I can describe phase changes in terms of heat gain or heat loss.<br>• I can define and describe the characteristics of gases.<br>• I can differentiate the characteristics of gases from those of liquids and solids.<br>• I can observe and describe phenomena involving gases and use these to create a model of a gas.<br>• I can define physical change and give examples of physical changes.<br>• I can differentiate between a solution, a suspension, and a mixture.<br>• I can record observations and use those observations to validate, or refute, predictions.<br>• I can form conclusions about different types of chemical changes to matter.<br>• I can differentiate between physical and chemical changes to matter.<br>• I can identify, define, and describe the characteristics of different types of matter.<br>• I can utilize the characteristics of matter to compare and contrast different types of matter.<br>• I can define and describe the characteristics of the different states of matter.<br>• I can describe and apply the Law of Conservation of Mass.<br>• I can measure quantitative properties of matter including thermal conductivity, electrical conductivity, response to magnetic forces, and solubility.<br>• I can distinguish different states of matter by their characteristics.<br>• I can use the characteristics of matter to separate matter in mixtures. |

| | |
|---|---|
| **ELA Writing Standard:**<br>1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.<br>a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped in paragraphs and sections to support the writer's purpose.<br>b. Provide logically ordered reasons that are supported by facts and details.<br>ELA Writing Standard (2017)<br>3. Write narratives in prose or poem form to develop experiences or events using effective literary techniques, descriptive details, and clear sequences. d. Use concrete words and phrases and sensory details to convey experiences or events precisely. | |

## Stage 2 – Evidence

| Evaluative Criteria | Assessment Evidence |
|---|---|
| | **The procedure of the CEPA is:**<br>● Review Lesson 8: Qualitative Analysis.<br>● Review the substances explored throughout the course of the unit. |

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| | |
|---|---|
| | • Break the class into groups of 3 students.<br>• Distribute the CEPA handout.<br>• Explain that each group will be given an unknown substance and that they must use the qualitative methods learned in Lesson 8, as well as throughout the course of the unit, to predict, observe, and conclude what they think their substance is.<br>• The substances (baking soda, chalk dust, salt, wax, or flour) will then be distributed in bags labeled A-E (respectively).<br>• The students will have access to all the equipment used in Lesson 8.<br>• The students will record their observations using text or illustrations, and after the have finished their examinations, will prepare a presentation based on those observations using a piece of chart paper.<br>• The groups will share their data, predictions, observations, and conclusions with the class.<br>• The groups will be graded based on the CEPA rubric.<br>• The posters can be hung throughout the classroom or hallway to exemplify student work. |
| **Other Assessments** | Students will be assessed on their responses to the various Science Journal prompts, the "exit ticket" activities, the attached worksheets, and participation in class discussions and activities. |

## Stage 3 Learning Plan

**Lesson 1: The Who, What, When, Where, Why & How of Being a Scientist:** Students will study the practices of effective scientists and review the eight scientific practices. The short YouTube rap video "How to be a Scientist" also emphasizes important scientific practices such as curiosity and keen observation. This lesson also gives an introduction to some scientific tools that will be used throughout the unit and how to use each tool appropriately and safely.

**Lesson 2: Matter Is Everywhere:** The classroom teacher will teach this lesson as an introduction to the unit. The students will activate prior knowledge by completing the lesson opening, in which they discuss what they believe "matter" to be as a class, creating a working definition for this vocabulary term. The students will be introduced to the vocabulary and then will be broken up into "home groups" of 4 students to complete a jigsaw activity with the provided article. Each member of the group will be responsible for reading 1 section of the article with the members of the other groups reading the same passage. The students will work together to gather contextual definitions for the vocabulary and then will "teach" the other members of their "home group" about the section of the article that they read before presenting an overall summary to the class as a whole. This summary and the related definitions will be used to synthesize a class wide summary and a vocabulary chart that will be hung on the wall throughout the remainder of this unit.

**Lesson 3: Modeling Matter:** Students will learn about the three phases of matter and how matter can change from one phase to another. A kinesthetic activity, in the second half of the lesson, helps students to understand the different phases of matter by behaving like particles of matter themselves.

**Lesson 4: Who Passed the Gas?** This lesson reviews the creation of models representing the three states of matter (solid, liquid, gas) and explores the characteristics of gases through experiments involving dry ice. The students are continually asked to make predictions throughout the course of this lesson in order to further their understanding of key concepts such as diffusion, volume, and density, as well as touching upon other vocabulary such as sublimation. This lesson also includes a possible literacy extension that can be completed by the classroom teacher to further student comprehension and retention. This lesson has two possible break points (dividing the lesson into three class periods) to be utilized as deemed appropriate by individual classroom teachers due to possible time constraints.

**Lesson 5: Physical Changes:** This lesson requires experimental stations that must be prepared ahead of time. In this lesson students will investigate physical changes through a series of experiments and demonstrations. The different types of physical changes that appear in the lesson are changes in shape/size, solutions, suspensions, mixtures, and phase changes.

**Lesson 6: Chemical Changes:** This lesson will begin with a review of physical changes as well as the three types of matter (solids, liquids, and gases). The Classroom Teacher or Science Fellow will then demonstrate a chemical change using baking soda, vinegar, a flask, and a balloon before discussing student observations and demonstrating the procedures for the 4 stations. The students will then complete the changes at each of the 4 stations in groups and will record their predictions, observations, and conclusions on the provided data sheet before discussing their findings as a class and completing the exit ticket activity.

**Lesson 7: Solutions, Suspensions and Separating Mixtures:** This lesson requires demonstrations that need to be prepared ahead of time. Students will investigate unique properties of matter in mixtures and use those properties to separate the mixtures.

**Lesson 8: Introduction to Qualitative Analysis:** This lesson will introduce students to the concept of qualitative analysis through hands-on activities and observations. The vocabulary for this lesson will be pre-taught, and the students will use their observational skills to first separate and classify a jar of pebbles before moving on to 5 "unknown" substances. Students will examine the 5 substances using color, hardness, and reflectivity in order to create a claim about what each substance is. Students will also discuss the differences between qualitative and quantitative analysis and the positive and negative aspects of qualitative analysis. This lesson directly relates to the CEPA so ensure students comprehend the information before proceeding on to lesson 9.

**Lesson 9: Electrical and Thermal Conductivity:** This lesson requires materials that must be prepared ahead of time. Students will observe quantitative characteristics of matter through a series of experiments and demonstrations. The properties to be studied are electrical conductivity, thermal conductivity, response to magnetic forces, and solubility. The lesson will conclude with a brief discussion of error in measurement during experiments.

**Lesson 10: Conservation of Mass, Part 1:** Students will begin this lesson by drawing molecular models of solids, liquids, and gases. They will also be introduced to the Law of Conservation of Mass and will test this law using water in its various forms (ice, water, and water vapor). The students will experiment with the melting of ice and will watch a video describing evaporation and condensation. This lesson will provide the foundation of scientific knowledge necessary for the next lesson of this unit.

**Lesson 11: Conservation of Mass, Part 2:** Students will begin this lesson by participating in a hands-on activity with modeling clay that exemplifies how the Law of Conservation of Mass applies to mixtures as well as to what was learned in the previous lesson. The students will then proceed to watch a video before completing an experiment in which they weigh water and Kool-Aid individually before weighing the mixture (they will complete this experiment with salt after). This lesson allows students more opportunity to practice predicting, observing, and concluding and will further their mastery with understanding and applying the Law of Conservation of Mass.

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# Lessons at a Glance

| | | | |
|---|---|---|---|
| Independent online student research | Tech Integration | YouTube Video | |
| Outdoor education | Kinesthetic | | |

| Lesson | Core Activities | Extensions | Aspects of Lesson |
|---|---|---|---|
| 1.The Who, What, When, Where, Why & How of Being a Scientist | • Lesson Activator<br>• Safety Guidelines | • "How to be a Scientist" YouTube rap | YouTube |
| 2. Matter Is Everywhere | • "Matter" Discussion<br>• Jigsaw Activity | | |
| 3. Modeling Matter | • Think-Pair-Share<br>• Move like Molecules | | |
| 4. Who Passed the Gas? | • Dry Ice Activity | • Comic | |

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| | | | |
|---|---|---|---|
| 5. Physical Changes | • Physical Change Demonstration Stations | | |
| 6. Chemical Changes | • Analyzing Fire/Smoke Demonstration<br>• Chemical Change Stations | | |
| 7. Solutions, Suspensions and Separating Mixtures | • Mixture Stations | | |
| 8. Introduction to Qualitative Analysis | • Examining Substances | | |
| 9. Electrical and Thermal Conductivity | • Thermal Conductivity Demonstration<br>• Exploring other Quantitative Properties (Solubility)<br>• Electrical Conductivity | | |
| 10. Conservation of Mass, Part 1 | • Law of Conservation of Mass Exercise | | |
| 11. Conservation of Mass, Part 2 | • Kool-Aid Mixture Experiment | | |

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# Lesson Feature Key

Lessons in this unit include a number of features to help instructors. This key is a quick guide to help identify and understand the most important features.

## Icons

**Talk science icon:** Look for this icon to let you know when to use some of the talk science strategies (found in the unit resources of this unit)

**Anchor phenomenon icon:** Indicates a time when an anchoring scientific phenomenon is introduced or when an activity connects back to this important idea**.**

**Text Formatting:**

[SP#: ….] Any time you see a set of brackets like this, it indicates that students should be engaged in a specific science or engineering practice.

Underlined text in the lesson:

This formatting indicates important connections back to the central scientific concepts and is useful to note these connections as an instructor, as well as for students.

## Callouts

**Teaching Tip**

In these call out boxes, you'll find tips for teaching strategies or background information on the topic.

**Student Thinking Alert**

Look out for common student answers, ways in which students may think about a phenomenon, or typical misconceptions.

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# Tiered Vocabulary List

| Tier One | Tier Two | Tier Three |
|---|---|---|
| Measure | Scale | Thermometer |
| Liquid | Matter | Beaker |
| Solid | Evaporate | Hand Lens |
| Melting | Condense | Particles |
| Freezing | Volume | Diffusion |
| Solid | Reaction | Mohs Scale |
| Liquid | Evaporation | Atom |
| Gas | Reflectivity | Mass |
| Temperature | Mass | Molecule |
| Boiling | Properties | Volume |
| Weight | | Phase/state |
| | | Phase Change |
| | | Sublimation |
| | | Density |
| | | Mixture |
| | | Solution |
| | | Suspension |
| | | Chemical Change |
| | | Filtration |
| | | Luster |
| | | Quantitative |
| | | Qualitative |
| | | Conductivity |
| | | Solubility |
| | | "Law of Conservation of Mass" |
| | | Proximity |

# Lesson 1: The Who, What, When, Where, Why & How of Being a Scientist

**Taught by the Classroom Teacher**

## BACKGROUND

### Overview of Lesson

Students will study the practices of effective scientists and review the eight scientific practices. The short YouTube rap video, "How to be a Scientist" also emphasizes important scientific practices such as curiosity and keen observation. This lesson also gives an introduction to some scientific tools that will be used throughout the unit and how to use each tool appropriately and safely.

### Focus Standard(s)

**3-5.TE.1.2** Identify and explain the appropriate materials and tools to construct a given prototype safely.

**ELA Reading Standard (2017)**

2. Determine one or more main ideas of a text and explain how they are supported by key details; summarize a text.

**ELA Writing Standard (2017)**

1.Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

### Student Learning Targets

- Establish rules for safe and appropriate use of scientific tools.
- Identify the following tools and the purpose of each: microscope, scale, thermometer, beaker, and hand lens.

### Assessment

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Have the students respond to one or more of the following questions in their science journals:

- What makes an effective scientist?
- Choose a scientific practice and give a concrete example of that practice.
- Choose a scientific tool; describe a situation in which a scientist appropriately and safely uses that tool.

### Targeted Academic Language/ Key Vocabulary

**Tier 1:** Measure
**Tier 2:** Scale
**Tier 3:** Thermometer, Beaker, Hand lens

## RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| **1** | **Scale** | **Bin** |
| **1** | **Thermometer** | **Bin** |
| **1** | **Beakers** | **Bin** |
| **1** | **Hand Lens** | **Bin** |
| 1 per student | Science Journals | Classroom Teacher |
| 1 | https://www.youtube.com/watch?v=MwvOCTdIaSE | CMC website |
| 1 per student | Lyric sheet for "How to be a Scientist" | Binder |

****Items in bold should be returned for use next year****

## LESSON DETAILS

### Lesson Opening/ Activator

Begin with a class discussion of at least one of the following questions: What do scientists do? What does a scientist look like? What makes an effective scientist? Feel free to add more questions if needed. After providing the students with lyrics, watch "How to be a Scientist" YouTube rap video as a class https://www.youtube.com/watch?v=MwvOCTdIaSE. Discuss what it means to be a scientist. Who can be a scientist? How can you "think like a scientist?" Do you need fancy tools to be a scientist? Emphasize that qualities like curiosity, open-mindedness, and forming arguments based on evidence are what make a

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scientist. NOTE: Be sure students understand anybody can be a scientist: female, male, etc. There is no “right person”—science is only about asking questions and finding answers to them in the world around us.

## During the Lesson

1. Reintroduce the students to the eight scientific practices. Briefly explain what each practice means and why it is important. Can ask students which practices are reflected in the “How to be a Scientist” video. Display the poster of the eight scientific practices prominently in the classroom.

    **The 8 Scientific Practices**
    1. Ask questions and define problems
    2. Develop and use models
    3. Plan and carry out investigations
    4. Analyze and interpret data
    5. Use mathematics and computational thinking
    6. Construct explanations (for science) and design solutions (for engineering)
    7. Engage in argument from evidence
    8. Obtain, evaluate, and communicate information

2. Establish a set of safety guidelines for classroom experiments and appropriate use of tools. Use the lab safety checklist attached to the end of this lesson plan as a basis for the classroom guidelines. Consider having the class sign a contract or pledge that they will abide by the safety guidelines.

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Some example guidelines may include (From *Massachusetts DOE Science and Technology/Engineering Curriculum Framework,* October 2006, pp. 128-129):

- Always use tools on a clean, flat surface (i.e. table)
- Never eat or drink during science experiments
- Never eat or drink materials/tools used in experiments
- Report all accidents to the Classroom Teacher immediately
- Do not touch tools/materials without the permission of a teacher or science fellow
- Only use tools/materials for their intended purpose
- Carry microscopes with one hand on the base and one hand on the arm
- Always wash hands before and after an experiment
- Clean up workspace after you're done

3. Present the following scientific tools to the class: scale, thermometer, beaker, and hand lens. Demonstrate appropriate use of each tool, and then have the students model appropriate use of each tool. Tell the students they will be using these tools throughout the matter unit. You may use the attached pictures of each tool as posters to hang in the classroom.

4. Introduce the distinction between *qualitative* and *quantitative* measurement. Explain that tools such as the hand lens can be used to make **qualitative** measurements based on observable characteristics (color, texture, size descriptions, etc.). Tools such as the scale and thermometer provide **quantitative** measurements by giving an exact number that can be associated with an object (weight or temperature, in this case).

5. Tell students that in each lesson they will be discovering answers to the unit's essential question. Post the question on large chart paper and have students think, pair, share responses: **How does matter change?**

6. Add the ideas to the large chart, to which you will return over the course of the units to review and revise.

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7. Let the students know they will be studying the following topics in the matter unit. Perhaps have them paste the graphic organizer below into their science journals.

8. What makes an effective scientist? (Probing: How are these qualities valuable?)

    a. According to the "How to be a scientist" rap video, _______.
    b. If students disagree: Although I agree with _______, I also believe _______ makes an effective scientist.

## Assessment

Have the students respond to one or more of the following questions in their science journals:

- Choose a scientific practice and give a concrete example of that practice.
- Choose a scientific tool describe its use.

# Lesson 2: Matter is Everywhere

**Taught by the Classroom Teacher**

## BACKGROUND

### Overview of Lesson

The classroom teacher will teach this lesson as an introduction to the unit. The students will activate prior knowledge by completing the lesson opening, in which they discuss what they believe “matter” to be as a class, creating a working definition for this vocabulary term. The students will be introduced to the vocabulary and then will be broken up into “home groups” of four students to complete a jigsaw activity with the provided article. Each member of the group will be responsible for reading one section of the article with the members of the other groups reading the same passage. The students will work together to gather contextual definitions for the vocabulary and then will “teach” the other members of their “home group” about the section of the article that they read before presenting an overall summary to the class as a whole. This summary and the related definitions will be used to synthesize a class wide summary and a vocabulary chart that will be hung on the wall throughout the remainder of this unit.

### Focus Standard(s)

**5. RI.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text

**5. RI.2** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text

**5. RI.8** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).

## Student Learning Targets

- I can summarize an article about matter.
- I can restate key points from an article.
- I can identify evidence that supports the main idea of the text.

## Assessment

After completing the jigsaw activity, have the students respond to the following assessment question in their Science Journals:

- What is matter? Use evidence from the article to support your answer. **[SP7-Engaging in Argument from Evidence]**. The students will then respond to the 10 questions found at the end of the article (in their Science Journals). These responses can be shared as a class if there is time. The teacher will collect the Science Journals at the end of this lesson for assessment.

## Academic Language/ Key Vocabulary

**Tier 1:** Liquid, Solid
**Tier 2:** Matter
**Tier 3:** Particles, Diffusion, Mohs Scale, Atom

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Science Journal | Classroom Teacher |
| 1 per student | Matter is Everywhere Article and Questions | Binder |
| 1 per group | Chart paper | Classroom Teacher |

****Items in bold should be returned for use next year****

## Lesson Opening/Activator

The students will begin this lesson by breaking into pairs and discussing what they think the word "matter" means (based on previous learning and opinions) with their partner. This step is important for addressing misconceptions about matter. The class will then regroup and discuss the various ideas that were discussed, with the teacher listing possible definitions on the whiteboard. The class will decide which definition they believe is the most accurate. The teacher will guide this discussion in order to touch on important concepts related to "matter" and to ensure the accuracy and effectiveness of this opening activity.

## During the Lesson

Introduce the following vocabulary terms from the article by writing each word on the board. Make sure each student can read the words. Explain to the students that they will create working definitions throughout the course of their reading using contextual clues and then will work with the rest of the class to write the correct definition for each vocabulary word.

- Mohs hardness scale
- Liquid
- Gaseous
- Solid
- Matter
- Particle
- Atom
- Diffusion

1. Break the students into groups of four ("home groups") and assign each member of the group with a number (1-4). Explain that each member of the group will be responsible for reading 1 section of the article corresponding with their assigned number (1 reads the introduction, 2 reads the section entitled "How Do We Know?", etc…) and they should write down the vocabulary words that appear in their section, as well as what they think the definition of those words are based on contextual clues and prior knowledge.

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2. Have the students move to different locations of the classroom based on their number and allow them to complete the reading with their peers. They will then discuss the reading with those peers to insure comprehension before regrouping into their "home groups" and "teaching" the other members of their "home groups" about what they read and the vocabulary they came across.

3. The "home groups" will then synthesize a complete summary of the article based on their combined readings and will write this summary on a piece of chart paper. They will include the previously mentioned list of vocabulary on this chart paper, as well as their contextual definitions for these words. The groups will then present their summary and definitions to the class and will hang their poster near the whiteboard for the remainder of this lesson. **[SP8-Obtaining, Evaluating, and Communicating Information]**

4. The class will then work as a whole to create a comprehensive summary of the reading, and will discuss the various contextual definitions of the provided vocabulary (with the teacher providing guidance and information as necessary) in order to create working classroom definitions to be used throughout the course of this unit. This vocabulary (and the corresponding definitions) will then be written on a piece of chart paper and hung on the wall throughout the remainder of this unit to provide guidance to the students as necessary. **[SP8-Obtaining, Evaluating, and Communicating Information] Do as a class but maybe add an exit ticket to see what the kids learn individually**

5. After completing the jigsaw activity, have the students pair up to answer the following question: How do the vocabulary terms relate to matter? How was the article helpful in helping us connect the vocabulary words to Matter?
   a. After investigating the word _______, I believe it relates to Matter because ________.
   b. The article that we read gave me more information about _______.

## Assessment

After completing the jigsaw activity, have the students respond to the following assessment question in their Science Journals:

- What is matter? Use evidence from the article to support your answer. **[SP7-Engaging in Argument from Evidence]**. The students will then respond to the 10 questions found at the end of the article (in their Science Journals). These responses can be shared as a class if there is time.
- The teacher could collect the Science Journals at the end of this lesson for assessment.

Extension: With the guidance of a checklist/worksheet, students could independently research the vocabulary words to check their understanding. Students can then use what they've learned and share with a partner.

# Lesson 3: Modeling Matter

## BACKGROUND

### Overview of the Lesson

Students will learn about the three phases of matter and how matter can change from one phase to another. A kinesthetic activity, in the second half of the lesson, helps students to understand the different phases of matter by behaving like particles of matter themselves.

### Focus Standard

**5-PS1-1.** Use a model of matter made of particles too small to be seen to explain common phenomena involving gases, phase changes between gas and liquid, and dissolving.

### Student Learning Targets

- I can define matter and give examples of both matter and non-matter.
- I can describe the properties of the three phases: solid, liquid, or gas.
- I can recognize drawings of different phases of matter by its properties of shape and volume.
- I can use appropriate scientific terms --melting, evaporating, condensing, and freezing – to describe the changes between phases.
- I can describe phase changes in terms of heat gain or heat loss.

### Assessment

- Identify solids liquids and gases by their properties relating to shape and volume.
- Complete grade-level appropriate MCAS questions about matter.

### Targeted Academic Language/ Key Vocabulary

**Tier 1:** Melting, Freezing, Solid, Liquid, Gas

**Tier 2:** Matter, Evaporate, Condense

**Tier 3:** Mass, Atom, Molecule, Volume, Phase/State, Phase Change

## RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Science Journal | Classroom Teacher |

****Items in bold should be returned for use next year****

## LESSON DETAILS

**Vocabulary** (to be done by the classroom teacher before science fellow arrives)

Use this time to review the concept of matter first introduced in the article from the previous lesson. Key vocabulary to focus on for the upcoming lesson: **matter**, **atom**, **molecule, solid**, **liquid**, and **gas**. Some questions that might help the students remember the article and the vocabulary words include: What is made of matter? What is matter made of? What are the three states of matter? The "Matter is Everywhere" article does not provide a scientific definition for the word "matter," so please make sure the students know it. Definitions of mass and volume may help students to better understand the definition of matter.

- **Matter** - anything that has mass and takes up space (volume)
- **Mass** - the amount of matter in an object
- **Volume** - the amount of space taken up by an object

### Lesson Opening/Activator

Give the students two minutes to make a list of everything in the classroom. The teacher can stretch the class' understanding by asking such questions as "What do we breathe in?" What do we breathe out?" Invite the students to add their classmates' items to their own lists in their Science Journals. After the time is up, have students share the items from their lists and create a full class list on the board. Do not erase the list at the end of this activator, for it will be needed in the next part of the lesson.

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

**Introduction to Matter and Phases of Matter**

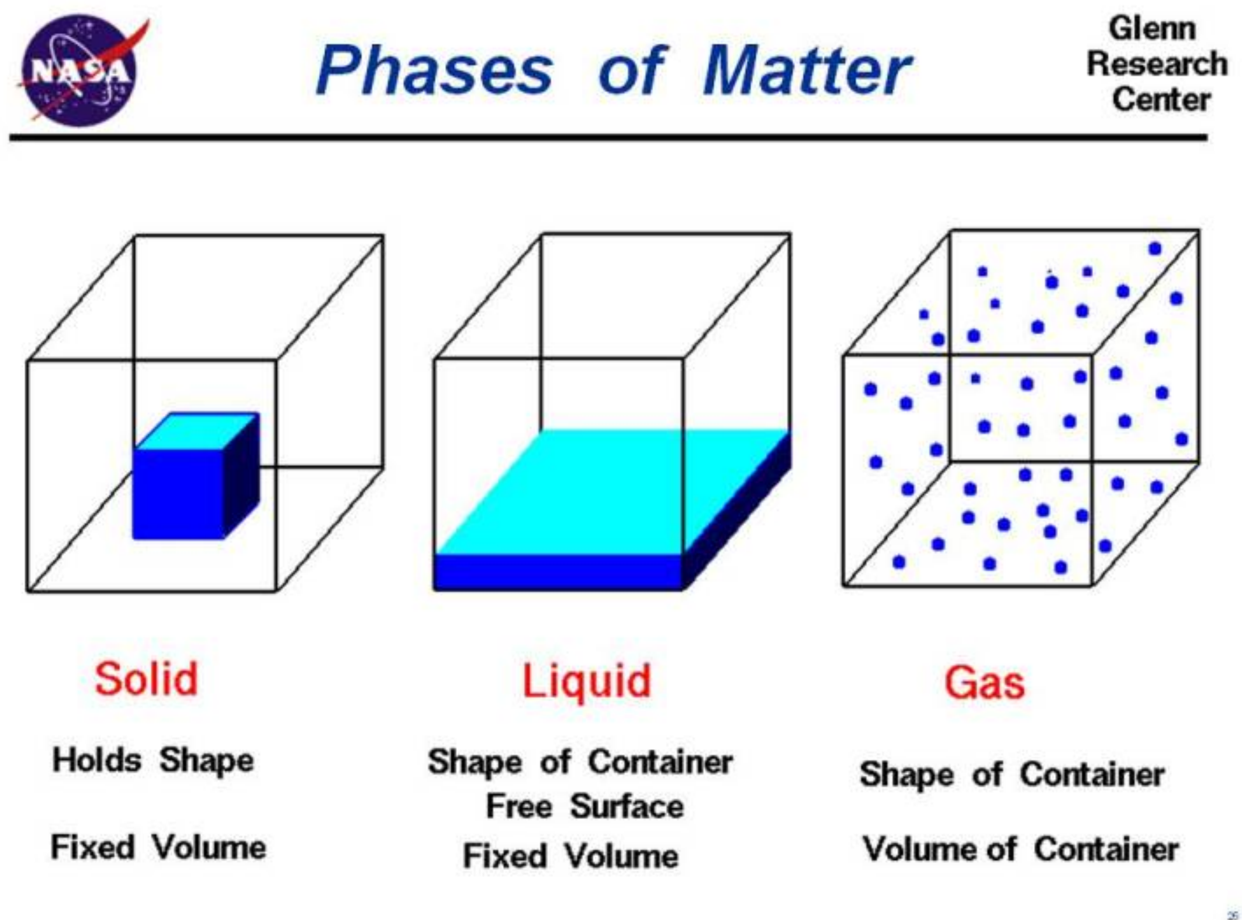
1. Regroup the list of words from the activator activity so that all items of the same phase (solid, liquid, gas) are together, but do not label the categories (yet). Begin by asking students to group similar items together, and correct for errors if necessary.

2. When each list is complete, discuss as a class the reasons for how the items are grouped. What properties do items within each category share?

3. Now, label each category appropriately as solid, liquid, or gas. Remind the students that these are the three phases of matter. (Note: the word "state" is a synonym for, and therefore interchangeable with, the word "phase"). Every form of matter belongs to one of the three phases. Define each phase by the arrangement of the particles of matter (atoms or molecules) in that phase. After each phase has been defined, you may erase the list of classroom items.

   - Solid - matter has fixed volume and fixed shape; particles vibrate in place.
   - Liquid - matter has fixed volume but takes on the shape of its container; particles flow freely across one another
   - Gas - matter takes on the volume and the shape of its container; particles move randomly in all directions

4. Use the Phases of Matter graphic (below) to aid with the definition of each phase. Draw the particle representations of each phase on the board, clearly showing the shape and volume of each phase. Keep these drawings on the board for use later in the lesson. **[SP-2 Developing and using models].**


NASA
Phases of Matter
Glenn Research Center
Solid
Holds Shape
Fixed Volume
Liquid
Shape of Container
Free Surface
Fixed Volume
Gas
Shape of Container
Volume of Container

## Phase Changes

1. Have students “turn and talk” with a classmate to discuss the following question:
   Does matter always stay in the same phase?
   a. Probing questions: Where have they seen phase changes before? Have you ever had ice cream on a hot day? What happens to the solid ice cream if you don’t eat it fast enough? What happens to lakes in the winter? What happens to puddles when the sun comes out after it rains? **[PS-1 Asking questions].**

2. A phase change is a change of matter from one state to another. What do all of these phase changes have in common? Will ice cream melt if it is left in the freezer? Do lakes freeze in the summer? **Phase changes are only possible when matter gains or loses heat.** (Note: it may be easier to explain this in terms of temperature rather than heat. Since temperature is a measurement of heat, the two words can be interchanged in this lesson).

3. Every phase change has its own special name. Some of these names are part of our common speech and some are not. Add arrows between the pictures of the different phases on the board, labeling each arrow with the appropriate scientific term. Also indicate whether heat (temperature) is added or lost during the phase change.
   - Melting - solid to liquid (heat gain)
   - Evaporating - liquid to gas (heat gain)
   - Condensing - gas to liquid (heat loss)
   - Freezing - liquid to solid (heat loss)
   - For the adventurous: Sublimating – solid to gas without becoming a liquid (heat gain)

Let students know they will be exploring phase changes more in the next two lessons.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

## Activity

Extension: This activity could take place outside weather permitting. Students can use the outdoor space to spread out and imitate the different behaviors.

1. Students will now test their newly acquired knowledge about matter by behaving like particles of matter themselves. This activity can be done by the whole class at once provided there is sufficient space, or in smaller groups of 4-6 students. Get everyone participating in the activity up out of his or her seat and to the front of the classroom.

2. Students will act out the three phases of matter as follows:
    a. Solid: students form a tight clump together
    b. Liquid: students spread out across the front of the classroom, demonstrating how liquids take on the shape of their containers
    c. Gas: students spread out across the entire classroom, demonstrating how gases take on the shape *and* the volume of their containers

3. Begin by calling out a phase: solid, liquid, or gas. Ensure that the students perform the correct action associated with each phase. If some students seem lost, provide hints about the shape and volume each phase takes with respect to its container.

4. When all students are demonstrating the appropriate action for the given phase, call out the name of another phase. If the students are organized in small groups for this activity, switch out groups every few rounds to give everybody a chance.

5. To make the activity more difficult, refer to each phase change by its scientific name (melting, evaporating, condensing, and freezing).

6. To make the activity even more difficult, describe the phase changes in terms of heat gain and loss rather than explicitly naming each phase. For example, if the students are initially in the solid phase and the activity leader says, "I'm adding

heat," the students should change to the liquid phase. Reinforce that matter can only change from one phase to another when heat is added or lost.

**Extension: introduce the movement of individual particles into the activity.**

- Solid: particles vibrate in place
- Liquid: particles move back and forth past each other
- Gas: particles move randomly in all directions

## Lesson Closing

- Recap the lesson with some questions about matter, properties of matter, and phases of matter. What are some examples of matter? What are some non-examples of matter? What does all matter in the universe have in common? How is a table similar to a glass of water? (Both made of matter, both have fixed volume). How is a table different from a glass of water? (Different phases: table has fixed shape and has more mass).

- Connect today's lesson to the essential question: How does matter change?

## Assessment

- Identify solids liquids and gases by their properties relating to shape and volume.
- Complete grade-level appropriate MCAS questions about matter.

### MCAS Questions

**12** A student freezes some orange juice. Which of the following statements **best** describes how the orange juice is different after it is frozen?

A. It is a liquid.
B. It weighs more.
C. It stays in one shape.
D. It takes up less space.

**4** Chris left a glass of water on a windowsill. When he looked at the glass a few days later, some of the water had evaporated.

Which of the following **best** describes what happened to the particles of water that evaporated?

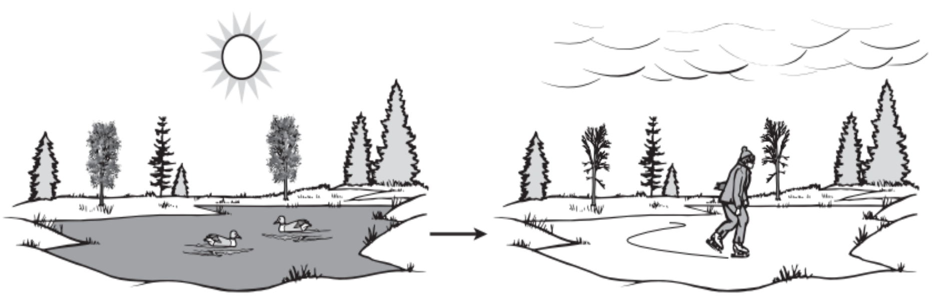
A. They became larger in size.

B. They spread out into the air.

C. They were absorbed by the glass.

D. They passed through the glass into the air.

**16** A pond is pictured below in two different seasons.



A B

Which of the following has caused the changes in the pond from A to B?

A. The pond water has lost heat energy.

B. The pond water temperature has increased.

C. Warm water has risen to the top of the pond.

D. All of the water has evaporated from the pond.

# Lesson 4: Who Passed the Gas?

## BACKGROUND

### Overview of the Lesson

This lesson reviews the creation of models representing the three states of matter (solid, liquid, gas) and explores the characteristics of gases through experiments involving dry ice. The students are continually asked to make predictions throughout the course of this lesson in order to further their understanding of key concepts such as **diffusion, volume**, and **density**, as well as touching upon other vocabulary such as **sublimation**. This lesson also includes a possible literacy extension that can be completed by the classroom teacher to further student comprehension and retention. This lesson has two possible break points (dividing the lesson into three class periods) to be utilized as deemed appropriate by individual classroom teachers due to possible time constraints.

### Focus Standard(s)

**5-PS1-1** Use a model of matter made of particles too small to be seen to explain common phenomena involving gases, phase changes between gas and liquid, and dissolving.

**5. W.4** Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

**5. SL.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly. [References optional literacy activity]

## ELA Writing Standard (2017)

Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped in paragraphs and sections to support the writer's purpose.

## Student Learning Targets

- I can define and describe the characteristics of gases.
- I can differentiate the characteristics of gases from those of liquids and solids.
- I can observe and describe phenomena involving gases and use these to create a model of a gas.

## Assessment

Have students define and describe the characteristics, as well as their observations regarding these characteristics, of gases in their Science Journal. Use these characteristics to compare and contrast the characteristics of gases with the characteristics of liquids and solids.

## Targeted Academic Language/ Key Vocabulary

**Tier 1:** Gas
**Tier 2:** Volume
**Tier 3:** Sublimation, Density

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Science Journal | Classroom Teacher |
| **1 per student** | **Safety Glasses** | **Bin** |
| **1 per class** | **Sprayable Air Freshener** | **Bin** |
| **1 per class** | **Essential Oil of Orange** | **Bin** |

| | | |
|---|---|---|
| **1 per class** | **Plastic Bucket** | **Bin** |
| **1 per class** | **Tall Drinking Glass** | **Bin** |
| **1 per class** | **Roll of Paper Towels** | **Bin** |
| **1 per class** | **10 Gallon Aquarium** | **Bin** |
| **1 per class** | **Liquid Bubbles** | **Bin** |
| 1 per class | Unit of Dry Ice (including tongs, goggles, and gloves) | Contact College Liaison 3 days prior to lesson |
| 10 per class | Balloons or rubber gloves | Bin |
| **5 per class** | **Film Canister** | **Bin** |
| 1 per student | "States of Matter" Comic | Binder |

****Items in bold should be returned for use next year****

# LESSON DETAILS

## Lesson Opening/ Activator

1. Review the information from the previous lesson regarding the similarities and differences between solids, liquids, and gases. Break the students up into groups of four and have them draw molecular models of a solid, a liquid, and a gas. The students will then reconvene as a class and volunteers share their drawings, allowing time for questions and comments at the end of each presentation. (Limit presentations to two minutes each.) The teacher will use the information presented by the students to draw models of a solid, a liquid, and a gas on the whiteboard for reference throughout the course of this lesson. This will activate prior knowledge and will allow students to more effectively engage with this lesson. **[SP2-Developing and Using Models]**

2. After the completion of the review, the Classroom Teacher or Science Fellow(s) will tell the students today they will be exploring and discussing the properties of gases. Spray air freshener (or the essential oil of orange for a hypoallergenic

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

alternative) on 1 side of the classroom. Ask the students to raise their hands when they can smell either the air freshener or essential oil. As the smell permeates the classroom, have the students note their observations in their Science Journals. After the completion of this portion of the lesson, discuss what the students noticed about the smell and what that leads them to believe about the characteristics of gases. Introduce the following vocabulary during this activity:

- Diffusion
- Volume

## During the Lesson

### Introduction to Gases

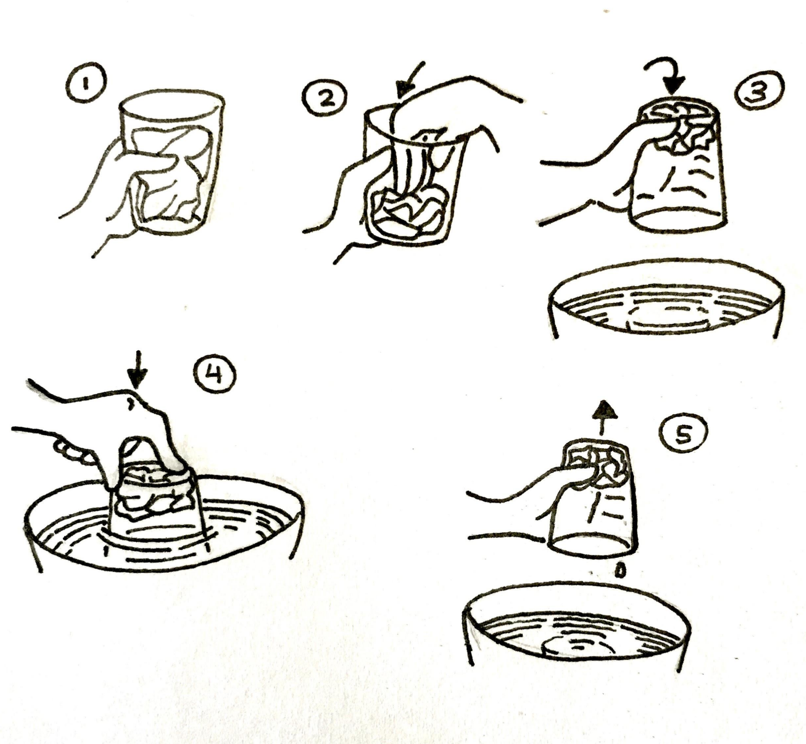
1. Discuss the fact that gases spread out to fill the available space (refer to the previous introduction to **diffusion**). Starting from one spot in the classroom, the air carrying the scent will spread throughout the classroom, out the door, into the hallway, and eventually outside. This is why smells in the air eventually go away. Explain that diffusion is one of the characteristics of gases.

2. Go on to explain diffusion allows a gas to spread and fill ANY container that it is in, regardless of the size or shape. This means that the **volume** of a gas changes as it **diffuses** to take the shape of a given container. The teacher can draw a model of diffusion on the whiteboard, with the students copying this model into their Science Journals in order to increase comprehension. Explain to the students the class will now conduct a series of experiments to explore the various characteristics of gases.

### Gas and Volume

1. The teacher or Science Fellow will then ask the students what is invisible and all around them. This will allow for the class to participate in a discussion about air. Throughout the course of this discussion, have the students think about how they know there are gases (air) all around them.

2. Following the discussion, fill a bucket with water and place it in front of the room, explaining this experiment will prove there are gases all around the students. Ask the students to write any observations that they may have in their Science Journals.
3. Crumple a piece of paper or a paper towel into a ball and push it into the bottom of the clear drinking glass. Hold the glass vertically with the open end facing down, and push it straight down into the water. Lift the glass straight out of the water. Remove the paper and have the students observe and record the results in their Science Journals.




**Visual for the crumpled paper experiment.**

4. After the completion of this demonstration, discuss the following questions and ideas with the class:
   - What happened to the paper?
   - Why didn't it get wet?
   - What was in the glass besides the paper that kept the water from getting in?

   Note: Throughout the discussion, be sure to highlight to the students gas takes up space (volume) like all matter, so the water couldn't fit all the way in the glass. **[SP6-Constructing Explanations]**

**This is a possible break-point due to time constraints (this decision can be made at the discretion of the Classroom Teacher)**

**Dry Ice**

1. If this portion takes place on a different day than the beginning of this lesson, be sure to review the concepts previously discussed in order to insure student comprehension and retention of the information.

2. The Classroom Teacher will then tell the class they will be observing and experimenting with a type of gas created from dry ice. The Classroom Teacher or Science Fellow(s) will explain to the students that dry ice is solid carbon dioxide and it must be kept very cold and at room temperature dry ice undergoes **sublimation** and is converted from a white solid to a clear gas (carbon dioxide), skipping the liquid phase because the temperature change is so great. At this point, the Classroom Teacher or Science Fellow should define sublimation and discuss this concept with the students in order to gauge comprehension, providing information as necessary to allow for this comprehension to take place. Go on to explain that, due to its extremely cold temperature, dry ice can cause damage to skin if handled directly, so students should always use tongs or insulated gloves when handling it. State it is also important not to get any dry ice dust into your eyes when crushing or grinding the solid, so students (and teachers) should always wear protective goggles.

3. Explain to the students when dry ice is placed in warm or hot water, clouds of white fog are created; this fog is not $CO_2$ gas, but condensed water vapor mixed with $CO_2$. The fog is heavy, because it is mixed with $CO_2$; it will settle at the bottom of a container and can be poured. Introduce the concept of **density** to the students at this point and explain how matter that is more dense will sink, while matter that is less dense will float (use the example of a marble sinking in a pool while an inflated ball floats to help clarify this concept if necessary).

4. **Instruct the students to put on their safety glasses and insure that the students remain at a safe distance for all of the experiments**. Before starting this activity, have students make predictions about what will happen in their Science Journals (after explaining briefly the activity). They can use drawings or text to record their predictions. Hold open a balloon and put a few small pieces of dry ice inside. Tie the balloon closed. At this point, volunteers can share what their predictions are and why they think that will happen. The class will then observe what is happening to the balloon (is it inflating? deflating?) and discuss why they think this is happening.

5. The Classroom Teacher or Science Fellow will then ask the following questions:
    - Why did the balloon inflate?
    - What is happening to the solid dry ice inside the balloon?
    - Why does the balloon get bigger when the dry ice turns into a gas?
    - How do these observations help explain the difference between solids and gases?

   **WARNING: THE BALLOON MAY POP DEPENDING UPON HOW MUCH DRY ICE WAS PUT IN IT.**

6. Before this next activity, again ask students to predict what will happen when a few pieces of dry ice are placed in a film canister either through drawing or text. Discuss the predictions as a whole class. Place a few small pieces of dry ice in a film canister. Observe the reaction and discuss what occurs, focusing on the following questions:
    - Why does the top of the canister come off?

- What is happening to the solid dry ice inside the canister?
- How does this show how solids and gases are different?
- How fast do gas molecules move? (Refer to the top of the canister flying off)
- How fast do solid molecules move?
- Use the observations of the students as well as guided discussion to relate these ideas to volume and how the volume of a gas depends on the container it is in.

**WARNING: THE TOP OF THE CANISTER WILL FLY OFF DUE TO THE INCREASE IN PRESSURE. AIM THE CANISTER AWAY FROM THE STUDENTS AND OTHERS IN THE CLASSROOM.**

**This is a possible break-point due to time constraints. (This decision can be made at the discretion of the Classroom Teacher.)**

If there was a break prior to this step, be sure to review the previously learned information with the students through a guided discussion on what they remember, focusing on **volume**, **density,** and **diffusion**.

1. Place dry ice in a fish tank and add warm water (quantity is not a factor). A white fog should form and settle on the bottom of the tank. The teacher will ask the students why they think the fog is on the bottom of the tank (once again referring to the concept of **density**––the white fog is denser than the air around it but less dense than the water beneath it).

2. The teacher will then tell students that volunteers will blow bubbles into the fish tank and ask the students to make predictions in their Science Journals (through drawing or writing) about what will happen to the bubbles (will they float on top of the fog? Sink beneath it?). **Tell the students not to breathe in the gas as a safety precaution!**

3. The class will then observe the ensuing process and discuss what occurred and whether the students' predictions were correct or incorrect. The following questions can be asked during this step in order to guide the class discussion in the appropriate direction:

- Which gas has a higher **density** (refer to the previous discussion on density and have the students define this vocabulary word and write it in their Science Journal if necessary): the breath in the bubble or the carbon dioxide and water vapor?
- How can you tell? Relate this to a helium balloon that rises into the air (unlike a balloon filled with your breath). Relate this question to the density of liquid and solids––which state of matter is the densest? Which is the least? **[SP7-Engaging in Argument from Evidence]**

4. If students are struggling with the concept of **density**, put some of the dry ice in a bowl with hot water and then pour the gas onto the floor. Ask the students why the gas stays on the floor (is it denser than the air around it?). The teacher will then relate this to the bubble experiment in order to increase student comprehension of an important scientific concept. You could also re-define density: Density is the amount of stuff in a given space. If there is more stuff in that space, then the object will be denser. For example, if you have two balls of the same size, one made of Styrofoam and the other made of metal, the metal object will be denser because it's heavier. With our gases, it's very similar. The white gas from the dry ice has more "stuff" in it than the normal air does, and that's why it sinks.

## Literacy Extension

1. Have the students break into groups of three and read the provided comic (http://chogger.com/comics/neLw4/states-of-matter).The groups will then work together to finish the comic, explaining the similarities and differences between the three different states of matter using their own ideas. The groups can divide the roles of illustrator, writer, and creative designer among themselves or can share the responsibilities. After completion, the groups will present their finished comics to the class. Time will be allotted in between presentations for questions/compliments. **(This extension can be completed by, and at the discretion of, the Classroom Teacher)**.
2. Time permitting, students who volunteer can act out their comics to the class.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

## Lesson Closing

The Classroom Teacher will ask the students to think back to the first demonstration of the empty glass, ball of paper and bucket of water. The students will then write in their Science Journal about what the dry ice experiments allowed them to conclude about the density of a gas compared to the density of a liquid. The students can also discuss the varying densities of the different gases as demonstrated in the dry ice experiments. In order to get the students to think about the topics in the next two lessons (physical and chemical changes), ask students if matter can 'change' and if so, how.

## Assessment

Have students define and describe the characteristics, as well as their observations regarding these characteristics, of gases in their Science Journal. Use these characteristics to compare and contrast the characteristics of gases with the characteristics of liquids and solids.

# Lesson 5: Physical Changes

## BACKGROUND

### Overview of the Lesson

**This lesson requires experimental stations that must be prepared ahead of time.** In this lesson students will investigate physical changes through a series of experiments and demonstrations. The different types of physical changes that appear in the lesson are changes in shape/size, solutions, suspensions, mixtures, and phase changes.

### Focus Standard(s)

**PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

### ELA Writing Standard (2017)

Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped in paragraphs and sections to support the writer's purpose.

### Student Learning Targets

- I can define physical change and give examples of physical changes
- I can differentiate between a solution, a suspension, and a mixture
- I can observe phase changes as examples of physical changes

## Assessment

Students will be assessed on participation in class activities, completion of the lesson worksheet, and the following prompt: Give an example of a solution, a suspension, and a mixture and explain how they are different

## WIDA Language Objectives

TBD

## Targeted Academic Language/ Key Vocabulary

**Tier 3:** Physical Change, Mixture, Solution, Suspension

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| **1 bottle** | **Vegetable Oil** | **Bin** |
| As needed | Water | Classroom Teacher |
| As needed | Ice | Classroom Teacher |
| **1 bag** | **Flour** | **Bin** |
| **1 box** | **Salt** | **Bin** |
| **4** | **Beakers** | **Bin** |
| **1 piece per student** | **Play-Doh** | **Bin** |
| 1 per student | Science Journal | Classroom Teacher |

****Items in bold should be returned for use next year****

# LESSON DETAILS

Vocabulary (to be taught by Classroom Teacher before Science Fellow arrives). Make sure students are familiar with the following words before the lesson. Pictures are provided at the end of the lesson to be used as a teaching reference.

- **Physical change**: a change in an object that does not change the matter that makes up the object
- **Mixture**: a combination of two or more types of matter
- **Solution**: a mixture of one type of matter that is dissolved in another type of matter
- **Suspension**: a mixture of one type of matter that is finely spread out in another type of matter

## Lesson Opening/Activator

Give each of the students a piece of Play-Doh. Ask the students to make something using the Play-Doh. Ask the students to answer the following question in their Science Journal: Think about the Play-Doh when you first received it. Is the Play-Doh still made of the same kind of matter or did it change after you made something with it?

### Physical Changes

- Review the definition of physical change. A **physical change** is a change in an object that does NOT alter the matter that makes up the object. For example, each student has changed the shape of his or her object, but it is still made up of Play-Doh. Therefore, the Play-Doh has undergone a physical change.

- Other examples of physical changes include changing the color, mass, volume, or state of matter; mixing one kind of matter with another (or many others); and dissolving matter in a liquid, such as water. A mixture of two or more kinds of matter can always be separated back into the different kinds of matter.

- Give a few more demonstrations of physical changes to help the students better understand the idea. Some quick and easy demonstrations are ripping or crumpling a piece of paper or making a mark on the whiteboard.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

- The students will continue their study of physical changes by traveling in small groups through a series of four stations around the classroom. Each student will complete a worksheet as they pass through each station. You will need to have the materials for each station organized ahead of time. Also, when groups rotate stations, the students will need assistance cleaning up their station and readying it for the next group.

- Each station will provide the students with an opportunity to perform a physical change on one or more types of matter. Explain the directions for each station to the students.

- At each station, students will first make a prediction about what they think will happen when they mix the two substances, then perform the physical change and make observations. Finally, they will make concluding remarks by answering the following questions:
    - Probing questions: What physical change has taken place? How do you know it's a physical change?
        - _____ physical change has taken place. I know this because I observed __________.
          **[SP-3 Planning and carrying out investigations].**

**Physical Change Demonstration Stations**
**Station 1: Salt and Water**

- The initial setup of the station requires a beaker of water (about half full) and some salt (only a few tablespoons are needed for each group). Students may take turns slowly pouring the salt into the water, stirring after each addition. What happens to the salt when it first hits the water? What happens to the salt after the water has been stirred? Is this a mixture, solution, or a suspension? What is the evidence for their answer? (Salt and water forms a *solution*). At the end of the station, have the students pour the beaker down the sink, fill it again with water, and refill the salt for the next group.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

### Station 2: Flour and Water

- The initial setup of the station requires a beaker of water (about half full) and some flour (only a few tablespoons are needed for each group). Students may take turns slowly pouring the flour into the water, stirring after each addition. What happens to the flour when it first hits the water? What happens to the flour after the water has been stirred? Is this a mixture, solution, or a suspension? What is the evidence for their answer? (Flour and water forms a *suspension*). At the end of the station, have the students pour the beaker down the sink, fill it again with water, and refill the flour for the next group.

### Station 3: Oil and Water

- The initial setup of the station requires a beaker of water (about half full) and some oil (only a few tablespoons are needed for each group). Students may take turns slowly pouring the oil into the water, stirring after each addition. What happens to the oil when it first hits the water? What happens to the oil after the water has been stirred? Is this a mixture, solution, or a suspension? What is the evidence for their answer? (Oil and water forms a *mixture*).

- Think back to lesson 4 and the term "density." What does this experiment show about the density of oil relative to the density of water? At the end of the station, have the students pour the beaker down the sink, fill it again with water, and refill the oil for the next group.

### Station 4: Water and Ice

- The initial setup of the station requires a beaker of water (about half full) and several ice cubes. Add the ice cubes to the beaker of water. Where are the ice cubes relative to the water? What can you say about the density of ice versus the density of water? After a few minutes, observe the beaker. What has changed on the inside of the beaker? What has changed on the outside of the beaker? What would you call this physical change? At the end of the station, have students pour the beaker of water down the sink, fill it again with water, and get more ice for the next group.

## Assessment

Students will be assessed on participation in class activities, completion of the lesson worksheet, and the following prompt: Give an example of a solution, a suspension, and a mixture and explain how they are different.

Kool-Aid added to water is a solution

Flour added to water is a suspension

Oil added to water is a mixture

# Lesson 6: Chemical Changes

## BACKGROUND

### Overview of the Lesson

This lesson will begin with a review of physical changes as well as the 3 types of matter (solids, liquids, and gases). The Classroom Teacher or Science Fellow will then demonstrate a chemical change using baking soda, vinegar, a flask, and a balloon before discussing student observations and demonstrating the procedures for the 4 stations. The students will then complete the changes at each of the four stations in groups and will record their predictions, observations, and conclusions on the provided data sheet before discussing their findings as a class and completing the exit ticket activity.

### Focus Standard

**PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

### Student Learning Targets

- I can record their observations and use those observations to validate or refute their predictions.
- I can form conclusions about different types of chemical changes to matter.
- I can differentiate between physical and chemical changes to matter.

## Assessment

Students will define both physical and chemical changes and list the differences in their Science Journals. They will also complete the “exit ticket” activity at the end of the lesson and will hand in the tickets for assessment.

## WIDA Language Objectives

TBD

## Targeted Academic Language/ Key Vocabulary

**Tier 1:** Temperature

**Tier 2:** Reaction

**Tier 3:** Chemical Change

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Chemical Change Recording Sheet | Binder |
| **1 per member of the class** | **Safety glasses** | **Bin** |
| 1 box | Baking soda | Bin |
| 1 bottle | White vinegar | Bin |
| 2 balloons | Latex-free Balloons | Bin |
| **1 unit** | **Flask** | **Bin** |
| **1 package** | **Long Matches** | **Bin** |
| **25 units** | **Beaker** | **Bin** |
| 1 bottle | Milk | Contact Sue Beauchamp |
| **1 unit** | **Squeeze bottle** | **Bin** |
| 5 tablets | Alka-Seltzer tablets | Bin |

| | | |
|---|---|---|
| | Water | Classroom Teacher |
| At least 125 mL | Lemon juice | Bin |
| **2 units** | **Thermometer** | **Bin** |
| **2 units** | **Spoon** | **Bin** |
| **6 pieces** | **Steel wool** | **Bin** |
| **1 roll** | **Aluminum foil** | **Bin** |

****Items in bold should be returned for use next year****

# LESSON DETAILS

## Lesson Opening/ Activator

1. This lesson will begin with a review of physical changes and the three types of matter from the previous lessons. The students will be paired off and asked to define physical change as well as drawing molecular models of the 3 types of matter (solids, liquids, and gases). The Classroom Teacher or Science Fellow will then ask what happens if you bake something; can the ingredients be separated out? If this change isn't physical, what could it be called? The Classroom

   Teacher or Science Fellow will use these questions to guide the discussion towards the introduction of **chemical changes** (which occur when two or more types of matter react to form a different type of matter). **[SP2-Developing and Using Models]**

2. The Classroom Teacher or Science Fellow will then demonstrate a chemical change using vinegar, baking soda, a flask, and a balloon. The adults and students will wear safety glasses for this section. The Classroom Teacher or Science Fellow will ask the students to predict what will happen when the baking soda and vinegar mix, and the students will share their predictions before this experiment takes place. After the discussion is over, the Classroom Teacher or

Science Fellow will mix the baking soda and vinegar in the flask and place the balloon over the top. The ensuing reaction will cause the balloon to fill with carbon dioxide, indicating a chemical change. After the conclusion of this experiment, the teacher or Science Fellow will ask the students if the previous change was a chemical or physical one (can the ingredients be separated out?). This discussion will allow students to activate prior learning by exposing them to a familiar reaction while at the same time laying the groundwork for further study of chemical changes.

## During the Lesson

1. The Classroom Teacher or Science Fellow will write "chemical change" on the whiteboard and define it for the students. The students will then break into pairs and come up with a list of possible chemical changes (baking, lighting a match, fire, etc…) and share their ideas with the class. The Classroom Teacher or Science Fellow will list possible chemical changes on the whiteboard and discuss whether the listed reactions are correct or not (providing accurate but related alternatives, so that the pairs do not feel ostracized for providing incorrect answers). At this point, the Classroom Teacher or Science fellow should highlight chemical changes are usually accompanied by a change in temperature (as energy is released or absorbed), and the resulting matter is different than the original and cannot be separated into the original substances.

2. **Make sure you are near a window or outside for this step so the fire alarm doesn't go off! Weather permitting, teachers can also demonstrate this outside.** The Classroom Teacher or Science Fellow will then tell the students they will be lighting a match. All members of the class will wear safety glasses. The students will work with their partner to predict what will happen and if the change that occurs is a physical change or a chemical change. The Classroom Teacher or Science Fellow will then light the match and hold it so all the students can see what is happening. During this time, the Classroom Teacher or Science Fellow will highlight the smoke that the match is giving off and the different color of the burned match. After the match is blown out, the teacher or Fellow will discuss the change from wood to ash and will show the students how the burned section of match is different from the unburned section. The students will then share their observations and will decide as a class if the previous reaction was a chemical or physical change. The teacher or Fellow will guide the discussion in such a way the students can come to the realization that it was in fact a

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chemical change based on what they observed. If students are struggling to comprehend the difference between chemical and physical changes, have them work with their partner to list the differences between the burning of the match and the physical changes that were shown in the previous lesson and to share those differences with the class. **[SP7-Engaging in Argument Based on Evidence]**

3. The Classroom Teacher or Science Fellow will then explain students will be working at stations to create chemical changes. The Classroom Teacher or Science Fellow will demonstrate the four changes to the class. Students will then divide into 4 groups, with each group going to a separate station. They will wear safety glasses for the duration of this activity. The groups will remain at each station for five to seven minutes and will record their predictions, observations, and conclusions on the provided data sheet. The Classroom Teacher and Science Fellow will circulate as necessary to insure that the appropriate science safety practices are being followed (as described in Lesson 1) and that the directions are being followed. Instructions for each station can be listed on a piece of chart paper (if deemed appropriate by the classroom teacher). The 4 stations, and the instructions for each station, are:

    1. **Materials: Milk in beakers, vinegar in a squeeze bottle, and a spoon.**
       The students will mix the milk and the vinegar and stir the solution, predicting and then observing what occurs. (liquid to solid).

    2. **Materials: 1 Alka-Seltzer tablet, a beaker filled with water**.
       The students will add **HALF** of the Alka-Seltzer tablet to the water and observe what occurs (liquid to gas).

    3. **Materials: Baking soda, 25 mL of lemon juice in beakers, a spoon, and a thermometer.**
       The students will mix the baking soda with the lemon juice, stir the solution, and then use the thermometer to record the temperature change (taking measurements every minute). (The temperature will drop as the chemical change occurs).

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4. **Materials: Vinegar in a beaker, steel wool, thermometer, an empty beaker, aluminum foil.**
   The students will soak the steel wool in the vinegar, wring it out, wrap the steel wool around the thermometer, place it in the empty beaker and cover the beaker with aluminum foil (insure that the thermometer remains visible). They will record the temperature change every minute. (The temperature rises and the color changes during this chemical change).

4. The class will then reconvene and the groups will share their predictions, observations, and conclusions from the stations (limit this to 3 minutes per group). The class will then use the information gathered from the stations to describe the differences between physical and chemical changes, with the Classroom Teacher or Science Fellow listing the differences on the whiteboard and the students copying the differences into their Science Journals.

## Lesson Closing

The students will then work in pairs to create Venn diagrams comparing and contrasting physical and chemical changes. (A possible Venn Diagram template can be found at the end of this lesson.) They can use examples in the diagrams if they deem it appropriate. These will then be presented to the class, with time for questions and comments after each presentation. (The presentations should last no more than two to four minutes each).

## Assessment

Students will define both physical and chemical changes and list the differences in their Science Journals. They will also complete the "exit ticket" activity at the end of the lesson and will hand in the tickets for assessment.

# Matter: Lesson 6 Exit Ticket

Please show in the table below whether each of the following is a physical change or a chemical change.

| | Physical Change | Chemical Change |
|---|---|---|
| A car rusting | | |
| Adding water to orange juice | | |
| Eating and digesting a piece of cake | | |
| Burning wood in a fire | | |
| Making salad dressing | | |
| Baking bread | | |
| Running a car engine | | |
| Taking a shower | | |
| Making Kool-Aid (or another powdered drink) | | |

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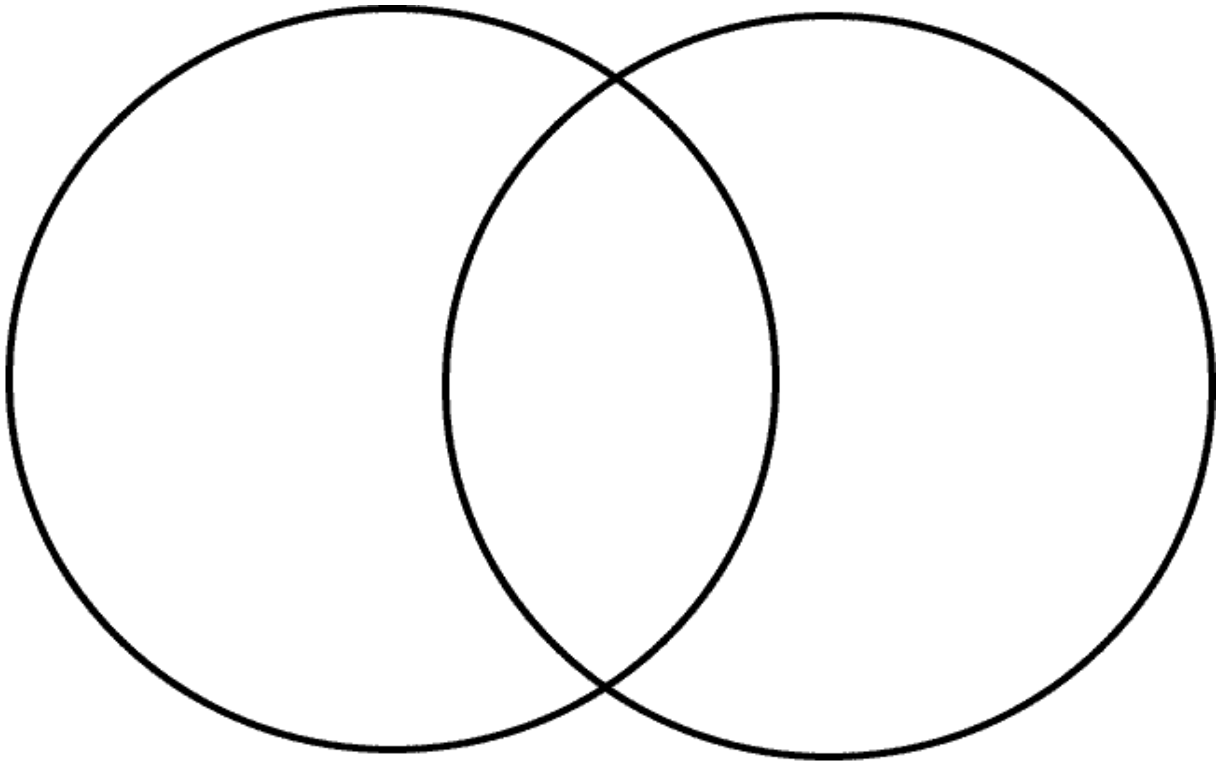

# Lesson 7: Solutions, Suspensions and Separating Mixtures

## BACKGROUND

### Overview of the Lesson

This lesson requires demonstrations that need to be prepared ahead of time. Students will investigate unique properties of matter in mixtures and use those properties to separate the mixtures.

### Focus Standard(s)

**PS1-3** Make observations and measurements to identify substances based on their unique properties

### Student Learning Targets

- I can distinguish different types of matter by their characteristics.
- I can use the characteristics of matter to separate matter in mixtures.
- I can explain the physical changes that are involved in forming and separating mixtures.
- I can identify a mixture as a solution or a suspension.

### Assessment

Assessment will be based on participation in experimental stations and the following prompt: In their Science Journals, have students make a list of all the physical and chemical changes they observed during the lesson.

### Targeted Academic Language/ Key Vocabulary

**Tier 2:** Evaporation

**Tier 3:** Filtration

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| **1 bag** | **Kool-Aid powder** | **Bin** |
| | **Dirt** | **Bin** |
| | **Iron Filings** | **Bin** |
| 1 bag | Sand | Bin |
| 1 bag | Chex Mix or alternative for those who have allergies | Classroom Teacher |
| **3** | **Large Beaker** | **Bin** |
| **1** | **Small Beaker** | **Bin** |
| **1** | **Hot Plate** | **Bin** |
| **4** | **Filter** | **Bin** |
| **1** | **Funnel** | **Bin** |
| **2** | **Bowl** | **Bin** |
| 1 per student | Science Journal | Classroom Teacher |

****Items in bold should be returned for use next year****

# LESSON DETAILS

## Lesson Opening/Activator

Review the concept of scientific **properties** first introduced in Lesson 2. All matter has many properties, and different types of matter can be distinguished by their properties. In their science journal, have each student think of two objects in the room. List as many properties for each object as they can. Which properties are similar and which are different? What sorts of

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physical changes could you perform on the object? What sorts of chemical changes could you perform on the object? Discuss as a class some different objects and their properties.

**Solutions, Suspensions, and Separating Mixtures**

1. Review **solutions** and **suspensions** (lesson 5) by mixing Kool-Aid powder and water in one beaker, and dirt and water in another beaker.

2. Ask the students which beaker contains a solution (Kool-Aid), which contains a suspension (mud), and ask them to prove their statement using evidence they observe about each mixture. The fact Kool-Aid is clear (transparent) shows that the powder has dissolved, a characteristic of a solution. Mud is cloudy (opaque) because the dirt particles do not dissolve in the water, a characteristic of a suspension. **[PS-7 Engaging in argument from evidence].**

3. Explain the goal of this lesson is to separate these and other mixtures. Remind students that all matter can be distinguished by its properties, and scientists take advantage of this fact to be able to separate mixtures.

4. Divide the students into four groups and explain to them they will be traveling around to different stations using different techniques to separate different mixtures. Each station should be completed in 5-10 minutes. Pass out the lesson worksheet, one per student. **[PS-3 Planning and carrying out investigations].**

5. Review the station descriptions ahead of time, so you can give clear and accurate instructions to the students as they move from station to station.

6. Set up the four stations as follows. **<u>Please have the materials organized ahead of time.</u>**

**Station 1: Evaporation Separation (requires a Classroom Teacher or Science Fellow to operate hot plate)**

1. Pour a small amount of the Kool-Aid prepared at the beginning of the lesson into a small beaker on the hot plate. Turn on the hot plate.

2. After a few minutes, the Kool-Aid will begin to boil. As it boils, ask students to write down their observations on the worksheet or in their science journals.

3. Ask questions to help guide their observations. Do they notice the bubbles? What does this indicate? (It indicates a phase change as the liquid water evaporates into gas). What happens to the volume of liquid in the beaker? (It decreases as the water evaporates).

4. After most of the water has evaporated, the remaining powder will color the bottom of the beaker. If the water is completely boiled off, the hot plate may burn some of the powder at the bottom of the beaker. Ask the students if the powder is still the same after it's burned. (Hint: Burning is a chemical change).

5. Before the students leave the station, make sure that they understand how the Kool-Aid was separated and the coloring on the bottom of the beaker is the Kool-Aid powder.

6. Wash out the small beaker in the sink to prepare for the next group. Mix more Kool-Aid if necessary.

**Station 2: Magnetic Separation**

Mix iron filings and sand in a small bowl.

1. How is it possible to separate the iron from the sand? Try picking out the iron filings individually. It will be very difficult to pick out a piece of iron without picking out sand as well. Clearly, there are too many iron filings to complete this process in a timely manner.

2. Ask students if they can think of any properties of iron or sand that might be helpful in sorting. Iron is magnetic, but sand is not.

3. Pass the magnet over the mixture and observe what happens to the iron filings. Give each student a turn with the magnet.

4. At the end of the station, replace the iron in the sand by simply grabbing it off of the magnet. The teacher/science fellow may want to do this to make sure the iron doesn't make a mess.

**Station 3: Filtration Separation**

1. Prepare a mud-and-water mixture for this station.

2. Explain the concept of a filter to the students. A filter is a material with very small holes that allow certain things through but not others. Filters separate based on size––particles that are small pass through, while particles that are big do not.

3. Have students think of some objects they know that act like filters. Some examples students might have seen in their own house include a colander, a window screen, and a coffee filter.

4. To filter the mud, place a piece of filter paper in a funnel and insert the funnel into an empty beaker.

5. Slowly pour some of the mud prepared at the beginning of the lesson into the funnel. Students can take turns pouring as well.

6. Ask the students to write down their observations on their worksheet or in their science journals. Some questions to help guide their observation include: What color is the liquid pouring into the beaker? Is it completely clear? What

might that say about some of the particles in mud? What does the substance look like that's left behind in the funnel?
Is it completely dry? How might you separate the rest of the water in it?

**Station 4: Manual Separation**

1. Present the students with a bowl of Chex Mix (or alternative). **Make it clear that the Chex mix is not to be eaten because it is part of an experiment.**

2. Brainstorm various ways to sort the Chex Mix. Especially for the groups who visit this station towards the end of class, ask if any of the techniques they have seen before might be helpful.

3. After a minute or so of brainstorming, have the students sort the Chex Mix. Students can make different piles of Chex Mix pieces on the tabletop. Initially, be intentionally vague: there are many different ways to sort the various components, including by size, shape, color, or texture.

4. After they have sorted the Chex Mix one way, ask them to sort it in a different way. You may have to remind the students to think about different properties of the Chex mix.

5. Have a friendly competition to see which group can sort the Chex Mix in the most ways in the given time period.

6. You may want to also have some extra Chex Mix (or other kind of food) handy to give to the kids at the end of the experiment, since they will be very tempted by the Chex Mix.

7. Using the physical and chemical changes that the students witnessed as evidence, have them pair up and discuss the properties of each change, as well as the properties of solutions, mixtures, and solutions.
    - Probing questions: What properties of filtration, magnetic, and evaporation separation did we observe in our investigation?
        - In _________ investigation, we observed ___________.

## Assessment

Assessment will be based on participation in experimental stations and the following prompt: In their Science Journals, have students make a list of all the physical and chemical changes they observed during the lesson.

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# Lesson 8: Introduction to Qualitative Analysis

## BACKGROUND

### Overview of the Lesson

This lesson will introduce students to the concept of qualitative analysis through hands-on activities and observations. The vocabulary for this lesson will be pre-taught, and the students will use their observational skills to first separate and classify a jar of pebbles before moving on to five "unknown" substances. Students will examine the five substances using color, hardness, and reflectivity in order to create a claim about what each substance is. Students will also discuss the differences between qualitative and quantitative analysis and the positive and negative aspects of qualitative analysis. This lesson directly relates to the CEPA, so ensure students comprehend the information before proceeding on to lesson 9.

### Focus Standards

**PS1-3** Make observations and measurements to identify substances based on their unique properties, including color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility.

### ELA Writing Standard (2017)

1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
    a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped in paragraphs and sections to support the writer's purpose.

## Student Learning Targets

- I can identify, define, and describe the characteristics of different types of matter.
- I can utilize the characteristics of matter to compare and contrast different types of matter.

## Assessment

Students will be assessed based on participation in the class discussions and activities and on their response to the following prompt in their Science Journals: How do the methods used in the first activity relate to the methods used in identifying and classifying the materials later in the lesson? Are there other ways that one can distinguish between different types of matter? Is qualitative analysis a precise or imprecise method of distinguishing between different types of matter?

## WIDA Language Objectives

TBD

**Targeted Academic Language/ Key Vocabulary**
**Tier 2:** Reflectivity,
**Tier 3:** Luster, Qualitative, Quantitative

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| **1 per group** | **Flashlight** | **Bin** |
| **1** | **Large Glass Jar** | **Bin** |
| **1 bag** | **Pebbles of different size, shape, color, reflectivity, etc.** | **Bin** |
| 1 bag per group and 1 bag for teacher, labeled "A" | Salt | Bin |

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| | | |
|---|---|---|
| 1 bag per group and 1 bag for teacher, labeled “B” | Baking Soda | Bin |
| 1 bag per group and 1 bag for teacher, labeled “C” | Chalk Powder | Bin |
| **1 bag per group and 1 bag for teacher, labeled “D”** | **Wax** | **Bin** |
| **1 bag per group and 1 bag for teacher, labeled “E”** | **Nails** | **Bin** |

****Items in bold should be returned for use next year****

# LESSON DETAILS

## Vocabulary Activity

Teachers can pre-teach the vocabulary using any method that they deem to be appropriate. An example of this is the “4-square” method.

## Lesson Opening/Activator

Divide students into groups of three and show them the jar filled with different pebbles. Ask the groups to observe the jar and write down a total of five characteristics of the different type of pebbles. Then ask the groups to raise their hands and use the characteristics they wrote down to identify the different type of pebbles. (For example: the blue pebbles, the largest pebbles, the smooth pebbles, the shiny pebbles, etc.). Perform this activity until all the different types of pebbles have been identified and differentiated based on their unique characteristics. Explain that this type of identification is “qualitative”, meaning it is sense-based (sight, touch, smell, etc…) as opposed to “quantitative” (number-based). If students are struggling differentiating between qualitative and quantitative, break down both vocabulary words to their roots (“quality” and “quantity”) and use those to assist the students in comprehending the differences. **[SP8-Obtaining, Evaluating, and Communicating Information]**

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## During the Lesson (Make sure the students do not taste the substances in the following steps!)

1. Discuss how scientists use different methods of observation and measurement to differentiate between the different substances in the world. Tell students depending on how these characteristics change the change in matter can be classified as chemical changes (where the property of matter changes) and physical changes (where the state of matter changes). This allows for the opportunity to review information from previous lessons and bolster it as needed.

2. Explain to students that characteristics of matter can be found by observing the:
   - Color
   - Hardness
   - Reflectivity

**Display the included pictures of the different criteria through an image projector to give the students a visual aid for this portion of the lesson.**

3. Divide the class into groups of four and present to each group a small quantity of salt, chalk powder, baking soda, nails (or long screws), and wax. Substances should be labeled A, B, C, D, and E, respectively but otherwise should not be named or identified in any way.

4. Instruct the students to examine all of the substances and write down the observations of the different characteristics in their Science Journals:
   - Color- students write down the color observed.
   - Hardness – students use their fingers in order to feel each type of matter in order to ascertain the respective relative hardness. **Instruct the students to wash their hands after completing this qualitative test.**
   - Reflectivity – students use a flashlight to see if there is any reflectivity.

5. After all the substances have been analyzed, ask each group what they predict each substance is and write down those predictions on the whiteboard. Allow each group time to explain why they predicted what they did.

6. Write the names of the different types of matter on the whiteboard, holding up each distinct type as you explain what they are. This step will allow the students to connect auditory learning with visual learning.

7. After reviewing the actual names of the substances, give the groups time for reflection on whether their predictions were supported or refuted, and give them the opportunity to share the main points of their discussions with the class. **[SP4-Analyzing and Interpreting Data]**

## Lesson Closing

1. After the previous discussion has been completed, give the students time to respond to the following prompt in their Science Journals: How do the methods used in the first activity relate to the methods used in identifying and classifying the materials later in the lesson? Are there other ways that one can distinguish between different types of matter? Is qualitative analysis a precise or imprecise method of distinguishing between different types of matter?

2. After the students have finished responding to this prompt, have them share what they wrote with the rest of the class (this can be extended or shortened based on time constraints).

**Assessment**

Students will be assessed based on participation in the class discussions and activities and on their response to the following prompt in their Science Journals: How do the methods used in the first activity relate to the methods used in identifying and classifying the materials later in the lesson? Are there other ways that one can distinguish between different types of matter? Is qualitative analysis a precise or imprecise method of distinguishing between different types of matter?

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Use this page as possible color examples but explain to students they can use any color descriptor they find useful. Qualitative assessments can vary based on who is making the observation (though they're usually fairly consistent).

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MOHS HARDNESS SCALE
INCREASING HARDNESS
1 TALC
2 GYPSUM
FINGERNAIL
3 CALCITE
COPPER COIN
4 FLUORITE
5 APATITE
KNIFE / GLASS
6 FELDSPAR
STEEL
7 QUARTZ
8 TOPAZ
9 CORUNDUM
10 DIAMOND
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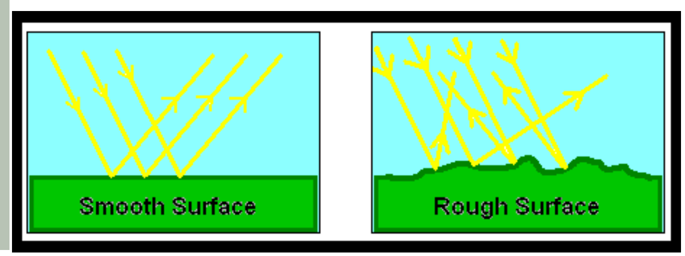
Smooth Surface
Rough Surface

# Lesson 9: Electrical and Thermal Conductivity

## BACKGROUND

### Overview of the Lesson

**This lesson requires materials that must be prepared ahead of time.** Students will observe quantitative characteristics of matter through a series of experiments and demonstrations. The properties to be studied are electrical conductivity, thermal conductivity, response to magnetic forces, and solubility. The lesson will conclude with a brief discussion of error in measurement during experiments.

### Focus Standards

**PS1-3** Make observations and measurements to identify substances based on their unique properties, including color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility.

### Speaking and Listening Standards (2017)

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. (See grade 5 Reading Literature Standard 1 and Reading Informational Text Standard 1 for specific expectations regarding the use of textual evidence.)

## Student Learning Targets

- I can measure quantitative properties of matter including thermal conductivity, electrical conductivity, response to magnetic forces, and solubility.
- I can discuss how errors in measurement can lead to different results for the same experiment.

## Assessment

Students will be assessed on participation in class experiments and responses to the following science journal prompt: Have students write in their science journals about how an experiment could be affected by errors of measurement (for quantitative measures) or errors in observation (for qualitative measures).

## Targeted Academic Language/Key Vocabulary

**Tier 3:** Conductivity, Solubility

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| **1** | **Hot Plate** | **Bin** |
| | Water | Classroom Teacher |
| **1** | **Metal Spoon** | **Bin** |
| **1** | **Wooden Spoon** | **Bin** |
| **1** | **Plastic Spoon** | **Bin** |
| **4 per group (16-20 total)** | **Beaker** | **Bin** |
| **1** | **Candle** | **Bin** |
| **1 bag** | **Salt** | **Bin** |
| **1 bag** | **Sugar** | **Bin** |
| **1 box** | **Baking Soda** | **Bin** |

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| | | |
|---|---|---|
| **1 box** | **Chalk Powder** | **Bin** |
| **1 per group** | **Nails or Screws** | **Bin** |
| 4 per group (16-20 total) | Empty Soda Bottles (with labels to show nutrition facts) | Classroom Teacher |
| **1 per group** | **Electrical Circuit with multimeter** | **Bin** |
| **1 per group** | **LED** | **Bin** |
| **1 per group** | **Scale** | **Bin** |
| **1 per group** | **Magnet** | **Bin** |
| 1 per student | Science Journal | Classroom Teacher |

****Items in bold should be returned for use next year****

# LESSON DETAILS

### Vocabulary Activity

The vocabulary for this lesson should be pre-taught by the Classroom Teacher in any manner they deem appropriate. An example of this is the "four-square" method.

## Lesson Opening/ Activator

Divide the class into smaller groups, and give each group one of each different type of soda and juice bottles. Give the students a few minutes to write down the nutrition facts from each bottle, using the percent of daily value as the unit of measurement. Ask them which one has the highest of each category. Show them how different substances can be categorized by measuring quantitative differences.

**Introduction to Quantitative Analysis**

1. Review with the students what they remember about qualitative analysis. Ask them how they figured out how different materials had different properties. Further, discuss how scientists use different methods of observation and measurement to differentiate between the different substances in the world that aren't based on qualitative reasoning. Talk about how numbers and precise measurements can also be used to differentiate materials.

2. Introduce the following properties as ways scientists use to differentiate between different types of matter. Pictures of each property are included at the end of the lesson.
    - Electrical conductivity
    - Thermal conductivity
    - Response to magnetic forces
    - Solubility

3. Explain that like the nutrition facts on the soda and juice bottles, each of these properties can be measured with a single number that is unique for different types of matter. In this lesson, the students will measure electrical conductivity and solubility quantitatively but use qualitative methods to measure thermal conductivity and response to magnetic forces.

**Thermal Conductivity**

1. The teacher will demonstrate the properties of thermal conductivity for the class, since this requires the use of a hot plate.

2. Boil a beaker of water on the hot plate.

3. While the water is boiling, use a small candle to melt wax onto the end of three spoons: one metal, one wooden, and one plastic. Allow the wax to cool and harden.

4. When the water has boiled, place all three spoons into the water, wax side up. Try to angle the spoons so that the wax is not in the column of steam rising from the boiling water.

5. Observe the spoons and note which spoon melts the wax the fastest. What does this indicate about the thermal conductivity of each substance? Make sure the students understand the material with the highest thermal conductivity melts the wax the fastest.

6. Explain although thermal conductivity was measured qualitatively in this experiment, scientists can use quantitative data to represent thermal conductivity. It is typically measured in the amount of energy transferred in a specific distance at a specific temperature.

**Exploring Other Quantitative Properties**

1. Divide the class into small groups and present to each group a small quantity of salt, sugar, chalk powder, baking soda, and nails (or long screws). Substances should be labeled A, B, C, D, and E, respectively.

2. Each group will also receive three beakers of water, an electrical circuit with an LED and a multimeter, paper clips, a magnet, and a scale.

3. As the students perform the experiments, tell them to write down their qualitative and quantitative observations in their Science Journals.

**Solubility**

1. Students will measure solubility by the quantity (mass) of a material that can be dissolved in a given volume of water.
2. Students will be given four beakers each filled with 50 mL of water.
3. Weigh each beaker using the scale, and write down this number in your science journal.
4. Now, slowly add salt to the first beaker, stirring constantly. Keep adding salt until it stops dissolving. Stop adding as quickly as possible after you observe particles that do not dissolve.

5. Weigh the beaker again. How does it compare to the weight of just water in the beaker? Write this number down in your science journal.
6. Subtract the weight of the beaker of water from the beaker of salt water to obtain the mass of salt added to the water.
7. Divide the mass of salt by 50 to obtain the solubility of salt in units of grams per milliliter.
8. Repeat steps 4-7 with the sugar, chalk powder, and baking soda, using a new beaker each time.
9. Rank the materials from highest solubility to lowest solubility. **[PS-4 Analyzing and interpreting data].**
10. End by discussing whether the nails can be dissolved in water or not (and why they cannot be).

**Electrical Conductivity**

The Classroom Teacher or Science Fellow will prepare a circuit with a multimeter to measure current ahead of time. Connect the battery directly to the multimeter by connecting the black wire on the battery to the black electrode on the multimeter. Then, attach one alligator clip to the red wire on the battery and the other alligator clip to the red electrode on the multimeter. Then, turn the multimeter on to 200 mA (exactly one quarter turn clockwise). To test that the circuit is set up correctly, connect the two alligator clips together. The multimeter should give a non-zero reading. Experimental samples can be tested by fastening the alligator clips on opposite ends of a nail, or by attaching the alligator clips to paper clips and submerging the paper clips in a solution."

Use the alligator clips on the wires of the circuit to connect to the different materials and measure their electrical conductivity.

1. Test the nail first. Place one clip on each side of the nail. Write down the number displayed on the multimeter (this is a *quantitative* observation). Then, observe whether the LED is lit or not (a *qualitative* observation). Ask the students which of these measurements––multimeter or LED––is quantitative and which is qualitative.

2. To test the remaining materials, use the beakers with dissolved materials from the solubility experiment.

3. Instead of placing the alligator clips directly in the beakers, attach them to paper clips and place the paper clips in the water.

4. For each material, write down the number displayed on the multimeter and observe whether the LED is lit or not.

5. Rank the materials from highest electrical conductivity to lowest electrical conductivity first using only the LED measurements. Then, have students complete the ranking using the multimeter measurements. How do these two rankings compare? Which is more accurate? Why?

**Response to Magnetic Forces**

1. Pass a magnet over each substance. Observe if the substance is attracted to the magnet or not and write down observations in your science journals.
2. Whereas other quantitative properties are measured with numbers, magnetic attraction is quantified as all or none.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

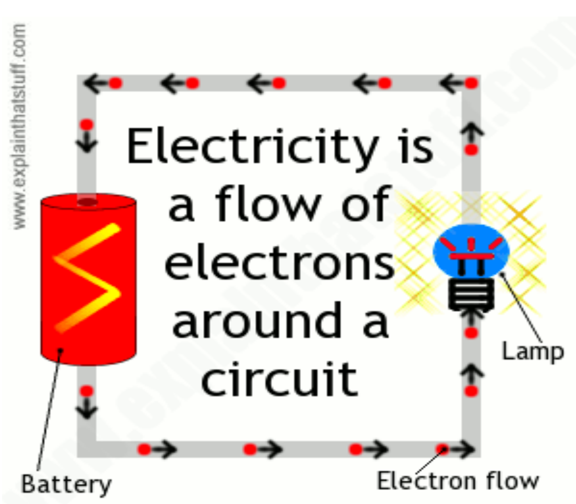
## Lesson Closing

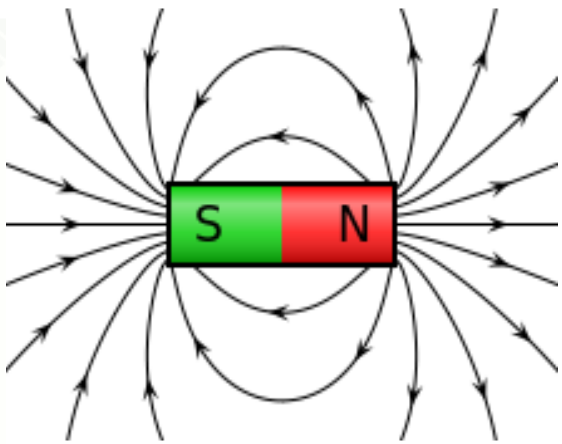
Before discussing as a class, have students pair up and share their investigative findings for the day. Then, discuss as a class each group's measured results.

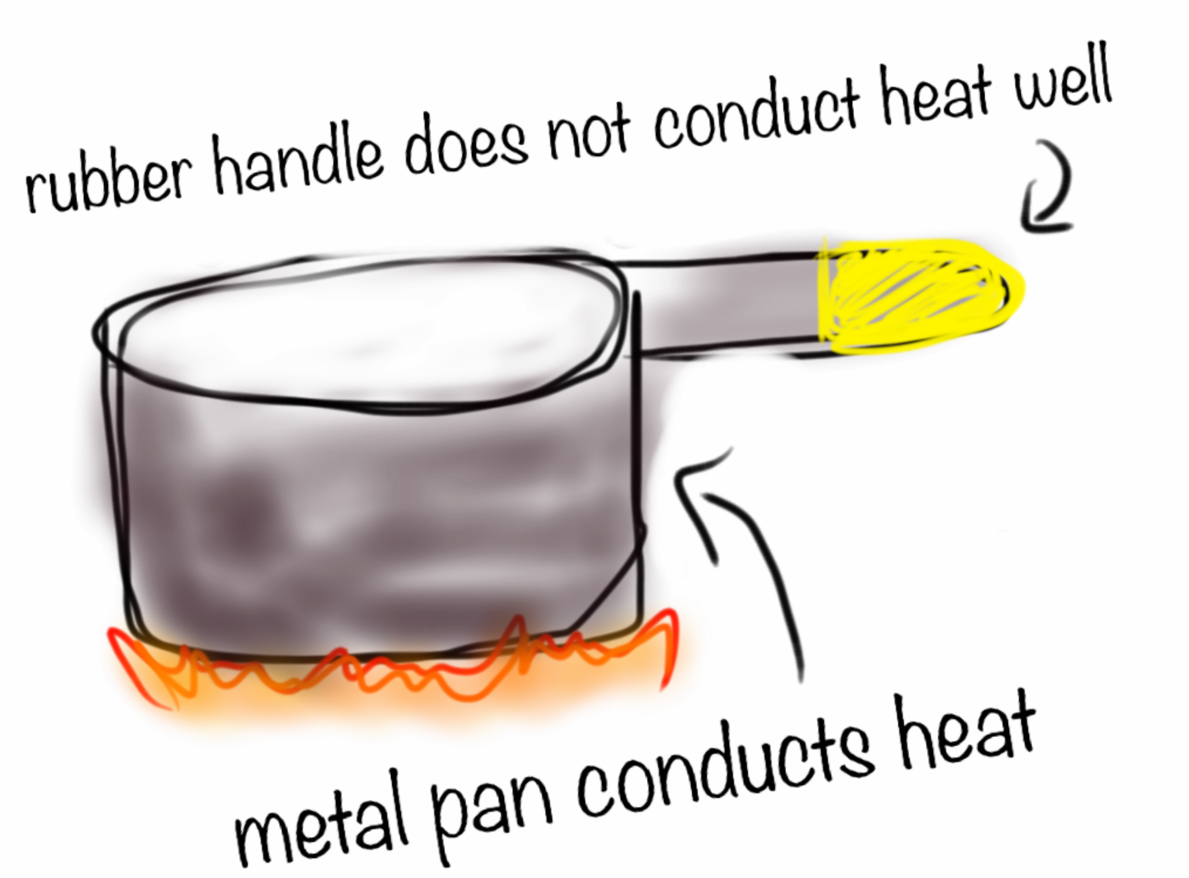
1. Are all of the numbers the same or are they different?
2. Is this because each group's materials are different or is there another explanation? **[PS-6 Constructing explanations].**

## Assessment

Students will be assessed on participation in class experiments and responses to the following science journal prompt: Have students write in their science journals about how an experiment could be affected by errors of measurement (for quantitative measures) or errors in observation (for qualitative measures).




rubber handle does not conduct heat well
metal pan conducts heat

# Lesson 10: Conservation of Mass, Part 1

## BACKGROUND

### Overview of the Lesson

Students will begin this lesson by drawing molecular models of solids, liquids, and gases. They will also be introduced to the Law of Conservation of Mass and will test this law using water in its various forms (ice, water, and water vapor). The students will experiment with the melting of ice and will watch a video describing evaporation and condensation. This lesson will provide the foundation of scientific knowledge necessary for the next lesson of this unit.

### Focus Standards

**PS1-2** Measure and graph the weights of substances before and after a reaction or phase change to provide evidence that regardless of the type of change that occurs when heating, cooling or combining substances, the total weight of matter is conserved.

### ELA Writing Standard (2017)

1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
    a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped in paragraphs and sections to support the writer's purpose.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

## Student Learning Targets

- I can define and describe the characteristics of the different states of matter.
- I can describe and apply the Law of Conservation of Mass.

Teach To Learn
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### Assessment

Students will be assessed based on their participation in class discussions and activities as well as by their response to the following prompt in their Science Journal: Describe, in your own words, the Law of Conservation of Mass. Why do you think this law is important?

### Targeted Academic Language/ Key Vocabulary

**Tier 1:** Freezing, Boiling, Melting

**Tier 2:** Mass

**Tier 3:** Law of Conservation of Mass, Proximity

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| **1 per group** | **Hotplate** | **Bin** |
| 3 per group | Ice Cubes | Classroom Teacher |
| **2 per classroom** | **Ice Cube Tray** | **Bin** |
| **2 per group** | **Oven Mitts** | **Bin** |
| **1 per group** | **Beaker** | **Bin** |
| **1 per class** | **Scale (that can measure in grams)** | **Bin** |
| 1 per class | Projector and Internet Access | Classroom Teacher |

****Items in bold should be returned for use next year****

**Vocabulary Activity**
The vocabulary for this lesson should be pre-taught by the Classroom Teacher in any manner they deem appropriate. An example of this is the "four-square" method.

## Lesson Opening/Activator

1. Have the students draw molecular models for the three states of matter (solid, liquid, and gas). Use these molecular models to describe the three states of matter and how the atoms or molecules of the substance remain the same during the phase changes but the proximity (closeness) of the atoms or molecules changes. Ask the students to describe how this "looseness" of atoms/molecules is observed when water changes state from a solid to a liquid to a gas. (Some correct answers to this prompt would be: describe how the density goes down during these phase changes, how the volume changes during the phase changes, etc…)
2. To review the three different types of state of matter, show the video (http://easyscienceforkids.com/all-about-states-of-matter/ ).

## During the Lesson

1. Begin this lesson by reviewing what students have already learned about qualitative and quantitative analysis. The Classroom Teacher or Science Fellow will list the different attributes of qualitative and quantitative analysis on the whiteboard. Guide the discussion by asking if those characteristics change when any given matter goes through a phase change.

2. Write "Law of Conservation of Mass" on the whiteboard. Ask students if they can define what this law is, and if not, guide the students to the correct definition by breaking down the law into "conservation" and "mass" in order to provide hints for the students. After a working definition has been created, ask students if, according to this law, the mass of a given substance changes when it goes through a phase change. After asking this question, break students into pairs and have them complete a "think-pair-share" (in which the students come up with their own answer to the question, discuss this answer with their partner, and then share the pair's combined answer with the class).

3. After the previous discussion is completed, break the students into four groups, and explain they are going to test whether a substance loses mass when it goes through phase change. Pass out the beakers (containing ice cubes and liquid water) and have the groups weigh the beaker and record that weight in their science journals. Have the groups then predict what they think will happen to the weight of the beaker when the ice is melted and have them record their predictions in their Science Journals.

4. Pass out the hotplates and explain that the surface of the hotplates becomes very hot and that the students should be very careful. Turn on the hotplates and place the beakers on them until the ice is melted. Do not let the water boil! As soon as the ice finishes melting, remove the beaker (using oven mitts) and weigh the beaker. Have the students record the second weight and discuss among themselves whether or not their prediction was supported or refuted before sharing their results with the class. **[SP4-Analyzing and Interpreting Data]**

5. Ask the groups what they predict would happen if the water continued to boil-would it still weigh the same? If not, why? (Make sure to include the terms evaporation and condensation in this discussion).

6. Show the YouTube video (https://www.youtube.com/watch?v=wBUeXssJvz0) demonstrating the evaporation and condensation of water as it is heated and cooled. **Make sure you stop the video at 1:17 (1 minute and 17 seconds)**.

7. Discuss whether the video supported or refuted each group's predictions. **[SP8-Obtaining, Evaluating, and Communicating Information]**

## Lesson Closing

Discuss how matter can exist in different states. Discuss the importance of having matter in different states in the world (talk specifically about how water exists in all three states on Earth––what does this mean for our environments and ecosystems?). Ask students what happens when different materials mix with each other. In preparation of the next lesson, ask students if the original materials maintain their properties.

## Assessment

Students will be assessed on participation in class experiments and responses to the following science journal prompt: Have students write in their science journals about how an experiment could be affected by errors of measurement (for quantitative measures) or errors in observation (for qualitative measures).

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

# Lesson 11: Conservation of Mass, Part 2

## BACKGROUND

### Overview of the Lesson

Students will begin this lesson by participating in a hands-on activity with modeling clay that exemplifies how the Law of Conservation of Mass applies to mixtures as well as to what was learned in the previous lesson. The students will then proceed to watch a video before completing an experiment in which they weigh water and Kool-Aid individually before weighing the mixture (they will complete this experiment with salt next). This lesson allows students more opportunity to practice predicting, observing, and concluding and will further their mastery with understanding and applying the Law of Conservation of Mass.

### Focus Standards

**PS1-2** Measure and graph the weights of substances before and after a reaction or phase change to provide evidence that regardless of the type of change that occurs when heating, cooling or combining substances, the total weight of matter is conserved.

### Speaking and Listening Standard (2017)

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

(See grade 5 Reading Literature Standard 1 and Reading Informational Text Standard 1 for specific expectations regarding the use of textual evidence.)

## ELA Writing Standard (2017)

Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped in paragraphs and sections to support the writer's purpose.

## Student Learning Targets

- I can apply the Law of Conservation of Mass to the mixing of two separate types of matter.
- I can identify and explain the different phase changes that can occur to matter.
- I can explain how, when different types of matter are mixed, some properties change while others remain the same.

## Assessment

Students will be assessed on participation in class discussions, activities, and experiments, as well as on their response to the following prompt in their Science Journal: If, according the Law of Conservation of Mass, matter can neither be created nor destroyed, only changed; do you think that matter permanently keeps any of its properties as it goes through phase changes? Are there any applications of phase changes to or from liquids that are especially significant to everyday life?

## Targeted Academic Language/ Key Vocabulary

**Tier 1:** Weight
**Tier 2:** Properties
**Tier 3:** Law of Conservation of Mass

# RESOURCES AND MATERIALS

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Science Journal | Classroom Teacher |
| **1 per group and 1 for the teacher** | **2 balls of modeling clay (different colors)** | **Bin** |
| **1 per group** | **Graduated Cylinder** | **Bin** |
| 2 per group | Weigh Boats | Bin |
| **2 per group** | **Beaker** | **Bin** |
| 1 per class | Container of Kool-Aid | Bin |
| 1 per class | Container of Salt | Bin |
| **3 per class** | **Scale (that measures in grams)** | **Bin** |
| **1 per group** | **Spoon** | **Bin** |

****Items in bold should be returned for use next year****

# LESSON DETAILS

## Vocabulary Activity

The vocabulary for this lesson should be pre-taught by the Classroom Teacher in any manner they deem appropriate. An example of this is the "four-square" method.

## Lesson Opening/ Activator

1. The Classroom Teacher or Science Fellow will break the students into pairs and distribute the modeling clay (each pair gets two different colors of clay) and ask the pairs to list all of the properties of both colors of modeling clay they observe. A scale will be available for the students to weigh each ball of modeling clay. The Classroom Teacher or Science

Fellow will then ask for volunteers and have those volunteers share their observed properties with the class, with either the Classroom Teacher or Science Fellow recording the properties on the whiteboard. The Classroom Teacher or Science Fellow then demonstrate how to mix the two separate colors of modeling clay together before instructing the students to do the same. After the clay has been mixed, the Classroom Teacher or Science Fellow will ask the pairs to once again list the properties of the modeling clay (using the scale once again).

2. The pairs will then compare and contrast the 2 different lists of properties: Probing questions: What properties remained the same (texture, etc…) and what changed (weight, color, etc…)?

3. **The Classroom Teacher or Science Fellow will use this discussion to emphasize that weight is additive** (so the combined clay weighs the same as the two separate balls of clay added together). The Classroom Teacher or Science Fellow will guide the discussion to focus on what properties remained the same and what properties changed in order to activate prior knowledge regarding mixtures and the Law of Conservation of Mass. **[SP4- Analyzing and Interpreting Data]**

4. To exemplify how substances mix together and to emphasize the learning from the opening activity, the teacher will show the video about mixing liquids (http://www.youtube.com/watch?v=P5Y9Axrh7zA) (including the sound of this video is optional and up to the teacher's discretion––it is mainly a visual aid) and talk about how even when liquids are mixed, the combination still contains the original materials and displays some of the original properties.

## During the Lesson

1. The Classroom Teacher or Science Fellow will review the different stages of matter by once again breaking the students into pairs and asking them to list all of the phase changes they can think of (evaporation, condensation, deposition, sublimation, etc.) before sharing their lists with the class. This “think-pair-share” activity will remind students matter can change constantly.

2. The Classroom Teacher or Science Fellow will then ask volunteers to list how they have measured the different properties of different types of matter in previous lessons. The Classroom Teacher or Science Fellow will use this discussion to pose the following question: when different states and types of matter mix, would the mixture have any new properties? If so, what do you think they would be? Would you predict that the weight of the mixture is the sum of the ingredients? The teacher will once again emphasize that weight, as a property, is additive.

3. The Classroom Teacher or Science Fellow will then divide the students into five groups. The Classroom Teacher or Science Fellow will then ask the groups to predict what will happen to the weight of water when Kool-Aid is added to it. These predictions will be written down in the Science Journals, and volunteers will share their predictions with the class, providing reasoning for their assertions as necessary.

4. The groups will then take turns using weigh boats to measure out 15 grams of Kool-Aid on the scale.

5. The groups will then measure out 240 mL of water, weigh it, and record that weight in their Science Journals.

6. The groups will then mix the Kool-Aid and water (using the spoons) and weigh the resulting mixture and then record that weight in their Science Journals. The groups will then work to identify any correlation between the weight of the mixture and the weights of the water and Kool-Aid. The Classroom Teacher or Science Fellow will wait three to five

minutes to allow the groups time to analyze the data before asking the students if the weight of the mixture is the same as the combined weights of the Kool-Aid and water, and if each group's observations supported or refuted their predictions. **[SP8-Obtaining, Evaluating, and Communicating Information]**

7. The groups will then be asked to predict if the same results would occur if the Kool-Aid were replaced with salt. After these predictions have been made and shared, the previous experiment will be repeated **with salt instead of Kool-Aid**.

8. After the experiment has concluded, the Classroom Teacher or Science Fellow will once again ask the groups to share their observations and whether their second prediction was correct or not? If their hypothesis was refuted, why do they think their prediction was wrong?

## Lesson Closing

After the completion of the experiments, the Classroom Teacher or Science Fellow will ask the students to complete a "think-pair-share" (or other activity that can be chosen by the Classroom Teacher or Science Fellow) for the following question:

1. How do the experiments that were just completed support or refute the Law of Conservation of Mass?
2. **Note:** After the pairs have completed their answers, they will share them with the class.

## Assessment

Students will be assessed on participation in class discussions, activities, and experiments, as well as on their response to the following prompt in their Science Journal: If, according the Law of Conservation of Mass, matter can neither be created or destroyed, only changed, do you think that matter permanently retains any of its properties as it goes through phase changes? Are there any applications of phase changes to or from liquids that are especially significant to everyday life?

# Curriculum Embedded Performance Assessment (CEPA):

Students will:
- Work in groups of three to identify an unknown substance using qualitative analysis.
- Predict what the substance is based on initial observations.
- Conclude whether the group's initial prediction was supported or refuted by the qualitative observations.

Classroom Teacher will:
- Create a handout designed to explain the procedure to the groups of students.
- Develop a rubric to accurately and effectively grade the members of each group based on participation, use of scientific equipment, presentation, accuracy, and any other facet of the CEPA activity that the teachers deems fit to be graded.
- Assist the groups as necessary to insure comprehension.

Explanation of procedure:
1. The Classroom Teacher will decide what type of matter that each group is given based on the substances examined throughout the course of the lesson (baking soda, chalk dust, salt, wax, or flour).
2. The students will record their predictions, observations, and conclusions in their Science Journals.
3. The groups will use this information to synthesize a presentation in which they introduce their unknown substance, explain their predictions and observations, and conclude what the substance actually is. (The Classroom Teacher or Science Fellow can interject as appropriate to guide discussion).

Procedure (for the teacher):
- Review Lesson 8: Qualitative Analysis.
- Review the substances explored throughout the course of the unit.
- Break the class into groups of three students.

- Distribute the CEPA handout.
- Explain each group will be given an unknown substance and that they must use the qualitative methods learned in Lesson 8 and throughout the course of the unit, to predict, observe, and conclude what they think their substance is.
- The substances (baking soda, chalk dust, salt, wax, or flour) will then be distributed in bags labeled A-E (respectively).
- The students will have access to all the equipment used in Lesson 8.
- The students will record their observations using text or illustrations, and after the have finished their examinations, will prepare a presentation based on those observations using a piece of chart paper.
- The groups will share their data, predictions, observations, and conclusions with the class.
- The groups will be graded based on the following rubric.
- The posters can be hung throughout the classroom or hallway to exemplify student work.

# Science Talk and Oracy in T2L Units

**Science talk is much more than talking about science.** In line with the science and engineering practices, students are expected to make a claim that can be supported by scientific evidence. The MA STE Standards (and the NGSS) value the importance of engaging in an argument from evidence. NGSS defines how this practice takes form in the real world: *"In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated."*

Students are asked to participate in articulate and sensible conversations in which they are able to communicate their ideas effectively, listen to others to understand, clarify and elaborate ideas, and reflect upon their understanding. These forms of talk can be developed using scaffolds such as the A/B Talk protocol (below) and strategies for class discussions (from the Talk Science Primer, link below). Oracy is developed in the physical, linguistic, cognitive, and social-emotional realms; each of these realms can be expanded upon over time in order to develop a thoughtful speaker. Being able to display appropriate body language, use proper tone and grammar, be thoughtful and considerate thinkers, and allow space for others thoughts and opinions are all important facets of oracy to work on and through with students. Incorporating the appropriate scaffolding is an important aspect of fostering these skills. Techniques for teaching effective science talk often include modeling, discussion guidelines, sentence-starters, and generating roles, while gradually putting more responsibility on students to own their thinking and learning.

Part of creating a safe school environment for students is allowing them a space that is comfortable enough for them to express ideas and ask questions, while being validated for their thoughts and questions; students should be feel comfortable and confident when speaking and listening for understanding. Effective talk is an important part of being an active, intelligent member of a community and society. Successful development in oracy is important for future employability and general well-being of adults.

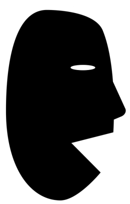
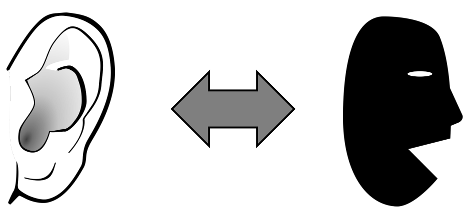
**The following resources should be helpful examples of how to employ effective use of progressive oracy and science talk in your classrooms.**

- Oracy in the Classroom: https://www.edutopia.org/practice/oracy-classroom-strategies-effective-talk
- Science Talk Primer: https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

MCLA NAPS Williams
Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

# A/B Talk Protocol

*Adapted from [https://ambitiousscienceteaching.org/ab-partner-talk-protocol/](https://ambitiousscienceteaching.org/ab-partner-talk-protocol/)*

<table>
<tr>
<td>1. Share your ideas<br>Partner A<br><br>• I think ______ happened because…<br>• Evidence that supports my idea is…<br>• The activity we did with ______ helps me know more about ______ because…<br>• One thing I'm wondering about is…</td>
<td>2. Listen to Understand<br>Partner B<br><br>• I heard you say ______. What makes you think that?<br>• I heard you say ______. What if ______?<br>• Can you explain the part about ______ again?<br>• What do you mean when you say ______?</td>
</tr>
<tr>
<td>3. Clarify and elaborate<br>Partner A<br><br>Answer partner's questions or ask for clarification in order to understand a question.</td>
<td>4. Repeat steps 2 & 3 until all questions are answered<br> </td>
</tr>
<tr>
<td>5. Switch roles and repeat steps 1-4<br></td>
<td>6. Reflect on your understanding in writing<br>• My idea about ______ changed when my partner said ______.<br>• I will add ______ to my idea about ______ because…<br>• I still have questions about…<br>• I may be able to answer my question(s) if I could investigate ______.</td>
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# List of Unit Resources

Lesson 1

| Quantity | Item | Source |
| --- | --- | --- |
| **1** | **Scale** | **Bin** |
| **1** | **Thermometer** | **Bin** |
| **1** | **Beakers** | **Bin** |
| **1** | **Hand Lens** | **Bin** |
| 1 per student | Science Journals | Classroom Teacher |
| 1 | https://www.youtube.com/watch?v=MwvOCTdIaSE | CMC website |
| 1 per student | Lyric sheet for "How to be a Scientist" | Binder |

Lesson 2

| Quantity | Item | Source |
| --- | --- | --- |
| 1 per student | Science Journal | Classroom Teacher |
| 1 per student | Matter is Everywhere Article and Questions | Binder |
| 1 per group | Chart paper | Classroom Teacher |

**Lesson 3**

| Quantity | Item | Source |
| --- | --- | --- |
| 1 per student | Science Journal | Classroom Teacher |

Lesson 4

| Quantity | Item | Source |
| --- | --- | --- |
| 1 per student | Science Journal | Classroom Teacher |

| | | |
|---|---|---|
| **1 per student** | **Safety Glasses** | **Bin** |
| **1 per class** | **Sprayable Air Freshener** | **Bin** |
| **1 per class** | **Essential Oil of Orange** | **Bin** |
| **1 per class** | **Plastic Bucket** | **Bin** |
| **1 per class** | **Tall Drinking Glass** | **Bin** |
| **1 per class** | **Roll of Paper Towels** | **Bin** |
| **1 per class** | **10 Gallon Aquarium** | **Bin** |
| **1 per class** | **Liquid Bubbles** | **Bin** |
| 1 per class | Unit of Dry Ice (including tongs, goggles, and gloves) | Contact College Liaison 3 days prior to lesson |
| 10 per class | Balloons or rubber gloves | Bin |
| **5 per class** | **Film Canister** | **Bin** |
| 1 per student | "States of Matter" Comic | Binder |

Lesson 5

| Quantity | Item | Source |
|---|---|---|
| **1 bottle** | **Vegetable Oil** | **Bin** |
| As needed | Water | Classroom Teacher |
| As needed | Ice | Classroom Teacher |
| **1 bag** | **Flour** | **Bin** |
| **1 box** | **Salt** | **Bin** |
| **4** | **Beakers** | **Bin** |
| **1 piece per student** | **Play-Doh** | **Bin** |

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

| | | |
|---|---|---|
| 1 per student | Science Journal | Classroom Teacher |

Lesson 6

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Chemical Change Recording Sheet | Binder |
| **1 per member of the class** | **Safety glasses** | **Bin** |
| 1 box | Baking soda | Bin |
| 1 bottle | White vinegar | Bin |
| 2 balloons | Latex-free Balloons | Bin |
| **1 unit** | **Flask** | **Bin** |
| **1 package** | **Long Matches** | **Bin** |
| **25 units** | **Beaker** | **Bin** |
| 1 bottle | Milk | Contact Sue Beauchamp |
| **1 unit** | **Squeeze bottle** | **Bin** |
| 5 tablets | Alka-Seltzer tablets | Bin |
| | Water | Classroom Teacher |
| At least 125 mL | Lemon juice | Bin |
| **2 units** | **Thermometer** | **Bin** |
| **2 units** | **Spoon** | **Bin** |
| **6 pieces** | **Steel wool** | **Bin** |
| **1 roll** | **Aluminum foil** | **Bin** |

Lesson 7

| Quantity | Item | Source |
|---|---|---|
| **1 bag** | **Kool-Aid powder** | **Bin** |
| | **Dirt** | **Bin** |
| | **Iron Filings** | **Bin** |
| 1 bag | Sand | Bin |
| 1 bag | Chex Mix or alternative for those who have allergies | Classroom Teacher |
| **3** | **Large Beaker** | **Bin** |
| **1** | **Small Beaker** | **Bin** |
| **1** | **Hot Plate** | **Bin** |
| **4** | **Filter** | **Bin** |
| **1** | **Funnel** | **Bin** |
| **2** | **Bowl** | **Bin** |
| 1 per student | Science Journal | Classroom Teacher |

Lesson 8

| Quantity | Item | Source |
|---|---|---|
| **1 per group** | **Flashlight** | **Bin** |
| **1** | **Large Glass Jar** | **Bin** |
| **1 bag** | **Pebbles of different size, shape, color, reflectivity, etc.** | **Bin** |
| 1 bag per group and 1 bag for teacher, labeled "A" | Salt | Bin |
| 1 bag per group and 1 bag for teacher, labeled "B" | Baking Soda | Bin |

| | | |
|---|---|---|
| 1 bag per group and 1 bag for teacher, labeled “C” | Chalk Powder | Bin |
| **1 bag per group and 1 bag for teacher, labeled “D”** | **Wax** | **Bin** |
| **1 bag per group and 1 bag for teacher, labeled “E”** | **Nails** | **Bin** |

Lesson 9

| Quantity | Item | Source |
|---|---|---|
| **1** | **Hot Plate** | **Bin** |
| | Water | Classroom Teacher |
| **1** | **Metal Spoon** | **Bin** |
| **1** | **Wooden Spoon** | **Bin** |
| **1** | **Plastic Spoon** | **Bin** |
| **4 per group (16-20 total)** | **Beaker** | **Bin** |
| **1** | **Candle** | **Bin** |
| **1 bag** | **Salt** | **Bin** |
| **1 bag** | **Sugar** | **Bin** |
| **1 box** | **Baking Soda** | **Bin** |
| **1 box** | **Chalk Powder** | **Bin** |
| **1 per group** | **Nails or Screws** | **Bin** |
| 4 per group (16-20 total) | Empty Soda Bottles (with labels to show nutrition facts) | Classroom Teacher |
| **1 per group** | **Electrical Circuit with multimeter** | **Bin** |
| **1 per group** | **LED** | **Bin** |

| | | |
|---|---|---|
| **1 per group** | **Scale** | **Bin** |
| **1 per group** | **Magnet** | **Bin** |
| 1 per student | Science Journal | Classroom Teacher |

Lesson 10

| Quantity | Item | Source |
|---|---|---|
| **1 per group** | **Hotplate** | **Bin** |
| 3 per group | Ice Cubes | Classroom Teacher |
| **2 per classroom** | **Ice Cube Tray** | **Bin** |
| **2 per group** | **Oven Mitts** | **Bin** |
| **1 per group** | **Beaker** | **Bin** |
| **1 per class** | **Scale (that can measure in grams)** | **Bin** |
| 1 per class | Projector and Internet Access | Classroom Teacher |

Lesson 11

| Quantity | Item | Source |
|---|---|---|
| 1 per student | Science Journal | Classroom Teacher |
| **1 per group and 1 for the teacher** | **2 balls of modeling clay (different colors)** | **Bin** |
| **1 per group** | **Graduated Cylinder** | **Bin** |
| 2 per group | Weigh Boats | Bin |
| **2 per group** | **Beaker** | **Bin** |
| 1 per class | Container of Kool-Aid | Bin |

| | | |
|---|---|---|
| 1 per class | Container of Salt | Bin |
| **3 per class** | **Scale (that measures in grams)** | **Bin** |
| **1 per group** | **Spoon** | **Bin** |