



Image via iStock.com/p_zzz



Anchoring Phenomenon

Sewage water is consumed by people, but they do not get sick.



Lesson Concept

Ask questions based on observation, then identify questions that can be investigated to identify the **matter** in the town water samples.



Identified Problem

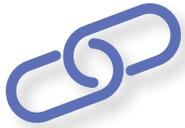
Water collected from a town may be contaminated. The town officials are requesting help to design a process that will identify the particles in the water and then clean the water.



Standards

Refer to Appendix 5.1 for NGSS, CCSS–ELA and Math, and California ELD standards.

5.1 Town Water Samples



Storyline Link

This learning sequence targets engineering design; the design challenge is to design a process that will identify the particles in the water and clean the town's water supply.

This lesson is the first in the sequence and is designed to activate students' prior experience with contaminated water, elicit their questions about contamination from observations of a video and actual water samples, and generate investigation questions that will drive their learning through the next set of lessons. This lesson introduces the identified problem: Water collected from a town may be contaminated. The town officials are requesting help to design a process that will identify the particles in the water and then clean the water. In order to do this, students, throughout the learning sequence, will build on their prior knowledge that matter is made of particles too small to be seen, but even so, the matter can be detected by other means.

In Lesson 2: Finding Impurities in Water, students will investigate how the quantity of matter in the water impacts its contamination level.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.



Time

110 minutes

Part I	20 minutes	Engage
Part II	45 minutes	Engage
Part III	45 minutes	Engage



Materials

Whole Class

- Chart paper
- Sink or tap water (warm)
- Distilled water
- 4 one-quart clear jars with lids
- 3 tablespoons sugar
- 1 tablespoon iron filings
- 4 tablespoons salt
- 2 tablespoons sand
- Long-handled spoon or stirring rod
- A small amount of sugar, iron filings, salt, and sand for display
- Drinking Filtered Sewage Water video
(<https://www.youtube.com/watch?v=sQBfCh-vmsw&feature=youtu.be>)

5.1 Town Water Samples

Individual

- Science notebook
- Sticky notes
- 2 different-colored pencils
- 5.1.H1: Town Water Samples

Advance Preparation

1. Prepare the four Town Water Sample jars by placing the ingredients into each jar and then filling the jar with very warm water.
 - Jar #1 has 3 tablespoons of sugar and 1 tablespoon of iron filings; stir until the sugar dissolves.
 - Jar #2 has 2 tablespoons of salt, 2 tablespoons of iron filings, and 2 tablespoons of sand; stir until the salt dissolves.
 - Jar #3 has 2 tablespoons of salt; stir until the salt dissolves.
 - Jar #4 is filled only with DISTILLED water.
2. Make copies of **5.1.H1: Town Water Samples**.
3. Preview the [Drinking Filtered Sewage Water](https://www.youtube.com/watch?v=sQBfCh-vmsw&feature=youtu.be) video (<https://www.youtube.com/watch?v=sQBfCh-vmsw&feature=youtu.be>).
4. For guidance on student-led discussions, see “The Inquiry Project’s Talk Science Primer” by Sarah Michaels and Cathy O’Connor: (https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf).

5.1 Town Water Samples



Procedure

TEACHER NOTE

This entire lesson is an Engage, designed to elicit students' prior knowledge, gather their wonderings about contaminated water, and encourage them to think about questions they would like to investigate. Student ideas should be recorded, but not challenged or corrected during this lesson.

Part I

Engage (20 minutes)

Ask questions that can be investigated to identify the types and quantity of matter, including very small and unseen matter in the town water samples.

1. Show the [Drinking Filtered Sewage Water](#) video. Have the students think-pair-share regarding questions the video caused them to have. As a class, start a Class Question Board by recording questions raised during the discussion on sticky notes. *Expected student responses (ESRs): Who would drink that water? How could they clean it that fast? How did they know it was clean? What was in the water?*

TEACHER NOTE

For guidance on creating question boards, see Jordine, Jeff and Ruben Torres: "Enhancing Science Kits with the Driving Question Board" *Science and Children* April/May 2013; pages 57–61.

2. Ask students to help you categorize the questions. Move the sticky note questions into the new categories and tell students they will be adding to this board throughout the lesson.
3. Connect to student experiences by asking them to respond to the following prompt in their science notebook: "Think of a time when you wondered if some water was safe to drink. What made you have concerns?" Give students 3 minutes to write in their science notebook. Walk around and encourage students to expand on their writing.

TEACHER NOTE

For reluctant writers, suggest students draw a picture of their experience/memory. If a student seems stuck, ask if they would drink water from a puddle outside the classroom, a lake, or a stream. Is the water safe to drink? Why or why not?

5.1 Town Water Samples

4. Ask students to share their response with their table group and then have a representative from several groups share with the whole class. *Expected Student Responses (ESRs): I don't want to get sick; I might get a stomachache; it could rot my teeth; my mom would be really mad.* Make a summary statement of their comments: it seems like no one wants to drink "gunky" water because no one wants to get sick.
5. Have students think about the local water supply chain: "Where does the local water come from? How might the local water become contaminated? How can we prevent that from happening? How can we fix it? How can we make sure we don't have contaminated water?" Ask students to write their ideas in their science notebook and then share with a partner. Ask a few partners to share. Share this prompt: I wonder if we can think about how we could make sure we don't have contaminated water?
6. Explain to the students that they get some answers to those questions in this learning sequence, but they will not be dealing with sewage like they saw in the video.

Part II

Engage (45 minutes)

Develop a model to identify the types and quantity of matter, including very small and unseen matter, in the town water samples.

7. Introduce the problem: "There is a town that is concerned about its local water sources. Many believe that the sources have been contaminated. The town has hired you and your fellow environmental engineers to design a solution to remove the contaminants from the water. Before you can begin to design a solution to this problem, you must first ask questions about the situation that you can investigate, determine what contaminants, if any, are in the water, and learn the properties of the contaminants. Then you can determine ways in which to remove the contaminants."
8. Show the four Town Water Samples you prepared, and explain that these samples contain water collected from local sources. Pass the jars around or allow students to walk past the jars and examine them closely. To pique student interest, you can pour water from each jar into different glasses while the students observe the contaminated water. Give students an opportunity to discuss their observations in small groups.
Safety Note: Do not allow anyone to drink from the jars.
9. Ask students to work in table groups. Distribute **5.1.H1: Town Water Samples** and have the groups decide who will observe which jar (#1, #2, or #3). It is ok if some students have the same jar as long as each jar is observed by at least one person at the table. All students will observe Jar #4. Ask them to observe the contents of the jar and create a model of what they observe for their jars.

TEACHER NOTE

The students will return to **5.1.H1: Town Water Samples** in Step 12 where they will revise their models after they gather additional information.

5.1 Town Water Samples

10. Have table groups share their models. Then direct students to create a page in their science notebook titled “Town Water Samples Observations and Wonderings.” Have students write questions they have concerning the contents of the jars they selected both in their science notebook and on sticky notes (one question per sticky note).
11. Have students place their sticky notes on a new page of the Class Question Board (from Step 1) in the existing categories. If necessary, make new categories for the new questions.

TEACHER NOTE

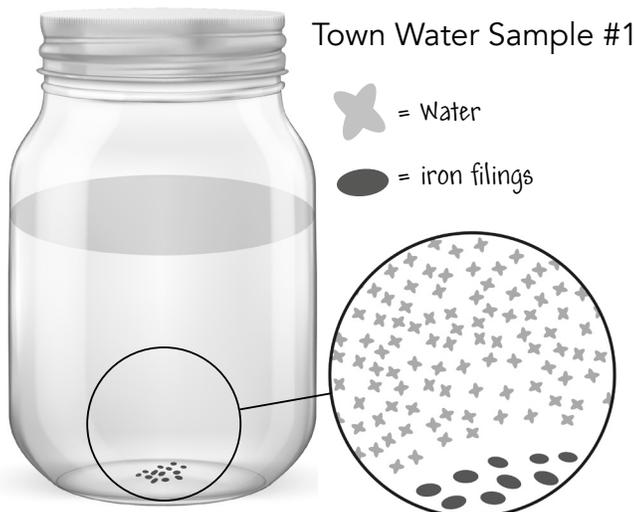
If students need scaffolding on asking questions, ask them what observations will reveal more information. You want to lead students to ask questions that can be investigated.

There are many types of questions students can ask. This lesson focuses on investigation questions rather than testable questions. The term *investigation* is the broadest category of inquiry; an *experiment* is a special kind of investigation in which variables are identified and tested to determine cause-and-effect relationships. Investigation questions are often answered by reading, research, or making observations.

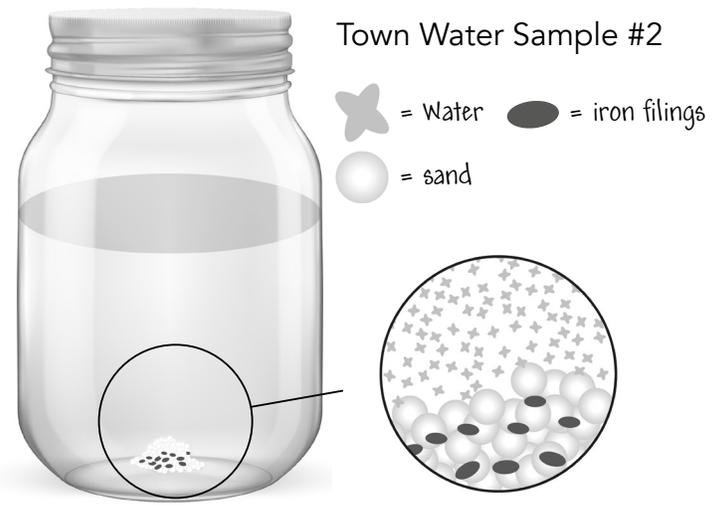
Students may generate testable questions in this lesson (e.g., *what is the effect of the contaminant on the cloudiness of the water?*). In Step 13, student will sort out these questions to be addressed at another time.

12. Make an announcement: “The police have surveyed the area where they think the contamination might have occurred. They found empty bags of sugar, salt, iron filings, and sand near the town’s water sources. This could be evidence of tampering with the water.” Ask students how this announcement might affect their observations and models. Have students add to or refine their models using a different-colored pencil.

Here are examples of what students might draw:

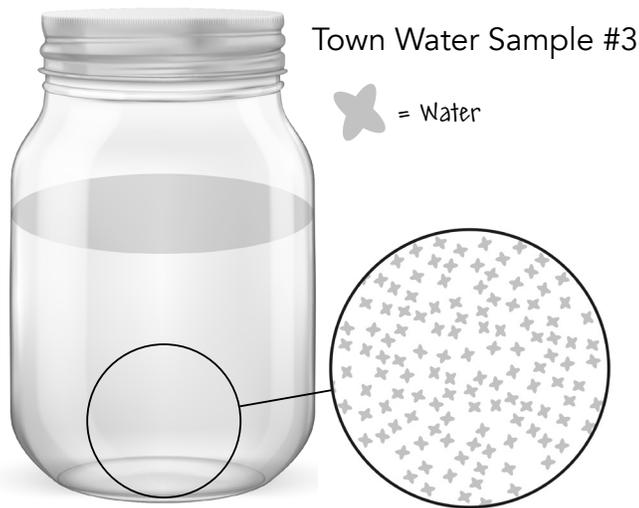


I only see water and iron filings. There could be salt and/or sugar, but I do not know for sure. They are too small to be seen.

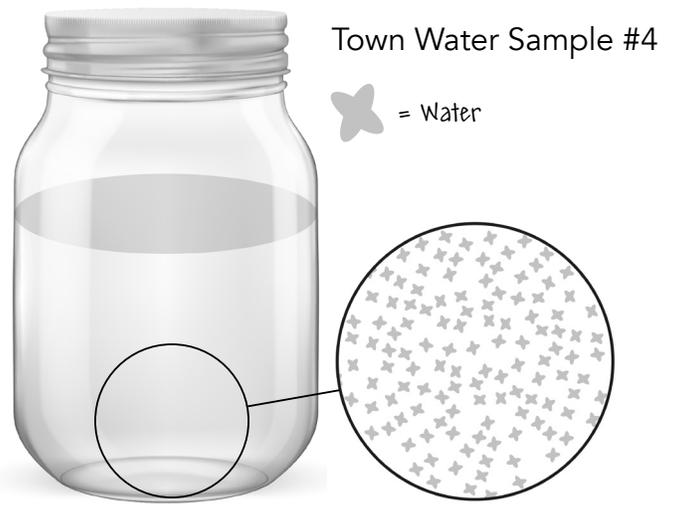


I see sand, iron filings, and water. There could also be sugar and salt in jar #2, but I do not know for sure. They are too small to be seen.

5.1 Town Water Samples



I only see water. Salt and sugar might be in jar #3, but I do not know for sure. I think they are too small to be seen.



I only see water. There could be sugar and/or salt in jar #4, but I do not know for sure. They could be too small to be seen.

13. After students have recorded their observations and developed their models, ask them to share their ideas with their table group.

- What do you notice in the different models?
- What do some of the models have in common?
- How are the parts of the model that are observable represented?
- How are the parts of the model that are not observable represented?
- Which jars have sugar or salt in them? Why do you think that? Do you know for sure?
ESRs: They could be in any of the jars, but we can't see them; a jar could have both or only one—we don't know for sure.
- Use your model to explain how there may be other material in the water that you cannot see. (See ESRs above.)
- What are you wondering about? What questions, if any, do you want to add to the Class Question Board?

TEACHER NOTE

If there were no questions about the “unseen” particles in the first set of wonderings, their refined model should now have some representation of the unknown matter in the water such as what the contaminants are, how much is present, etc. Students should now have questions about those particles.

If students are still having trouble thinking about unseen matter in the water, demonstrate for the group. Take a glass of water, add a small amount of salt or sugar, and stir until dissolved. Ask, “Can you see the salt/sugar in the water? How would anyone know it is there?”

5.1 Town Water Samples

TEACHER NOTE

► After the lesson, collect **5.1.H1: Town Water Samples** as a formative assessment to gather information to direct future lessons and provide students with feedback on the expectations for drawing a model. Assess students' application of PS1.A to see if they can use prior knowledge about the particulate nature of matter. If a student model does not include "other" particles such as sugar, salt, iron, etc. for at least jars #1, #2, and #3, remind them of the story and the samples of these materials they looked at.

Part III

Engage (45 minutes)

Ask questions that can be investigated to identify the types and quantity of matter, including the very small and unseen matter.

14. Ask table groups to share 1–2 new wonderings (questions) after they listened to the information from the police and add the questions to the Class Question Board. Ask the groups to add their sticky note questions to the appropriate categories. Create a new category if necessary.
15. Review the Class Question Board with the class, then ask table groups to select their top three questions that they think are the best investigation questions. Use these prompts to help students identify the investigation questions:
 - What questions can be answered using data from investigations?
 - What type of question would result in learning new information about the potentially dirty water?
 - Which questions are focused?
 - How might we investigate the question? (Do we have the resources in our classroom to do that?)
 - If your question is a yes/no question, how can you change it so that it asks for information (data)?

ESRs:

- *How much matter (quantity) causes the water to look dirty?*
 - *How do we know if the jar water is harmful to drink?*
 - *Are there germs in the water?*
 - *Why does the "dirt" not cause the water to smell bad?*
 - *How can the water be cleaned?*
 - *How can we determine what is in the water?*
 - *How could the environment or humans have impacted the water?*
16. At this point, move testable questions that require an experiment to another chart labeled Testable Questions.

5.1 Town Water Samples

17. Ask table groups to share their top three questions by circling them on the Class Question Board. Put check marks next to the questions that are duplicates.
18. Connect the students' questions to what they will investigate in the upcoming lessons:
 - Quantity of matter in the water (Lesson 2: Finding Impurities in Water)
 - *How do we know if the water is clean and safe to drink?*
 - *How much matter is in the water?*
 - *Is any amount of contaminating matter safe?*
 - Type of matter in the water (Lesson 3: Properties of Matter)
 - *How do we know what type of matter is in the jars?*
 - *Do any jars have no contamination?*
 - *How do we know if there is other matter in the jar?*
 - Cleaning the water (Lesson 4: Cleaning Water and Lesson 5: Separating Mixtures)
 - *How can the contaminating matter be removed from the water?*
 - *How can we make the water clean or safe to drink?*
 - *Are there different ways to clean the water?*

TEACHER NOTE

This learning sequence specifically targets the problem of material in the water and the process of removing it. Students may have questions about preventing the contamination of water. If so, create that category for the Class Question Board. If students do not yet have these questions, it is likely that they will over the course of the sequence, and the category can be added at that time. Water protection and preservation are not addressed explicitly in this learning sequence, but these questions help students realize problems that may exist within the larger system. These issues within the system can be added as an extension or differentiation strategy at the end of the learning sequence.

19. Remind students that the focus is to understand the anchoring phenomenon of sewage water becoming drinkable. We are just beginning to think about the science in the anchoring phenomenon by asking questions. We also need to think about the engineering challenge of how to clean the town water. Ask, "Which of our questions do we think we need to answer to help us explain how sewage water might be made drinkable?"
20. Have students work in pairs to review and discuss the questions in their science notebook as well as the questions on the Class Question Board. Hold a class discussion to gather the questions the students think could help in the design process. Transfer the sticky notes or rewrite them on a new question board called the Design Solutions Question Board. *ESRs: How do we know if the water is clean and safe to drink? How much matter is in the water? Is any amount of contaminating matter safe? How can the water be cleaned?*

5.1 Town Water Samples

21. Ask the class to review these questions and determine if they have any others they want to add. Have them write the questions on a sticky note and put them on the Design Solutions Question Board. Tell students they will return to this board when they are ready to think about their design.

References

60 minutes. (2018, April 29). *Drink filtered sewage water*. Retrieved from <https://www.youtube.com/watch?v=sQBfCh-vmsw&feature=youtu.be>

Jordine, J., & Torres, R. (2013). Enhancing Science Kits with the Driving Question Board. *Science and Children*, April/May, 57–61.

Michaels, S., & O’Conner, C. (2012). The Inquiry Project’s Talk Science Primer. Retrieved from https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

Schwarz, C. V., Passmore, C., & Reiser, B. J. (2017). *Helping students make sense of the world using next generation science and engineering practices*. Arlington, VA: NSTA Press, National Science Teachers Association.

Toolbox 5.1

Town Water Samples

Toolbox Table of Contents

5.1.H1 Town Water Samples

5.1.12

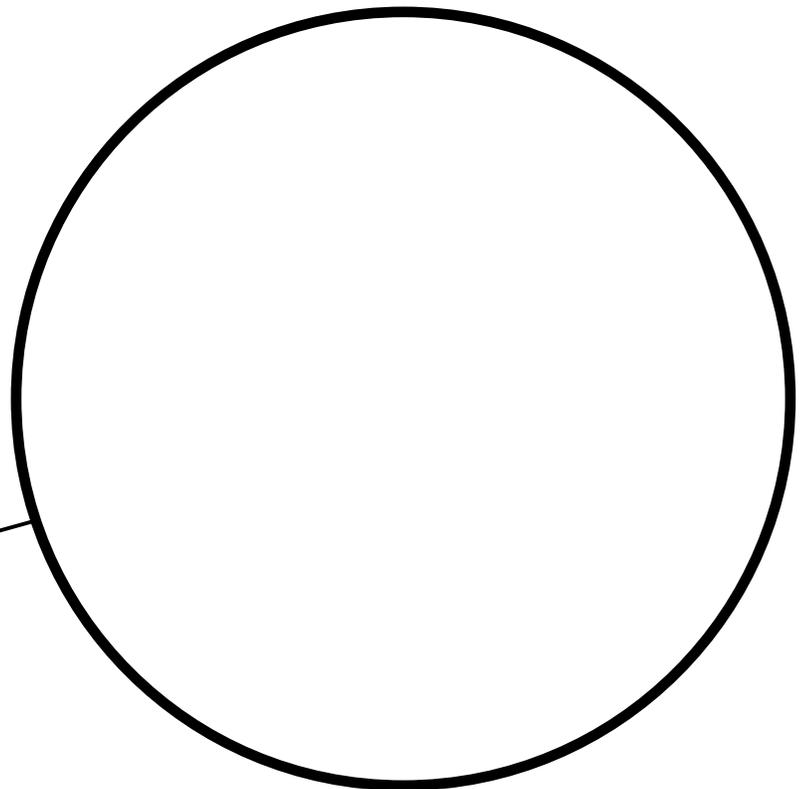
Town Water Samples

Each table group will decide who will draw each jar (#1, #2, or #3). Draw and describe a model of everything inside your jar from the perspective of two different scales:

1. as you see it (macroscopic view) and
2. as you would see it if you could shrink down to a very small scale (as you might see with a microscope)

True Scale (as seen with eye—macroscopic)

Small Scale (microscopic)



Town Water Sample # _____

Use your model to explain why you can't see the contaminants.

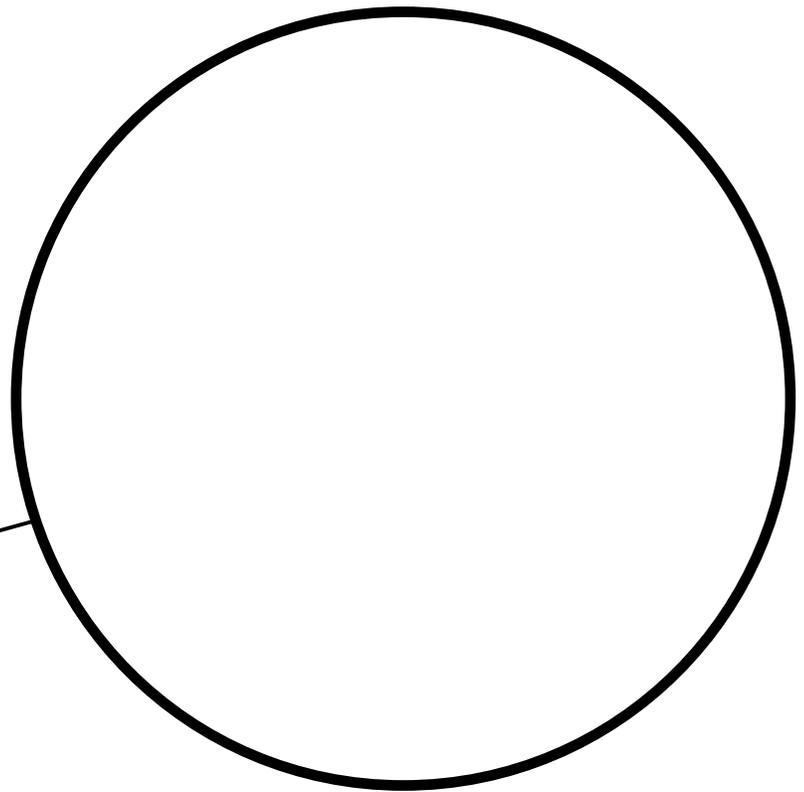
Town Water Samples (continued)

Draw and describe a model of everything inside your jar #4 from the perspective of two different scales:

3. as you see it (macroscopic view) and
4. as you would see it if you could shrink down to a very small scale (as you might see with a microscope)

True Scale (as seen with eye—macroscopic)

Small Scale (microscopic)



Town Water Sample #4

Use your model to explain why you can't see the contaminants.

Appendix 5.1

Town Water Samples

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)

- | | |
|----------------|---|
| 5-PS1-3 | Make observations and measurements to identify materials based on their properties. <i>[Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.]</i>
<i>[Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]</i> |
|----------------|---|

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)

Asking Questions and Defining Problems (Target SEP)

- Use questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
- Use prior knowledge to describe problems that can be solved.
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes criteria for success and constraints on materials, time, or cost.

Developing and Using Models (Supporting SEP)

- Develop and/or use models to describe and/or predict phenomena.

DISCIPLINARY CORE IDEAS (DCI)

PS1.A: Structure and Properties of Matter

- 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.

CROSCUTTING CONCEPTS (CCC)

Scale, Proportion, and Quantity

- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.

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Appendix 5.1

Common Core State Standards (CCSS)

CCSS ELA SPEAKING AND LISTENING

CCSS.ELA-LITERACY.SL.5.1

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.

- b. Follow agreed-upon rules for discussions and carry out assigned roles.
- c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
- d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

MATHEMATICS PRACTICES

MP.2

Reason abstractly and quantitatively.

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California English Language Development (ELD) Standards

CA ELD

Part 1.5.1 Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics.

EMERGING	EXPANDING	BRIDGING
Contribute to conversations and express ideas by asking and answering <i>yes-no</i> and <i>wh-</i> questions and responding using short phrases.	Contribute to class, group, and partner discussions, including sustained dialogue, by following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	Contribute to class, group, and partner discussions, including sustained dialogue, by following turn-taking rules, asking relevant questions, affirming others, adding relevant information, building on responses, and providing useful feedback.

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