1 Exploring Materials

TALKING IT OVER
1 CLASS SESSION

ACTIVITY OVERVIEW

NGSS CONNECTIONS

Students begin to gather and synthesize information about the physical and chemical properties of three materials—glass, aluminum, and plastic. They assess how this information might be used as evidence for making a decision about which material to use for a drink container in relation to the structure and function of that object.

Prepare to teach the unit by reviewing the unit overview and assessment chart for a summary of the NGSS taught and assessed in this unit and how the standards are woven together throughout the unit. Decide in advance which assessments you plan to emphasize. Also review the NGSS pathways on the SEPUP website, and the phenomena and storyline documents found in Teacher Resources IV, "Unit Specific Resources."

NGSS CORRELATIONS

Performance Expectations

Working towards MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Disciplinary Core Ideas

MS-PS1.A Structure and Properties of Matter: Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used and describe how they are supported or not supported by evidence.

Asking Questions and Defining Problems:

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Ask questions to identify and clarify evidence of an argument.

Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in findings.

Crosscutting Concepts

Structure and Function: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology: Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World: The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time.

Common Core State Standards—ELA/Literacy

WHST.6-8.1: Write arguments focused on discipline-specific content.

WHAT STUDENTS DO

Students brainstorm and discuss what they know about the properties of aluminum, glass, and plastic as materials for producing single-use drink containers. They discuss their current understanding of the advantages and disadvantages of each material and develop a list of questions needed to decide which is better for single-use drink containers. They then examine four graphs of data on the materials to help inform their choices.

MATERIALS AND ADVANCE PREPARATION

- *For the teacher*

* 1 plastic drink bottle
* 1 glass drink bottle
* 1 aluminum can
1 Literacy Student Sheet 1, "Keeping a Science Notebook"
1 Literacy Student Sheet 4c, "Writing Frame–Evidence and Trade-offs" (optional)
1 Scoring Guide: EVIDENCE AND TRADE-OFFS (E&T) (optional)

- *For each student*

1 Science Skills Student Sheets 5a and 5b, "Interpreting Graphs" (optional)
1 Literacy Student Sheet 4c, "Writing Frame–Evidence and Trade-offs" (optional)
1 Scoring Guide: EVIDENCE AND TRADE-OFFS (E&T) (optional)

**not included in kit*

TEACHING SUMMARY

GET STARTED

1. The class identifies properties that can be used to compare materials.
   a. Show the drink containers to the class, and ask students which material—aluminum, glass, or plastic—would make the best single-use drink container.
   b. Read the introduction and Guiding Question.

DO THE ACTIVITY

2. If you have not previously done so, introduce the SEPUP model for collaborative work.
   a. Introduce SEPUP's 4-2-1 model for collaborative work.
   b. Clarify which situations are appropriate for collaboration and which are appropriate for working independently.
   c. Introduce strategies for effective group interaction.
3. Introduce the use of a science notebook and the preparation of lab reports.
4. Students compare properties of glass, aluminum, and plastic.
   a. Assist students as needed in setting up their data tables.
   b. Distribute Science Skills Student Sheets 5a and 5b, "Interpreting Graphs," and use them to support students' skills in analyzing the materials graphs and descriptions (optional).
   c. Have students share their materials choices and reasoning for their choices.
   d. If you have not previously done so, introduce safety in the science classroom.

BUILD UNDERSTANDING

5. Introduce crosscutting concepts.
    a. Explain that crosscutting concepts bridge disciplines.
    b. Give an example that makes sense for students.
    c. Introduce the crosscutting concept of structure and function.
    d. Relate structure and function to this activity.
6. Introduce evidence and trade-offs.
    a. If you have not previously done so, introduce the meaning and use of evidence in science.
    b. Distinguish evidence from opinion.
    c. Discuss the sources, quality, and quantity of evidence.
    d. Introduce the idea that decisions about solutions to scientific and engineering problems often involve trade-offs.
    e. Provide an example of trade-offs.
    f. Develop some examples of trade-offs in students' lives.
7. (OEC QUICK CHECK; E&T ASSESSMENT) If you have not previously done so, introduce the SEPUP Assessment System.
    a. Provide an overview of the Scoring Guides.
    b. Explain the expectations for student growth over time.
    c. (LITERACY) Support student writing with the Writing Frame.

TEACHING STEPS

GET STARTED

1. The class identifies properties that can be used to compare materials.
    a. Show the drink containers to the class, and ask students which material—aluminum, glass, or plastic—would make the best single-use drink container.

    Have students record their initial responses and rationales in their science notebooks. You may wish to pass the containers around the class or leave them somewhere accessible for students to examine during the activity.

    b. Read the introduction and Guiding Question.

    Read the introduction aloud. Introduce the term *properties*. When words are formally defined in an activity, they appear in bold type in the Key Vocabulary list. Encourage students to use these words when talking or

writing about science. During discussions listen for these words to see if students are using them correctly. Decide how you will support students' understanding of the vocabulary—perhaps by setting up a word wall in the classroom. For more suggestions on ways to develop students' understanding of and proficiency with scientific vocabulary, see the section on Vocabulary Development in Teacher Resources II, "Diverse Learners."

Have the class suggest which properties glass has that make it appropriate as a single-use drink container material. List the properties on the board for students to refer to later in the activity. Explain that students will work in groups to discuss the properties of aluminum and plastic. They will then examine data on the three materials to evaluate which would be the best choice for making a single-use drink container.

DO THE ACTIVITY

2. If you have not previously done so, introduce the SEPUP model for collaborative work.

   a. Introduce SEPUP's 4-2-1 model for collaborative work.

      Explain that many of the activities in this book use the SEPUP 4-2-1 cooperative learning model. Students work in groups of four or in pairs to share, discuss, compare, and revise their ideas and to conduct investigations and activities. In all cases, each individual student is responsible for contributing ideas, listening to others, recording and analyzing their results, and monitoring their own learning.

   b. Clarify which situations are appropriate for collaboration and which are appropriate for working independently.

      In science, collaboration is essential to the development of new ideas and to a better understanding of scientific concepts. However, scientists must publish only their own work and must give others credit when they build on others' ideas.

   c. Introduce strategies for effective group interaction.

      Explain or model what productive group interactions (both agreement and constructive disagreement) look like and sound like. For more information about group work, including two optional Student Sheets to help support students' interactions, see the Facilitating Group Interactions section of Teacher Resources II, "Diverse Learners."

3. Introduce the use of a science notebook and the preparation of lab reports.

   Introduce science notebooks.

   Explain your expectations for the type and organization of students' notebooks. Keeping a science notebook helps students to track data; record predictions, hypotheses, and questions as they investigate; process ideas; build scientific writing skills; and write lab reports. "Keeping a Science Notebook" in Appendix E of the Student Book provides suggested guidelines. For more information about science notebooks, see the Literacy section of Teacher Resources II, "Diverse Learners."

4. Students compare properties of glass, aluminum, and plastic.

   a. Assist students as needed in setting up their data tables.

      Be sure students discuss the properties of glass from the class discussion and add those to their data tables. If appropriate, have groups briefly share responses with each other when they finish Procedure Step 2 and/or share the questions they list in Procedure Step 3.

      PROCEDURE STEP 2 SAMPLE STUDENT RESPONSE

      COMPARING MATERIALS

Type of material	Advantages	Disadvantages
Glass	*Reusable* *Can be recycled* *Easy to see through*	*Breaks easily* *Broken glass can be dangerous* *Heavy*
Aluminum	*Lightweight* *Can stack* *Can be recycled* *Lots of cans are recycled*	*One-time use only* *Cannot reclose an aluminum can after it's been opened*
Plastic	*Reusable* *Lightweight* *Doesn't break easily*	*Can't always be recycled*

   b. Distribute Science Skills Student Sheets 5a and 5b, "Interpreting Graphs," and use them to support students' skills in analyzing the materials graphs and descriptions (optional).

      If students are having trouble interpreting the graphs in Part B, you may wish to use the Science Skills Student Sheets 5a and 5b to help with their analysis. For more information and for answers to the Science Skills Student Sheets, see Teacher Resources II, "Diverse Learners."

c. Have students share their materials choices and reasoning for their choices.

After students have completed their group discussions in Step 5, have one student in each group share the group's choice with the class for which material they believe to be the best for making a single-use drink container. Make sure they also explain the reasoning behind their choice. This process supports the practice of obtaining, evaluating, and communicating information, which will be expanded on in the Analysis section of this activity and in activities that follow.

d. If you have not previously done so, introduce safety in the science classroom.

Explain that students are required to know and understand all classroom expectations for safety. Distribute the safety contract and guidelines you are using and review your expectations for classroom safety. Point out the location of safety gear in the classroom and review when and how to wear all basic safety gear, such as chemical splash goggles and gloves. Demonstrate how to use emergency safety equipment, including the eye-and-face wash. Provide plenty of time for students to ask questions, and then have them sign the safety agreement. Have them take it home for a parent's or guardian's signature, and tell them to return the signed agreements before the date you plan to conduct the next activity. Although the element samples in the next activity are generally considered safe to handle, the activity is an opportunity to familiarize students with wearing the protective equipment.

BUILD UNDERSTANDING

5. Introduce crosscutting concepts.

a. Explain that crosscutting concepts bridge disciplines.

They can be a lens or touchstone through which students make sense of phenomena and deepen their understanding of disciplinary core ideas. Refer students to the chart in Student Book Appendix G, "Crosscutting Concepts," and point out the symbols and definitions provided.

b. Give an example that makes sense for students.

For example, students have almost certainly noticed patterns, such as the predictable pattern of the seasons every year. Earth scientists might study patterns in rock layers; physical scientists might study patterns in the behavior of chemicals; and life scientists might study patterns in the kinds

of trees in different climates. Observing, questioning, and trying to explain patterns are things all scientists do. This is why patterns are considered a crosscutting concept.

c. Introduce the crosscutting concept of structure and function.

This crosscutting concept relates to the close relationship between the structure of an object or system and what it does or how it behaves. Review the symbol used for Structure and Function in Appendix G, "Crosscutting Concepts." Structure and function applies from the atomic scale to the astronomical scale. For example, the functions of parts of the human body depend on their structures. An arm has a very different structure and function from the digestive system. Use this or other accessible examples to clarify this crosscutting concept for students. Scientists look at relationships between structure and function to figure out how things work.

d. Relate structure and function to this activity.

In this activity, and in many activities in this unit, students look at the structure and function of an object to determine what materials are best suited to making a particular object. In this activity, students looked at the properties of aluminum, glass, and plastic to determine which of those materials best fits the structure and function of a single-use drink container.

6. Introduce evidence and trade-offs.

a. If you have not previously done so, introduce the meaning and use of evidence in science.

Analysis item 2 provides an opportunity to introduce the definition of evidence provided in the Student Book. Explain that scientists collect information (data) with various tools and strategies, including observation and experimentation. Like scientists, students will use evidence to develop explanations, construct scientific arguments, and recommend solutions to problems.

b. Distinguish evidence from opinion.

Explain that evidence is information that supports a claim. In contrast, an opinion is the view someone takes about a certain issue based on their own judgment. An opinion might not be based on evidence. An informed opinion might be based on evidence; however, another person may have a different opinion based on the same evidence. To distinguish evidence from opinion in science, it is helpful to determine if a statement describes

information gathered through reliable and appropriate procedures and is likely to be reproducible. The question is: Could someone else gather similar information under similar circumstances? If the answer is yes, the statement is not opinion and is likely to be evidence.

c. Discuss the sources, quality, and quantity of evidence.

When evaluating evidence, scientists consider the source, quality, and quantity of the evidence available. Biased or insufficient evidence compromises the validity of scientific conclusions. Scientific conclusions should logically follow the evidence collected and should not be overly generalized beyond the context of the investigation.

The criteria for quality evidence may vary among the scientific disciplines. However, evidence is generally considered of higher quality if it is obtained through systematic investigation and is reproducible, meaning another investigation under the same set of circumstances would obtain similar data.

Criteria for quantity also vary but might include the sample size or number of trials in an experiment, the number of observations that support a conclusion, or the availability of multiple studies or multiple lines of evidence that lead to the same conclusion.

d. Introduce the idea that decisions about solutions to scientific and engineering problems often involve trade-offs.

This unit includes issues that relate to science and/or engineering and that may lead to decisions about the best solutions or designs for solving problems. One goal of this curriculum is to teach students that

- decisions about possible solutions often involve trade-offs.
- identifying trade-offs involves analyzing evidence.

Explain to students that in this unit, they will make several decisions about choosing materials. In this activity, students look at the trade-offs of aluminum, glass, and plastic as materials for a drink container. In a decision involving trade-offs, something positive (or desirable) is given up to gain another positive (or desirable) outcome. Since many decisions involve trade-offs, students should understand that a perfect choice is often not possible. It is possible, however, to recognize and analyze the trade-offs associated with each decision.

e. Provide an example of trade-offs.

For example, when asked, "Paper or plastic?" at a store checkout counter, most shoppers make the choice quickly. But there are several trade-offs attached to choosing paper or plastic. A shopper who chooses paper over plastic may do so to avoid generating plastic waste. In requesting the paper bag, though, they are contributing to other environmental problems, such as increased water and energy use, and the higher amounts of solid waste and CO_2 emissions associated with making paper bags. Neither choice is ideal, and both choices have a downside. Identifying the trade-offs helps clarify the reasoning that is being applied to make a decision.

f. Develop some examples of trade-offs in students' lives.

To further explore trade-offs, brainstorm with the class a list of decisions they make every day that involve trade-offs. Choose one, and talk through the associated trade-offs of deciding one way or another. This practice will familiarize students with ways of identifying and considering trade-offs in this and subsequent activities.

7. (OEC QUICK CHECK; E&T ASSESSMENT) If you have not previously done so, introduce the SEPUP Assessment System.

a. Provide an overview of the Scoring Guides.

Explain that Analysis item 2 is the first assessment in this unit, and you will use it to introduce the SEPUP Assessment System to your students, not as a formal assessment. See Teacher Resources III, "Assessment," to be sure you are familiar with the overall system.

Before assigning the assessment, distribute the EVIDENCE AND TRADE-OFFS (E&T) Scoring Guide, and use it to model how the system works. Point out the levels in the first column of the Scoring Guide. Tell students these levels are the same for all Scoring Guides and range from 0–4. Then review the descriptions of each level. For example, a Level-4 response is complete and correct in all Scoring Guides. Point out that the scores (0–4) are based on the quality of their responses and do not correspond to letter grades. Allow students to refer to the Scoring Guide as they prepare their answers. Be sure that they understand that the Scoring Guides do not include the specific content students must provide in their responses; rather, they explain the overall expectations for responses at various levels of performance on the task. Note that this Analysis item can also be used as an OEC Quick Check because the practice of obtaining, evaluating, and

communicating information is being used in the context of an evidence and trade-offs question. For more information about the Scoring Guides and how you and students can use the system to improve their work, see Teacher Resources III, "Assessment."

b. Explain the expectations for student growth over time.

Explain to students that they aren't expected to always produce complete and correct work on their first attempts. Instead, they should work toward developing consistent Level-3 and Level-4 answers as they become more proficient with the concepts (both disciplinary core ideas and crosscutting concepts) and science and engineering practices being assessed. It is not necessary (or even expected) that an "A" student will always write Level-4 responses, especially at the beginning of the course or when they are introduced to a new Scoring Guide.

c. (LITERACY) Support student writing with the Writing Frame.

To help students complete Analysis item 2, you may wish to pass out Literacy Student Sheet 4c, "Writing Frame–Evidence and Trade-offs." This sheet provides a literacy strategy that gives students a structure for communicating their ideas. It helps students organize their ideas into coherent written responses. For more information, see Teacher Resources II, "Diverse Learners." A sample Level-4 response can be found in the Sample Responses to Analysis, below.

SAMPLE RESPONSES TO ANALYSIS

1. Did the graphs of the data help you make a decision about the advantages and disadvantages of each material? Explain.

Student responses may vary. One sample response is shown here:

The graphs helped me make a decision about the advantages and disadvantages of glass, metal, and aluminum because I did not know which was recycled the most, which was the most expensive to produce, which one caused the most pollution and waste, and how many containers could be made from each ton of material. That data helped me to choose aluminum as the best material instead of plastic, which I had originally chosen, because the graphs showed that you can make a lot more containers out of one ton of aluminum than you can out of glass or plastic. It is a lot cheaper to make a container out of aluminum, and aluminum is recycled more than glass or plastic. I think this makes aluminum the best choice, even though creating a ton of aluminum creates more waste and pollutants.

2. (OEC QUICK CHECK; E&T ASSESSMENT) Imagine you are an environmentalist who is concerned with pollution, litter, and problems with a bottle's impact on the environment. Based on the information from this activity, which material would you claim is the best for making a single-use drink container?

   Write a letter from an environmentalist's viewpoint to the president of the drink company describing your recommendation at this time. Support your reasoning with evidence, and identify the trade-offs of your decision.

   Hint: To write a complete answer, first state your opinion. Provide two or more pieces of evidence that support your opinion. Evidence is factual information or data that support or refute a claim. Then consider all sides of the issue and identify the trade-offs of your decision. A trade-off is an exchange of one outcome for another—giving up something that is a benefit or advantage in exchange for something that may be more desirable.

   Student responses may vary based on the material they choose.

   SAMPLE LEVEL-4 RESPONSE

   There is a lot of discussion about the issue of which material is best for single-use drink containers—glass, aluminum, or plastic. My decision is that the best material is aluminum. My decision is based on the following evidence: First, you can make a lot more aluminum containers from a ton of aluminum than you can glass or plastic; second, aluminum is recycled a lot more than glass or plastic; third, aluminum containers are less expensive to make than glass or plastic containers. People who disagree with my decision might say that glass is better because making a ton of glass does not produce as many pollutants and waste as making a ton of plastic.

REVISIT THE GUIDING QUESTION

What information would help you decide which material is best for making a single-use drink container?

Have students discuss their responses to Analysis item 2 and what information from the activity was helpful in making their decision. Let students know that they will continue to gather information about the three materials—glass, aluminum, and plastic—in the following activities. Over the course of the unit, they will have several opportunities to evaluate which material might be best for different uses, and they will evaluate other materials, their uses, and their impact on society and the environment.

ACTIVITY RESOURCES

KEY VOCABULARY

evidence

material

property

trade-offs

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