Teresa was running late for soccer practice and knew her coach would make her run extra laps if she arrived even a minute late. She had 30 seconds to spare when she reached the field and tossed her backpack down next to her teammates' bags.

About half way through practice, they all stopped for a water break. Teresa pulled out her favorite bright pink reusable water bottle from her bag and drank deeply from it. Her friend Linea was drinking from an aluminum bottle. She looked at Teresa's bottle and said, "How can you stand that plastic bottle? Doesn't it make your water taste kind of funny?" Teresa replied, "I guess, a little, but I love the color and that it won't break. You know I'm always throwing my backpack around."

After practice, when Teresa got home, she was getting her water bottle out to fill it for the next day. Her dad was busy putting away groceries, including a package of bottled water that she knew was for her dad's lunches that he took to work. "Hey Dad," Teresa asked, "why don't you use a reusable water bottle like me and Mom?" Her dad said, "Well, you know how I often have meetings with clients at their offices or at different job sites? I don't want to worry that I'll forget a reusable water bottle and then have to go back and get it later. It's easier for me to just grab a disposable one and recycle it when I'm done with my water."

Later, Teresa was thinking about what her dad said. It made sense, but she wondered if her dad always had a spot to recycle his water bottles. And wouldn't it be less expensive to keep using the same bottle instead of always buying more? And what about her plastic bottle? It did kind of make the water taste funny. Teresa wondered if she and her dad were making the best choices.

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How do scientists and engineers decide which material is best to use to make things? What do they need to know about the materials to choose the best one? What are those materials made of and where do they come from? Do the materials react differently in different environments? What happens when the materials are no longer able to be used?

To investigate these questions, you will develop and use models to describe the composition of different materials and how those materials respond under various conditions. You will gather and make sense of information about where the materials come from and how scientists and engineers decide which material is best for making a product.

1 Exploring Materials

TALKING IT OVER

CONSIDER THE WORLD around you. The book in your hands, the floor underneath your feet—each is made from a type of material. The word material can have several meanings. To a scientist or engineer, a **material** is a type of solid matter used to make things. For example, clothing, homes, and computers are all made from different materials. Materials scientists and materials engineers study existing materials and design new ones. When they design these materials, here are some of the things they think about:

- How will they be used?
- What resources are needed to make them?
- What will happen to them when they are no longer useful?

For example, think about the materials used to make drink containers. Plastic was not used to make bottles until 1947. Until then, almost all drink containers in the United States were made of glass. Consumers would return glass milk and soft drink bottles and get their deposits paid back, and the drink bottling companies would clean and refill the bottles to sell again. Today, most drink containers are made mainly of aluminum, plastic, or glass. Each material has particular characteristics, or **properties**, that make it useful for holding drinks. Each material is made from specific resources and affects the environment when it is discarded or recycled.

In this unit, you will learn about some of the properties materials engineers investigate when deciding which material to use for a specific purpose. For this activity, you will be looking at materials used in making disposable drink containers.

You are a materials scientist working for a bottling company. The president of the company has asked you which type of material to use to make containers for a new drink brand. You decide to look for a material that will both work well and have the fewest bad effects on the environment. Should it be aluminum, glass, or plastic? How will you decide? What evidence will you use?

GUIDING QUESTION

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

PROCEDURE

Part A: Comparing Properties of Materials

1. Prepare a data table for recording the advantages and disadvantages of each of the three materials—aluminum, glass, and plastic. Your table should fill an entire page in your science notebook. Give the table a title.
2. With your group,
   a. discuss and list the properties you already know of for each of the three materials—aluminum, glass, and plastic.
   b. decide whether each property is an advantage or disadvantage if you are using the material to make a drink container.
   c. record in your data table your decision from Step 2b.
3. With your group, discuss what other questions you would like answered before deciding which of the three materials—aluminum, glass, or plastic—is the best choice for making a single-use drink container. Record your group's questions in your science notebook.

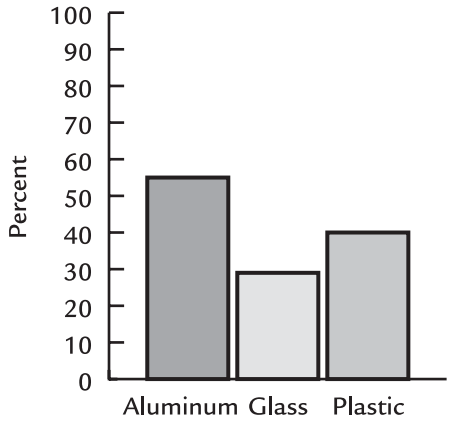
Part B: Choosing a Material

4. Review the information provided in the following graphs and descriptions. Complete the following with your group for each graph and description:

   a. Discuss what you think the data in the graph mean about each of the three materials—aluminum, glass, and plastic. Is it an advantage or disadvantage if you are using that material to make a single-use drink container?

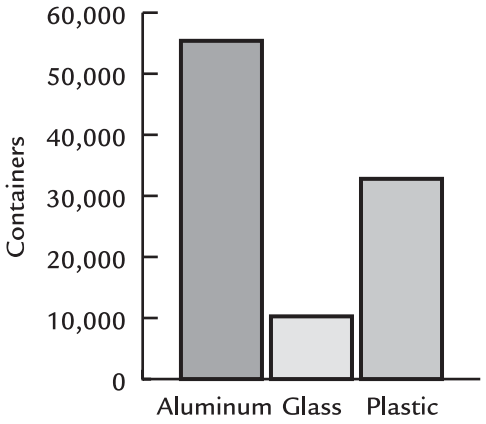
   b. Record in your data table your decision from Step 4a.

Percent Recycled



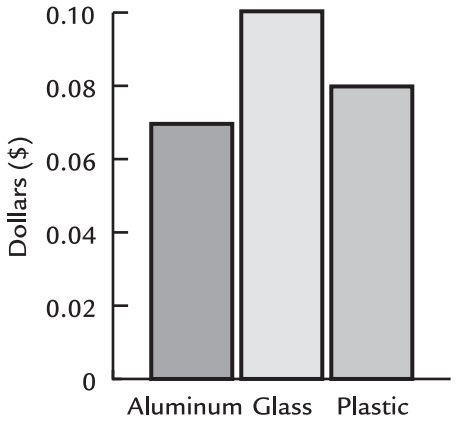
This graph compares what percentage of the material is recycled.

Containers Per Ton of Material



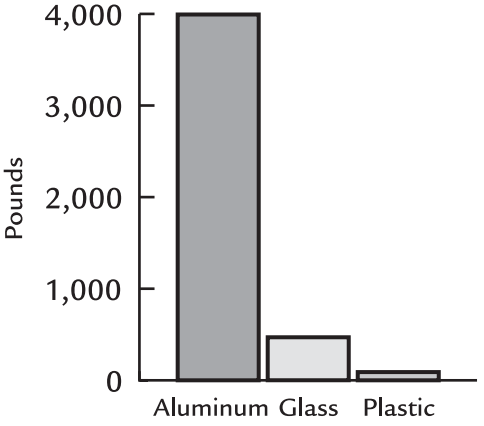
This graph compares how many containers can be made out of 1 ton of each material.

Cost to Produce Container



This graph compares the cost (in U.S. dollars) of making one container out of each material.

Pollutants and Waste Created in Producing One Ton



This graph compares how many pounds of pollutants and waste are created during the process of manufacturing 1 ton of each material.

5. With your group, discuss which material you think is the best choice for making a single-use drink container based on the evidence you have. Record your group's choice and your reasoning for that choice in your science notebook.

ANALYSIS

1. Did the graphs of the data help you make a decision about the advantages and disadvantages of each material? Explain.
2. 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.