Studying Materials Scientifically

Kai, did you hear about those barrels they found by the baseball field yesterday?"

"No, what happened?" Kai stopped. She had been hurrying to get ready for the baseball game.

"They found barrels full of chemicals near the field, so they cancelled the game," Gabriela grumbled.

"What? I gave up going to the movies so I could play today."

"The town started digging into that empty lot next to the baseball field to build the new playground. When they cleared out the brush and garbage, they found at least ten old corroded barrels full of stuff."

"Do they know what is in them?" asked Kai.

"Nope, so they have to call in a hazardous materials team to open the barrels. I heard my uncle talking about it last night with my dad. My uncle works for the company that will come in and do the testing," Gabriela continued. "The testing will be done today and thus, the game is cancelled."

"Really, well that's kind of scary," Kai responded. "We have been playing there since we were little. What if the stuff in the barrels is hazardous? How are they going to figure out what it is?"

"I think they'll take samples, and do some tests," said Gabriela.

• • •

Our world is filled with substances. The liquids we drink, air we breathe, and the roads we walk on are all made from different combinations of substances. The substances people use to make products are called materials. Each material has unique properties. For example, we can identify gold by its shiny characteristic metallic color. But how can these properties help to identify unknown samples? In this unit you will look at how substances can be identified based on their chemical and physical properties. You will learn how to handle potentially hazardous substances with care as you study materials scientifically.

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1 Handling Hazardous Materials

VIEW AND REFLECT

You are cleaning out a cabinet at home and you find an old jar filled with what appears to be a mixture of rusty pieces of metal and a thick oily liquid. What should you do? Is it safe to dump it out? How could you figure out what to do with it if you're not sure what it is?

In this unit you will work with an unlabeled jar filled with a mixture of substances. When you don't know the contents of a container, it is best to assume they are hazardous. **Hazardous materials** (HAZ-ur-dus ma-TEER-ee-uls) are substances that pose a danger to the health and safety of living organisms. They can cause injury or even death. People who are trained to clean up or dispose of hazardous materials are often members of a hazardous materials, or "hazmat," team. Before working with potentially hazardous chemicals in this unit, you will learn how to handle and identify them.

CHALLENGE

How should unidentified materials be handled?

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PROCEDURE

1. Watch a segment about hazardous materials on the SEPUP DVD, "Hazardous Materials."
2. In your science notebook, make a list titled "Handling an Unknown Substance." As you watch the DVD, list the steps the hazmat team takes when approaching and handling the unidentified barrel.
3. Watch the DVD again. Record any additional precautions the hazmat team took that you did not list in your notebook in Step 2.
4. Compare your list with the lists of the other members of your group. As you do this:
   - Listen to and consider the precautions listed by others.
   - If you disagree about a precaution, explain to the rest of the group why you disagree.
5. Add to the list in your notebook any new ideas that your group members proposed.

ANALYSIS

1. Based on what you observed on the DVD, make a list of safety precautions you would take if you found a jar of unidentified substances at home.
2. If you found a jar filled with unidentified substances at school, would you handle it differently than you would at home? Add to your list from Question 1 any additional safety precautions you would take.

3. How could you identify the contents of an unlabeled jar? Explain ways to identify the jar's contents.
4. Could you determine the contents of the unlabeled jar through observation alone? Explain.

Key to Analysis Icons

 = Answer the question by yourself.

 = Discuss with your partner.

 = Discuss with your group.

 = Discuss the question in class.

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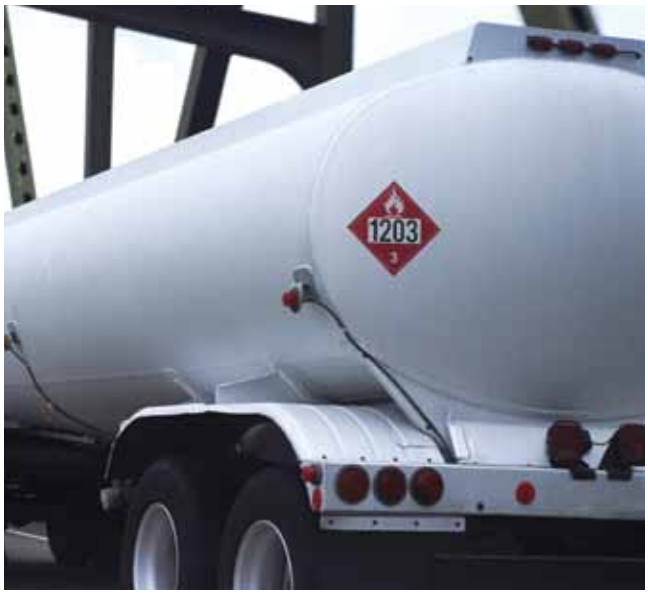
2 Types of Hazards

If you found an unlabeled container in your home, how would you know whether its contents were hazardous? A hazmat team assumes the contents are hazardous until it identifies the properties of each substance, and you should do the same. Since substances can be hazardous in many different ways, it is important to be prepared for the dangers they pose.

Hazardous materials, like those in the barrel in the last activity, are transported daily throughout the United States. Whenever they are shipped in large volumes, they must be labeled according to their class of hazard, as the U.S. Department of Transportation (D.O.T.) requires.

In science classes you will encounter a variety of potentially hazardous substances. Some are more hazardous than others. To prepare to work with them, you will learn how to choose and use safe methods.

CHALLENGE **What types of hazards do certain substances pose?**



DOT labels posted on vehicles and containers alert people to the dangers of the substances inside.

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MATERIALS

For each group of four students

- **1 set of 12 Chemical Data Cards**

For each student

- **1 Student Sheet 2.1, "Classroom Substances"**
- **1 Student Sheet 2.2, "Venn Diagram of Classroom Substances"**

PROCEDURE

1. Look at the table on the next page that shows the labels that the D.O.T. requires on hazardous materials. You may have seen some of these labels on large trucks or on storage containers. Discuss what each label reveals about the material.
2. Divide the set of Chemical Data Cards in half. You and your partner will work with six of the cards.
3. With your partner, read the six cards. Consider places where you might have encountered the substances on each card.
4. Familiarize yourself with each of the substances the cards describe as you fill out Student Sheet 2.1, "Classroom Substances." For each substance, list:
   - The hazard class(es) it belongs to.
   - The safety precautions people should take when using this substance.
5. When you have finished the six cards, switch sets with the other pair in your group and repeat Steps 3 and 4.
6. Work with your group to sort all 12 substances according to the hazard class(es) you assigned to each in Step 4.
7. Record the results of your sorting on Student Sheet 2.2, "Venn Diagram of Classroom Substances."

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Labeling Hazardous Materials

Class	Label	Description of Class	Examples
Biohazard		Can cause infection or disease in living organisms.	Tools used for medical treatment and procedures, disease-causing microorganisms and viruses
Corrosive		Liquids that chemically wear away at solid materials.	Sulfuric acid, bleach, oven cleaners
Explosive		Materials that cause sudden release of pressure, gas, or heat when exposed to a change in pressure or temperature.	Nitroglycerin, TNT, gases stored under pressure
Flammable		Liquids that catch on fire when exposed to a spark, flame, or heat source.	Gasoline, paint thinner, paints, acetone, ethanol, kerosene
Flammable Solid		Materials that ignite in the presence of oxygen or when exposed to water or humidity.	Magnesium metal, sulfur, naphthalene (ingredient in moth balls)
Gas		Gases stored under pressure that are flammable, toxic, or explosive.	Propane, butane
Oxidizer (reactive)		Materials that react chemically to cause other materials to burn.	Hair bleach and laundry bleach products, certain pool chemicals
Radioactive		Materials that release nuclear energy that causes damage to living organisms.	Used or unused nuclear fuel, uranium ore, radon
Toxic		Materials that are poisonous if inhaled, ingested, or absorbed through skin.	Insecticides, brake and transmission fluids, household cleaners

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ANALYSIS

1. Which substances from Student Sheet 2.1, "Classroom Substances," fall into more than one hazard class?

2. Explain in detail the safety guidelines you would follow when working with potassium hydroxide.

3. Of the substances listed on Student Sheet 2.1, which do you think poses the greatest hazard to the health of humans and animals? Explain.

4. If a shipment of sodium borate were sent to your classroom, which hazard label(s) do you think would be on the box?

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3 A Plan to Separate the Mixture

When a hazmat team works with an unknown substance, the team first tries to identify it, after taking care of any immediate hazards. The substance could be a **mixture**—a combination of two or more pure substances that can be physically separated. It is essential for the team to know what is in the mixture so that they can determine how to store and dispose of its different substances.

The first step in identifying an unknown substance is to take a sample of each part of the mixture. In this activity, you will design a three-part plan to:

- separate the liquid and solid substances.
- separate the different liquids.
- separate and clean the different solids.

CHALLENGE **How can you separate the substances in a mixture?**

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MATERIALS

For each group of four students

- 1 plastic cup with lid, containing unidentified mixture
- 2 pairs of plastic forceps
- 2 droppers
- 1 funnel
- 2 pieces of filter paper
- 1 metal screen
- 1 piece of steel wool
- 1 SEPUP tray
- 3 small plastic cups with lids
- 1 cup of water
- paper towels

For each student

- 1 pair of safety goggles

SAFETY

Wear safety goggles while working with chemicals. Do not touch the mixture or bring it into contact with your eyes or mouth. Keep the lid on the cup. Wash your hands after completing the activity.

PROCEDURE

1. Your teacher will provide you with a sealed sample of an unidentified mixture. With your group, carefully examine the sample.
2. Record in your science notebook your observations about the mixture and each substance it contains. Be as descriptive as possible.
3. With your group, discuss ways to separate the different substances and the safety precautions you will need to take. Be sure to consider the tools available to you in the materials list.
4. Work with your group to create a procedure for safely separating the substances. In your plan, be sure to:
   - List materials or tools you will use.
   - Explain each step in detail.
   - Describe safety precautions you will take.
5. Record the procedure in your science notebook.

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6. Because the solids and liquids were mixed together, the solids may still have some liquid on them. Discuss with your group how you can remove the liquid.
7. Record these additional steps in your science notebook.
8. Obtain your teacher's approval of your plan.

ANALYSIS

1. Based on your observations, how many substances do you think there are in the unidentified mixture? Explain.

2. Compare your plan with the plans of others in your class. What ideas do they have for separating the substances that you did not think to include in your plan?
3. What safety precautions will you take when separating the mixture?
4. What is the purpose of separating the different substances in the mixture?
5. You are walking down the sidewalk and see a puddle of green, oily liquid on the ground. Could you identify the contents of the puddle through observation alone?

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4 Hazardous Materials at Home

One way to reduce the risk of household hazardous chemicals is to dispose of them when they are no longer needed. But how can you handle and get rid of them without harming yourself, others, or the environment? In this activity you will read about Hassan, who must decide how to dispose of the contents of an unlabeled jar he found when cleaning at home.

CHALLENGE **How should unwanted household hazardous materials be handled?**

MATERIALS

For each student

1 **Student Sheet 4.1, "Intra-act Discussion: Household Hazardous Materials"**

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PROCEDURE

1. Assign one of the following roles to each person in your group. Note that there are two roles that change from Act 1 to Act 2. Two people should be ready to change to new roles for Act 2.

   Act 1

- *Hassan, a middle school student*
- *Mother, head of purchasing for Community Hospital*
- *Maya, his 12-year-old sister*
- *Grandfather*

   Act 2

- *Hassan*
- *Mother*
- *Mark Chu, Director of Waste Collection Center*
- *Karen Greenbach, Environmental Engineer*

2. In your group, read the role-play aloud. As you read, think about what each character is saying.
3. With your group, discuss the types of products you might find at home that could pose a hazard.
4. Mark whether you agree or disagree with the statements on Student Sheet 4.1, "Intra-act Discussion: Household Hazardous Materials." Then predict what you think other members of your group will say.
5. Discuss the statements with your group. Have each person share and explain his or her opinion about each statement.

HAZARDOUS MATERIALS AT HOME

Act 1: At Hassan's Home

Mother: Hassan, did you finish cleaning out the cabinet? I want to put the new cleaning supplies there when you're done.

Hassan: Almost. I found this jar filled with oily stuff. I have no idea what it is.

Grandfather: The people who lived here before sure left a lot behind. You'd think they were running a chemical factory. What is it?

Hassan: I really can't tell. Most of the jars don't have labels, or the labels are so faded I can't read them. This jar is filled with an oily mess with pieces of metal and something else in it.

Maya: Can I see?

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Hassan: Be careful! It might be dangerous. How do you think I should get rid of it?

Grandfather: Why don't you just dump it down the drain?

Maya: But what if it's hazardous? We learned at school that a lot of the things we buy to clean our homes and take care of our gardens contain chemicals that are bad for us and the environment.

Mother: Some household products can be very reactive, toxic, or flammable. At the hospital, I work with other department heads to be sure we make good decisions about the hazardous products we use.

Hassan: Why would a store sell cleaning products if they're harmful? They're being diluted with water when you put them down the drain. Doesn't that take away any hazard?

Grandfather: That's what I think. I always wash everything down the sink, or throw it in the garbage. They treat wastewater don't they? And the garbage is taken to a dump, so what's the harm in that?

Mother: All those chemicals dumped down the drain build up. Imagine all the homes around the world over 20 years—that's a lot of cleaning supplies in the water systems. These chemicals can do long-term harm to animals, organisms, and habitats.

Grandfather: I've been dumping cleaners down the drain for years.

Mother: But now we are more aware of how chemicals can affect us and other organisms. I read an article in last week's newspaper that said it is no longer legal to throw out batteries in the garbage. Batteries have to be recycled by dropping them off at a recycling center.

Grandfather: But batteries are made to be disposable. I don't see why they need to be recycled.

It is estimated that in most homes in the United States there are 10 to 40 liters (3 to 10 gallons) of hazardous materials in household products.

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Maya: We learned about recycling batteries at school. They contain heavy metals that can leak into the ground if they sit in landfills.

Mother: *(looking at Grandfather)* That reminds me. Remember how Mama used to take our temperature with a mercury thermometer? It was filled with silvery metal. Once, when the thermometer broke, we played with the little metal beads of mercury liquid. Now liquid mercury is known to be hazardous and is not used in thermometers.

Grandfather: Who would have thought that it was harmful? Mercury was used in so many different products like batteries, light switches, and thermometers.

Mother: Not anymore. Research has shown that it is toxic. If you're exposed to it for long periods of time, it can affect your nervous system.

Hassan: But what should I do with the jar?

Mother: We need to figure out what it is. A postcard came in the mail last week announcing a "Household Hazardous Waste Drop-off Day" at the Waste Collection Center. Let's take it there and see if they can help us. We'll drive over after we drop your sister off at soccer practice.

Act 2: At the Waste Collection Center

Director Chu: How can I help you?

Hassan: We'd like to know if we can dump this down the drain to get rid of it.

Director Chu: Do you know what it is?

Hassan: No, it wasn't labeled.

Mother: Hassan found it while he was cleaning out one of our cupboards at home. It l ooks like it has been there for a long time.

Director Chu: It will take some testing, but we will identify what is in it. Then we will know how to dispose of it. This is Karen Greenbach, our environmental engineer, who is an expert on testing methods. *(Turning to Karen)* Karen, we have an unlabeled jar here. Can you help these people?

In 2005, regulations in more than 30 states prohibited throwing batteries in the trash. They can leak toxic chemicals that can harm organisms.

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Household hazardous waste collection days are a way to safely dispose of latex paint, batteries, and other hazardous substances.

Karen Greenbach: I'd be happy to. We will send it to a lab where it will be separated. Then they will run tests to identify each of the parts.

Hassan: If it was bought in a store, wouldn't it be safe to just throw it out?

Director Chu: Sometimes the chemicals that are toxic, flammable, or corrosive are what make a product work. There aren't strict regulations about what is put in household products, so it is important to consider what hazards they pose when you are buying, using, and throwing them out.

Mother: When people buy products for their homes they usually choose what is most affordable and the best at doing the job. They don't often take into account the health or environmental hazards they might cause.

Director Chu: There have been many cases of people mixing and storing products incorrectly and getting hurt. It's important to know what you're working with and to consider their hazards.

Karen: The next step with your jar will be for us to send it to a lab to determine what is in it. It looks like a mixture of several liquids and some solids.

Hassan: Then what will you do with it once the parts have been identified?

Karen: If it is not hazardous, we will dilute it and pour it down the drain. But if it is hazardous, we will package it and put it in a special hazardous waste landfill. These sites are made so that hazardous material contained in them will not leak into the ground and groundwater.

Mother: Thank you for helping us.

Hassan: We have to tell Grandpa: No more dumping everything down the drain!

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ANALYSIS

1. In what ways can household products be harmful?
2. Give an example of a product that can no longer be discarded in the garbage. Explain why this is no longer allowed.
3. Where in people's homes do you think they are likely to have the greatest number of potentially hazardous products?
4. **Reflection:** Why do you think there are now more regulations about the use and disposal of hazardous substances than there were 20 to 40 years ago?

EXTENSION

When is your community holding a hazardous waste drop-off day? See if you can locate information in your area about when and where to take potentially hazardous materials.

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5 Separating the Mixture

To properly dispose of the unidentified mixture found in the jar, you need to identify the substances it contains. In this activity, you will follow the separation procedure that you developed in Activity 3, "Developing a Separation Plan." Once the substances are separated, you will be able to perform tests to determine the identity of the liquids. Since you do not yet know what the substances are, treat them as if they are hazardous.

CHALLENGE **How can the substances in the mixture be separated?**

MATERIALS

For each group of four students

- **1 plastic cup with lid, containing unidentified mixture**
- **2 pairs of plastic forceps**
- **2 droppers**
- **1 funnel**
- **2 pieces of filter paper**
- **1 metal screen**
- **1 piece of steel wool**
- **1 SEPUP tray**
- **3 small plastic cups with lids**
- **1 cup of water**
- **paper towels**
- **access to hot soapy water**

For each student

- **1 pair of safety goggles**
- **1 copy of separation plan from Activity 3**
- **Student Sheet 5.1, "Chemical Safety Data Sheet"**

Identifying an unknown substance in the field often takes several steps to first isolate a sample and identify its contents.

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SAFETY

Wear safety goggles while working with chemicals. Clean up any spills immediately. Do not touch the mixture or bring it into contact with your eyes or mouth. Wash your hands after completing the activity.

PROCEDURE

1. Your teacher will return to you the cup that contains a sample of the unidentified mixture.
2. Review with your group your written procedure for safely separating the parts of the mixture. Be sure you have included all essential safety procedures.
3. Work with your group to follow your procedure to separate the solids from the liquids, and then clean the solids. If you need to change any steps as you work, be sure to record the new steps in your procedure.
4. Place the cleaned, separated solids in a small plastic cup with a lid. You will test them in Activity 7, "Identifying Solids."
5. Separate the liquids, placing them into two separate small plastic cups. You will perform tests in Activity 6, "Identifying Liquids," to find out what the liquids are.
6. For each substance you isolated from the mixture, start an entry on Student Sheet 5.1, "Chemical Safety Data Sheet." You will fill in more information about each substance in future activities.

ANALYSIS

1. What changes did you have to make to your separation procedure while you were performing the procedure? Why?

2. What safety precautions did you take while working with the unidentified mixture?
3. How would you separate:
   a. oil and vinegar?
   b. salt and iron shavings?
   c. salt and sand?

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6 Identifying Liquids

Now you will investigate the liquids' physical and chemical properties. **Physical properties** are characteristics that can be observed or measured about a substance without changing it into something else in the process. Color, texture, and appearance are some of the physical properties you will determine in this activity. **Chemical properties** are traits of a substance that you find by seeing if it reacts in certain ways with other chemicals. You will do tests for the chemical properties of corrosiveness and toxicity. Assume the liquids are hazardous until you identify them.

CHALLENGE **What are the liquids in the mixture?**

After an oil tanker accident, the crude oil floats on top of seawater because it is less dense. An inflatable barrier can then be used to separate the oil, which has different properties than the seawater.

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MATERIALS

For each group of four students

- 1 small cup of Liquid A
- 1 small cup of Liquid B
- 1 dropper bottle of ethanol
- 1 dropper bottle of potassium thiocyanate
- 2 plastic vials with lids
- 1 pH color scale

For each pair of students

- 1 pair of plastic forceps
- 1 dropper
- 1 SEPUP tray
- 2 cobalt chloride paper strips
- 2 pieces of pH paper
- paper towels
- access to hot soapy water

For each student

- 1 pair of safety goggles
- Student Sheet 5.1, "Chemical Safety Data Sheet"

SAFETY

Wear safety goggles while working with chemicals. Clean up any spills immediately. Do not touch the mixture or any part of it, and do not bring it into contact with your eyes or mouth. Wash your hands after completing the activity.

PROCEDURE

1. Review the information contained in Table 1, "Tests to Identify Liquids" on the next page. It lists the tests that you will use to gather evidence about the liquids you separated from the mixture. Listen carefully as your teacher demonstrates the procedure for each test.

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Table 1: Tests to Identify Liquids

Test	Procedure	Interpreting Test Results
Appearance	Examine the liquid. Observe its color, transparency, and thickness.	Describe your observations in detail.
Miscible in water	1. Add 50 drops of water to a vial. 2. Add 10 drops of the liquid being tested. 3. Secure the top on the vial. 4. Observe.	If the liquid beads up or forms a separate layer on the top or bottom of the water, it is NOT MISCIBLE in water. If the liquid mixes, it is MISCIBLE in water.
Miscible in ethanol	1. Add 50 drops of ethanol to a vial. 2. Add 10 drops of the liquid being tested. 3. Secure the top on the vial. 4. Observe.	If the liquid beads up or forms a separate layer on the top or bottom of the water, it is NOT MISCIBLE in water. If the liquid mixes, it is MISCIBLE in water.
Contains water	1. Place a dropperful of the liquid to be tested in a clean cup in the SEPUP tray. 2. Dip a piece of cobalt chloride paper into the liquid. 3. Remove it, and place it on a paper towel. 4. Observe.	If the paper remains blue, water is NOT PRESENT in the liquid. If the paper turns pink, water is PRESENT in the liquid.
Corrosive	1. Place a dropperful of the liquid to be tested in a clean cup in the SEPUP tray. 2. Dip a strip of pH paper into the liquid. 3. Remove and place it on a paper towel. 4. Match the color of the moistened strip to the pH color scale.	If the pH is 3–11, the solution is NOT CORROSIVE. If the pH is less than 3 or greater than 11, the solution is CORROSIVE.
Toxic	1. Place a dropperful of the liquid to be tested in a clean cup in the SEPUP tray. 2. Dip 1 drop of potassium thiocyanate solution. 3. Observe.	If the solution does not turn red, the liquid is NOT TOXIC. If the solution turns red, the liquid is TOXIC.

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2. In your notebook, create a table similar to the one shown below, "Properties of Separated Liquids," to record the results of your work.

Properties of Separated Liquids

Test	Liquid A	Liquid B
Appearance		
Miscible in water		
Miscible in ethanol		
Contains water		
Corrosive		
Toxic		

3. Work with your partner to test the liquids. Record the results of each test in your table.

4. Follow your teacher's directions for cleanup.

ANALYSIS

1. Look at Table 2, "Information on Selected Liquids," on the next page.
   a. Compare the information from this activity with the information in the table. Look for similarities.
   b. Based on their properties, what are the identities of Liquid A and Liquid B?
   c. Support your answers with at least three pieces of evidence for each liquid.

2. Based on the information in Table 2, would you label Liquid A or Liquid B from the mixture as hazardous?

3. Using evidence from this activity, add the following to Student Sheet 5.1 for Liquid A and Liquid B:
   a. The name of the liquid you identified.
   b. Under "Hazards," write yes or no for those categories that apply.

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Table 2: Information on Selected Liquids

Type of Liquid	Appearance	Miscible in Water	Miscible in Ethanol	Contains Water	Corrosive	Flammable	Toxic
Iodine solution (used in disinfectants)	Transparent, yellow to brown liquid	Yes	Yes	Yes	Not corrosive	Not flammable	Toxic
Iron nitrate solution (used in garden fertilizers, vitamins)	Transparent, orange liquid	Yes	Yes	Yes	Corrosive	Not flammable	Toxic
Isooctane (used in fuels)	Transparent, colorless liquid	No	No	No	Not corrosive	Flammable	Toxic
Lauric acid solution (used in soaps and shampoo)	Transparent, colorless liquid	No	Yes	No	Not corrosive	Flammable	Slightly toxic
Mineral oil (used in furniture oils, baby oils, cleaning products)	Transparent, colorless to pale yellow liquid	No	No	No	Not corrosive	Flammable	Not toxic
Citric acid solution (used in foods, household cleaners)	Transparent, colorless or pale yellow liquid	Yes	Yes	Yes	Slightly corrosive at very high concentrations	Not flammable	Not toxic

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7 Identifying Solids

Now you will test and identify the solid substances. The solids appear to be metal and plastic, but you need more information to determine what they are made of. The tests that you used for identifying the liquids do not help to identify solids. So in this activity, you will perform a set of different tests to determine the physical and chemical properties of the solids. This information will help you identify the solids. Assume the solids are hazardous until you identify them.

CHALLENGE **What are the solids in the mixture?**

Easy-to-rip candy wrappers and durable surgical scissors are both made of silver-colored metal. However, the unique physical properties of the metals are quite different and, as a result, the scissors are much stronger than the wrapper.

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MATERIALS

For each group of four students

- 1 cup containing unidentified solids
- 1 battery harness with alligator clips and small lightbulb
- 1 9-volt battery
- 1 dropper bottle of copper chloride
- 1 dropper bottle of ethanol
- 1 dropper bottle of water
- 1 piece of steel wool
- 2 plastic vials with caps

For each pair of students

- 1 graduated cylinder
- 1 pair of plastic forceps
- 1 SEPUP tray
- 1 cup of water
- paper towels

For each student

- 1 pair of safety goggles
- Student Sheet 5.1, "Chemical Safety Data Sheet"

Scientists can identify types of rock from the moon, based on their chemical and physical properties.

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SAFETY

Wear safety goggles while working with chemicals. Clean up any spills immediately. Do not touch the mixture or any parts of the mixture, and do not bring them into contact with your eyes or mouth. Wash your hands after completing the activity.

PROCEDURE

1. Review the information contained in Table 1, "Tests to Identify Solids." It describes tests that you will use to gather evidence about the solids you separated from the mixture. Listen carefully as your teacher demonstrates the procedure for each test.
2. In your notebook, create a table similar to "Properties of Separated Solids," shown below. Decide with your class what you will call each type of solid. Record these names in the top row of your table.

Properties of Separated Solids

Test				
Electrical conductivity				
Density relative to water				
Density relative to ethanol				
Reacts with copper chloride				

3. Be sure each solid is prepared for testing. If a solid has a coating, gently clean the surface with steel wool, rinse it, and dry it well.
4. Work with your partner to test one of the solids. Record the results of each test in your table.
5. Rinse and dry each solid, and place it back in its container.
6. Work with your partner to repeat Steps 4 and 5 for each type of solid from the mixture.
7. Follow your teacher's directions for cleanup.

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Table 1: Tests to Identify Solids

Test	Procedure	Interpreting Test Results
Electrical conductivity	1. Snap the battery into the battery harness with lightbulb. 2. Attach the clips on opposite ends of the solid being tested. 3. Observe the bulb.	If the bulb does not light, the material does NOT CONDUCT electricity. If the bulb lights, the material CONDUCTS electricity.
Density relative to water	1. Put 5 mL of water into a vial. 2. Gently place the solid being tested in the vial. 3. Secure the cap on the vial and gently shake. 4. Observe.	If the solid floats, it is LESS DENSE than water. If the solid sinks, it is MORE DENSE than water.
Density relative to ethanol	1. Put 5 mL of ethanol into a vial. 2. Gently place the solid being tested in the vial. 3. Secure the cap on the vial and gently shake. 4. Observe.	If the solid floats, it is LESS DENSE than ethanol. If the solid sinks, it is MORE DENSE than ethanol.
Reacts with copper chloride	1. Place the solid being tested in a cup of the SEPUP tray. 2. Place 5 drops of copper chloride on the solid. 3. Observe for signs of chemical reaction. Signs of a reaction may include a color change, bubbling, temperature change, or precipitate forming. Note: If a reaction does occur, use the forceps to dip the solid in water to stop the reaction.	If no signs of a reaction are visible, the solid does NOT REACT with copper chloride. If one or more signs of a reaction are visible, the solid REACTS with copper chloride.

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ANALYSIS

1. Look at Table 2, "Information on Selected Solids," on the next page.
   a. Compare your data with the information in the table. Look for similarities.
   b. Based on their properties, what are the solids?
   c. Support your answer with at least three pieces of evidence for each solid.

2. Were you able to identify what material each solid was made of? Explain.

3. In this activity you performed four tests on each solid. List which test(s) identified:
   a. physical properties of the solids?
   b. chemical properties of the solids?

4. Using evidence from this activity, add the following to Student Sheet 5.1 for each type of solid:
   a. The name of the solid material you identified.
   b. Under "Hazards," write yes or no for those categories that apply.

5. You have been asked to submit a report to your state's Hazmat Training Center explaining the safety procedures you followed while identifying the solids. Write a letter to the hazmat director that explains:
   a. all safety steps taken during this activity.
   b. why each was necessary.

This equipment, including a meter, is being used to test the conductivity of a sample. Which materials from Table 2 would you predict conduct electricity?

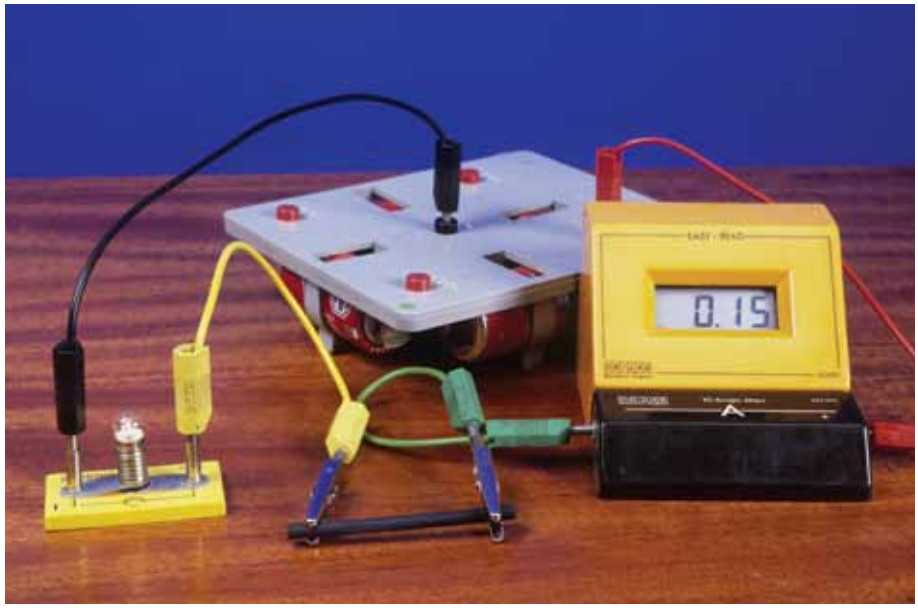

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Table 2: Information on Selected Solids

Type of Solid	Physical Description	Conducts Electricity	Density Relative to Water	Density Relative to Ethanol	Reacts with Copper Chloride	Hazards
Plastics						
High-density polyethylene (HDPE)	Plastic, produced in different colors, shapes, and sizes	No	Floats	Sinks	No	None
Polystyrene (PS)	Plastic, produced in different colors, shapes, and sizes	No	Sinks	Sinks	No	None
Polyvinyl chloride (PVC)	Plastic, produced in different colors, shapes, and sizes	No	Sinks	Sinks	No	None
Metals						
Aluminum	Silver gray metal	Yes	Sinks	Sinks	Yes	None
Beryllium	Silver gray metal	Yes	Sinks	Sinks	Yes	Toxic
Iron	Silver gray metal	Yes	Sinks	Sinks	Yes	None
Magnesium	Silver gray metal	Yes	Sinks	Sinks	Yes	Flammable
Zinc	Silver gray metal	Yes	Sinks	Sinks	Yes	Flammable, toxic

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8 Measuring Volume

In the last activity, you compared the density of several solids to water. In the next three activities, you will learn how to determine density and use it to identify a substance. You will begin by learning how to measure the volume of an object. **Volume** is the amount of space a material takes up. The material can be a solid, liquid, or a gas. You use volume measurements in your daily life to describe amounts of things such as one gallon of gas, two liters of soda, or one quart of milk. The metric system units scientists use to measure volume are the liter (L) and the cubic meter (m^3). Smaller volumes are often measured in milliliters (mL) or cubic centimeters (cm^3). The table on the next page shows metric units used to measure mass, length, and volume that you will use in this unit along with the English units commonly used in the United States.

In this activity, you will focus on measuring the volume of solid objects using two different methods—measurement and calculation and water displacement. This will prepare you to determine the volume of the metallic solids from the mixture.

CHALLENGE

How do you measure the volume of a solid object?

What volume of liquid is currently in the measuring cup? This glass measuring cup, commonly found in home kitchens, measures volume in both English and metric units.

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Units of Measurement		
	Common Metric Units	**Common English Units**
Length	Centimeter (cm) Meter (m) Kilometer (km)	Inch (in) Foot (ft) Yard (yd) Mile (Mi)
Mass	Gram (g) Kilogram (kg)	Ounce (oz) Pound (lb)
Volume	Milliliter (ml) Liter (l) Cubic centimeter (cm^3) Cubic meter (m^3)	Cup (c) Quart (qt) Gallon (g)

MATERIALS

For each group of four students

- **1 set of six objects:**
  - **light gray cube**
  - **dark gray cube**
  - **light gray cylinder**
  - **dark gray cylinder**
  - **light gray bar**
  - **dark gray bar**

For each pair of students

- **1 pair of plastic forceps**
- **1 50-mL graduated cylinder**
- **1 pipette**
- **1 calculator**
- **supply of water**
- **paper towels**

For each student

- **1 pair of goggles**
- **1 metric ruler**
- **Student Sheets 8.1a and 8.1b, "Two Methods to Measure Volume"**

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SAFETY

Review the procedure and decide on appropriate safety measures for working with the unknown solids. If you do not know what material an object is made from, assume it is hazardous until you prove otherwise.

PROCEDURE

1. Record on Student Sheet 8.1a, "Two Methods to Measure Volume," the letter on your group's cup of objects.
2. Remove the six objects from the cup so that you can observe each one.
3. Predict the order of the six objects from least to greatest volume. Record your predicted order in your notebook.
4. Watch your teacher demonstrate how to measure the volume of an object using two methods:
   - measurement and calculation
   - water displacement
5. Divide the six objects into two sets so that each pair in your group gets either the light gray set or the dark gray set. Each pair will begin by measuring the volumes of the three objects in one set.
6. Decide which method listed in Step 4 above is best for determining the volume of each object.
7. Determine the volume of each object. Record your data and calculations on Student Sheet 8.1b.
8. Exchange objects with the other pair of students in your group, and repeat Steps 6 and 7.
9. Compare your data for each object with the results found by the other pair of students in your group. If you think any of your results are inaccurate, repeat your measurements and calculations.
10. Based on your data, list the six objects from least to greatest volume. Record the measured volume of each of the six objects in your notebook.

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ANALYSIS

1. Choose one of the objects from Student Sheet 8.1b. Which method—water displacement or measurement and calculation—did you use to determine its volume? Explain why you chose that method.

2. Look at the way you ordered the objects by volume in Step 3. Compare this with the measured volumes you recorded in your notebook in Step 10. Were they the same? Explain.

3. Copy the three lists of measurements shown below. Pay close attention to the units that follow each number.

List 1	List 2	List 3
150 mL	2 mL	1 L
11 mL	801 mL	999 mL
200 mL	27 cm^3	998 cm^3

   a. Cross out the smallest volume in each list.

   b. Circle the largest volume in each list.

4. How would you measure the volume of:

   a. a cardboard shoebox?

   b. a plastic pen?

   c. an irregularly shaped stone?

   d. a child's wooden block?

   e. some orange juice?

   f. the two metallic solids from your mixture?

5. In this activity, you were working with unidentified materials. Explain the safety steps you took when working with the solids.

6. How would you explain volume to a 10-year-old?

   - Include at least two examples that would be familiar to a child and that would clarify your explanation.
   - Include a diagram to help you explain your ideas.

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9 Measuring Mass, Calculating Density

Density is a physical property that describes the mass of a substance per unit of volume. It is one of many physical properties of a substance that can be useful when trying to identify what a substance is made from. In previous activities you determined whether substances were more or less dense than water, alcohol, and saltwater. This was comparison of one substance to another. But to calculate the exact density of a material, it is necessary to make measurements of a substance's mass and volume. Then you can calculate density by using the following formula:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

You now know how to measure volume. Once you have also measured an object's mass, you can calculate its density. The **mass** of an object describes how much matter is in the object. An object with greater mass has more matter than an object with less mass. Mass is measured in the metric unit grams (g), or related units such as kilograms (kg).

In this activity you will measure mass so that you can calculate the density of different materials. This is determining **quantitatively** (kwan-ta-TAY-tive-lee)—with numbers. Because pure substances have characteristic densities, you can use the calculated density to identify the type of material an object is made from.

CHALLENGE

How can you use the mass and volume of an object to calculate its density?

The objects on the balance have the same volume, but different masses.

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MATERIALS

For each group of four students

- 1 set of six objects:
  - light gray cube
  - dark gray cube
  - light gray cylinder
  - dark gray cylinder
  - light gray bar
  - dark gray bar

For each pair of students

- 1 balance
- 1 pair of plastic forceps
- 1 calculator

For each student

- Student Sheets 8.1a and 1b, "Two Methods to Measure Volume"

SAFETY

Review the procedure, and decide on appropriate safety measures for working with the unknown solids. If you do not know what material an object is made from, assume it is hazardous until you prove otherwise.

PROCEDURE

Part A: Measuring Mass

1. Obtain the same set of objects you used in Activity 8, "Measuring Volume."
2. In your science notebook, create a data table similar to Table 1, "Mass, Volume, and Density of Six Objects," on the next page. You will use it to record your data and calculations.
3. Divide the six objects into two sets so that each pair in your group has either the light gray set or the dark gray set. Each pair will begin by determining the masses of the three objects in one set.
4. Use a balance to find the mass of each object to the nearest 0.1 gram (g). Record your data in your table.
5. Exchange objects with the other half of your group, and repeat Step 4.

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Part B: Calculating Density

6. In Table 1, record the volume of each object from Student Sheet 8.1b, "Two Methods to Measure Volume."

7. Work with your partner to calculate the density of each object, dividing its mass by its volume. Record this data in your table.

$$\textbf{Density} = \frac{\textbf{mass}}{\textbf{volume}}$$

8. Compare your results with the results of the other pair of students in your group. If you think any of your results are inaccurate, repeat your measurements and your calculations.

Table 1: Mass, Volume, and Density of Six Objects

Object	Mass (g)	Volume (cm^3 or mL)	Density Calculation	Density ($g/c\ m^3$ or g/mL)
Light gray bar				
Dark gray bar				
Light gray cube				
Dark gray cube				
Light gray cylinder				
Dark gray cylinder				

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Part C: Using Density to Identify Materials

9. Now that you have calculated the density of several objects, you will use this to identify the material each of the objects is made from. In your science notebook, make a table similar to Table 2, "Identifying Objects' Material Using Density."

Table 2: Identifying Objects' Material Using Density

Name of Object	Density Calculated	Closest Density from Table 3	Object's Material

10. In your new table, fill in the name and density calculated for each object from Table 1, "Mass, Volume, and Density of Six Objects."

11. Compare the densities you calculated in Table 2 with the densities shown in Table 3, "Densities of Selected Solids," on the next page. Find the density closest to the density of each object, and enter that in Table 2.

12. Identify the material that might make up each of the six objects.

Hint: Look for the material that has a density closest to the density that you determined for each object. Write the density and the material of this object in Table 2.

This bowling ball and balloon have very similar volumes, but because the bowling ball has more mass per volume, it is more dense.

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ANALYSIS

1. What material is each metallic solid made of? Use data from this activity to support your explanation.
2. Now that you have identified what each solid is made of, look at the hazards for each in Table 2, "Information on Selected Solids," in Activity 7. What safety precautions must you take when working with these materials?
3. A block of wood is 4 cm wide, 5 cm long, and 10 cm high. It weighs 100 grams.
   - **a.** Calculate its volume.
   - **b.** Calculate its density.
   - **c.** Will the block sink or float in water? Explain. (Remember, the density of water is 1.0 g/cm^3.)
   - **d.** Imagine cutting the block into two exactly equal halves. Calculate the volume, mass, and density of each piece.
   - **e.** How do the densities of the new pieces compare with the density of the original block? Use your answer to Question 3d and a diagram to illustrate your answer.

Table 3: Densities of Selected Solids

Type of solid material	Density (g/cm^3)
Plastics	
High-density polyethylene (HDPE)	0.95
Polystyrene (PS)	1.1
Polyvinyl chloride (PVC)	1.3
Metals	
Magnesium	1.7
Beryllium	1.9
Aluminum	2.7
Titanium	4.5
Zinc	7.1
Iron	7.9
Tungsten	19.4

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10 Density of Unknown Solids

In Activity 9, "Measuring Mass, Calculating Density," you saw that determining the density of an object can help determine the material it is made from. In this activity, you will use density to identify the remaining two unknown metallic solids you separated from the unidentified mixture. Once you have identified the parts of the mixture, you will use the information you collected to create a hazard label for it.

How can you use density to identify solids?

Density is one of the many properties of materials that can be found in reference tables.

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MATERIALS

For each group of four students

- **1 cup containing metallic solids separated from the mixture in Activity 5, "Separating the Mixture"**

For each pair of students

- **1 50-mL graduated cylinder**
- **1 metric ruler**
- **1 cup of water**
- **1 pair of plastic forceps**
- **1 pipette**
- **1 calculator**
- **1 balance**
- **paper towels**
- **1 Material Safety Data Sheet (MSDS) booklet**

For each student

- **1 pair of safety goggles**
- **Student Sheet 10.1, "More Density Data"**
- **Student Sheet 5.1, "Chemical Safety Data Sheet"**
- **Table 3, "Densities of Selected Solids" from Activity 9**

SAFETY

Review the procedure, and decide on appropriate safety measures for working with the unknown solids.

PROCEDURE

Part A: Identify Solids Using Density

1. Look at the two metallic solids you separated from the unlabeled mixture. Discuss with your partner how to best calculate the density of the metal solids. Be sure to consider the tools included in the materials list.
2. Work with your partner to create a procedure for determining the density of each solid. In your plan, be sure to:
   - List the materials or tools you will use.
   - Explain each step in detail.
   - Describe safety precautions you will take.
3. Record the procedure in your science notebook.

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Data for Two Metallic Solids

Name of Object	Mass (g)	Volume (cm^3 or mL)	Density (g/cm^3 or g/mL)	Object's Material

4. Make a data table similar to the one above. You will use it to record your data during your investigation.
5. Obtain your teacher's approval of your plan.
6. With your group, decide which pair will work with which object first.
7. Conduct your investigation for that object, and record your results in your data table. Be sure to include units of measurement for each measurement you record.
8. Switch objects with the other pair in your group. Repeat Step 7.
9. Compare your density calculations with those of the other pair in your group. Are your measurements the same? If not, perform additional calculations to verify the density of each solid.
10. Use the densities you calculated to determine the material each object is made of. To do this:
    a. Look at the information in Table 3, "Densities of Selected Solids," on page A-40 in Activity 9.
    b. Find the density in the table that is closest to the density you calculated for each solid.
    c. Record the name of the material in the column, "Object's material."

Part B: More Density Data

11. Look at Student Sheet 10.1, "More Density Data." The data shown was measured by a lab that made additional measurements of the two metallic pieces from the mixture. The lab took several mass and volume measurements using instruments with more precision.
12. Using the mass and volume measurements on Student Sheet 10.1, calculate the density for each set of data. Record your answers on Student Sheet 10.1.

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13. Compare the densities determined by the lab with your measurements from "Data for Two Metallic Solids." With your group, determine the amount of variation, and discuss the reasons for the variations.

14. Using both the data on Student Sheet 10.1, and your measurements, identify the material each metallic piece is made from. To do this, look once again at the density values, "Densities of Selected Solids," on page A–40 in Activity 9. Use this information to determine the type of materials the objects are made from.

Part C: Constructing a Label for the Unlabeled Mixture

15. With your partner, make a label for the unlabeled mixture.

16. As you design a label, consider:

    a. What information from your Chemical Data Sheets will you include?

    b. What directions about handling, storage, and disposal of the mixture will you include?

    Note: If you wish to include storage and disposal guidelines on your label, refer to the Material Safety Data Sheet booklet for information about each substance.

ANALYSIS

1. Based on your density calculations and the data on Student Sheet 10.1, what are the two metallic solids from the unlabeled mixture? Provide evidence from the activity to support your answer.

   Hint: Compare values with those listed in "Densities of Selected Solids" on page A-40 of Activity 9.

2. How many substances were in the unlabeled mixture? What were they?

3. Review your answer to Analysis Question 1 in Activity 3, "Plan to Separate the Mixture." How close was your prediction about the number of substances in the unlabeled mixture?

4. **Reflection:** What are the three most important things you learned in this unit about identifying and studying materials scientifically?

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11 Choosing a Cleaner

You are the Safety Officer for Sunnyvale Hospital. Your job responsibilities include monitoring procedures and products used for cleaning the hospital. When you choose cleaning products to be used by the hospital, you must know how they are stored and disposed of, and be aware of any hazards they pose to the cleaning staff who use them daily.

You have been asked to evaluate information about four window-cleaning products. You will analyze the trade-offs of selecting one product rather than another. This means you will consider the benefits and drawbacks of each and choose one to purchase for the hospital.

As you evaluate the products, keep the following in mind:

- *The glass cleaner you choose will be stored in a locked room that is located next to the hospital's boiler room. This makes the room very warm in winter months.*
- *The cleaner will be kept in a large cabinet that also contains other cleaning products including bleach used to disinfect laundry and hospital surfaces.*
- *The hospital recently started a recycling program. All containers used by the hospital are recycled if possible.*

CHALLENGE **Which glass cleaner will you select for the hospital?**

Cleaning products are used in homes every day. But when used in different settings, like hospitals, potential hazards may change.

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MATERIALS

For each student

1 **Student Sheet 11.1, "Comparing Glass Cleaners"**

PROCEDURE

1. On the next page are descriptions of possible ingredients in glass cleaners. Review this information to familiarize yourself with these ingredients.
2. With your group, read the product information provided for each of the four glass cleaners on pages A-48 and A-49. Use this information to help decide which cleaner to select for the hospital. As you read, make a list of the categories of information in the labels.
3. Compare your list with the factors shown in the left-hand column of Student Sheet 11.1, "Comparing Glass Cleaners." If there are factors in your list that are not listed on the student sheet, add them to the left-hand column.
4. Record information about each cleaner on the student sheet. You will use this information to compare the glass cleaners.
5. Decide which of the four glass cleaners you will select for the hospital. Begin by re-reading the introduction to this activity. Based on how the cleaner will be used, stored, and disposed of, decide which three factors are the most important in making your decision. Draw a star to the left of the three factors you selected on the student sheet.
6. With your group discuss which product you will purchase. Consider the evidence and trade-offs for selecting each product. Remember to listen to and consider the ideas of the other members of your group. If you disagree with the other members of your group, explain why you disagree.

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What's in a Cleaner? Possible Ingredients in Glass Cleaners

Ammonia *(ah-MOAN-ya)* is good at dissolving grease. Because it kills microorganisms it is a disin-fectant. If mixed with bleach it releases toxic vapors.

2-Butoxyethanol *(2 bew-tox-ee-ETH-an-all)* is a transparent, colorless liquid that has a fruit-like odor. It is a solvent, which dissolves dirt. It is also a disinfectant. It can be listed under several names, including butyl cellusolve, butyl glycol, and butyl oxitol.

Coloring is added to make a cleaning product pleasing to the eye. Coloring does not add to the cleaning ability of the product.

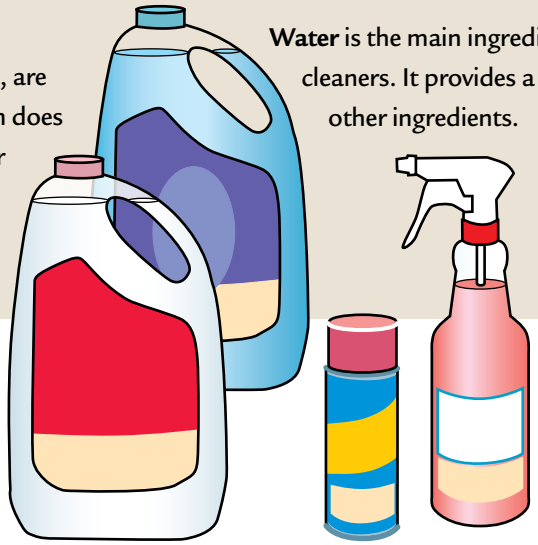
Fragrances, such as pine, lemon, or floral, are sometimes added so the cleaning solution does not have an unpleasant chemical smell, or to help get rid of bad odors in a house or other building. They do not add to the cleaning power of the product.

Isobutane *(eye-so-BEW-tane)* is added in aerosol spray cans, not because it helps to rid surfaces of dirt, but because it helps force the cleaning solution out of the spray nozzle. It is very flammable.

Isopropanol *(eye-so-PRO-pa-nol)* is a solvent that is good at dissolving grease and disinfecting surfaces. It is the main ingredient in rubbing alcohol.

Surfactants *(sur-FAK-tants)* break up the surface tension of water. They are added to cleaners to prevent streaking or spotting as the cleaned surface dries.

Water is the main ingredient of most cleaners. It provides a liquid base for the other ingredients.



ANALYSIS

1. Which cleaner have you selected?
   a. State your decision.
   b. Support your decision with as many pieces of evidence from the activity as you can.
   c. Discuss the trade-offs of your decision.
2. Did the physical characteristics of each product affect your decision? Explain.
3. Which factors were the most important in making your decision? Explain.

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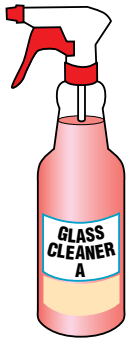

INGREDIENTS:
ISOPROPANOL 12%
SURFACTANT 10%
WATER 78%

CLEANING ABILITY: 80%*
*Based on customer satisfaction surveys.

COST: $6.25 FOR 1 GALLON

ENVIRONMENTAL IMPACT: MEDIUM

PRODUCT A: MATERIAL SAFETY DATA SHEET		
Physical Characteristics	Transparent red liquid Floral scent Miscible in water Density 0.99 g/mL	
Toxicity	1	Scale: 3 – high risk 2 – moderate risk 1 – slight risk 0 – no risk
Flammability	0	
Warning Label	Keep out of reach of children. Avoid eye and skin contact.	
Health Effects	May cause eye and skin irritation.	
First Aid	Eye contact: Flush eyes with water immediately. Skin contact: Wash contaminated area thoroughly with soap and water. Ingestion: Drink lots of water. If pain or discomfort persists, call a doctor immediately.	
Handling	It is always good to wear gloves and goggles when handing chemicals.	
Storage	Keep out reach of children.	
Disposal	Pour down the drain with plenty of water. Recycle container.	

PRODUCT B: MATERIAL SAFETY DATA SHEET		
Physical Characteristics	Transparent colorless liquid in aerosol spray can. Ammonia scent Miscible in water Density 0.99 g/mL	
Toxicity	**1**	**Scale:** **3** – high risk **2** – moderate risk **1** – slight risk **0** – no risk
Flammability	**3**	
Warning Label	**DANGER:** Reacts with chlorine bleach to form toxic gas. **WARNING:** Extremely flammable. Do not use near flames or sparks. Avoid contact with eyes. Breathing of vapors can be toxic.	
Health Effects	Breathing in vapors can cause irritation of nose and lungs.	
First Aid	**Eye contact:** Flush eyes with water immediately. **Inhalation:** Move to fresh air. If pain or discomfort persists, call a doctor immediately.	
Handling	Keep away from eyes. Use in a well-ventilated area.	
Storage	Store in a cool, well-ventilated area in closed containers away from heat, and open flames.	
Disposal	Place in trash ONLY if can is empty.	

INGREDIENTS:
AMMONIA 5%
2-BUTOXYETHANOL 5%
ISOBUTANE (PROPELLANT) 5%
WATER 85%

CLEANING ABILITY: 95%*
*Based on customer satisfaction surveys.

COST: $10.25 FOR 6 12-OZ CANS

ENVIRONMENTAL IMPACT: HIGH

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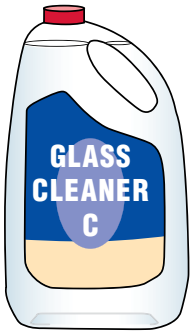

INGREDIENTS:

ISOPROPANOL	6%
2-BUTOXYETHANOL	4%
SURFACTANT	10%
WATER	80%

CLEANING ABILITY: 90%*

*Based on customer satisfaction surveys.

COST: $6.65 FOR 1 GALLON

ENVIRONMENTAL IMPACT: HIGH

PRODUCT C: MATERIAL SAFETY DATA SHEET

Physical Characteristics	Transparent colorless liquid Citrus scent Miscible in water Density 0.99 g/mL	
Toxicity	**1**	**Scale:** **3** – high risk **2** – moderate risk **1** – slight risk **0** – no risk
Flammability	**1**	
Warning Label	**CAUTION:** Slightly flammable. Store away from heat, flame, and sources of sparks.	
Health Effects	Slightly toxic. If ingested, drink lots of water and contact a physician.	
First Aid	**Eye contact:** Flush eyes with water immediately. Ingestion: Drink lots of water. If pain or discomfort persists, call a doctor immediately.	
Handling	Keep away from eyes.	
Storage	Store in a cool, well-ventilated area in closed containers away from heat, and open flames.	
Disposal	Pour do wn the drain with plenty of water. Recycle container.	

PRODUCT D: MATERIAL SAFETY DATA SHEET

Physical Characteristics	White, cloudy liquid Ammonia scent Miscible in water Density 0.90 g/mL	
Toxicity	**1**	**Scale:** **3** – high risk **2** – moderate risk **1** – slight risk **0** – no risk
Flammability	**1**	
Warning Label	**DANGER:** Reacts with chlorine bleach to form toxic gas.	
Health Effects	Slightly toxic. If ingested, drink lots of water, and contact a physician. Inhaling vapors can damage mouth, nose, throat, and lungs.	
First Aid	**Eye contact:** Flush eyes with water immediately. **Inhalation:** Move to fresh air. **Ingestion:** Drink lots of water. If pain or discomfort persists, call a doctor immediately.	
Handling	Avoid contact with eyes. Work with in a well ventilated area.	
Storage	Store in a cool, well ventilated area in closed containers away from heat and open flames.	
Disposal	Pour down drain with plenty of water. Recycle container.	

INGREDIENTS:

AMMONIA	10%
WATER	90%

CLEANING ABILITY: 85%*

*Based on customer satisfaction surveys.

COST: $6.95 A GALLON

ENVIRONMENTAL IMPACT: LOW

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