

## Exploring Hazardous Materials

### Activity Overview

Students begin to learn about hazardous materials as they are introduced to a scenario involving an abandoned barrel of hazardous waste. They watch a video segment that shows how a HAZMAT team responds to potentially hazardous waste. They then make observations of simulated hazardous waste. Students extend the investigation by identifying hazardous materials at home.

### CONCEPTS, PROCESSES, AND ISSUES

(with NSE 5–8 Content Standards Correlation)

1. Hazardous materials are substances that pose a danger to the health and safety of living organisms. (*PhysSci: 1*)
2. Careful observation can provide important information about a substance. (*Inquiry: 1*)
3. Hazardous substances may be present as solids, liquids, or gases. (*PhysSci: 1*)
4. Hazardous materials must be identified before being treated, moved, or disposed of. (*Perspectives: 4*)
5. Hazardous materials are commonly found in homes. (*Perspectives: 4*)

### TEACHING SUMMARY

#### Step 1.

Introduce the hazardous materials scenario.

#### Step 2.

Watch a video to learn how HAZMAT teams handle hazardous waste.

#### Step 3.

Make observations of simulated hazardous waste.

#### Step 4. (Assessment)

Compare classroom approaches to those shown in the video.

#### Step 5.

Investigate hazardous materials at home.

### MATERIALS

For the teacher

- \* 1 overhead projector
- \* 1 videocassette recorder
- \* 1 TV monitor
- \* news story of local hazardous materials accident (optional)
- 1 video, "Hazardous Materials/Waste Disposal"
- 1 Transparency 1.1, "Hazardous Waste Flow Chart"
- 1 Transparency 1.2, "Guidelines for Safety and Success in the SEPUP Lab"
- 1 Transparency 1.3, "Household Hazardous Materials Sample Table"
- 1 Transparency 1.4, "Feedback Form: Analyzing Data"
- 1 Transparency 1.5, "Scoring Guide: Analyzing Data"
- 1 500-mL barrel
- 1 scoop
- 1 240-mL bottle containing iron (III) nitrate crystals
- 2 500-mL bottles of mineral oil
- 1 packet of 240 aluminum washers
- 1 packet of 240 iron washers
- 1 vial containing black and beige high density polyethylene (HDPE) squares
- 1 30-mL graduated cup
- \* 1 graduated beaker
- \* access to water

For each group of four students

- 1 plastic cup, with lid, containing approximately 60 mL of simulated hazardous waste
- \* 1–2 paper towels

For each student

- \* 1 pair of safety goggles
- 1 paper copy of Transparency 1.4, “Feedback Form: Analyzing Data” (optional)
- 1 paper copy of Transparency 1.5, “Scoring Guide: Analyzing Data” (optional)

*\*not supplied in kit*

### Safety Note

*The chemicals used in this activity may cause skin irritation. Use caution when handling solutions. Always wear safety goggles and thoroughly rinse any area that comes into direct contact with laboratory chemicals.*

## Advance Preparation

Consider searching the Internet and/or local newspapers for articles related to hazardous materials accidents or spills in your area. The National Transportation Safety Board (NTSB) provides news releases and other information about such accidents on its website ([www.nts.gov](http://www.nts.gov)).

To prepare enough simulated hazardous waste for 8 groups, you must first prepare an approximately 40,000 ppm solution of iron nitrate by filling the 240-mL bottle containing iron nitrate crystals with water. Next put 40 mL of the 40,000 ppm iron nitrate solution into the barrel and add 280 mL of water to dilute the solution to approximately 5,000 ppm.

Then put these additional four substances in the barrel:

- 160 mL of mineral oil
- 48 iron washers
- 48 aluminum washers
- 48 black and beige HDPE squares (approximately 3 mL by volume)

Over time, reactions between the liquids and solids in the simulated waste compromise the results of testing that occurs later in the module. If you wish to prepare the simulated waste in advance, place only the solids in the barrel. Add the liquids only on the day of the activity.

When you distribute simulated waste for student use, place about 60 mL into each cup so that each cup contains approximately the following:

- 40 mL of iron nitrate solution
- 20 mL of mineral oil

- 6 iron washers
- 6 aluminum washers
- 6 beige HDPE squares
- 6 black HDPE squares

In Activity 1, the barrel of simulated hazardous waste can be reused for multiple class periods. To conduct Activity 4 with more than one class period of students, you will need to prepare additional simulated waste (see Advance Preparation in Activity 4).

### Teacher’s Note

*To model the scenario described both on the student sheet and in the video, you can scoop out samples from the barrel into the plastic cups in front of the class. After the first class examines the mixture, you can either pour the samples back into the barrel so that the next class can see you sampling from a barrel, or you can keep the samples in the plastic cups. After your last class of students has observed the simulated waste, pour the samples back into the barrel or keep them in the plastic cups for use in Activity 3. Do not discard the simulated waste.*

*Over time, the iron washers will begin to react with the iron nitrate, resulting in the corrosion of the washers and increasing the opacity of the iron nitrate. This will begin to affect both student observations and the results of the testing of the different liquids (which is conducted in Activity 5). If you do not or cannot test the liquids within 3–4 days of preparation of the simulated waste, you may wish to discard the mixture and prepare a fresh mixture. Note that the solids can be removed from the mixture, rinsed, and then recycled or placed in the solid wastestream. To dispose of the liquids, pour them down the drain while running water.*

Blackline masters for all student pages are provided at the end of each activity and should be photocopied as described in the table on the next page. Transparencies are provided in the kit, and masters are included with the relevant activity in case you need to make copies. In addition, PDF files for printing all blackline masters are provided on the CD-ROM that accompanies this module. Please note that the Investigation pages have not been designed to be kept or written upon by the students. A single class set can be photocopied and reused with each of your classes. Some activities include Thinking More About Investigation X pages, which are to be handled like Investigation pages, unless otherwise indicated. Student Sheets and Transparencies are listed in the Materials list when they are included.

### Use of Blackline Masters in SEPUP Modules

Page Type	Kept By Each Student?	Number Needed
Investigation	No	1 reusable class set
Thinking More About Investigation X	No*	1 reusable class set*
Student Sheet	Yes	1 copy per student
Transparency	No	1 reusable copy

\* Occasionally these are distributed to each student and written upon.

During every Investigation, each student is expected to keep a written record of all data collected, including responses to any Questions assigned. We recommend that each student organize all written work, including that done on the Student Sheets, in a science notebook.

**Assessment.** Throughout this module, there are opportunities to assess student progress using the ANALYZING DATA (AD) variable from the SEPUP Assessment System. In this activity, students are asked to record and evaluate evidence from observations.

To establish a baseline for each student's ability to analyze data and to provide you with a sense of the overall level of the class as a whole, we recommend that you introduce students to the use of Transparency 1.4, "Feedback Form: Analyzing Data" and/or Transparency 1.5, "Scoring Guide: Analyzing Data." The Feedback Form lists the expectations for only the "complete and correct" and "above and beyond" levels of the Scoring Guide. Students and teachers often find the Feedback Form useful as a guide when preparing and assessing responses. For more details, see Step 3 of the Teaching Suggestions for this activity, the section on assessment in the Introduction, and Appendix C, "Assessment." Paper copies of the Feedback Form and Scoring Guide are used during class in several activities throughout this module. In addition to providing each student with a paper copy of these documents, you may want to prepare a laminated class set of each that you can distribute when needed and then collect for future use.

These assessment criteria may be similar to many rubrics that you and/or your students have previous-

ly used, and we recommend that you have students use them when responding to Analysis Question 2. If appropriate, use the criteria to develop an exemplar of a Level 3 ("complete and correct") response and provide each student with a copy of the exemplar and the Feedback Form and/or the Scoring Guide.

## Teaching Suggestions

### GETTING STARTED

#### Step 1. Introduce the hazardous materials scenario.

Write the word "hazardous" on the board. Ask students to share their ideas about what it means and have them share examples. They are likely to respond that it is something that is harmful or bad for human health. Tell students that over the course of the module, they will be learning about hazardous materials by conducting a simulation.

Write the word "simulation" on the board and explain that a simulation is a model or example of a real-life situation or event. It is used by teachers and others primarily because the real event or situation is too dangerous, too complex, or too expensive to duplicate in the classroom or other settings. For example, airline pilots might receive training on new equipment using a simulator before actual flights. You may want to ask students for other examples of simulations, such as video games or school fire drills.

Tell students that during the course of this module, they will be simulating a hazardous materials investigation and will learn about and model techniques similar to those used by hazardous materials (HAZMAT) teams across the country. As the module progresses, you may want to use Transparency 1.1, "Hazardous Waste Flow Chart," to review where students are in the process of investigating the hazardous waste.

### INVESTIGATING

#### Step 2. Watch a video to learn how HAZMAT teams handle hazardous waste.

Tell the students they are about to view a short video simulating the discovery of an abandoned barrel of hazardous waste. Pause the tape when the question, "Why doesn't the HAZMAT team go over to the barrel right away?" is displayed on the screen. Encourage students to discuss why the HAZMAT team examines the barrel from a distance. Emphasize the importance

of not approaching or opening unidentified waste without protective clothing because of the possibility of fire from flammable substances or the release of hazardous vapors.

### Teacher's Note

*Some students may need guidance in relating the footage shown in the video to their own lives. If necessary, explain that abandoned hazardous waste can be found anywhere because hazardous waste can be expensive to dispose of properly. In urban environments, abandoned waste may be discovered on unused lots or in abandoned buildings. In rural or suburban environments, waste may be left on undeveloped land.*

### Step 3. Make observations of simulated hazardous waste.

Tell students that they can now observe the contents of the barrel. To model the scenario described in the video, display the plastic barrel containing simulated hazardous waste. Emphasize that the barrel contains simulated hazardous waste; the contents are appropriate for use by students and do not require the high level of safety demonstrated in the video. However, classroom laboratory safety procedures should be followed at all times. Project Transparency 1.2, "Guidelines for Safety and Success in the SEPUP Lab," and review the guidelines with your students. Hand out copies of Investigation 1, "What's in the Barrel?" and inform students that they will now have the opportunity to investigate the contents of the barrel. Scoop out 60 mL of the simulated waste from the barrel into the plastic cups in front of the class; try to ensure that each cup contains each substance found in the mixture. Distribute the plastic cups containing the waste to each group of students. Emphasize that they are not to touch the material with their bare skin.

Direct students to examine the sample and make observations in their science notebooks. Not all students will observe all of the substances in the mixture. After students have finished recording their observations, ask a few students to read their descriptions aloud. Record student observations on the board. Students are likely to describe the mixture as containing several substances, such as a clear, colorless liquid; an opaque orange liquid; pieces of a round silvery solid; pieces of a round darker solid; and so on. They may refer to the fact that there are colored squares floating in the clear layer of the mixture, while the other solids have settled to the bottom of the orange layer.

Some students may describe the contents with even greater specificity—for example, they may say that it contains plastic or aluminum. Remind students of the difference between observation and inference. You may want to provide examples, such as the ones shown in the following table.

Observations	Inferences
A child is wearing a skirt.	The child is a girl.
A boy has a cast on his arm.	The boy broke his arm.
A car has several dents in it.	The car has been in an accident.

Ask, *Do we have enough evidence to identify these substances? Why or why not?* Encourage students to consider that, at this point, identification of the substances is based solely on observation. For example, you may want to explain that an observation might describe a "shiny, silver-colored, round solid about a centimeter across with a hole in it." The idea that this material might be a metal, or a specific metal such as aluminum, is an inference based on other information, such as previous experience with aluminum. You may want to ask, *What other substances could this material be? What could we do to find out for sure?* Students are likely to suggest isolating and testing the material to accurately identify it. Explain that students will have a chance to conduct such experiments in the next few activities.

After students have completed their observations, collect the samples for use with other classes or pour the samples back into the barrel. (See the Teacher's Note at the beginning of this activity.)

### SYNTHESIZING

**Step 4. (Assessment) Compare classroom approaches to those shown in the video.**

Highlight the idea that hazardous materials are not limited to solids and liquids and may include hazardous gases as well. Relate the video segments to the classroom barrel by asking, *Do you think that the classroom samples contained any simulated hazardous gases? Why or why not?* Students are likely to point out that the samples were left uncovered, and, if there had been any gases, they would have dissipated into the air. Also, no precautions were taken to

capture any gases or to ensure safety against hazardous gases. Explain that although the simulated waste did not contain any gases, gases can be dissolved in liquids, and a sudden release can result in an explosion. Students may be familiar with the fact that soft drinks contain dissolved carbon dioxide, which, on occasion, can be released violently when a container is opened. In addition, some gases are poisonous. Emphasize the idea that any of the most common phases of matter—gas, liquid, or solid—can pose a hazard. Then discuss Question 1.

#### QUESTION 1

*How did the way in which the HAZMAT team approached the waste in the barrel differ from the way in which your class approached the waste? In what ways were the approaches the same?*

Students may point out that the teacher opened the barrel and distributed the simulated waste without the level of precaution shown in the video. The barrel in the video is first investigated from a distance using binoculars as well as equipment that can measure temperature and the presence of vapors. The waste is then sampled to begin to identify it. Students were given samples of the simulated waste without any initial testing and made only visual observations.

While the HAZMAT team wears a lot of protective gear, including a full body suit, boots, respirators, and gloves, students also wore safety gear (goggles). Both students and the HAZMAT team were also aware of the potential for danger and were careful not to have direct contact with the waste.

Question 2 offers a good opportunity to introduce and discuss the assessment criteria for the ANALYZING DATA (AD) variable in the SEPUP Assessment System. You can use Transparency 1.4, “Feedback Form: Analyzing Data” and/or Transparency 1.5, “Scoring Guide: Analyzing Data,” to introduce students to the rubric and clarify your expectations for each level. The expectations for a Level 3 (“complete and correct”) and a Level 4 (“above and beyond”) response are shown on Transparency 1.4. Expectations for all scoring levels are included on Transparency 1.5. You may also want to give each student paper copies of the Feedback Form and the Scoring Guide. These

assessment criteria may be similar to many rubrics that you and your students have used previously, and we recommend that you have students use them as a guide as they respond to Question 2. Exemplars of Levels 1–4 responses are included in Appendix C, “Assessment.”

#### Teacher’s Note

*Some teachers find it useful to display the assessment criteria on butcher paper or posterboard somewhere in the classroom.*

It is important for the learning and assessment goals to be clear and not concealed from the students. Explain how you will use the Scoring Guide and when students will get feedback. Make sure to point out that the Scoring Guide levels do not correspond to letter grades. For example, it is not necessary, or at this point even expected, that “A” students will write Level 4 responses. In fact, at this point, the small amount of information that the students have been given by the activity makes it extremely difficult to write a Level 4 response. Emphasize that if the student doesn’t have sufficient information to work with, it can be impossible to provide a good answer. Point out that being aware of what information you don’t have can be as important as being aware of the information that you do have. Once you know what information is missing, you can then figure out how to obtain that information.

If rubric use is unfamiliar to many or all of your students, we do not recommend that you score student responses to this question using the AD criteria at this point. In such a case, it might be more productive to use Question 2 as an opportunity to introduce the rubric and the preparation of a complete and correct Level 3 response.

You may decide to conduct a practice session before scoring work. Have each student answer Question 2 and use the Scoring Guide or Feedback Form to score another student’s work. Collect the papers and give students individual, written feedback on why you agree or disagree with the scores. If you have time, invite students to revise their responses, discuss your feedback, or score a different student’s paper in light of your feedback. This will help students both understand the use of the rubric before they are graded and develop a method for regulating their own learning. This helps establish clear assessment

goals and student ownership, both of which are key aspects of effective instruction. You can also use student responses to Question 2 to establish a baseline for each student's ability to analyze data and to give you a sense of the overall level of the class. You may use this baseline to gauge student progress later in the module when students are asked to make other evidence-based decisions.

#### QUESTION 2 (Assessment)

*How many different substances do you think are in the classroom barrel? Explain your reasoning.*

Although student responses will vary, guide students to support their answers with evidence from their observations. The following is a complete and correct Level 3 response.

We were given a sample of the mixture that looked like it contained all of the substances found in the barrel. Based on observation alone, there were six different substances in our sample. I observed two different liquids (one was colorless and one was orange). There were also four different types of solids: dark circles, shiny circles, black squares, and beige squares. There could be more substances, but you can't tell from just looking.

#### QUESTION 3

*Is it possible to identify the contents of the classroom barrel through observation alone? Why or why not?*

While it is possible to make an educated guess about some of the contents of the barrel, there is not enough evidence to make an accurate identification. Substances may be similar in color or appearance and can easily be misidentified. For example, the silvery solid is most likely a metal. However, without further testing, there is not enough evidence to be absolutely certain that it is a metal or to determine which metal it is.

#### Step 5. Investigate hazardous materials at home.

Ask students how the scenario of an abandoned hazardous waste might relate to their own lives. If you have information about a local hazardous material accident or spill, you may want to share it with the class and discuss how the local incident is similar to or

different from the barrel scenario. You can address the danger that hazardous materials can pose to human health and safety. Then point out that hazardous materials are not limited to barrels of abandoned waste or major accidents or spills. Ask students to consider whether they have any materials in their homes that might be hazardous. They may suggest substances such as drain cleaners, bleach, oil, lighter fluid, natural gas, and prescription medications. Typically, these substances have labels that identify potential hazards. In some cases, though, labels may fall off or substances may be transferred to other, unlabeled containers. Many household substances can pose a hazard if used incorrectly or inappropriately; these hazards are magnified when substances are no longer identifiable.

Hand out Thinking More About Investigation 1, "What's Hazardous at Home?" and assign students to record information about household hazardous substances. Point out that they are required to obtain a signature of a parent or guardian before beginning the assignment and handling household hazardous materials. Explain that product labels generally provide a description of the hazard and the hazardous or active ingredients. Students will need to construct a data table to record this information. If your students need more guidance on the construction of a data table, you may wish to display or provide copies of Transparency 1.3, "Household Hazardous Materials Sample Table."

After students have completed the assignment, have each one share and compare findings with another student and then with the whole class. Compile and record the class data on the board so that students may look for any interesting patterns.

You may want to reinforce data organization and graphing skills by having students create bar graphs to show the amount of hazardous materials of each type found in the homes of the class as a whole or in each student's own home. This assignment could also be done as homework. The following is a list of common household hazardous materials you may want to use to create categories for the graphs:

Automotive fluids (e.g., motor oil, antifreeze, gasoline, windshield washer fluid)

Barbecue products (e.g., propane, charcoal briquettes, lighter fluid)

Health and beauty products (e.g., hairspray, fingernail polish remover, hair-coloring products, medications)

Home maintenance products (e.g., paint, varnish, stains, oils, mouse/rat poison)

Household cleaners (e.g., bleach, ammonia, disinfectants, carpet freshener, air freshener, window cleaner, furniture polish)

Laundry products (e.g., laundry detergent, fabric softener)

Lawn and garden products (e.g., fertilizer, pesticides, herbicides)

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## THINKING MORE ABOUT INVESTIGATION 1

### *What's Hazardous at Home?*

#### QUESTION 1

*What are some of the common uses of hazardous materials found in homes?*

Some common uses include household cleaners, automotive fluids, laundry products, and lawn products.

#### QUESTION 2

*How can you tell whether a material is hazardous?*

It usually has a warning or caution advisory on the label.

#### QUESTION 3

*List at least three actions that you can take to reduce your exposure to hazardous materials in the home.*

Responses may include suggestions such as wear gloves, use fewer chemicals, use less toxic chemicals, store and dispose of chemicals safely, replace lids tightly, and read labels.





# What's in the Barrel?

## ••••► CHALLENGE

### What are hazardous materials and how are they handled?

Imagine that you walk by your school's parking lot every day. You see a large barrel sitting on the edge of the lot, close to the bus stop. You have not seen it before. The barrel is not labeled, and no one is nearby. What should you do? How should the contents of the barrel be treated?

When the contents of a container are unknown, they are assumed to be hazardous and are handled by trained professionals. Hazardous materials are substances that pose a danger to the health and safety of living organisms. They may be capable of causing injury or even death. Professionals who investigate hazardous materials are usually a part of a hazardous materials, or HAZMAT, team.



**MATERIALS***For each group of four students***1 plastic cup, with lid, containing approximately 60 mL of simulated hazardous waste****1–2 paper towels***For each student***1 pair of safety goggles**

**Safety Note:** Do not touch simulated hazardous waste or bring it into contact with your eyes or mouth. Wear safety goggles while working with chemicals. Wash your hands after completing the activity.

**•••• ► PROCEDURE***Part One: The Barrel Mystery*

1. Watch a video simulating the discovery of an abandoned barrel of hazardous waste.

*Part Two: Observing Hazardous Waste*

2. Your teacher will provide you with a sample of the contents of the barrel. With your group, examine the sample.
3. Record your observations in your science notebook.
4. Share your observations with the rest of your class.

**•••• ► ANALYSIS****Group**

1. How did the way in which the HAZMAT team approached the waste in the barrel differ from the way in which your class approached the waste? In what ways were the approaches the same?

**Individual**

2. How many different substances do you think are in the classroom barrel? Explain your reasoning.
3. Is it possible to identify the contents of the classroom barrel through observation alone? Why or why not?

## Thinking More About Investigation 1

# What's Hazardous at Home?



Use caution when handling all hazardous materials, whether in school or at home. Before beginning to investigate hazardous materials in your home, notify your parents or guardian about this assignment by asking for a signature on the line below.

Signature of Parent/Guardian: \_\_\_\_\_

Learning how to recognize and safely store hazardous materials is important for everyone to know. Most homes contain about 10–40 liters (3–10 gallons) of hazardous chemicals.

### ••••► PROCEDURE

1. Create a data table to record the following information for at least five different substances:
  - What is the name of the hazardous material?
  - Is the material a solid, liquid, or gas?
  - What are the hazardous (or “active”) ingredients?
  - In what ways is this material hazardous?
2. Examine various rooms in your home for common materials that you think may be hazardous.
3. Use the information on the containers you find to help you complete your table.

### ••••► ANALYSIS

#### Group

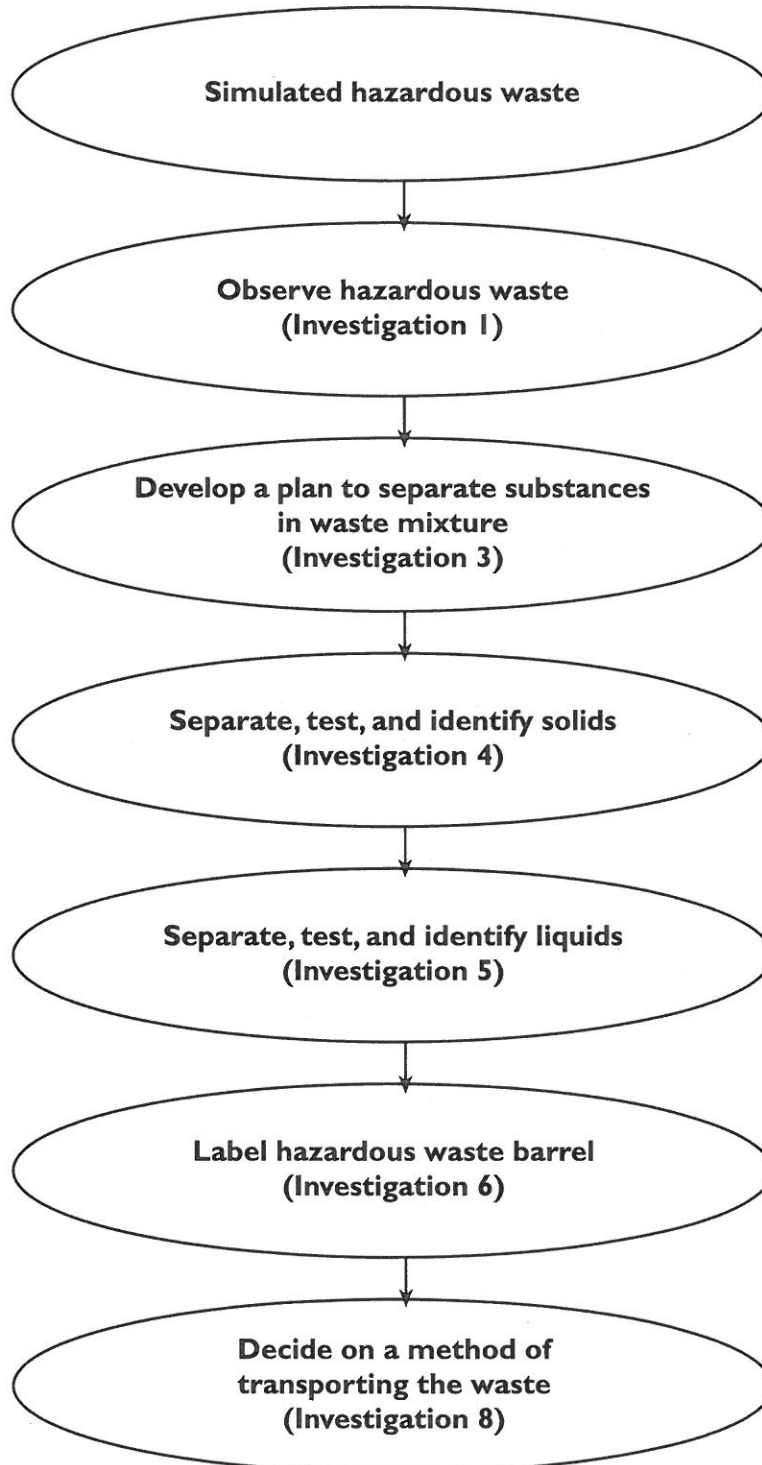
1. What are some of the common uses of hazardous materials found in homes?
2. How can you tell whether a material is hazardous?

#### Individual

3. List at least three actions that you can take to reduce your exposure to hazardous materials in the home.



# Hazardous Waste Flow Chart



# Guidelines for Safety and Success in the SEPUP Lab

## Safety Guidelines

- Wear safety goggles for any investigation that uses liquids or glassware.
- Don't taste solutions.
- Don't waste materials.
- Clean up materials, wash out trays, and put bottles away.
- Wash your hands when you are finished.
- Not sure what to do? Ask!

## Keys to Success

- Share materials within your group.
- Make careful observations.
- Look for similarities and differences.
- Record what you observe in your science notebook.
- Offer a conclusion based on evidence.

# Household Hazardous Materials Sample Table

What is the name of the hazardous material?	Is the material a solid, liquid, or gas?	What are the hazardous (or "active") ingredients?	In what ways is this material hazardous?
Bleach	liquid	sodium hypochlorite, sodium hydroxide	may cause eye or skin irritation; harmful if swallowed

# Feedback Form: Analyzing Data

Your response is <b>complete and correct</b> if:	YES	ALMOST	NO
You use evidence to support a logical interpretation of the data.			
You evaluate the source, quality, and/or quantity of evidence.			
Comments:			

You accomplish the <b>above and go beyond</b> in some significant way such as:	YES	ALMOST
You present a thorough examination of evidence.		
You connect your ideas with the science concepts learned.		
You provide an explanation for why alternative ideas were discarded.		
You provide suggestions for further relevant investigations.		
You include a diagram or visual to clarify your ideas.		
Other:		
Comments:		



# Scoring Guide: Analyzing Data

<p><b>Level 0</b></p>	<p>Your response is missing or not relevant.</p>
<p><b>Level 1</b> <i>On your way</i></p>	<ul style="list-style-type: none"> <li>• You identify evidence and/or</li> <li>• You explain what you think the evidence means.</li> </ul>
<p><b>Level 2</b> <i>Almost there</i></p>	<ul style="list-style-type: none"> <li>• You explain what you think the evidence means.</li> <li>• You use some evidence to support your ideas.</li> </ul>
<p><b>Level 3</b> <i>Complete and correct</i></p>	<ul style="list-style-type: none"> <li>• You use evidence to support a logical interpretation of the data.</li> <li>• You evaluate the source, quality, and/or quantity of evidence.</li> </ul>
<p><b>Level 4</b> <i>Above and beyond</i></p>	<p>You accomplish Level 3 and go beyond in some significant way such as:</p> <ul style="list-style-type: none"> <li>• You present a thorough examination of evidence.</li> <li>• You connect your ideas with the science concepts learned.</li> <li>• You provide an explanation for why alternative ideas were discarded.</li> <li>• You provide suggestions for further relevant investigations.</li> <li>• You include a diagram or visual to clarify your ideas.</li> </ul>

