MYSTERY SPILL

Overview

Students will investigate and categorize the properties of a variety of household substances that are used to simulate classes of hazardous materials commonly transported on highways. They will then be introduced to the standard placards which are used to identify these materials.

Through these experiences, students will learn the meaning of terms such as corrosive, oxidizer, and irritant. They will also learn how to carry out qualitative tests to identify chemicals.

CHEM Dilemm: Time: 15–30 minutes

Activity One: Identifying the Spill

Time: One class session

Students observe and perform tests on six white powders. They observe and record any interactions. They determine the identity of an unknown substance by testing it in the same manner.

Activity Two: Tracking the Trucks

Time: One class session

Students become familiar with highway placards and their meanings by playing a matching game.

Integrating CHEM into the Curriculum

Integration suggestions are on pages CI-1 and CI-29 in the Curriculum Integration section of this manual.

Teacher Background

Department of Transportation Placards

Trucks that carry hazardous chemicals are required by the U.S. Department of Transportation (DOT) to be marked with diamond-shaped placards that give information regarding the contents of the truck. Placards also contain four-digit numbers that identify the chemicals being transported (see the last pages of this unit for a list of numbers assigned to frequently transported chemicals). Each state police car carries a book that lists these numbers and describes the properties of the chemicals. In addition, the truck driver carries a set of papers, or manifest, that identifies the contents of the shipment.

The chart on page 124 shows the eight major classes of hazardous materials and their definitions.

We use many products from the chemical and petroleum industries. Trucks are the principal means of transport from refineries or plants where hazardous materials are made to factories where they are used and then to disposal facilities where wastes are taken. An estimated 60% of all hazardous materials travel our highways.

Most of us do not think about how a flammable substance like gasoline gets to our local service station until we read about a spill or fire on the highway. Most shipments reach their destination safely. However, statistically one in 10,000 do not, and those are the ones we are concerned about.

What happens when a spill occurs? Public safety professionals—highway patrolmen, local policemen, firefighters, and medics—arrive quickly. While the medics care for any injuries, other professionals try to discover what was spilled, how dangerous it is, and how to clean it up. If the placard and manifest belonging to the truck involved are not available, the safety officers must be able to test the material spilled or safely sample it and send it to a laboratory for analysis.

The use of placards and an example of the process of testing unknown substances will be explored in the following activities.

Further Background Information

Hazardous Materials Storage and Handling Handbook, U.S. Department of Defense, July 1987.

1996 North American Emergency Response Guidebook. U.S. Department of Transportation, Research and Special Programs Administration.

ChemEcology, The Chemical Manufacturers Association, 1300 Wilson Blvd., Arlington, VA 22209. This is a free monthly newsletter which focuses on the chemical industry's commitment to ecological concerns.

Activity 1: Identifying the Spill

Time: One class session

Preparation

Materials

For the class:

7 plastic cups labeled as follows:

Cup 1—Corrosive
Cup 2—Flammable
Cup 3—Irritant
Cup 4—Oxidizer
Cup 5—Poison
Cup 6—Radioactive
Cup 7—Unknown

Add 10–15 spoonfuls of each of the following to the corresponding plastic cups:

Cup 1—Citric acid
Cup 2—Flour
Cup 3—Detergent
Cup 4—Baking soda
Cup 5—Table salt
Cup 6—Sugar
Cup 7—Unknown (baking soda)

For each group of four students:

1 dropping bottle of test solution (vinegar)
★ 1 dropping bottle of water

For each pair of students:

1 CHEM tray
1 small plastic spoon
1 hand magnifier
4 strips of pH paper
★ 1 paper towel

For each student:

1 Activity Sheet: Identifying the Spill

★ *denotes that item is supplied by the teacher*

Advance Preparation

Make a copy of the Identifying the Spill activity sheet for each student.

To introduce this CHEM unit and to increase student interest in the activity you may wish to simulate a chemical spill in your room. You can dress up for the event by wearing coveralls. While students are out of the room, overturn a toy truck and some of the unknown substance from Cup 7 on a table. If possible, obtain or create some yellow caution tape to isolate the area.

Note: Do not put out Cup 7 for student use.

Safety Note

Tell students that the materials used here are safe to handle but that in a real situation safety clothing and goggles would be worn. Emphasize that if they ever come upon a real spill, they should not try to remove anything or attempt any cleanup.

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Instructional Guidelines

CHEM Dilemm

Either project or distribute the CHEM Dilemm. Tell the students that they are going to look at the CHEM Dilemm (page 127) to help them discuss their ideas about chemical spills with their group. See page RG-12 in the Reference Guide for background information and instructions on how to use the CHEM Dilemm.

Getting Started

After the groups have discussed the CHEM Dilemm, explain that in the event of a spill someone has to determine what substance was spilled and whether it is hazardous. Safety officers need to be familiar with a variety of tests that will answer these questions.

Ask the students how a substance might be tested. (*Can it burn? Does it react in a certain way with other specific substances, such as water? pH or other indicator paper?*)

Discuss the meaning of the word simulation to make sure students understand that the actual substances used in the activity are harmless. You may wish to discuss with students what they already know about the seven categories of hazardous materials. Tell students you will discuss these categories in Activity Two.

Procedure

Distribute the materials to the students. Show them how to transfer one spoonful of a substance to a small cup in the CHEM tray. Demonstrate how to test a substance by adding a small piece of pH paper moistened with tap or distilled water to the substance in Cup 1 (cornstarch) and have one or more students help you note the color of the paper. Then slowly add 20 drops of the test solution (vinegar) to the same substance and have students help you observe what happens.

Assign one student from each pair to come up to the supply table and transfer one spoonful of each substance from the cups numbered 1 to 6 to the corresponding numbered cups in their CHEM trays. Have them return to their work stations so they and their partners can test the full tray. Go over the directions with the students to be sure everyone understands the procedures. Explain that they should tear each piece of pH paper in half before using it. When everyone has finished testing the six substances and has filled in their data table, have them report their observations. Discuss similarities and differences in the reports for each substance. Emphasize the importance of keeping written records.

Now ask students to imagine that they are members of an emergency response team and that they must identify the substance that is involved in the simulated highway spill in your room. Explain that now that they know how to test and categorize substances they can try to figure out what the spilled substance is. They know that it is one of the six tested by its physical appearance. Place one teaspoon of the unknown substance from Cup 7 into an empty large cup of the CHEM tray of each group for testing. (If you have set up the toy truck with the spilled material, let students get their unknown sample from the spill.)

Have the students test the unknown substance with the test solution and the pH paper.

Follow-up Discussion

After students have finished testing the unknown substance, discuss their observations and have the class agree on the identity of the unknown. Ask them to think about whether appearance (a physical property) or the reaction with pH paper or with testing solution (both chemical properties) were more useful for identifying the unknown. Most of the white powders look very much alike; the chemical properties are generally more useful for identifying the unknown. Following the class discussion, have students clean up.

Date _____ Name _____

Identifying the Spill

In this activity you will perform, observe, and record a series of tests on some substances in order to identify an unknown simulated hazardous material.

Materials

For each group of four students:

- 1 dropping bottle of test solution
- 1 dropping bottle of water

For each pair of students:

- 1 CHEM tray
- 1 small plastic spoon
- 4 strips of pH paper
- 1 paper towel
- 1 hand magnifier
- 1 spoonful of substance from each of the cups numbered 1–6

Procedure

1. Measure one spoonful of the substance labeled "Cup 1—Corrosive" into Cup 1 of your CHEM tray.
2. Repeat the process for cups numbered 2–6 using Cups 2–6 of your CHEM tray.

3. Carefully observe the appearance of each substance with the hand magnifier and record your observations in the data table on the next page.

4. Cut each strip of pH paper in half to make 8 strips. Add a drop or two of water to one small piece of pH paper. Touch the wet pH paper to the substance in Cup 1. Observe the paper and record the results of your test in the data table.
5. Repeat the test using fresh paper for each solid in Cups 2–6.
6. Add 20 drops of test solution to Cup 1. Stir and observe carefully. Clean the spoon with a paper towel. Record your observations in the data table on the next page.
7. Repeat Step 6 for each of the other five substances in Cups 2–6.

Follow the instructions on the next page→

Date _____ **Name** _____

Identifying the Spill (continued)

Procedure (continued)

7. Imagine there has been a spill of an unknown substance on a highway. You are part of the hazardous materials response team. Your job is to identify the substance spilled. Place a sample of the unknown substance in Cup 7 of your CHEM tray and identify it using the test solution and pH paper.

Data Table

Cup	Substance	Appearance	Color with pH Paper	Reaction with Testing Solution
1	Corrosive			
2	Flammable			
3	Irritant			
4	Oxidizer			
5	Poison			
6	Radioactive			
7	Unknown			

I think the spill substance is: _____

because _____

_____

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