Activity 3

1–2 CLASS SESSIONS

Separating a Mixture

Activity Overview

This activity introduces students to the idea that the simulated hazardous waste is a mixture. Before the substances in a mixture can be tested and identified, they must first be separated. Students construct a procedure to separate the different substances that compose the simulated hazardous waste. Students develop a three-part plan to (1) separate the liquid and solid substances, (2) separate the different solids, and (3) separate the different liquids.

CONCEPTS, PROCESSES, AND ISSUES

(with NSE 5–8 Content Standards Correlation)

1. Mixtures may be heterogeneous or homogeneous and may contain substances in more than one phase. *(PhysSci: 1)*
2. A mixture of substances often can be separated into the original substances on the basis of one or more characteristic properties, such as density and solubility. *(Phys Sci: 1, Inquiry: 1)*
3. Pure substances are identified by performing qualitative tests to determine their chemical and physical properties. *(PhysSci: 1; Inquiry: 1)*

TEACHING SUMMARY

Step 1.
Discuss the fact that the simulated hazardous waste is a mixture.

Step 2.
Create a plan to separate the different parts of the hazardous waste mixture.

Step 3.
Review student plans.

MATERIALS

For the teacher

- 1 Transparency 3.1, "Graphic Organizer: Substances"
- 1 Transparency 3.2, "A Sample Procedure"
- * 1 overhead projector

For each group of four students

- 1 plastic cup, with lid, containing simulated hazardous waste
- 2 droppers
- 1 funnel
- 1 metal screen
- 2 pairs of forceps
- 2 plastic spoons
- 2 narrow-mouthed plastic cups (to serve as the base for the funnel)
- * 2 SEPUP trays
- 1 cup of water

For each student

- * 1 pair of safety goggles

**not supplied in kit*

ADVANCE PREPARATION

You can use the simulated hazardous waste from Activity 1 to provide each group of four students with a 60-mL sample (see Advance Preparation in Activity 1). When you place the simulated waste into cups for students to observe, be sure that each sample contains at least a small amount of each substance. Ideally, each sample should contain approximately the following:

- 40 mL of iron nitrate solution
- 20 mL of mineral oil
- 6 iron washers
- 6 aluminum washers
- 6 black HDPE squares
- 6 beige HDPE squares

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.

Teaching Suggestions

GETTING STARTED

Step 1. Discuss the fact that the simulated hazardous waste is a mixture.

Tell students that they have successfully completed their HAZMAT training and that they have been given the responsibility to develop a procedure to separate, test, and identify the simulated hazardous waste left abandoned in the barrel.

Have students locate their notes from Investigation 1, "What's in the Barrel?" and ask a few students to share their responses to Question 2, in which they described how many substances they thought were in the barrel. So far, the waste in the barrel has been discussed and handled as a single substance, though observations indicate that it is a mixture. This is a good opportunity for you to introduce or review some important chemical concepts regarding mixtures, compounds, and separation techniques.

Write the word "mixture" on the chalkboard and ask students to define or give examples of a mixture. Write their suggestions on the chalkboard. From their answers, develop an understanding that a mixture is a combination of more than one item or substance. Although students may not realize it, they deal with many kinds of mixtures daily, and not all of these mixtures are liquids. Ask, ***What mixtures have you observed around your home? How might you separate these mixtures?*** For example, a mixture of clothes destined for the washer and dryer must first be separated by color and nature of fabrics: darks from lights or whites, and delicate fabrics such as rayon or nylon from sturdier fabrics such as cotton or cotton blends. The mixture of clothes that comes fresh from the dryer must also be sorted before being stored away in closets and drawers. This sorting is generally accomplished by making use of some system of categories: socks in the sock drawer, shirts on hangers in the closet, sheets in the linen closet, and so on.

Explain that to scientists, all matter consists of chemicals, which may be present either as pure substances (elements or compounds) or as mixtures. You may wish to use Transparency 3.1, "Graphic Organizer: Substances," to help differentiate these concepts. Mixtures are often compared with compounds. A **compound** consists of two or more elements that are combined chemically and are often difficult to separate. A **mixture**, by contrast, consists of two or more substances that are not combined chemically and thus are usually easier to separate. Students frequently have difficulty distinguishing between mixtures and compounds. Explain that a chemical reaction is needed to separate compounds. For example, common compounds include salt, sugar, and water. A chemical reaction is needed to separate salt, a compound also known as sodium chloride, into the elements sodium and chlorine.

Mixtures, on the other hand, can often be separated by physical means, such as filtration and distillation. Explain that forceps, magnets, sieves and filters, and even phase changes (evaporating or freezing to isolate parts of the mixture) are all considered means of physical separation. Common mixtures include seawater, concrete, soil, air, and fruit salad. Ask , ***How could you separate the substances in sea water (saltwater)?*** Some students may suggest separating the salt and water by evaporating (or boiling) the water from the mixture, leaving behind the salt.

You might also want to introduce the idea that mixtures can be either heterogeneous or homogeneous. A *heterogeneous* mixture is one in which some or all of the components can be distinguished from other components. Sand and water or sand and salt mixtures are heterogeneous. A *homogeneous* mixture is one that appears the same throughout—the different components of the mixture are uniformly mixed and cannot be distinguished. Homogeneous mixtures are also known as solutions. Examples of solutions include tea and sugar dissolved in water.

Teacher's Note

The simulated hazardous waste is a heterogeneous mixture of five substances: iron (III) nitrate solution, mineral oil, aluminum washers, iron washers, and high-density polyethylene squares. The iron (III) nitrate (orange-brown liquid in water) is itself a solution, or homogeneous mixture. Although in this activity the students will not separate the solution by evaporating water to obtain iron (III) nitrate crystals, you can have them do this as an extension.

INVESTIGATING

Step 2. Create a plan to separate the different parts of the hazardous waste mixture.

Distribute Investigation 3, "Making a Plan." Provide each group with the materials listed in the materials section. If your students do not have extensive experience with the SEPUP tray, you may wish to suggest to them that the large cups can be used for storing materials, and the small cups are a good size for conducting tests.

Students are instructed to work together to create a plan to separate the mixture into the individual substances. Investigation 3 suggests that students first separate solids from liquids and then separate the individual solids and individual liquids. Explain that students are to develop and record a step-by-step procedure similar to the ones they used in the first two investigations. Be sure to emphasize that all classroom safety rules still apply and that student procedures should take this into account. For example, any procedure that calls for the simulated waste to be handled directly with hands will not be approved.

If appropriate, you may wish to show the first one or two steps on Transparency 3.2, "A Sample Procedure," to help students get started. Transparency 3.2 shows one simple way to separate the mixture; however, students may have alternative approaches. Some students may request additional equipment or items from home to complete their separations. It is up to you to decide how much independence students can have. SEPUP recommends encouraging student groups to develop their own procedures, regardless of how much they may vary, as long as they are safe. Although you may be able to anticipate that certain procedures are not likely to work well, allow students to create and eventually follow their own plans. They will have opportunities to modify their plans as they implement them.

SYNTHESIZING

Step 3. Review student plans.

Discuss student plans, as described in Question 1. Call on students from several groups to read their procedures aloud to the class. Alternatively, you may wish to have them read only one component of their procedures so that all groups are motivated to develop and revise their own plans. Other students may ask for clarification or have questions at this time. Encourage students to address any questions or concerns by modifying their written procedures appropriately.

Collect student procedures or carefully check each procedure that students show you. You may want to have students turn in their plans at the end of one class session so you can review them before the next class session.

QUESTION 1

Share your plan for separating the mixture with the class. How is your plan similar to other plans? How is it different?

> Many aspects of the separation plan will be similar across groups, in part because they are separating the same mixture using the same materials. The specific aspects of plans, as well as the specificity of the procedures, however, will be different. For example, student plans may vary in terms of where they intend to place separated solids.

QUESTION 2

What is the purpose of separating the different substances in the mixture?

> The purpose of separating the substances is to be able to identify them so that they can be handled properly. Separation is the first step. Only then can the substances be tested and identified.

QUESTION 3

Would knowing the hazards posed by each substance in the mixture have helped you create your procedure? Why or why not?

> Knowing the hazards posed by each substance would be helpful in creating a safer procedure for separation. For example, if one of the solids were a substance that is extremely reactive with oxygen, it would be important to keep this solid away from air (by keeping it surrounded by another liquid or gas).

Making a Plan

• • • • ▶ CHALLENGE

How will you separate the substances in the hazardous waste mixture?

In training for your local HAZMAT team, you learned how to test for different types of hazards. You now need to identify each substance so you can safely handle and dispose of the hazardous waste. The first step is to separate each substance in the mixture.

MATERIALS

For each group of four students

- 1 **plastic cup, with lid, containing simulated hazardous waste**
- 2 **droppers**
- 1 **funnel**
- 1 **metal screen**
- 2 **pairs of forceps**
- 2 **plastic spoons**
- 2 **narrow-mouthed plastic cups**
- 2 **SEPUP trays**
- 1 **cup of water**

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

1. Carefully examine the sample of simulated hazardous waste. Discuss with your group how you could separate the solid substances from the liquid substances. Be sure to consider and investigate the materials included in the materials list.

2. **Separating Solids and Liquids:**
Work with your group to create a step-by-step procedure for separating the solids from the liquids. Be sure to explain each step and to identify which materials you will use to conduct each step.

3. Record this procedure in your science notebook.

4. Because the solids and liquids were mixed together, the solids may still have some liquid waste on them. Discuss with your group how you can remove this residue.

5. Record these additional steps of your procedure in your science notebook.

6. **Separating Different Solids:**
Work with your partner to create a step-by-step procedure for separating the different solids from each other. Be sure to explain exactly where you will place the different solids as you separate them.

7. Record this procedure in your science notebook.

8. **Separating Different Liquids:**
Work with your partner to create a step-by-step procedure for separating the different liquids from each other. Remember to identify which materials you will use in each step.

9. Record this procedure in your science notebook.

10. Obtain your teacher's approval of your plan.

• • • • ▸ ANALYSIS

Group

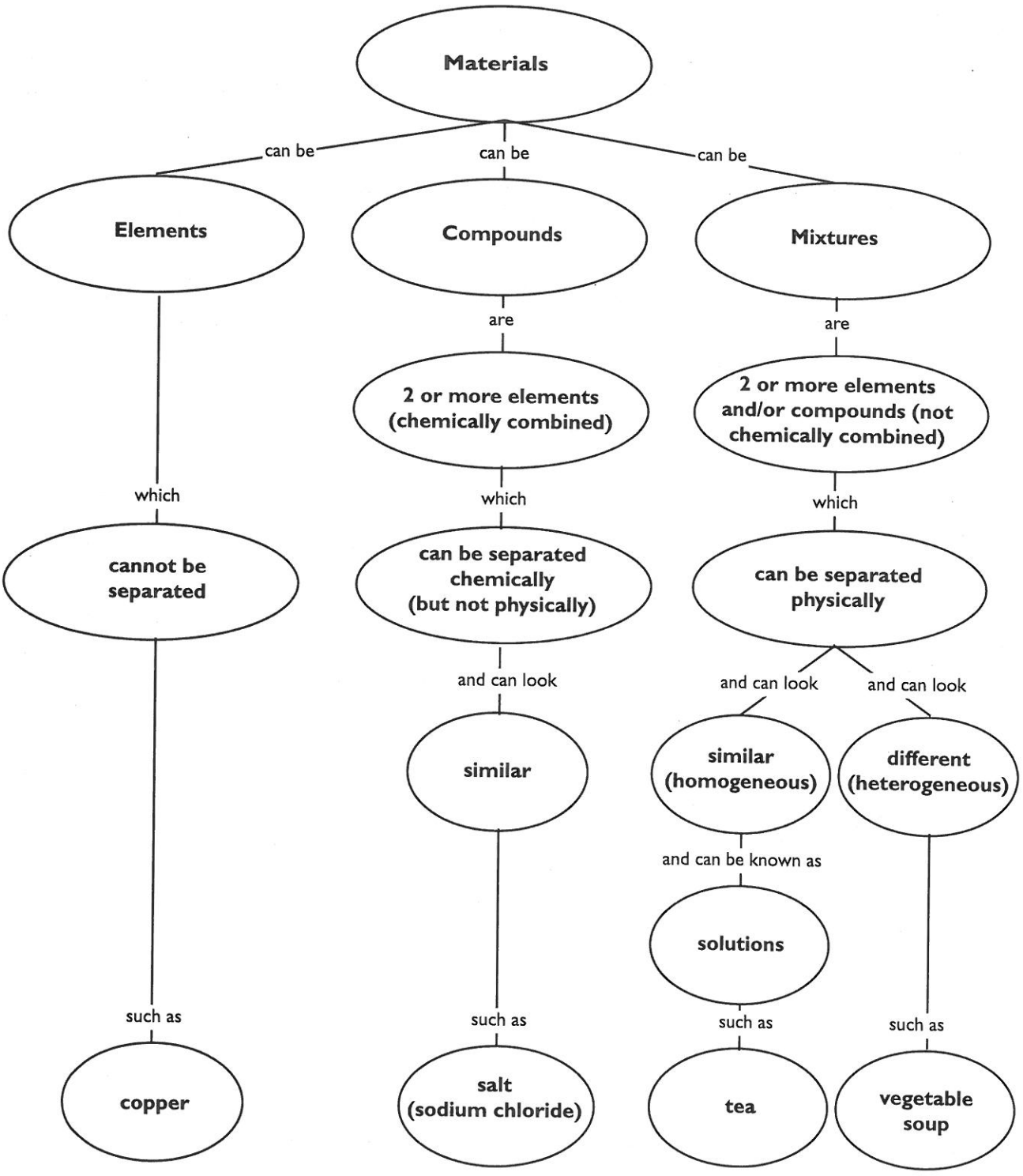
1. Share your plan for separating the mixture with the class. How is your plan similar to other plans? How is it different?

2. What is the purpose of separating the different substances in the mixture?

Individual

3. Would knowing the hazards posed by each substance in the mixture have helped you create your procedure? Why or why not?

Graphic Organizer: Substances



A Sample Procedure

Separating Solids and Liquids

1. Place the metal screen securely inside the funnel.
2. Place the funnel on top of a narrow-mouthed plastic cup.
3. Slowly pour the simulated waste into funnel.
4. Move the funnel that contains the solids onto another empty plastic cup.
5. Pour water over the solids in the funnel to rinse them.
6. Use a spoon to scoop the rinsed solids into Cup A of a SEPUP tray.
7. Discard the rinse water and clean the cup. Keep liquids in the plastic cup and solids in the SEPUP tray.

Separating Different Solids

8. Use forceps to pick out the pieces of silvery circles and place them in Cup B.
9. Use forceps to pick out the pieces of light squares and place them in Cup C.
10. Use forceps to pick out the dark squares and place them in Cup D. Leave the pieces of dark circles in Cup A.

Separating Different Liquids

11. Use a dropper to move the clear liquid into a clean cup.
12. Leave the orange liquid in the original cup.