Mixtures, Solutions, and Suspensions

Purpose

To explore how mixtures, solutions, and suspensions form by combining and then attempting to separate various materials.

Process Skills

Observe, measure, predict, collect data, interpret data, communicate, draw conclusions

Background

When you combine two or more materials, they will usually become a **mixture**, a **solution**, or a **suspension**. The materials you mix might be any combination of **solids**, **liquids**, and **gases**. In a *mixture*, each material keeps its own properties. A tossed salad is a mixture of many solids. You could easily separate the lettuce, tomatoes, and onions. The carrots do not combine with the cucumbers. A solution is a special kind of mixture. In a *solution*, the atoms of the materials bond with each other. It is much harder to separate materials in solutions than in mixtures. Grape juice is an example of a liquid solution in which fruit juice and water combine. In a *suspension*, tiny pieces of solid material float within the liquid. For example, when you mix dirt and water, the dirt is temporarily suspended in the liquid. In time, gravity will pull the small particles of dirt to the bottom of the water.

Time –

Part 1: about 1 hour
Part 2: about 5 minutes (next day)

Grouping – Pairs or small groups

Materials
(per group)

- ❑ Data Sheets 1a, 1b, and 2
- ❑ 2 large, clear jars with lids
- ❑ masking tape
- ❑ marker
- ❑ powdered clay
- ❑ iron filings
- ❑ salt
- ❑ water
- ❑ tablespoon
- ❑ ½-cup measuring cup
- ❑ paper plate
- ❑ bowl
- ❑ coffee filters
- ❑ plastic spoon
- ❑ piece of metal mesh or screen material
- ❑ magnet
- ❑ variety of other supplies

Figure A

Procedure

Part 1: Separating Mixtures, Solutions, and Suspensions

Predict: As a group, examine the available materials in this activity. Observe the properties of the powdered clay, iron filings, salt, and water. Then discuss a plan for how to separate each combination of materials listed on Data Sheet 1a. Also discuss whether you think each combination of materials will turn into a mixture, solution, or suspension. Complete the two *Prediction* columns of the data table on Data Sheet 1a.

1. Use masking tape and a marker to label the jars as Jar 1 and Jar 2.
2. Add 1 tbsp. powdered clay and 1 tbsp. iron filings to Jar 1. Put the lid on securely. Shake the jar vigorously ten times. Then remove the lid (see Figure A).
3. Try to separate the combination of materials according to the plan you recorded on the data table (first *Prediction* column). Use any available supplies to try separating the materials (see Figure B). If you are unable to separate the materials using your original plan, try another approach, which may include supplies other than those listed in this activity. [**Note**: Get your teacher's permission before trying any methods that may pose safety risks.]

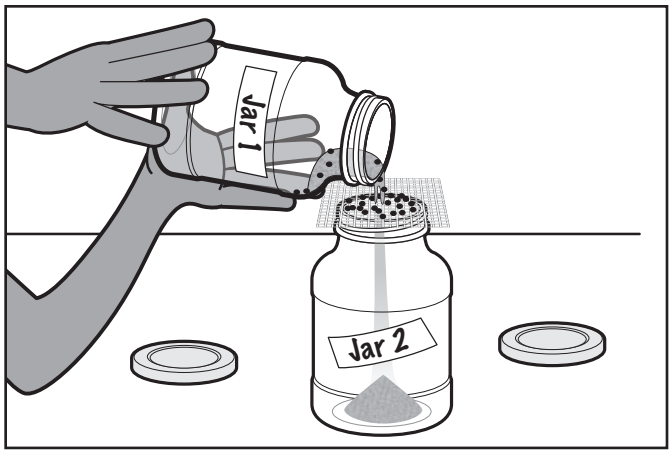

Figure B

4. Record your results for this combination of materials on Data Sheet 1b. In the first *Results* column, identify the method that worked best for separating the materials. If more than one method worked, list them all. If you were unable to separate the materials, write *none* in the box and then explain what else you might try in order to separate the materials. Use separate paper if you need more room.
5. Discuss as a group whether the combination of materials is a mixture, solution, or suspension and record this answer in the last column of Data Sheet 1b. Use separate paper if needed.
6. Pour the materials (whether separated or not) into Jar 2. All materials from each combination will wind up in Jar 2 after you have attempted to separate them.
7. Rinse out Jar 1. Dry thoroughly.

8. Repeat steps 2–7 by mixing each of the following combinations of materials in Jar 1:
   - 1 tbsp. salt mixed with 1 tbsp. iron filings
   - 1 tbsp. salt mixed with 1 tbsp. powdered clay
   - 1 tbsp. iron filings mixed with ½ cup water
   - 1 tbsp. salt mixed with ½ cup water
   - 1 tbsp. powdered clay mixed with ½ cup water
9. Now test what happens when all four materials are combined. All of the materials from earlier tests should now be inside Jar 2. Put the lid on securely. Shake the contents of Jar 2 vigorously ten times (see Figure C).

Figure C

10. Repeat steps 3–5 for the contents of Jar 2. Try separating each material from all the others and describe the methods that you used. Also discuss whether your group believes that the combination of the four materials was a mixture, solution, or suspension. Record this answer in the last box on Data Sheet 1b.
11. Finally, return your materials to Jar 2. Replace the lid. Shake the combined contents of Jar 2 ten times.
12. Use masking tape and a marker to label the jar with your names. Then set it in a place where it will be undisturbed until tomorrow. Collect and clean all other materials from the activity.
13. As a group, discuss how you think the contents of Jar 2 might change after sitting for one day. Record your prediction on Data Sheet 2.

Part 2: Observing Mixtures, Solutions, and Suspensions After One Day (Jar 2)

1. One day after completing Part 1, observe what has happened to the materials in Jar 2.
2. Record your observations on Data Sheet 2. Describe what has happened to each of the four materials. Then describe the overall appearance of the contents in Jar 2.
3. Discuss as a group how you will try to separate the materials, now that Jar 2 has sat for one day.
4. Use the methods you have chosen to try separating the materials that you combined in Jar 2. Record these methods on Data Sheet 2.
5. When done, dispose of the contents of Jar 2 and clean the materials used during the activity.

Name_____ Date_____

Collect Data

Materials	Predictions	
	Which method will be most effective for separating the materials?	Will a mixture, solution, or suspension form?
Powdered clay and iron filings		
Salt and iron filings		
Salt and powdered clay		
Iron filings and water		
Salt and water		
Powdered clay and water		
Powdered clay, salt, iron filings, and water		

Name_____ Date_____

Collect Data

Materials	Results	
	Which method was most effective for separating the materials?	Did a mixture, solution, or suspension form? Why do you think this was so?
Powdered clay and iron filings		
Salt and iron filings		
Salt and powdered clay		
Iron filings and water		
Salt and water		
Powdered clay and water		
Powdered clay, salt, iron filings, and water		

Name_____ Date_____

Prediction: How will the contents of Jar 2 change after sitting undisturbed for one day?

Collect Data

Material	Appearance and location of material
powdered clay	
iron filings	
salt	
water	
combined contents of Jar 2	

Sketch of Jar 2 after sitting for one day	Which methods will you use to separate each material from Jar 2?	
	powdered clay	
	iron filings	
	salt	
	water	

Name_____ Date_____

Analyze Data

1. Which materials were easiest to separate during Part 1? Why do you think this was so?

2. Which materials were most difficult or impossible to separate during Part 1? Why do you think this was so?

3. Which tools and methods did you find most helpful in separating the most materials? Why do you think this was so?

4. Compare how difficult it was to separate the contents of Jar 2 during Part 1 with how difficult it was to separate the contents of Jar 2 during Part 2 (after one day had passed):

5. Which of your plans for separating the materials had to be changed the most? Describe how and why you changed your methods.

Draw Conclusions

1. What other tools would have been useful to help separate materials during this activity? Why would they have been more useful than the tools you used?

2. Why do you think certain materials are easy to separate and others are difficult to separate?

3. Name three careers in which knowledge of the best ways to separate combined materials would be necessary.

Mixtures, Solutions, and Suspensions

TEACHING TIPS

These process activities will help students understand how matter combines in various ways. Students will explore and experiment with mixtures, solutions, and suspensions. They will observe physical and chemical changes in matter, including state changes and combinations of solids, liquids, and gases. These activities will provide a starting point for further investigation into chemistry and the properties of matter.

SET-UP AND PROCEDURES

- Review lab safety, materials management, and time management with students before beginning the activity.
- Before students make predictions and attempt to combine and separate their materials, you may want to conduct your own investigation so you will be able to judge whether students' results are reasonable.
- Provide adequate time for students to revise their plans and to try different methods if their initial prediction is not effective in separating the materials.
- Not all of the material combinations may be separable in the classroom. Students may get frustrated when they are unable to successfully separate the salt-and-water solution or the water-and-clay suspension. If time allows, you might let students leave the saltwater solution and the moist clay in the sun until the water has evaporated, effectively separating the salt and the clay from the water.
- Reinforce vocabulary (e.g., *mixture, solution, suspension, solids, liquids, gases*) throughout the activity.
- You may want to assign jobs for each student within each cooperative group. Examples include getter, recorder, mixer, measurer, water pourer, and reporter.

SAFETY

While special safety equipment is not necessary for this exploration, you may want students to practice using personal protective equipment (e.g., goggles, gloves) when adding materials to the jars and when shaking jars. Insist that students make sure the lid is securely screwed onto each jar before shaking it, and model a safe, two-handed method for shaking the jar to avoid breaks.

MATERIALS

- Using large, clear plastic jars is advisable. Avoid glass, if possible.
- The materials list does not include containers to hold each of the four materials that will be combined. Choose appropriate containers for each material, and let groups obtain their materials from these containers.

- To save time, you may want to prepare three plastic bags for each group that contain three tablespoons each of powdered clay, iron filings, and salt.
- If any of the materials are difficult to obtain, choose alternatives that will yield similar results when combined during this activity. Arts and crafts stores are likely to sell powdered clay, and many hardware, hobby, and science-supply stores sell iron filings.
- If a classroom sink is not available, a large tub or bucket of water may be used for rinsing jars.
- It is advisable to have a broom, dustpan, mop, and paper towels available in case of spills.
- Have extra materials available in case of spills.

EXTENSIONS AND VARIATIONS

- *Variation/Inquiry Science:* Try this exploration again, but allow each group to only use a coffee filter, a piece of metal mesh, *or* a magnet. Were students still able to separate their materials as effectively as they were when all three types of supplies were available?
- *Research/Technology:* Have a contest challenging groups of students to list the most examples of mixtures, solutions, and suspensions. Allow them to use library and online resources. Alternately, provide a list of items and encourage students to use what they have learned to determine which items on the list are mixtures, solutions, or suspensions.
- *Home Connection:* Have students observe how to separate a sugar-and-water solution by making rock candy at home. Send instructions home.
- *Field Trip:* Visit the school cafeteria, a restaurant, or a grocery store and have students list examples of mixtures, solutions, and suspensions.
- *Field Trip/Technology:* Take a trip to a local recycling or water-treatment plant to observe separation and filtration techniques. Encourage students to take digital photographs and then use a projected slideshow application to create a presentation about what they learned.
- *Research:* See Using the Internet in the *Unit Guide* for suggested websites to extend the learning.

ANSWER KEY

EXPLORATION Mixing Matter—Mixtures, Solutions, and Suspensions Data Sheet 1a

Name_____ Date_____

Collect Data

Materials	Predictions	
	Which method will be most effective for separating the materials?	Will a mixture, solution, or suspension form?
Powdered clay and iron filings	*Predictions will vary. Students should demonstrate that they have observed the properties of each material and that they understand the differences among mixtures, solutions, and suspensions.*	
Salt and iron filings		
Salt and powdered clay		
Iron filings and water		
Salt and water		
Powdered clay and water		
Powdered clay, salt, iron filings, and water		

ANSWER KEY

EXPLORATION Mixing Matter—Mixtures, Solutions, and Suspensions Data Sheet 1b

Name_____ Date_____

Collect Data

Materials	Results	
	Which method was most effective for separating the materials?	Did a mixture, solution, or suspension form? Why do you think this was so?
Powdered clay and iron filings	*Run a magnet through the clay to pick up the iron.*	*Mixture. The individual materials can be separated. They have not joined chemically. Each material keeps its own unique properties.*
Salt and iron filings	*Run a magnet through the clay to pick up the iron.*	*Mixture. The individual materials can be separated. They have not joined chemically. Each material keeps its own unique properties.*
Salt and powdered clay	*Separation is not possible using the available materials unless water is added.*	*Mixture. While it is difficult to separate the materials, they have not joined chemically. Each material keeps its own unique properties.*
Iron filings and water	*Use a magnet to pick up the iron or use mesh or filter paper to drain the water.*	*Mixture. The individual materials can be separated. They have not joined chemically. Each material keeps its own unique properties.*
Salt and water	*Separation is not possible using the available materials unless we let the water evaporate.*	*Solution. The salt has dissolved into the water and is equally distributed.*
Powdered clay and water	*Use filter paper or mesh to drain the water. (Some clay will remain suspended.)*	*Suspension. The powdered clay has not dissolved into the water but is floating in it. The powdered clay may be removed from the water by filtration or by letting it stand.*
Powdered clay, salt, iron filings, and water	*Students may list a combination of the techniques listed above.*	*A combination of a mixture, a solution, and a suspension. Some materials are only mixed, some are dissolved, and some are suspended.*

ANSWER KEY

EXPLORATION Mixing Matter—Mixtures, Solutions, and Suspensions Data Sheet 2

Name_____ Date_____

Prediction: How will the contents of Jar 2 change after sitting undisturbed for one day?

Answers will vary and should include detailed predictions.

Collect Data

Material	Appearance and location of material
powdered clay	*The powdered clay will likely be lying on top of the iron filings. Some clay may still be mixed with the iron filings.*
iron filings	*The iron filings will likely be on the bottom of the jar. (Depending on the size of jar used, students may have to look through the bottom of the jar to see the iron filings, but remind them not to disturb the contents.)*
salt	*Depending on the humidity and temperature of the location of the exploration, some salt may have separated from the water, leaving a very slight ring around the top water line of the jar. The rest of the salt will remain dissolved in the water.*
water	*The water will be positioned on top of the powdered clay. It may appear slightly cloudy due to the salt content.*
combined contents of Jar 2	*The water may be slightly cloudy but should be much clearer than when the jar was shaken. Layers will have formed. The iron filings will likely be found on the bottom, the powdered clay will be in the middle, and the salt water will be on top.*

Sketch of Jar 2 after sitting for one day	Which methods will you use to separate each material from Jar 2?	
Student sketches should match their observations described above.	powdered clay	*Answers will vary but should reflect previous knowledge of which methods worked best in Part 1 of the exploration.*
	iron filings	
	salt	
	water	

ANSWER KEY AND EXPLANATIONS

Analyze Data

1. Which materials were easiest to separate during Part 1? Why do you think this was so?

Answers will vary but are likely to focus on the iron filings, which are easily separated by using the magnet or filtration. None of the other combined materials are magnetic or have large enough particles to be caught by the metal mesh.

2. Which materials were most difficult or impossible to separate during Part 1? Why do you think this was so?

Answers will vary but are likely to focus on either the saltwater solution, which was impossible to separate except by evaporation, or the suspension (powdered clay and water), which was impossible to completely separate without allowing time for settling.

3. Which tools and methods did you find most helpful in separating the most materials? Why do you think this was so?

Answers will vary, but picking up iron filings with the magnet and filtering materials with the coffee filter may be the most useful tools and methods.

4. Compare how difficult it was to separate the contents of Jar 2 during Part 1 with how difficult it was to separate the contents of Jar 2 during Part 2 (after one day had passed):

Answers will vary. Students might indicate that it was easier to separate some of the materials (such as the powdered clay, salt, and iron filings during Part 1) because they were dry. Other materials (such as the powdered clay and water during Part 2) may have been easier to separate due to settling, once mixed with water.

5. Which of your plans for separating the materials had to be changed the most? Describe how and why you changed your methods.

Answers will vary, depending on the methods students chose. Students should compare the second and fourth columns of the completed table on Data Sheet 1, looking for examples of when they had to change their methods from what they thought would work best. Students should also explain why they had to change one of their methods the most.

ANSWER KEY AND EXPLANATIONS

Draw Conclusions

1. What other tools would have been useful to help separate materials during this activity? Why would they have been more useful than the tools you used?

Answers will vary but may include a sifter, a piece of fabric, or a heating device (to remove the water more quickly).

2. Why do you think certain materials are easy to separate and others are difficult to separate?

Mixtures tend to be easier to separate than solutions or suspensions because they retain their physical and chemical properties. Once materials combine into something new, it is more difficult to return the combination to its original parts. If two materials (e.g., sugar water mixed with salt water or iron filings mixed with steel filings) had similar properties, it would be difficult to separate the materials within them.

3. Name three careers in which knowledge of the best ways to separate combined materials would be necessary.

Answers will vary but may include chemist, baker, mining engineer, pharmacist, and waste-management worker (e.g., water treatment, recycling).