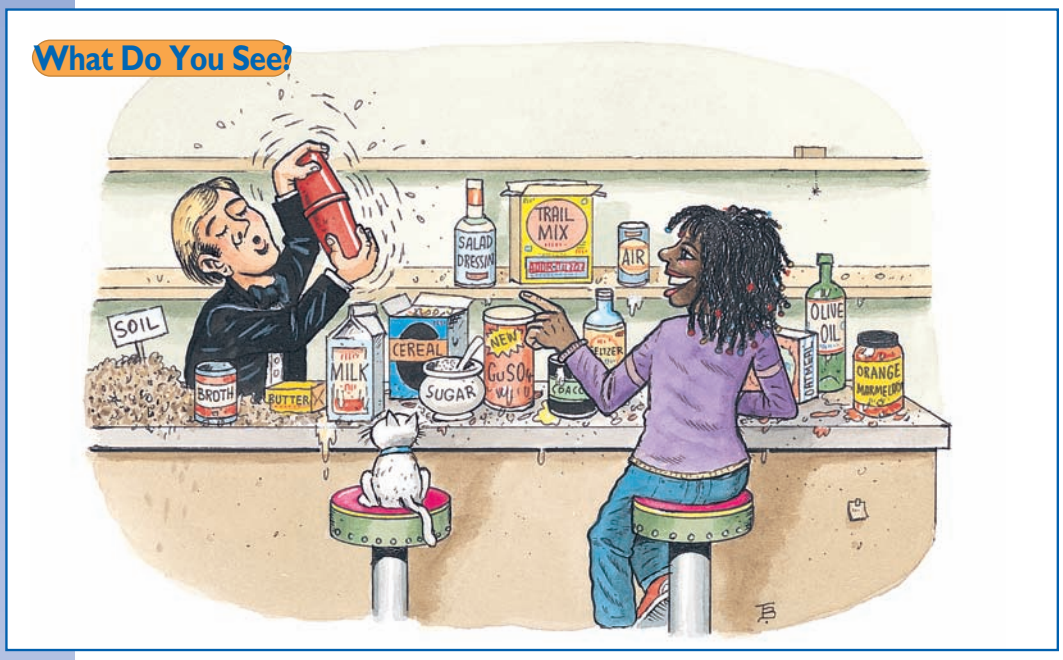
Activity 3 Solutions, Suspensions, and Colloids



GOALS

In this activity you will:

- Explore different ways that materials can be mixed together to make new materials.
- Test some materials to determine what kinds of mixtures they are.
- Determine why certain kinds of mixtures are manufactured for commercial use in particular situations.

What Do You Think?

One way to get different types of materials is to just mix them together. Lots of different things can happen when materials are mixed. You can get some good food or you can get dynamite. Each kind of mixture has its own characteristics. Taking mixtures apart is a different story.

- **Is it easier to separate milk from coffee or milk from a bowl of cereal? Why?**

Record your ideas about these questions in your *Active Chemistry* log. Be prepared to discuss your responses with your group and the class.

Investigate

1. Half-fill six test tubes with water. Number the test tubes.

   a) In your *Active Chemistry* log, prepare a table for your observations. You may wish to use a table similar to the one shown on the next page.

Safety goggles and a lab apron must be worn *at all times* in a chemistry lab.

No.	Materials mixed with water	Observations before mixing	Observations after mixing		
			Homogeneous or heterogeneous	Effect on laser beam	Passes through filter paper
#1	water only				
#2	0.5 g salt				
#3	drops of milk				

2. Add the following materials to the test tubes:

   #1—water only

   #2—0.5 g salt

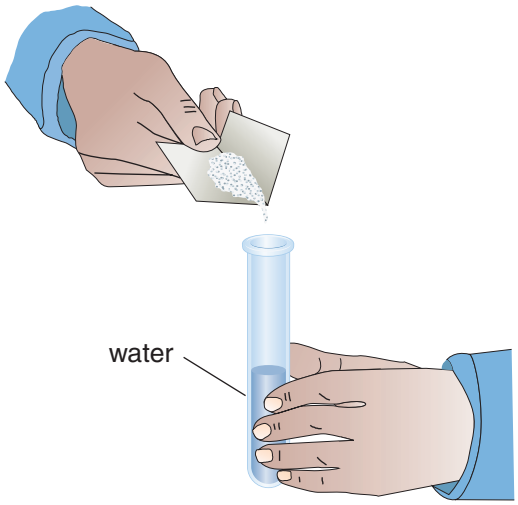
   #3—a few drops of milk

   #4—0.5 g $CuSO_4$ (copper sulfate)

   #5—2 mL olive oil

   #6—0.5 g soil

   a) Describe each material before mixing.



3. Stopper each test tube. Place your finger over the stopper and shake each for several minutes to make a mixture.

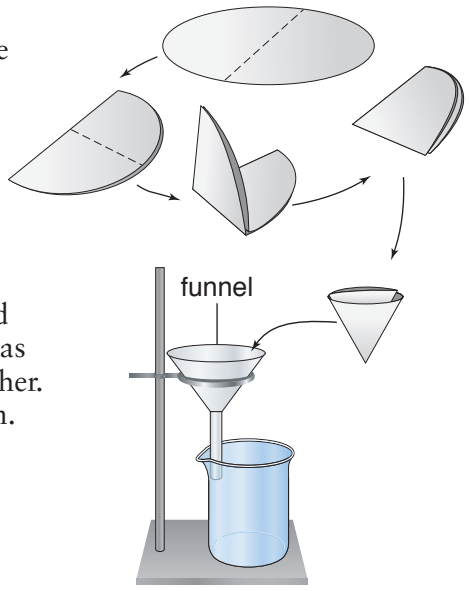
   Observe each mixture.

4. Consider the following characteristics of the mixtures:

- What is the appearance of each mixture after the vigorous mixing? Which ones have visible particles suspended in them? Which ones look totally uniform (homogeneous) throughout?
- Which mixtures separate (are heterogeneous) after sitting a few moments after vigorous mixing? Which remain mixed?
- Shine a laser pointer through each mixture. In which mixtures is the laser beam clearly visible? In which mixtures does it pass through with little effect?
- For each mixture place a small beaker below a funnel to catch the filtrate, as shown in the diagram. Pour the contents of each test tube into a funnel with filter paper. Which mixtures pass through? Which leave material behind on the filter paper?

  a) Record all your observations in the table in your log.

5. Discard materials and return all equipment as directed by your teacher. Clean up your station.



Wipe up spills immediately.

Report any broken or cracked glassware to your teacher.

Never look directly at a laser beam. Be sure the laser is pointed away from other people's eyes.

Wash your hands and arms thoroughly after the activity.

Chem Talk

CLASSIFYING MIXTURES

In this activity you mixed together water and several different materials to produce different kinds of mixtures. In some cases the materials you used were **pure substances**. A pure substance contains only one kind of particle throughout. For example, sugar is a pure substance. A mixture contains at least two pure substances. You may think of water as a pure substance; however, most water found in nature has different materials mixed with it, and is in fact a mixture.

Most materials that you find in nature, as well as most human-made materials, are mixtures of one or more pure substances. You made one kind of mixture, called a **solution**, when you added salt to water. In a solution, the particles that dissolve are so tiny they can't be seen with the naked eye. The mixture is said to be homogeneous. The dissolved particles (called the **solute**) remain mixed with the solvent indefinitely. The water, in this case, is the **solvent** and the salt is the solute. If a solution is filtered, everything passes through. Light passing through a solution has no special effect.

When you added milk to water, the water appeared cloudy. However, the tiny drops of milk remained suspended in the water and did not settle out over time. You could see the laser beam as it passed through the mixture, and when you filtered the mixture, it all passed through the filter paper. This kind of mixture is a **colloid**. In colloids, the dispersed particles are larger than those in solution and may be visible on close inspection with a microscope. The particles will also stay suspended indefinitely. All parts of the colloid will pass through a filter. Light, or any other form of electromagnetic radiation, is most effectively scattered when particles are about the same size as the wavelength of the light. In a colloid, many of the particles, which are made up of a great many molecules clumped together, may be just about the same size as light waves. When light passes through a colloid it is scattered and you can see where the light beam passes through. This is known as the **Tyndall Effect**.

When you added soil to water, you created a suspension. **Suspensions** have the largest of all the dispersed particles. The particles are visible to the eye and will settle out in time. The suspended particles can be separated by filtration. The mixture is said to be heterogeneous. A light beam shining through a suspension may be scattered, but the suspension is definitely not transparent.

Chem Words

pure substance: a substance that contains only one kind of particle and cannot be separated into simpler components without chemical change.

solution: a homogeneous mixture of two or more substances.

solute: the substance that interacts with a solvent to form a solution.

solvent: a substance present in a larger amount that interacts with the solute to make a solution.

colloid: a mixture containing particles larger than the solute but small enough to remain suspended in the continuous phase of another component. This is also called a colloidal dispersion.

Tyndall Effect: the scattering of a light beam as it passes through a colloid.

suspension: heterogeneous mixture that contains fine solid or liquid particles in a fluid that will settle out spontaneously. By shaking the container, they will again be dispersed throughout the fluid.

Checking Up

1. In your own words, describe how you would distinguish among a solution, a colloid, and a suspension.
2. What is the Tyndall Effect?

What Do You Think Now?

At the beginning of this activity you were asked:

- **Is it easier to separate milk from coffee or milk from a bowl of cereal? Why?**

Use what you know to develop a procedure to separate a mixture of salt, sand, and iron filings. Think about the following:

- **Which item is magnetic and how would you remove it from the mixture?**
- **What will dissolve in water and pass through a filter?**
- **What item is not magnetic and will not dissolve in water?**

Chem Essential Questions

What does it mean?

Chemistry explains a macroscopic phenomenon (what you observe) with a description of what happens at the nanoscopic level (atoms and molecules) using symbolic structures as a way to communicate. Complete the chart below in your *Active Chemistry* log.

MACRO	NANO	SYMBOLIC
Describe what you observed after preparing a solution, a suspension, and a colloid.	*In words, describe what is happening to the particles in a solution, a suspension, and a colloid.*	*Draw a picture to show how and why the Tyndall Effect appears in a colloid and not in a solution or a suspension.*

How do you know?

Look back at your data table and determine the visual clue that will help distinguish solutions, suspensions, and colloids.

Why do you believe?

On some days it is possible to see rays of light from the Sun distinctly coming through breaks in clouds. What atmospheric difference allows you to see the light rays on some days and not on others?

Why should you care?

You will be writing a movie scene for your challenge in this unit. How could you use lasers in the video and make them visible to the camera?

Reflecting on the Activity and the Challenge

In this activity you made mixtures with solid or liquid solutes and water as the solvent. The same basic principles apply regardless of the states of matter involved. For example, it is possible to have solid solutions. Metal alloys such as brass or bronze are such solutions. Fog, smoke, and clouds are mixtures that show the Tyndall Effect. A common stage effect is to produce smoke or fog to give an eerie setting. Many movies have used the Tyndall Effect to show the path of laser beams or flashlights. One easy way to produce this effect is to use a spray bottle of water to mist the air in a darkened room. Another way is to use chalk dust from an eraser. When a flashlight or laser pointer is directed through the mist, it shows up nicely, thanks to the Tyndall Effect.

Brass is a solid solution.

Chem to Go

1. Classify each of the following as a suspension, colloid, or solution. Explain your reasoning. (Hint: In some cases more than one answer may be possible.)
   a) A mixture is poured through a filter, and the entire mixture passes through.
   b) A mixture is left to stand for a while and small particles settle out.
   c) When viewed under a microscope, small particles are visible in the mixture.
   d) A beam of light passed through the mixture is scattered.
   e) The mixture is blue and transparent.
2. Suggest a method by which you could separate the various materials in each of the following mixtures:
   a) solutions
   b) colloids
   c) suspensions

3. Look in your kitchen at home and choose five products. Make your best guess as to the type of mixture they represent. Elaborate on the evidence that you used to classify the products into their respective categories. Explain what would happen to each product that you have chosen if it were in a different kind of mixture. For example, milk would settle if it was a suspension instead of a colloid. (Old-fashioned milk, before homogenization, did separate into the cream (oily) phase and the water phase.)
4. ***Preparing for the Chapter Challenge***

   Consider how you could use the properties of a solution, colloid, or suspension to produce a special effect for a movie scene. In a few sentences establish the setting for the scene, and describe the mood you want to create. In a paragraph or two, describe the chemistry required to understand the differences between the different types of mixtures and how they produce the special effect.

Inquiring Further

Cooking and mixtures

Cooking is a practical application of mixtures. One such application is the recipe for making mayonnaise. Mayonnaise is classified as a colloid. A liquid—liquid colloid is also called an emulsion. If you have access to the following materials, try making mayonnaise *at home*.

Recipe for Mayonnaise

Combine in a blender:

2 tablespoons beaten egg

1 large egg yolk

1/4 teaspoon dry mustard

1 teaspoon lemon juice

Blend the mixture for 20 s. While the blender is still running, add 3/4 cup of vegetable oil slowly in the thinnest stream you can manage. Serve immediately or keep for one to two days in the refrigerator.

Investigate the properties of the ingredients of mayonnaise that allow them to form this colloidal emulsion. What other substances are classified as emulsions? How could emulsions be used in a movie special effect?

Metals in cooking utensils are also examples of mixtures. Investigate the kinds of materials used in making metal cooking utensils. Why are some mixtures more suitable for cooking than others?

Do this only with the approval of a responsible adult.