Salting Out

Learning Objectives: Students learn general rules of why some substances will mix and some won’t.

GRADE LEVEL

6–8

SCIENCE TOPICS

Physical Properties
Atoms and Molecules
Solutions and Mixtures

PROCESS SKILLS

Describing/Defining
Predicting
Explaining

GROUP SIZE

2–3

SNEAK PEAK inside …

ACTIVITY

Students separate a solution into colored layers.

STUDENT SUPPLIES

see next page for more supplies
isopropyl alcohol
old permanent markers (e.g., Sharpie™)
salt
small glass jars with lids (e.g., baby food jars)

ADVANCE PREPARATION

see next page for more details
Label pop-top squeeze bottles, etc.

OPTIONAL EXTRAS

DEMONSTRATION

Oil and Water (p. A - 69)
Oil and Water and Soap (p. A - 70)

EXTENSIONS

Candy Color (p. A - 77)
Inquiry Opportunity—Test Solubility (p. A - 78)
Measure Layers (p. A - 78)

If available, goggles are recommended for this activity.

TIME REQUIRED

Advance Preparation
Set Up
Activity
Clean Up

10 minutes
10 minutes
30 minutes in each of two class sessions
5 minutes
Activity Note:
To increase student comprehension, run this activity over two class sessions. In the first, perform the two Teacher Demonstrations: Oil and Water and Oil, Water, and Soap. Discuss polarity with older students. Then take the second session to run the experiment in the jars.

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>small jars with lids (e.g., baby food jars)</td>
<td>4 per group</td>
</tr>
<tr>
<td>masking tape</td>
<td>1 roll per group</td>
</tr>
<tr>
<td>permanent markers (e.g., Sharpie™)</td>
<td>1 per group</td>
</tr>
<tr>
<td>pop-top squeeze bottles (e.g., water or sports drink)</td>
<td>2 per group</td>
</tr>
<tr>
<td>isopropyl alcohol (at least 90% concentration)</td>
<td>½ cup per group</td>
</tr>
<tr>
<td>water</td>
<td>½ cup per group</td>
</tr>
<tr>
<td>salt</td>
<td>½ cup per group</td>
</tr>
<tr>
<td>plastic cups, 8 oz.</td>
<td>1 per group</td>
</tr>
<tr>
<td>teaspoon measures</td>
<td>2 per group</td>
</tr>
<tr>
<td>8½” x 11” plastic protective sleeves (optional)</td>
<td>1 per group</td>
</tr>
</tbody>
</table>

For Extension and Demonstration supplies, see the appropriate sections.

Supplies Preparation

Markers:
- Use OLD (relatively dry) permanent markers. New markers are so full of alcohol and ink that they will leak into water solutions. Old markers will still nicely color alcohol solutions.

Salt:
- Fill cups with about ½ cup of salt.
- Label the cups “salt.”

Water:
- Fill pop-top squeeze bottles with about ½ cup of water.
- Label the bottles “water.”
**Alcohol:**
- Use at least 90% concentration of isopropyl alcohol; 99% is best.
- Fill pop-top squeeze bottle with about ½ cup of alcohol.
- Label pop-top squeeze bottles “alcohol, 90%” or with what percent you use.

**CAUTION:** Isopropyl alcohol is flammable and poisonous. Keep away from heat and open flames.

**Notes and Hints**
- To protect Instruction Charts from spilled liquids, insert each page into a plastic protective sleeve or laminate (optional).

**SETUP**

For each group
- 4 small glass jars with lids
- roll of masking tape
- permanent marker
- pop-top squeeze bottle of alcohol
- pop-top squeeze bottle of water
- salt in plastic cup
- 2 teaspoons
- Instruction Chart (suggestion: in protective sheet or laminated)

At a central location (or with the teacher)
- sponges and towels for clean up

**INTRODUCING THE ACTIVITY**

Let the students speculate before offering answers to any questions. The answers at right are provided for the teacher.

Choose questions that are appropriate for your classroom.

In this activity, students will color an alcohol solution using a permanent marker. Then they will mix the solution with water and see a big colored solution. Finally, they will add salt, shake, and observe the solution separate into a colored alcohol layer and a clear water layer.

**Let’s list a few things that can dissolve in water.**
Salt, sugar, honey, baking soda, baking powder, almost all acids and bases, lye, lemon juice, carbon dioxide (e.g., in soda), oxygen gas (e.g., in streams where fish breathe it), bath salts, food coloring.
What does it mean to dissolve? When you add something to water, how do you know it has dissolved?
When a substance is added to water, if it dissolves, the molecules move apart from each other and become completely surrounded by water molecules. One way to tell that something has dissolved is that the water looks clear. It may still have a color, but you can see through it.

Water is a great solvent, meaning it can dissolve many different things. Some scientists even call water a “universal solvent” because it dissolves so much. But does that mean it will dissolve everything? Can you give me some examples of substances that don’t dissolve in water? Sand, plastic, metal, oil, gasoline, kerosene, pennies, butter, people, glass, wood, permanent ink.

Is it possible to change water so that it dissolves things faster, or so that it dissolves more substances?
Yes, you can raise the temperature to dissolve more solids (e.g., sugar), or you can increase the pressure to dissolve more gases (e.g., the pressurized water in closed soda cans holds more bubbles).

Is it possible to change water so that substances will not dissolve?
Yes. Cooling water makes it less able to dissolve things, which is why hot chocolate mix powder collects on the bottom of mugs as the hot chocolate cools. In soda cans, shaking up the soda can cause the gas to escape. Finally, if the amount of water is reduced (through evaporation or boiling, for instance), any dissolved solid may come out. An example is ocean water leaving a salt crust as it dries on skin.
Oil and Water
This demonstration is best done before the activity. This will show students two liquids that don’t mix, as well as a colored molecule that only dissolves in water.

Supplies
- clear plastic bottle with lid (20 oz., 1-liter, etc.) or clear jar with lid
- water
- food coloring
- vegetable oil

Procedure
- Fill the plastic bottle halfway with water. Show this to the students.
- Add a few drops of food coloring. Mix and show this to the students. Does the food coloring dissolve in the water? How do you know?
- Add enough vegetable oil to the water to create a layer at least ½–1 inch thick. Screw the top on the bottle and shake it to mix the contents.
- Show the bottle to the students. Did the oil and water mix? How do you know? Where is the oil? Where is the water? Where is the food coloring?

Explanation
Oil and water are made of different types of molecules. The molecules in water have a small positive and a small negative charge, a bit like the poles on a magnet. We call such molecules with partial charges polar molecules. The molecules in oil have almost no positive or negative charge. We call these molecules non-polar molecules.

Different kinds of molecules do not mix well with each other. Polar molecules like to associate with other polar molecules. The molecules in the food coloring are polar (that is, they also have charges on them), so they mix with the water and not with the oil.

NOTE: The oil floats on the water because it is less dense than water. For a more detailed discussion of density, see the Explanation section of Density Rainbow.
**Oil and Water and Soap**

Continue from the previous demonstration to make oil and water mix. Soap will help the two liquids dissolve in each other.

**Supplies**
- bottle from last demonstration filled with oil and colored water
- liquid soap (hand soap, dish soap)

**Procedure**
- Add a squirt or two of soap to the mixture from the last demonstration. At first, the soap will likely sit between the water and oil layers, but then will sink to the bottom.
- Screw the top on the bottle and shake it to mix the contents.
- Show the bottle to the students. Did the oil and water mix? How do you know? Where is the oil? Where is the water? Where is the food coloring? Where is the soap?

**Explanation**
Soap molecules are long chains. On one end, there is a charge, meaning that this end of the soap molecule can mix with water. The rest of the molecule has no charge, meaning it can mix with oil. Soap therefore acts like a bridge between oil and water molecules to help them all mix together. After shaking the mixture and letting it sit for a while, the layers may separate again, but students should notice that the layers are not distinct. The food coloring seems to be in both layers, and it is hard to tell where the oil is and where the water is.

*Note:* For a more detailed description of how oil and water can be mixed together with soap, see the Explanation section for DNA Extraction. The second part, for older students, shows oil dissolving with soap in water.
Have students follow the Scientific Procedure on page A - 82, working in groups of 2–3. Below are suggestions to help the teacher facilitate the activity.

### NOTES

If available, goggles are recommended for this activity.

### Salting Out

**SCIENTIFIC PROCEDURE**

1. Label two spoons with masking tape one for "liquid" and one for "salt." Also label four jars with the numbers 1–4. Get the jars up on the Instruction Chart.

2. Look at the Instruction Chart and then add water or alcohol to the jars according to its directions.

3. In the next step you will add salt to Jar 1 and Jar 2. But before you do so:
   - **Predict:** Do you think the salt will dissolve in the water?
   - **Predict:** Do you think the salt will dissolve in the alcohol?

4. Now, add 1 spoonful of salt each to Jar 1 and to Jar 2. Put the lids on each jar and shake vigorously for 20–30 seconds.
   - **Record:** Describe what the salt and water look like.

### Running Suggestions

- To increase student comprehension, run this activity over two class sessions. In the first, perform the two Teacher Demonstrations: Oil and Water and Oil, Water, and Soap. Discuss polarity with older students. Then take the second session to run the experiment in the jars.
- Make certain students tightly close the jars before shaking them.
- Students should record their observations as the procedure sheet prompts them. Encourage students to use detail. If a question comes before a step, the student should record their answer to the question BEFORE doing that step.

You may want to instruct students to write their answers and draw pictures on separate pieces of paper so they will have more space to write.

- Old permanent markers work better because they produce better color separations than new ones. Brand new permanent markers may even color both the water and the alcohol. (New markers are so full of alcohol and ink that both can leak into the water.)
Ongoing Assessment

- What can happen when you combine two substances? They can mix, they can stay separate, or they can react to make something new.
- How do you know if something has dissolved? It so finely disperses as to become invisible in the liquid. The liquid is clear, you can see through it, but it may have a color. At this point, each molecule of salt is completely surrounded by liquid molecules.
- Why do you think some chemicals dissolve and some don’t? They have different chemical properties; in this case, things dissolve if they have similar charges. The charges on the water are attracted to the charges on the alcohol.
- Can you explain why the alcohol and water separate when you add salt? The salt strongly attracts the water and the salty water has too much charge to dissolve the alcohol.

Safety and Disposal Information

- If available, goggles are recommended for this activity.
- Waste isopropyl alcohol should be kept away from all sparks and flames. The small amounts used in this experiment may be poured down the sink drain with lots of water.
- All other materials can be thrown away as solid waste.

CAUTION: Isopropyl alcohol is flammable and poisonous. Keep away from heat and open flames.

Did the salt dissolve in the alcohol? Did the salt dissolve in the water?
Answers will vary. Some salt actually does dissolve in the alcohol but not very much. The alcohol is less polar than the water, so its charges are less well attracted to the charged particles in salt. Much more salt dissolves in the water, but the water can only hold so much salt.

Permanent markers are designed to not dissolve in water. Did the ink dissolve in the water? Did it dissolve in the alcohol? Why does it dissolve in the water and alcohol solution?
The permanent ink is more like the alcohol than the water. However, because the alcohol can dissolve with the water, the alcohol carries the marker ink into the water when it dissolves in the water. The alcohol acts as a bridge in the solution to keep the marker ink dissolved.

When you added the salt to the colored water and alcohol, what happened to the salt? Did it dissolve in the water or the alcohol?
Answers will vary. The salt dissolved mostly in the water, but some in the alcohol. It’s hard to tell where which liquid dissolved the salt just by
At the end of the experiment, which layer was alcohol and which was water? How do you know? Why do you say so?
The marker ink helps us guess the alcohol layer is on top. Another way to figure out which layer is which is to add a bit more water. If the water passes through the top layer and collects on the bottom, the top layer is alcohol. If the water stays on the top and increases the width of the top, the top layer is water.

The alcohol layer seems to be smaller than the water layer, but we started out with more alcohol, right? Why do you think it is smaller?
Answers will vary. The layer on top is small because some of the alcohol is dissolved in the lower water layer, even though the water is salty. In actual fact, neither the alcohol nor the water layers are completely pure—some alcohol remains dissolved in the water layer, and vice versa. NOTE: Observant students might point out that the water layer must have dissolved more of the alcohol, since the alcohol layer is smaller.

To further investigate this last question, students can complete Extension B.

EXPLANATION

This background information is for teachers. Modify and communicate to students as necessary.

In this activity, students make a colored solution of permanent marker ink, water, and alcohol. Then they cause the solution to form separate, colored layers by adding salt.

Like Dissolves Like—Salt in water
Salt dissolves in water because it is “like” water in a chemical way. Students explore this idea in the activity when they add salt to both water and alcohol. The salt dissolves easily in the water but does not dissolve very well in the alcohol. This demonstrates a common phenomenon in chemistry, that “like dissolves like,” or that chemicals that have similar properties will dissolve in each other. Thus, we see that salt and water have “something” more in common than salt and alcohol. Another place to see this is in the Teacher Demonstration, Oil and Water. Oil and water do not mix at all; they are insoluble. This implies that water and oil have very different chemical properties.
Like Dissolves Like—Permanent marker ink in alcohol
Permanent marker dissolves in alcohol because it is “like” alcohol in a chemical way. It does not dissolve in water because it is chemically unlike water. Students explore this idea when they add permanent marker to both the water and alcohol. *

After the solutions separate, students notice that the color from the permanent marker stays in the alcohol layer, not the water layer. Permanent marker ink is designed to resist washing with water (i.e., water does not dissolve it), but the ink dissolves easily in alcohol. Permanent marker ink must share some chemical properties with alcohol and not with water.

Alcohol and Water
Even though alcohol and water act differently when compared with salt or with marker inks, they are similar enough to dissolve in each other quite well. Students investigate this when they mix their colored alcohol and water: they find the color is evenly distributed through the entire mixture. This shows that the alcohol and water are soluble (will dissolve in each other). It also shows that permanent marker ink will dissolve in water when alcohol is present.

Students might construct a continuum like the following:

Salt.......................Water ...................... Alcohol..........................Permanent Marker Ink

Chemicals near each other on this chart are similar and will dissolve together, but chemicals that are far apart will not.

Salting Out—Separating alcohol and water
Adding salt to water/alcohol mixtures can separate them into layers. Even though water and alcohol mix well together, alcohol and salt do not. When salt is added to the solution, the salt dissolves in the water but not in the alcohol. Two layers are formed, with the alcohol layer on top. The marker ink allows us to see the separation more clearly, as it travels with the alcohol layer.

**NOTE:** The alcohol layer floats on the saltwater layer because it is less dense than water or saltwater. For a more detailed discussion of density, see the Explanation section of Density Rainbow.

* Note: Students might find that brand new permanent marker ink seems to dissolve in water. However, this isn’t really the case. Marker ink contains some alcohol, and a new marker has enough alcohol that some of the alcohol leaks into the water, carrying some of the dissolved ink. This allows the ink to mix in the water to a certain extent.
**EXTRA INFORMATION**

**Charges on Molecules**

When chemists say that “Like Dissolves Like,” they really mean “like charges dissolve like charges.” In other words, to understand whether solids or liquids dissolve together (i.e., are soluble), it is necessary to look at the electrical charges on the molecules. These charges come from how the electrons (negatively charged particles) are shared between atoms.

When atoms combine to make molecules, they can share their electrons in one of three ways: the atoms can share the electrons equally, one atom can take the electrons completely, or they can share the electrons unequally. The way the electrons are shared determines the overall charge of the molecule (see Figure 2).

**Equal Sharing = Covalent**

An example of almost equal sharing is found in oil. Molecules of vegetable oil have very little overall charge because most the atoms share the electrons almost equally. In mineral oil the sharing is even more equal, and the overall charge is even smaller. This type of sharing between atoms results in covalent chemical bonds.

**No sharing = Ionic**

An example of no sharing of electrons is found in table salt, where one atom (chlorine) completely takes the electron and acquires a strong negative charge. The atom that donated the electron (sodium) ends up with a strong positive charge. These opposite charges attract to form an ionic bond.

**Misconception Alert:** Even though the parts of the molecule have positive and negative charges, they cancel out, so each molecule has a total net charge of zero.

**Unequal Sharing = Polar**

Examples of unequal sharing are found in water and alcohol, where the atoms share the electrons unequally. Because the electrons are held nearer to one of the atoms, it acquires a partial negative charge, while the other atom gets a partial positive charge.

Because the atoms partially share the electrons, this type of bond is considered a covalent bond; however, it is called a polar bond because it is partially charged.

It is important to note that water shares its electrons much more unevenly than alcohol, so its molecules are much more charged (but still not completely charged like the salt).
**Misconception Alert:** Even though the parts of the molecule have small positive and negative charges, they cancel out so each molecule has a total net charge of zero.

**Charge and Solubility**
The charges on the molecules in chemicals like water, oil, alcohol, and salt affect how much they dissolve in each other. Salt molecules are very charged, so they dissolve easily in water, which has slightly charged molecules. Salt dissolves less easily in alcohol, because alcohol molecules have less charge than water.

Alcohol also has a portion of its molecule that has no charges, i.e., it is **non-polar**, like oil. This portion is less compatible with water and more compatible with non-polar molecules. Under normal circumstances, alcohol can dissolve in both polar and non-polar substances. This implies that permanent marker ink has molecules that have little or no charge since they dissolve in alcohol but not in water. Because alcohol dissolves with both water and permanent marker ink, the alcohol acts as a bridge between the water and the permanent marker ink allowing all three to mix together.

Finally, salt doesn’t dissolve in oil at all because oil has practically no charge at all. Some of these relationships are shown in Figure 3.

![Figure 3. Charge differences explain solubility.](image)

A difference in charge also explains why oil and water will not mix. Since oil molecules are almost entirely uncharged, they won’t mix with charged water molecules. Wax, fat, and rubber are also made of uncharged molecules and are similarly “waterproof.”
Some chemicals can dissolve in two different chemicals that don't dissolve in each other. For example, soap and alcohol can dissolve in both water and oil, even though water and oil don’t mix. What’s more, when soap (for instance) mixes with oil and water together, it helps the oil and water mix. (This is how soap and water remove cooking oil from pans.) In this way, soap acts as an **emulsifier** since it is helping two liquids mix that normally won’t.

**Salting Out Revisited**
When students add salt to the mixture of water, alcohol, and permanent marker ink, the mixture separates into two separate layers. One layer has alcohol and permanent marker ink, and one layer has salt and water. With its high charges, the salt dissolves much more easily in the water. This makes the saltwater mixture too charged for the alcohol to stay in solution. The salt effectively repels the alcohol, and the mixture separates.

**Salting Out Applications**
Chemists use salt to alter the charge of water solutions when they want to precipitate proteins, separate polar liquids from water, or concentrate dissolved chemicals (like the marker ink) in a non-water layer.

Scientists take advantage of how salt dissolves in water to purify proteins. When **biochemists** study the chemistry of the body, they often focus on the proteins, because understanding how proteins work can help them design new medicines, diagnose diseases, and understand how genes work. Unfortunately, though, most of the interesting **proteins** and other biological molecules of the body are dissolved in the watery interior of the cell. It can be very difficult to separate one protein from the thousands of other proteins and molecules.

One way to isolate proteins for study is to add precise amounts of salt to “salt out” the proteins. This forces the proteins to **precipitate**, or leave the water solution, similar to the way the colored alcohol does in the students’ experiment. Adding salt increases the charge of the overall solution, and, because all proteins have different charges, they precipitate from the salt water solution at different concentrations of salt.

### EXTENSIONS

**Extension A: Candy Color**
The dyes in many candies will dissolve in the water layer, not the alcohol. Students can use these candies to color the water layer in the jars. If the students want to color both the layers at the same time (that is, use candies to color the water and markers to color the alcohol), they should avoid using candies that are the same color as the marker.

**Extra Supplies**
- water soluble dyes: M&M’s™ candies, Skittles™ candies

**Extra Instructions**
- Follow the same procedure as the general activity.
- Substitute (or add) candies in Step #7 for the permanent marker.
Students should use two candies for each jar and leave them in the solution briefly. They should remove the candies before the colored coating dissolves completely (because, for example, the chocolate in M&M’s will dissolve and make a murky solution).

**Extension B: Inquiry Opportunity—Test Solubility**
Ask students what other compounds they think will dissolve in only water or in only alcohol. Why or why not? For example, “waterproof” or “water resistant” compounds (such as permanent markers) are more likely to dissolve in only alcohol. Other compounds are more likely to dissolve in water.

**Extra Supplies**
- dyes of unknown solubility: dry erase markers, overhead pens, colored markers, squares of paper with color printed from a computer, candies (as in Extension A above)

**Extra Instructions**
Students can repeat the entire procedure, but use another dye in place of marker inks. When students complete the procedure, they can evaluate whether their dye was successfully separated into either the alcohol or water layer.

**Extension C: Measure Layers**
After the salting out procedure is finished, students should add more of one ingredient to the layered solution. What will happen? Will both layers get bigger? Will one layer grow and the other shrink? By measuring the width of each layer beforehand, students can see the difference and calculate ratios.

**Extra Supplies**
- ruler (1 per group)
- extra alcohol
- extra water
- extra salt

**Extra Instructions**
1. Add alcohol
   - After completing the original Scientific Procedure, students should measure the depth of each layer in the jar.
   - Add one teaspoon of alcohol to the layers in Jar 3. Recap the jar and shake for 20–30 seconds
   - Re-measure the layers.
   - Students can repeat adding alcohol and re-measuring until the jar is full.
2. Add water
   - Start over. Recreate the layers in Jar 3 by redoing the original Scientific Procedure (students can skip any reference to Jar 1 and Jar 2).
   - Measure the depth of each layer in Jar 3.
   - Add one teaspoon of water. Recap Jar 3 and shake for 20–30 seconds.
   - Re-measure the layers.
   - Students can repeat adding water and re-measuring until Jar 3 is full.

3. Add salt
   - Start over again! Recreate the layers in Jar 3 by redoing the original Scientific Procedure (students can skip any reference to Jar 1 and Jar 2).
   - Add one teaspoon of salt. Recap Jar 3 and shake for 20–30 seconds.
   - Re-measure the layers.
   - Students can repeat adding salt and re-measuring until no more salt will go into solution.

Explanation
   - When alcohol is added: The alcohol layer increases in depth while the water layer decreases. This happens because the larger amount of alcohol is able to absorb (i.e., dissolve) some of the water. The water layer will shrink as the alcohol layer grows. Eventually the layers combine into one mixture of alcohol, water, and salt.

   - When water is added: This is more or less the opposite of adding alcohol. The water layer increases in depth and the alcohol layer decreases—the increased amount of water can dissolve more of the original alcohol. The alcohol layer will shrink as the water layer grows. Eventually the layers combine into one mixture of alcohol, water, and salt.

   - When salt is added: the salt dissolves mostly in the water, changing the water and making it less able to mix with the alcohol. This causes the alcohol layer to grow. The water layer appears to shrink, but it is hidden inside the growing pile of salt at the bottom of the jar.
CROSS-CURRICULAR CONNECTIONS

BIOLOGY

Cell Biology
Research the parts of the cell, the process of membrane transport, and the contents of the cytoplasm. Find out how the chemicals in the cytoplasm guide the cell in deciding what enters and leaves the cell through the membrane.

SOCIAL STUDIES

The Importance of Salt
The impact of salt on economies, trade, and culture is vast. Research the important role salt has had in food preservation, the growth and strength of cultures, and even in war.

RESOURCES

An introduction to the concept of polar and non-polar molecules, with pictures and diagrams.

Web – http://chem4kids.com
An excellent website with information on all chemical concepts. Their site map has a well-organized topic index. The topics “Solutions,” “Mixtures 1,” and “Mixtures 2” are relevant to this activity.

The Salt Institute has an extensive site explaining the place salt has in history, politics, and economics.

Frankel, Jill and Kline, Michael, Super Science Concoctions: 50 Mysterious Mixtures for Fabulous Fun
Reading Level: 3rd to 8th grade
Well-organized, detailed recipes, fun activities, and thorough, accurate scientific explanations. The first section focuses on solutions and mixtures; later sections explore other chemistry topics.

VOCABULARY

biochemists: scientists who study the chemistry of life processes
covalent bonds: connections between atoms where the electrons are equally shared; molecules with these bonds tend to be balanced electrically
dense: describes how tightly packed matter (molecules, people) is in a space; density is the noun
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>dissolve:</strong></td>
<td>when the molecules of one substance separate and become completely surrounded by the molecules of another substance</td>
</tr>
<tr>
<td><strong>electron:</strong></td>
<td>negatively charged particle found in atoms</td>
</tr>
<tr>
<td><strong>emulsifier:</strong></td>
<td>something added to two liquids that normally won’t dissolve to keep them uniformly mixed</td>
</tr>
<tr>
<td><strong>like dissolves like:</strong></td>
<td>the principle in chemistry where substances with similar molecules mix well</td>
</tr>
<tr>
<td><strong>insoluble:</strong></td>
<td>unable to dissolve</td>
</tr>
<tr>
<td><strong>ionic bonds:</strong></td>
<td>connections between atoms where the electrons are transferred from one atom to another; molecules with these bonds tend to be highly charged</td>
</tr>
<tr>
<td><strong>non-polar:</strong></td>
<td>describes neutral molecules whose charges are electrically balanced</td>
</tr>
<tr>
<td><strong>polar bonds:</strong></td>
<td>connections between atoms where the electrons are not equally shared; molecules with these bonds tend to have a small, unbalanced electrical charge</td>
</tr>
<tr>
<td><strong>polar molecules:</strong></td>
<td>molecules with partial electrical charges</td>
</tr>
<tr>
<td><strong>precipitate:</strong></td>
<td>to come out of a liquid solution as a solid</td>
</tr>
<tr>
<td><strong>protein:</strong></td>
<td>a large, complex biological molecule found throughout the body; hormones, enzymes, and antibodies are all proteins, as are many of the structural parts of the body</td>
</tr>
<tr>
<td><strong>salting out:</strong></td>
<td>adding salt to a solution of water and another liquid in order to separate or purify the liquid components</td>
</tr>
<tr>
<td><strong>soluble:</strong></td>
<td>able to dissolve in a particular substance</td>
</tr>
</tbody>
</table>
Salting Out

SCIENTIFIC PROCEDURE

1. Label two spoons with masking tape, one for “liquid” and one for “salt.” Also label four jars from #1 to #4. Put the jars on the Instruction Chart.

2. Look at the Instruction Chart and then add water or alcohol to the jars according to its directions.

3. In the next step you will add salt to Jar 1 and Jar 2. But before you do so:
   • Predict: Do you think the salt will dissolve in the water?
   • Predict: Do you think the salt will dissolve in the alcohol?

4. Now, add 1 spoonful of salt each to Jar 1 and to Jar 2. Put the lids on each jar and shake the jars for 20–30 seconds.
   • Record: Describe what the salt and water look like.
   • Record: Describe what the salt and alcohol look like.

5. Set Jars 1 and 2 aside.

6. In the next step you will add permanent ink to Jar 3 and Jar 4. But before you do so:
   • Predict: Do you think the ink will dissolve in the water?
   • Predict: Do you think the ink will dissolve in the alcohol?

7. Now swirl the tip of a permanent marker in the liquid in Jar 3 for 10 seconds. Repeat for Jar 4. Put the cap back on the marker when you’re finished. Put the lids on each jar and swirl them for 5 seconds.
   • Record: Describe what the ink and water look like.
   • Record: Describe what the ink and alcohol look like.
8. In the next step (but not yet), you will mix the contents of Jar 4 with those of Jar 3. Before you do so, what do you think will happen?
   • Predict: Draw and label a picture of what you think the mixture will look like. Where will the water be? Where will the alcohol be? Where will the ink be?

9. Now, pour the alcohol from Jar 4 into the water in Jar 3. Put the lid on the jar and swirl for 5 seconds to mix.
   • Record: Draw and label a picture of the mixture. Where is the water? Where is the alcohol? Where is the ink?
   • Record: Explain how you know where all the ingredients are.

10. In the next step, you are going to add salt to the mixture. Before you do so, what do you think will happen?
    • Think: Read over your results so far.
    • Predict: Draw and label a picture of what you think the mixture will look like after the salt is added. Where will the water be? Where will the alcohol be? Where will the ink be? Where will the salt be?

11. Now, add 1 spoonful of salt to the mixture in Jar 3. Put the lid on the jar, and shake it for 20–30 seconds.
    • Record: Draw and label a picture of your mixture. Where is the water? Where is the alcohol? Where is the ink? Where is the salt?
    • Record: Explain how you know where all the ingredients are.

12. Clean up your area.
    • Follow your teacher’s directions.
Salting Out

INSTRUCTION CHART

JAR #1
Add 4 spoonfuls water

JAR #2
Add 6 spoonfuls alcohol

JAR #3
Add 4 spoonfuls water

JAR #4
Add 6 spoonfuls alcohol
Salting Out

Recommended group size: 2–3

Number of Students: ______ Number of Groups: ______

<table>
<thead>
<tr>
<th>Supplies</th>
<th>Amount Needed</th>
<th>Supplies on Hand</th>
<th>Supplies Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>small jars with lids (e.g., baby food jars)</td>
<td>4 per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>masking tape</td>
<td>1 roll per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>permanent markers (e.g., Sharpie™)</td>
<td>1 per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pop-top squeeze bottles (e.g., empty Gatorade™)</td>
<td>2 per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>isopropyl alcohol (at least 90% concentration; 99% or more is best)</td>
<td>½ cup per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water</td>
<td>½ cup per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>salt</td>
<td>¼ cup per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>plastic cups, 8 oz.</td>
<td>1 per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>teaspoon measures</td>
<td>2 per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8½” x 11” plastic protective sleeves (optional)</td>
<td>1 per group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sponges and towels for clean up</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Extension A**

M&M’s™, Skittles™, or another candy with water soluble dye | 4 per group |  |  |

**Extension B**

dyes of unknown solubility: dry erase markers, overhead pens, colored markers, squares of paper with color printed from a computer, candies | varies | | |

**Extension C**

rulers | 1 per group |  |  |
extra alcohol | ¼ cup per group |  |  |
extra water | ¼ cup per group |  |  |
extra salt | ¼ cup per group |  |  |

Supply Worksheet continues on next page.
<table>
<thead>
<tr>
<th>Supplies</th>
<th>Amount Needed</th>
<th>Supplies on Hand</th>
<th>Supplies Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teacher Demonstration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil and Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clear plastic bottle with lid (20 oz., 1 liter, etc.) or clear jar with lid</td>
<td>1 per class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>food coloring, any color</td>
<td>1 bottle (only a few drops needed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vegetable oil</td>
<td>about ¾ cup or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oil, Water, and Soap</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bottle of liquid dish or hand soap</td>
<td>a few squirts from the bottle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Otherwise, supplies are the same as for the teacher demonstration with oil and soap.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>