

Italian Dressing: Can Oil and Water Mix?

You've probably shaken a bottle of oil-and-vinegar-type Italian salad dressing to mix it, only to have it separate again before you pour it on your salad. Isn't this annoying? You can investigate this system to understand why it happens as well as to learn something about some other everyday liquids.

Materials

- tape that can be written on
- pen
- ruler
- small, clear, colorless bottle (or jar) with lid
- 1 of the following to half-fill the bottle:
 - equal amounts vegetable oil and water or vinegar
 - oil-and-vinegar-type Italian salad dressing (not creamy style)
- liquid soap or detergent
- at least 3 of the following additives:
 - tincture of iodine
 - food coloring
 - mineral oil
 - baby oil
 - rubbing alcohol
 - nail polish remover
 - soft drink

Safety

Since some of the additives are flammable, do not perform these activities near a heat source. You may dispose of the final mixture down the drain and recycle the empty bottle.

Exploration

- Step 1 Place a strip of tape lengthwise on the bottle or jar, as shown in Figure 1. Half-fill the bottle or jar with either oil-and-vinegar-type salad dressing or equal amounts of vegetable oil and water or vinegar. Use a pen to mark a line on the tape at the top of each layer. Measure and record the height of each layer (the distance between the layer's bottom and its top). What observation(s) allows you to determine which substance constitutes the top layer and which one the bottom? What general property of substances is responsible for this positioning? Explain.

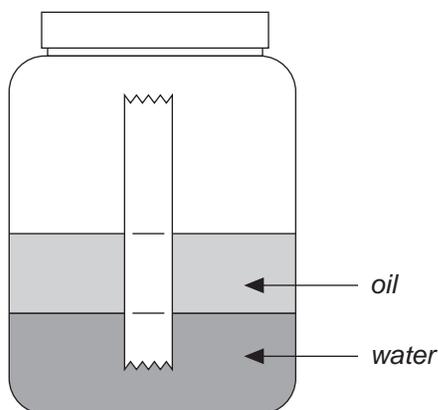


Figure 1: Attach a piece of tape to the outside of the bottle.

- Step 2 Add a little more water to the bottle, then remeasure the height of each layer. How can you tell if any of the added water dissolved in the oil? Explain your observations in terms of polarity.
- Step 3 Add just enough of one of the additives to your oil and water mixture to enable you to determine and record its position in the bottle. Also record the height of each layer and any other significant observations about the mixture. Gently shake the bottle and note any changes once the layers have again separated.
- Step 4 Repeat Step 3 with at least two more of the additives (added one at a time).
- Step 5 Add 20–30 drops of liquid soap or detergent to your mixture from Step 4. Shake the bottle well and allow it to stand for several minutes. Record the height of each layer and any other significant observations about the mixture. Explain your observations in terms of the nature of soap and detergent molecules.

Challenge

What can an oil-and-vinegar-type Italian salad dressing tell us about the polarity of some everyday liquids? Can oil and water mix?

Italian Dressing: Can Oil and Water Mix?

Concepts

polarity, solubility, emulsions, density

Expected Student Responses to Exploration

- Step 1 (a) The layer heights will vary.
 (b) The color of the vegetable oil should give it away.
 (c) The property of density.
 (d) Water goes to the bottom because it is more dense than the oil.
- Step 2 (a) The layer heights will vary. Both will be above the initial marks but only the water height will actually change.
 (b) None of the added water dissolved in the oil because the height of the oil layer did not change.
 (c) Water is a polar covalent substance and oil is a nonpolar covalent substance. A general rule of thumb for the solubility of covalent substances in one another is that “like dissolves like.” Since water and oil are not alike, they aren’t expected to dissolve in one another.
- Step 3 (a) The position of the additive should be recorded.
 (b) The layer heights will vary.
 (c) Students may note a change in position after shaking—the initial position may be unstable due to the manner of addition.
- | Additive | Layer Dissolved In |
|---------------------|---------------------------------------|
| tincture of iodine | water (red-brown) and oil (red-brown) |
| food coloring | water |
| mineral oil | oil |
| baby oil | oil |
| rubbing alcohol | mostly water; some oil |
| nail polish remover | mostly water; some oil |
| soft drink | water |
- Step 4 See table in Step 3(c).
- Step 5 (a) The layer heights should be tabulated—the oil layer should be decreased in height. The oil layer generally appears cloudy.
 (b) Soap or detergent molecules have a long nonpolar portion which is attracted to the oil molecules as well as an ionic portion that is attracted to water molecules. The result is that some of the oil gets suspended in the water, forming what is known as an emulsion.

Expected Student Answer to Challenge

Additive	Polarity
tincture of iodine	both polar & nonpolar portions
food coloring	polar/ionic
mineral oil	nonpolar
baby oil	nonpolar
rubbing alcohol	polar
nail polish remover	both polar & nonpolar portions
soft drink	polar

Yes, oil and water can mix with the addition of a soap or detergent-like substance.

Acknowledgment

This activity was developed as a part of the NSF-funded “General Chemistry: Discovery-Based Advances for the Two-Year College Chemistry Curriculum” project, grant #DUE-9354378.