

## DEMONSTRATION

You saw a jar of hot water placed upside down over a jar of cold water. The hot water stayed on top of the cold water without mixing.

1. Why did the hot water stay on top of the cold water?

2. Why do you think the hot and cold water mixed when the cold water was placed on top?



## ACTIVITY

### Question to investigate

Is there a density difference between hot and cold water?



### Materials for each group

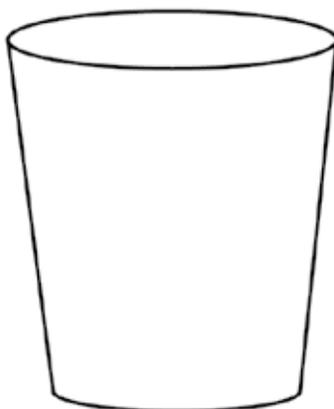
- Cold water (colored blue) in foam cup
- Hot water (colored yellow) in foam cup
- Room-temperature water in clear plastic cup (colorless)
- 2 droppers

## Procedure

1. Fill one dropper with blue cold water. Poke the end of the dropper about halfway into the colorless room-temperature water.
2. While observing from the side, very gently squeeze the dropper so that the cold water slowly flows into the room-temperature water.
3. Fill another dropper with yellow hot water. Poke the end of the dropper about halfway into the room-temperature water.
4. While observing from the side, very gently squeeze the dropper so that the hot water slowly flows into the room-temperature water.
5. Record your observations on the activity sheet.



3. Draw what you observed in the cup of room-temperature water after adding blue cold water and yellow hot water.



Be sure to label the areas of cold and hot water.

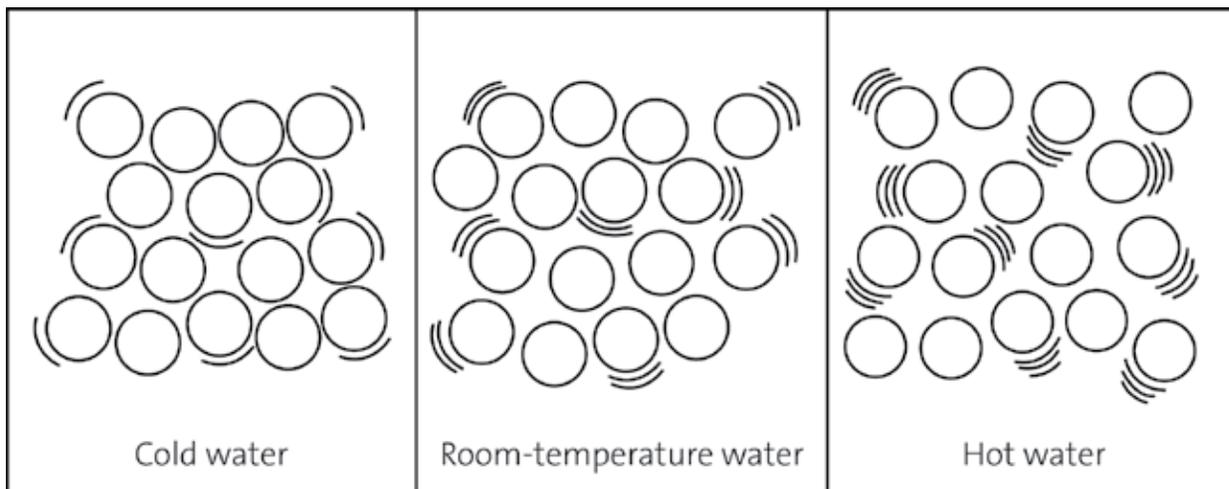
Is *cold* water more, less, or the same density as room-temperature water?

Is *hot* water more, less, or the same density as room-temperature water?

## EXPLAIN IT WITH ATOMS & MOLECULES

In the animation, you saw water molecules being heated and cooled.

4. Look at the model of water molecules in the diagram below to help you compare the volume, mass, and density of cold and hot water.



Write *more*, *less*, or *same* in the chart to describe the volume, mass, and density of cold and hot water compared to room temperature water.

Comparing cold and hot water to room-temperature water		
	Cold water	Hot water
Volume		
Mass		
Density		

5. Use what you know about density to answer the following questions.

Why does cold water sink in room-temperature water?

Why does hot water float on room-temperature water?

### ***TAKE IT FURTHER***

6. Your teacher did a demonstration with two cups of water that both had food coloring on the bottom. Ice was placed in one cup of water, but not the other. The food coloring mixed more quickly in the cup that had the ice. Use what you know about the density of water at different temperatures to explain why this happened.

*Note: Students may wonder why boats made out of dense material like steel can be made to float. This is a good question but not trivial to explain. To adequately answer this question, you will need to consider another aspect of sinking and floating. For an object to float, the mass of the water displaced by the object must equal the mass of the object. For example, a cube of steel will displace a certain volume of water equal to the volume of the cube. But the mass of the water displaced is less than the mass of the cube, so the cube sinks. But if you flatten out the steel cube and shape it into a large enough bowl and place the steel bowl in the water, the bowl will float. Its mass hasn't changed, but the volume of water it can displace has increased. The mass of the water displaced now equals the mass of the bowl and the bowl floats. You could stop your explanation here but there is another good question that can arise.*

Why should the *mass* of water displaced matter? This question requires a more physics-like perspective to answer. The mass of the bowl is pushing down onto the water by a force equal to the mass of the bowl  $\times$  the acceleration of gravity ( $\text{Force} = m \times a$ ). There is a law in physics that says that for every force on a stationary object, there is an equal and opposite force. In this case, the downward force of the bowl on the water is met with an equal force of the water pushing up on the bowl resulting in the bowl floating. If students have any question about an opposing upward force, ask them if they have ever tried to push an inflated ball like a beach ball under water.