Chapter 8: Quick Activities

Elements of Chemistry

Will the Raindrops Fall?

Water is a sticky substance, which explains why moisture in the air condenses into tiny droplets, as seen within a cloud or fog. These tiny droplets, in turn, coalesce into larger drops that fall, as seen with rain. So, what happens when a glass of water covered with plastic wrap punctured with many tiny holes is turned upside down?

PROCEDURE

1. Fill a tall glass with water and cover it with plastic wrap held taut with a rubber band around the rim.

2. Use a pin to poke many tiny holes into the plastic wrap directly over the mouth of the glass.

3. Predict what will happen when you turn the glass upside down over a sink. Will there be many tiny streams of water? Will a shower of raindrops form and fall? Will the water mostly not pass through the holes?

ANALYZE AND CONCLUDE

Explain your observation in terms of the stickiness of water molecules.

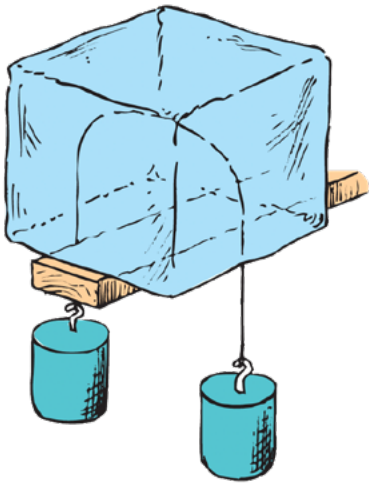
1. Is there any difference when you hold the glass still and level versus when you shake the glass or hold it at an angle?

2. Swirl some liquid dishwashing detergent into the water in the glass. Do you get the same results?

3. Assume you did the same activity using a wide-mouth plastic bottle with a hole drilled into the bottom. What results would you expect then?

Regelation

The principle behind ice-skating can be used to pass a metal wire through a block of ice. Create a large bubble-free ice block by adding recently boiled water to a plastic tub and freezing it in your freezer. Drape a thin metal wire across the ice block as shown in



the drawing. Dumbbells or water-filled jugs can be used as the weights. Once the wire has passed through, knock the ice with a hammer and see where it breaks. In the days before refrigerators, this was the way large ice blocks were cut to size for the kitchen icebox. What do you suppose would happen if string were used instead of wire? Why is thin wire preferable to thick wire?

Water Magic Trick

Glue-gun a plastic mesh screen in the mouth of an opaque plastic bottle just beneath the rim. Impress your friends by pouring water back and forth between this bottle and another one just like it but without the secret screen. With the water in your specially prepared bottle, place a card on top of the bottle. Hold the card and invert the bottle. Ask your friends what will happen when you take your hand off the card. They'll be amazed to see that the

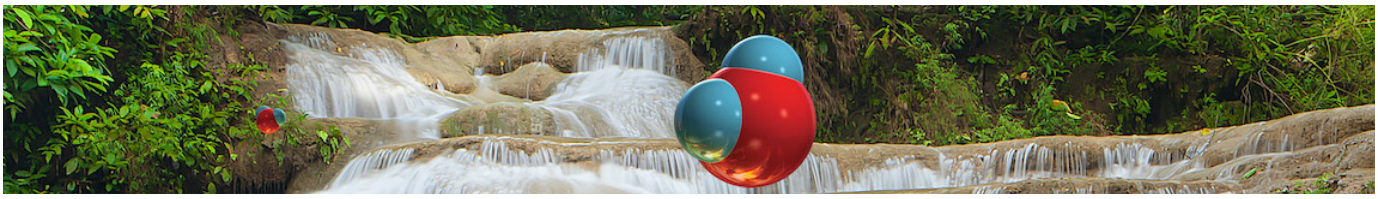
card stays. Be sure to explain the role of atmospheric pressure. Next, ask them what will happen when you knock off the card. They'll be even more amazed to see that the water doesn't come out. Finally, take a thin skewer stick and poke it up into the screen and ask what will happen when you let go of the stick. Let go of the stick and tell your friends that they're witnessing a "stickup." Of course, follow up with an explanation of the role that water's surface tension plays.

Cool Kitchen

Place a cup of salt and a cup of rice side by side on a piece of aluminum foil on a baking sheet. Heat the salt and rice for 10 minutes in an oven preheated to 250°C. Pour the salt and rice into two separate mugs. Which cools down faster? If you don't have a thermometer, judge their cooling rates by cautious touch. Which has the lower specific heat? Why does the heated rice adhere to the side of the mug?

Rice Heating Pad

Put the high specific heat of water to practical use by keeping warm on cold evenings or by soothing painful cramps. Fill a clean sock three-quarters full with rice, which by its nature absorbs a lot of moisture from the air. Tie the open end closed with a string (don't use metal wire!) and heat in a microwave for a couple of minutes. (Don't use a conventional oven!) The moisture in the grains becomes apparent when you take the sock out of the microwave—the released moisture has made the sock slightly damp. Carefully wrap the sock around your neck for instant gratification. Need a neck cooler? Store the rice-filled sock in the freezer. The moisture in the rice stays cold for a long time. These devices make great homemade gifts when a pretty fabric is used in place of the sock and a mild fragrance is added.



Author Responses to Quick Activities

Will the Raindrops Fall?

1. Some drops may initially fall, but by holding the glass still and at a level angle, you should find that the water tends to stay within the glass above the plastic wrap despite the many holes in the plastic wrap. It's interesting even to stick a pin through the plastic wrap while the glass is held upside down. The pin goes in, but when it comes out, the water stays behind. There are a number of things going on with this activity. First, be sure to review the Chapter 1 Quick Activity where you use a card to hold water in an upside-down glass. Recall that it's the weight of the air pushing up against the lower surface of the card that holds the water within the glass. The same thing is happening here except we're using plastic wrap rather than a card. But this doesn't explain how the water doesn't pour out through the holes. In Section 8.3 you learn about how the stickiness of water molecules gives rise to what we call surface tension where the surface of the water behaves like a thin rubber sheet. Because of this surface tension the water has a difficult time passing through these holes.
2. Some water is able to make it through and this is helped with motion, such as shaking or tilting the glass at an angle.
3. With a hole in the bottom of the inverted bottle, atmospheric pressure is able to push against the back side the water counteracting the atmospheric pressure pushing against the water at the mouth of the inverted bottle. These pretty much cancel each other out leaving the weight of the water as the remaining force, which pushes the water through the holes in tiny streams.

Regelation

Note that changes in phase are occurring as the ice melts below the wire and as the liquid water refreezes above. When the liquid water immediately above the wire refreezes, the water gives up energy. How much? Enough to melt an equal amount of ice immediately under the wire. This energy must be conducted through the wire. Hence this activity requires that the wire be an excellent conductor of heat. String is a poor conductor of heat, which is why it does not work as a substitute for metal wire.

Ice skaters know that the sharper their blades, the easier it is for them to glide. A sharper blade has a smaller surface area in contact with the ice and is thus able to apply a greater pressure. Similarly, a thin wire is able to slice through a block of ice more quickly than a thick wire. A thin wire, however, is also weaker and so might not be able to hold the anchoring weights without breaking.

Water Magic Trick

As a variation, you can begin your "magic show" having the water in the regular bottle when you demonstrate how atmospheric pressure pushes the card upward so that the water doesn't fall. Ask your friends what will happen when you turn the bottle sideways. (Atmospheric pressure works sideways too!) Then ask them what will happen when you flick off the card. Of course, the water comes rushing out. This builds up an expectation. Ask them if you can repeat the experiment. Pour water back and forth between the two bottles only this time u4e the bottle with the mesh screen.

Cool Kitchen

The first piece of evidence that the salt has a lower specific heat is that it has a higher temperature when you take your samples out of the oven. The second piece of evidence is that, despite this initially higher temperature, the salt cools faster than the rice. One reason rice has the higher specific heat is that each grain contains a fair amount of moisture. When you heat the rice, much of this moisture is released. Moisture continues to be released even after you take the rice out of the oven, which is why the grains adhere to the mug.

Rice Heating Pad

A must for every household. Good chemistry to you!