12. Bubble Bonanza

Investigate some physical properties of liquids, especially surface tension in a soap film. Demonstrate some surface tension principles.

**Life Skills:** cooperating  
**Science Process Skills:** observing, comparing, applying

**Time Frame**
- Helper Preparation: 25 min. plus the time to gather materials and review the Background Information and Youth Activity  
- Youth Activity: 40 min.

**Stuff You Need**

**Grabber (for the leader/helper only)**
- clean 9-in. pie pan
- 2 pieces of copy or notebook paper, 8.5 x 11 in.
- scissors
- liquid soap or detergent

**To Prepare for The Challenge and Challenge Continued (for 10-12 youth)**
- newspapers
- access to water and a sink
- gallon of warm water
- 1- to 2-gallon bucket for mixing the soap solution
- Joy™ or Dawn™ liquid dishwashing detergent, 1 cup per gallon of water
- one-cup measuring cup

**Optional**
- glycerin, 1 tablespoon per gallon of water
- several empty paper towel tubes
- masking tape

**The Challenge (per youth pair)**

**Surface Tension**
- clean bowl or bucket filled about 3/4 with water
- metal paper clip, #1 size
- toothpick
- liquid soap or detergent
- piece of bar soap
- small piece of waxed paper (about 8 x 8 cm, or 3 x 3 in.)
- large, clean plate filled with water
- pinch of talcum powder or cornstarch
- food coloring to tint the water (optional)

**The Challenge Continued (per two or three youth)**
- piece of kite string or thread, about 40 in. (100 cm) long for each youth
- 2 plastic drinking straws for each youth
- scissors
- tray or rectangular pan to hold soap solution to a depth of about one-half inch (alternative: large roasting pan)

**Expanded Activity (per youth pair)**
- soap solution from activity
- tray from activity
- small hand-strainer, such as the type used to strain tea leaves

**More Challenges (per youth pair)**
- small bowl, cereal or soup size
- milk to fill the bowl to a depth of 2 to 3 cm (1 in.)
- food coloring to tint the milk
- liquid dish detergent

**Bubble Engineer**
- soap solution from activity
- tray from activity
- empty plastic jug, for example, a milk or juice jug, or pop bottle
- scissors
- Karo® corn syrup
- Jell-O® powder

**Optional**
- window screen mesh, 15 x 15 cm (10 x 10 in.)
- Styrofoam cup with bottom removed
- plastic rings from a 6-pack of soda
- funnels
- tin can with ends removed and can edges filed to remove sharp edges
- six to ten pipe cleaners
- lightweight metal coat hanger
- pliers for bending the coat hanger
Safety Considerations

- Scissors should always be pointed downward when they are being carried. Do not allow any running with scissors in hand.
- Be careful of slippery floors. If this activity is done inside on an uncarpeted floor, spread newspapers on the floor so that it does not become dangerously slippery from dripped or spilled soapy water. Have the youth stop occasionally and wipe up soapy water that drips on the floor.
- Avoid getting soap in eyes. If soap does get in eyes, flush the eyes with running water for 15 minutes.
- Food coloring can stain. Remind the youth to wipe up any spills immediately.

Getting Started

Helpful Hints

1. For the Grabber activity, be sure that the pie pan or bowl is completely free of soap and oil when you drop the first spiral into it.

2. For The Challenge—Surface Tension, be sure that the bowl and paper clips are clean. Initially, the toothpick must also be clean and dry.

3. If the paper clip fails to float, have the youth gently rub the paper clip on their nose or forehead. A little grease or oil will help it stick less to the water and float more easily.

4. The Challenge Continued—Bubbles will work best if you can do it outside on a warm, relatively wind-still day. The bubbles will last longer if the air is more humid.

5. If the activity is done indoors, do it in a large open area. If the area is uncarpeted, spread newspapers on the floor so that it does not become dangerously slippery from spills.

6. Use Joy™ or Dawn™ liquid detergent. These brands produce bubbles that are more durable than other brands.

7. The soap solution produces more bubbles if it ages for a while. Aging time can be anywhere from half an hour to several days. If you have the time and facilities, make the soap solution ahead of time or have the youth make it during the meeting before the Bubble Bonanza activity. The soap solution can be stored in clean jugs. Be sure to label these jugs. If you are unable to let the soap solution age, adding about a tablespoon of glycerin will help make the bubbles last longer. Glycerin is commonly available at drugstores.

8. It is suggested that you save any soap solution leftover after this activity to use or to play with later. Store the soap solution in clean plastic jugs in a cool place, such as in a garage or basement. Be sure to label and date the jug so that you will know what is in it and how old it is.
Before the Activity

1. Practice the *Grabber*.

2. To save meeting time, you may want to cut the kite string or thread into 40-inch (100-cm) lengths ahead of time. To keep these from getting tangled, wrap them around empty paper towel tubes or wrap each around your hand and secure with masking tape.

3. If you are going to have the youth measure and cut their own strings, you might want to use masking tape to mark a distance of 40 inches on the floor, on a pole, or other objects that the youth can use to measure their strings. Set up several of these stations to allow several youth to measure their strings simultaneously.

4. To figure out how much soap solution you will need, fill one of the trays or pans that the youth will be using in this activity with 1-2 cm (1/2 in.) of water. Then, pour that water into a measuring cup, noting the total amount that the tray or pan contained. Multiply that amount by the number of trays or pans needed. For example, a fast-food restaurant tray needs about three cups of solution to fill it to a depth of one-half inch; so, about one gallon of solution will be enough for five or six trays.

Grabber

1. Fill a clean pie pan half full of water. The bowl used in the *Grabber* can be substituted for the pie pan if the bowl is completely free of soap and oil.

2. Put the two pieces of paper on top of each other so that you can cut two spirals at the same time. Starting on the outer-most ring of the spiral, cut the two spiral shapes so that each of the spiral rings is about one-half inch wide and each of the finished spirals will have about three twists.

3. Drop one of the spirals into the water. What happens? Nothing, the spiral just gets wet.

4. Remove the wet spiral and throw it away. It's all washed up!

5. Take the other spiral and place one drop of liquid soap or detergent on the very end of its outer-most spiral as shown in the above diagram. Ask the youth to predict what will happen when you place this spiral on the water. Test their predictions!

6. Place this second spiral, soapy side down, in the water. What happens this time? The spiral will spin around! This happens because the soap molecules break up the cohesion of the water molecules. As the soap molecules dissolve in the water, they push between the water molecules. So, all these molecules start
bumping and pushing on each other and anything else they encounter, including the paper spiral.

7. Tell the youth that they are going to explore the properties of surface tension and the effects of soap in today’s activity. They will even get to create beautiful bubbles!

**Doing the Challenge - Surface Tension**

1. Tell each pair of youth to fill a clean bowl 3/4 full of water. Be sure that this container is free of any oil or soap.
2. Instruct them to bend a paper clip so that one end forms a handle. As you tell them to do this, make one yourself for them to see.
3. Ask them to predict if a metal paper clip will float or sink when you set it on the water. Challenge them to test their predictions.
4. Instruct the youth to gently set the paper clip on the surface of the water in the bowl, using the bent part of the paper clip as a handle. The paper clip should float on the surface of the water, supported by the surface-tension “skin” of the water. If the paper clip doesn’t float, it is likely that the bowl or bucket is not completely clean. Hint: It helps if the paper clip is slightly greasy so that the water won’t stick to it. If any of the youth is having trouble getting their paper clip to float, suggest that they rub the paper clip gently on their nose or forehead; oils on the skin should be enough to do the job.
5. Have the youth closely look at the surface of the water where it is touching the paper clip and describe the surface. Ask them if the water surface is smooth or dented where it touches the paper clip. The water surface is dented.
6. Direct the youth to watch the paper clip closely as they gently touch the surface of the water, but not the paper clip, with the point of a dry toothpick. What happens? Nothing happens. The paper clip continues to float even though the toothpick is poking through the surface of the water.
7. Tell the youth to repeat the preceding step, but this time, dip the end of the toothpick into liquid soap or detergent before touching the water surface again. What happens this time? The soap will reduce the surface tension of the water and allow the paper clip to sink.
8. Explain to the youth that water, as well as other liquids, behave as if covered with a thin, stretchy skin, almost like a balloon. This thin “skin” is called surface tension. It resists being broken. Soap weakens the surface tension of water, making the water surface more elastic or stretchy. This allows the paper clip to break through the surface tension of the water and sink.
9. Direct the youth to get a piece of waxed paper and a clean, dry toothpick.
10. Tell them to put a drop of water on the waxed paper and notice the appearance of the drop. The drop is rounded like a small dome.
11. Tell them to gently touch the drop with a dry toothpick and observe what happens.
   Nothing will happen—the drop will retain its domed shape.
12. Have the youth dip the toothpick into soap or detergent and gently touch the drop of water on the waxed paper.
   This time, the bubble will spread out and become flatter because the soap reduces the water’s surface tension, which had held the drop in its domed shape.
13. Direct each youth pair to get a clean plate and fill it with water.
14. Have them sprinkle a pinch of talcum powder on the surface of the water when the water surface is still and calm.
15. Instruct the youth to dampen a finger and lightly rub it over a bar of soap. Then, have them touch the dampened, soapy finger on the water at one edge of the plate, observing what happens.
   The talcum powder will move away from the soap film as the soap spreads out across the surface of the water, away from the finger.

**The Challenge Continued - Bubbles**

**Making the Soap Solution**

If possible, do this part during a previous meeting.

1. Divide the youth into groups of three or four.
2. Have one person from each group get a bucket and fill it with warm water. Meanwhile, have the other people in each group spread newspapers on the floor around their work areas.
3. Pass the detergent around and direct each group to have one of their members measure out one cup of detergent and pour it in the bucket.
4. Direct the groups to gently and carefully stir their soap and water solutions, being careful not to slop it out of the bucket. Remind them to wipe up any spills.
5. Let the soap solutions set while the youth make their own bubble launchers. If possible, let the solution set for half an hour or longer or add about a tablespoon of glycerin to each gallon of soap solution.

**Constructing the Bubble Launchers**

1. If the strings were not pre-cut, instruct the youth to measure and cut their strings.
2. While some of the youth are cutting their strings, have the others get two straws each.

3. Instruct the youth to thread an end of their string through the two straws, similar to the way they would string beads to make a necklace.

4. Have each youth tie the ends of her or his string together in a knot.

5. As the youth finish step 4, ask them to hold up their creations by the straws and pull the string taut. With the string taut, their creations should form rectangles similar to the illustration shown on p. 55 of their activity books. Congratulate them on building bubble launchers!

**Making Bubbles**

1. Have each group obtain a tray or pan and set one of their bubble launchers in the tray.

2. Using the measuring cups as ladles or by carefully pouring, have each group put enough soap solution into their trays to cover the straws of the bubble launcher when they are laid flat in the tray.

3. Taking turns, the youth should dip their own bubble launcher into the soap solution, letting it soak for a few minutes.

4. Direct them to carefully remove the bubble launcher from the soap solution by holding the straws close enough together so that the string is loose. Tell them to let the excess solution drip back into the tray.

5. Then, they should slowly move the straws apart so that the strings and straw make a tight rectangle, resembling a window pane. See the illustration on p. 55 of the activity book. Ask them what they see. They should see a film between the straws and string.

6. Launching time! Holding the bubble launcher frame tight, the youth should wave the launcher through the air to make a giant bubble. Suggest that they twist the launcher to close off and release the bubble as they wave the launcher through the air. It may take a few tries to get a bubble. Encourage the youth to keep practicing—these big, beautiful bubbles are worth the effort!

**Why It Happens**

Surface tension holds water particles or molecules together in the smallest shape possible—a sphere. That's why drops of water bead up on surfaces and single bubbles always form spheres. You are seeing the effects of surface tension. Surface tension is what enables water strider insects to walk on water, and enables the paper clip in *The Challenge — Surface Tension* to float. The surface of the water dented under the weight of the paper clip because the surface is slightly stretchy. Because surface tension is so strong, that stretchiness is limited. Bubbles you can
form in plain water do not last very long. The molecules in the surface are pulling together so tightly that they break the water film before the bubbles get very big.

However, by adding soap or detergent to the water, the stretchiness of the water's surface is increased. The surface can no longer support the weight of a paper clip or pull the liquid into a dome or rounded shape. That also means that the water surface can stretch much more without breaking, and bubbles can get bigger and last longer.

**Talking It Over**

**Surface Tension**

**Sharing**

Q: What kept the paper clip floating?
A: The surface tension of the water forms an elastic “skin.” The paper clip rests on top of that surface tension “skin.”

**Processing**

Q: Compare the plain water and the soapy water. Which surface is tight enough to keep a paper clip from sinking? Why?
A: Because the surface tension of plain water is less than that of soapy water, the plain water can better keep the paper clip from sinking. The surface of the soapy water is more elastic and stretchy. As the paper clip weigths down on the stretchier soapy water surface, the surface breaks, allowing the paper clip to sink.

Q: Observe what happens to the talcum powder when you touched the water's surface with a soapy finger. Why do you think this happens?
A: The talcum powder quickly moves away from the soapy finger. The soap molecules spread out into the water causing the water molecules to move around, pushing the powder aside.

**Generalizing**

Q: What effect does soap or detergent have on water surface tension?
A: Soap or detergent weakens the surface tension of water and causes the surface to become more elastic or stretchy.

**Applying**

Q: Why should you get down to eye level when measuring liquids?
A: You should measure the liquid at eye level because the surface tension of the liquids can cause the surface of the liquid to arch.
Bubbles

Sharing

Q: Which liquid surface was more elastic, the water or the soap solution? How do you know?
A: The soap solution was more elastic because it could form a film and bubbles easily.

Q: When you launched your giant soap bubbles, what shape did the soap film take?
A: No matter what the shape of the bubble launcher, the bubbles will always try to form spheres. A smaller launcher will produce smaller spheres, and a larger launcher will produce larger spheres.

Processing

Q: Can you put your hand into a giant bubble without breaking it? How? Try it!
A: Yes, by dipping your hand into the soap solution, or dampening your hand and lightly rubbing it over a bar of soap and then touching the bubble, the bubble will be less likely to break. The soap and water on your hand will connect to the soap film of the bubble.

Generalizing

Q: When bubbles pop, do they pop on the top or the bottom? Why?
A: Bubbles usually pop at the top because gravity pulls downward on the soap film, stretching the film thinner and thinner at the top until finally, the bubble's film gets too thin and breaks.

Q: How was cooperating with a partner helpful?
A: Cooperating with a partner made it possible to find out more about soap films. It would have been impossible to hold the frame and pull on the string at the same time without the help of a partner.

Applying

Q: Using what you know about surface tension and bubbles, explain why soapy water cleans your hands or dishes better than plain water.
A: Soap molecules consist of long chains of carbon and hydrogen atoms. One end of the chain has a group of atoms which likes to be in water—this end is called the hydrophilic end. The group of atoms at the other end of the chain avoids water, but attaches easily to grease. This end is hydrophobic. When you wash your hands or dishes, the hydrophobic end of the soap molecule attaches to the grease or oils on your hands or dirty dishes. This lets the water seep underneath, prying the particles of grease and dirt loose and surrounding them with soap molecules. The grease and dirt can then be easily rinsed away by water. Plain water cannot get under the particles as easily.
Q: Do you think some soaps are better at bubble-making or cleaning than others? What could you do to find out?

A: The youth may answer yes or no to the first part of the question. Regardless of their answer, elicit their ideas for how they could test their answers. They might suggest an experiment along this line: Test several soaps by using each to wash a dirty, greasy plate and identify which soap(s) did the best job—they would need to keep everything as similar as possible in each test, such as using plates having similar amounts of dirt and grease on them; soaking the plates for the same amount of time, etc. Then they could make up bubble solutions, each containing one of the test soaps, and find out which soap(s) makes the best (largest, longest-lasting, etc.) bubbles. Encourage them to try their ideas.

Frequently Asked Questions

Q: How does soap reduce the surface tension of water?

A: In a solution of soap and water, the hydrophobic ends of the soap molecules do not want to be in the water at all. Those soap molecules that find their way to the surface squeeze their way between the water molecules to push their hydrophobic ends out of the water. In this way, the hydrophobic end of the soap molecules move the water molecules further apart from each other. As the distance between the water molecules on the surface increases, the water's surface tension decreases because it becomes harder for the water molecules to stay connected together at the surface. When this happens, the solution's surface becomes more elastic and bubbles can form.

Expanded Activity

What happens when one bubble meets another? In this Expanded Activity, youth will explore the shape of bubbles in contact with each other.

1. Inform the youth that they are going to find out what shape bubbles make when they touch each other. Ask them to predict what will happen when two or more bubbles come into contact with each other.

2. Tell the youth that they will need to be observant to notice if and how the shape of the bubbles changes when the bubbles touch.

3. Have the youth dip a small hand-strainer into the tray of soap solution used in the activity, and wave the strainer through the air. This will form multiple bubbles simultaneously. What happens to the shape of the bubbles?

When two bubbles meet, they will merge where they touch and form a common flat wall between them. Interestingly, when more than two bubbles meet, they will always connect in such a way that three bubble walls are at 120 degree angles. If the bubbles are the same size, they will form hexagons, like the comb of a honeybee hive.
More Challenges

1. Have the youth pour enough milk into a bowl to fill it to a depth of about 2 to 3 cm (1 in.). Let the bowl sit undisturbed for a few minutes.
2. When the surface of the milk is calm, tell the youth to gently drop a few droplets of food-coloring on to the surface of milk. Do not disturb the bowl.
3. Direct them to gently pour a stream of detergent down the side of the bowl and watch what happens.
   The detergent will cause the food-coloring to disperse nearly instantaneously. This demonstrates the same effect that the soapy finger had on the talcum powder in The Challenge—Surface Tension activity.

Bubble Engineer

1. Challenge the youth to make new bubble launchers. Have them use scissors to cut empty plastic jugs, such as the kind used for milk or juice, into frames outlining different shapes. Encourage them to try squares, rectangles, stars, and be creative! As an alternative to the plastic jugs, have them use plastic rings from 6-packs of soda pop, a Styrofoam cup or tin can with ends removed (watch out for sharp edges on the can!), window screen mesh, or a coat hanger or pipe cleaners bent into interesting shapes.
2. Have them dip these new bubble launchers into the tray containing soap solution.
3. As before, have them slowly lift the launcher out of the soap solution and allow the extra solution to drip back into the tray.
4. Direct them to wave the launcher through the air, or gently blow through the launcher to make a bubble. Remind them to observe the shape of the bubble.
5. Have the youth share their bubble-launcher design ideas or trade launchers with each other and try them.
6. Gently stir a tablespoon of Karo® syrup or a small-box of Jell-O® powder into the bubble solution. Let the solution sit for a few minutes.
7. Have the youth predict and test how the syrup or Jell-O® will change their bubbles.
   The syrup or Jell-O® will make the bubbles more elastic so that they will last longer.

Adaptations for People with Disabilities

- Participants with hearing impairments should be able to do this activity without any modifications other than those necessary for communicating instructions.
- Youth with mobility impairments may need to work with a partner. Those who would have difficulty using the straw-string bubble launcher might be able to use alternatives such as slotted kitchen spoons, drinking straws without the string or empty soup cans (dip one end in the soap solution and gently blow

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through the straw or can). Other good bubble launchers include funnels, the top part of 2-liter plastic bottles, and plastic rings from 6-packs of soda pop.

- Youth with visual impairments should work with a partner. The sighted partner should describe and explain what is happening. Have the partner blow bubbles onto the sight-impaired youth's hand.

**Acknowledgments**
