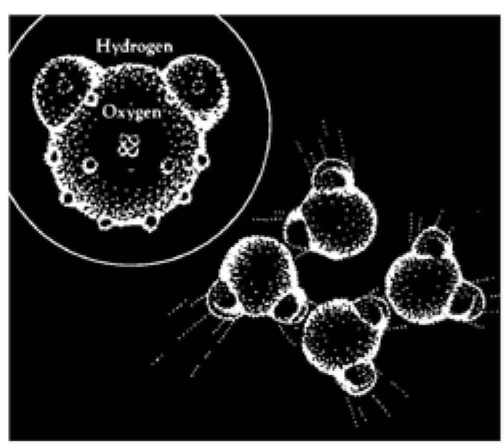
Bubbleology

The following Information thanks to Ron Hipschman at
http://www.exploratorium.edu/ronh/bubbles/bubbles.html
Image of girl and bubbles found at: http://familyfun.go.com/parties/bubble-party-709800/

What is so fascinating about bubbles? Why do we love to chase them and create them and pop them as soon as we can? Is it the precise spherical, round ball, shape, the incredibly fragile nature of the thin soap film, the beautiful colors that swirl and shimmer, or most likely, a combination of all these? Why does a bubble form a sphere at all? Why not a cube, tetrahedron, or other geometrical shape? Let's find out together.

If you could see molecules (the tiny pieces that make up everything) of water and how they act, you would notice that each water molecule attracts or pulls on its neighbors. Each has two hydrogen atoms and one oxygen atom, which is what H20 stands for. The extraordinary stickiness of water, the reason it pulls together, is due to the two hydrogen atoms, which are on one side of the molecule and are attracted to the oxygen atoms of other nearby water molecules. This attraction is called "hydrogen bonding." If the molecules of a liquid did not attract one another, then the constant movement of the molecules would cause the liquid to instantly boil or evaporate and we would never get a drink!

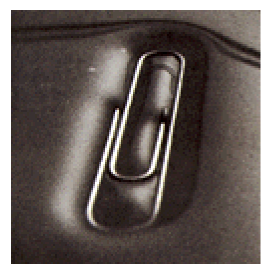


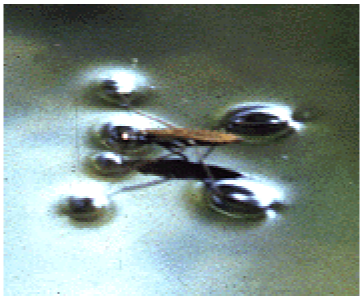
Of course in the liquid form of water, the molecules have too much energy to become locked together permanently; nevertheless, the numerous temporary "hydrogen bonds" between molecules make water an extraordinarily sticky fluid. (The hydrogen atoms are "attached" to one side of the oxygen atom, resulting in a water molecule having a positive charge on the side where the hydrogen atoms are and a negative charge on the other side, where the oxygen atom is. Since opposite electrical charges attract, water molecules tend to attract each other, making water kind of "sticky." All these water molecules attracting each other mean they tend to clump together. This is why water drops are, in fact, drops! If it wasn't for some of Earth's forces, such as gravity, a drop of water would be ball shaped -- a perfect sphere.

Within the water, at least a few molecules away from the surface, every molecule is engaged in a game of tug of war with its neighbors on every side. For every "up" pull there is a "down" pull, and for every "left" pull there is a "right" pull, and so on, so that any given molecule feels no net force at all because it is being pulled in every direction at the same time.

At the surface things are different. There is no up pull for every down pull, since of course there is no liquid above the surface; thus the surface molecules tend to be pulled downward, back into the liquid. It takes work to pull a molecule up to the surface. If the surface is stretched - as when you blow up a bubble - it becomes larger in area, and more molecules are dragged from within the liquid to become part of this increased area. This "stretchy skin" effect is called surface tension. Surface tension plays an important role in the way liquids behave. If you fill a glass with water, you will be able to add water above the rim of the glass because of surface tension pulling all the molecules back down so they don't fall over the sides. (Test it out) Or add lots of drops of water to the top of a penny!

You can float a paper clip on the surface of a glass of water. Before you try this you should know that it helps if the paper clip is a little greasy so the water doesn't stick to it (rub it on your nose or forehead.) Place the paper clip on a fork and lower it slowly into the water. The paper clip is supported by the surface-tension skin of the water.

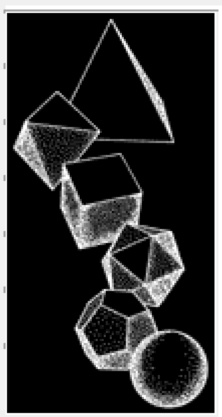




The water strider is an insect that hunts its prey on the surface of still water; it has widely spaced feet. The skin-like surface of the water is pushed down under the water strider's feet.

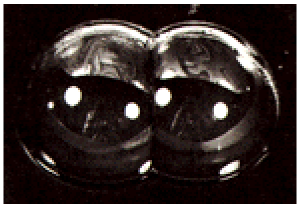
The Shape of a Bubble

A bubble, like a balloon, is a very thin skin surrounding air. The rubber skin of the balloon is elastic and stretches when inflated. If you let the mouthpiece of the balloon go free, the rubber skin squeezes the air out of the balloon and it deflates as it flies around the room. The same thing happens if you start blowing a bubble and then stop. The liquid skin of the bubble is stretchy and like a balloon it pushes the air out of the bubble, leaving a flat circle of soap in the bubble wand. Unlike a sheet of rubber that loses all tension when you let it go, a bubble always has its "stretch" no matter how small the surface becomes. If you blow a bubble and close the opening by flipping the wand over, the tension in the bubble skin tries to shrink the bubble into a shape with the smallest possible surface area that will hold the amount of air it contains. That shape always happens to be a sphere.

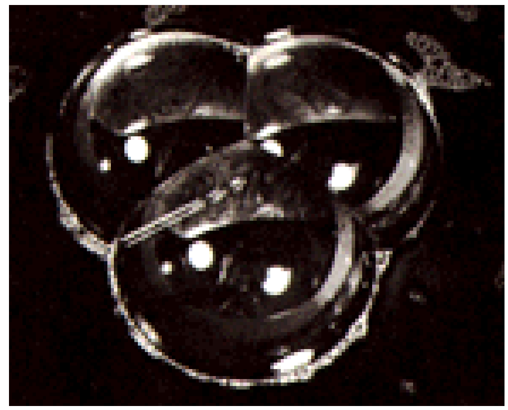


Shape	# of sides	Volume	Surface Area
Tetrahedron	4	1 cubic inch	7.21 square inches
Cube	6	1 cubic inch	6 square inches
Octahedron	8	1 cubic inch	5.72 square inches
Dodecahedron	12	1 cubic inch	5.32 square inches
Icosahedron	20	1 cubic inch	5.15 square inches
Sphere	infinite	1 cubic inch	4.84 square inches

When Bubble Meets Bubble

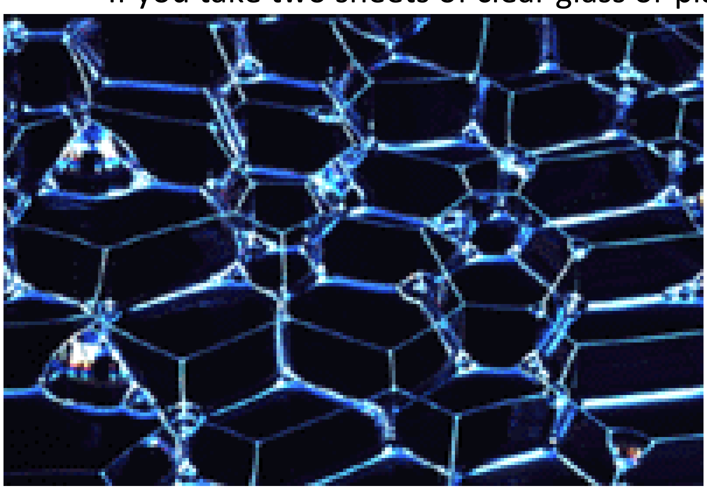


When one bubble meets with another, the resulting union is always one of total sharing and compromise (Human beings could learn a lot from bubbles.) Since bubbles always try to minimize surface area two bubbles will join together and share a common wall. If the bubbles on the right are the same size as the bubbles to the left, this wall will be flat. If the bubbles are different sized, the smaller bubble, which always has a higher internal pressure, will bulge into the larger bubble.



Regardless of their relative sizes, the bubbles will meet the common wall at an angle of 120 degrees. This is easy to see in the bubble picture to the right. All three bubbles meet at the center at an angle of 120 degrees. Although the mathematics to prove this would take more time than we want to spend right now, the 120 degree rule always holds, even with complex bubble collections like foam.

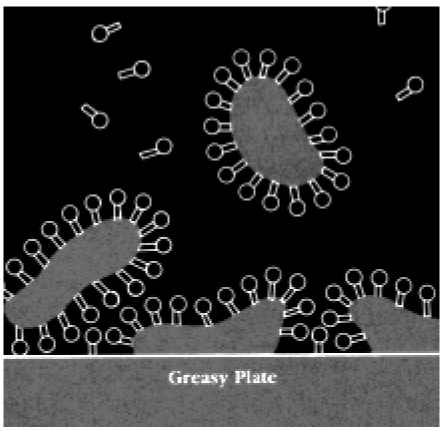
If you take two sheets of clear glass or plastic separated by about one-half inch, soak them in soapy solution and then blow bubbles between the sheets, you will get many bubble walls. If you look closely, you will notice that all of the vertices where three bubble walls meet (and there are always three,) form 120 degree angles. If your bubbles are all the same size, you will notice that the cells form hexagons and start to look much like the cells of a beehive. Bees, like bubbles, try to be as efficient as possible when making the comb. They want to use the minimum possible amount of wax to get the job done. Hexagonal cells are the answer.



Soap

Have you ever tried to blow a bubble with pure water? It won't work. Try it for yourself. There is a common misconception that water does not have the necessary surface tension to maintain a bubble and that soap increases it, but in fact soap decreases the pull of surface tension - typically to about a third that of plain water. In fact, detergent molecules will cover the surface of a bubble and let it get a lot bigger without breaking. A soap bubble is actually a sandwich with air on the inside: a layer of soap molecules, a layer of water and finally another layer of soap molecules. The inner and outer layers of soap molecules can stretch really far and the water helps hold the bubble together.

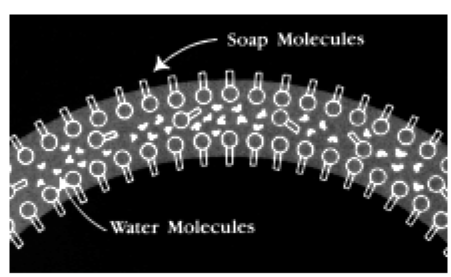
The surface tension (the downward pull of the molecules) in plain water is just too strong for bubbles to last for any length of time. One other problem with pure water bubbles is evaporation: the surface quickly becomes thin, causing them to pop.



Soap molecules are made of long chains of carbon and hydrogen atoms. At one end of the chain are atoms which like to be in water (hydrophilic—water loving). The other end wants to stay away from water (hydrophobic—afraid of water) but likes grease. In washing, the "greasy" end of the soap molecule attaches itself to the grease on your dirty plate, letting water seep in underneath. The particle of grease is pried loose by the water and surrounded by soap molecules, to be carried off by a flood of water.

In a soap-and-water solution the hydrophobic (greasy) ends of the soap molecule do not want to be in the liquid at all. Those that find their way to the surface squeeze their way between the surface water molecules, pushing their hydrophobic ends out of the water. This separates the water molecules from each other and spreads them apart. This makes the surface tension less because the water molecules are farther apart and can't pull as hard on each other. The water fearing soap molecules decrease the surface tension. If that over-filled cup of water mentioned earlier were lightly touched with a slightly soapy finger, the pile of water would immediately spill over the edge of the cup; the surface tension "skin" is no longer able to support the weight of the water because the soap molecules separated the water molecules, decreasing the pull between them, or in other words, their ability to hold together.

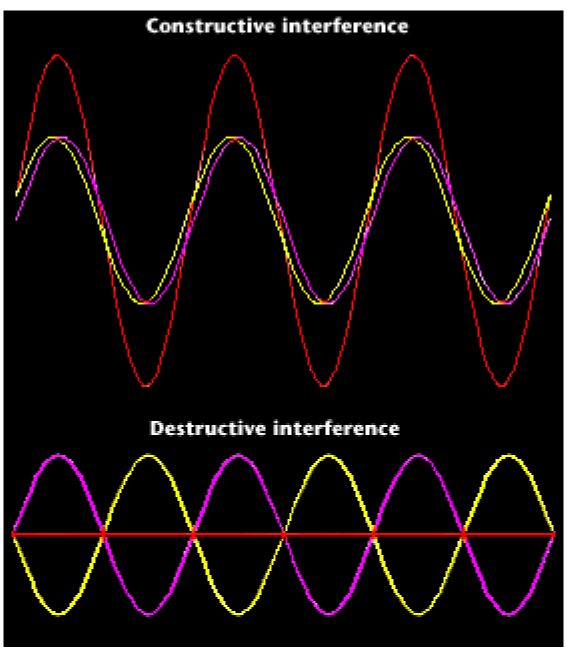
Because the greasy end of the soap molecule sticks out from the surface of the bubble, the soap film is somewhat protected from evaporation (grease doesn't evaporate) which helps the bubble not pop as quickly. A closed container filled with water vapor also



slows evaporation and allows bubbles to last even longer. I've blown soap bubbles on a watchglass glued to the bottom of a jar with a large mouth. Once I've sealed the jar the environment will support the bubble for quite a long time. My longest lasting bubble survived for three months! Eiffel Plasterer, a dear departed friend, farmer, educator, and bubble fanatic who lived in Huntington, Indiana blew a bubble that lasted for 342 days!

A Color Full Bubble

Color, one of the most beautiful aspects of bubbles, also provides us with an extremely accurate tool for measuring the thickness of the soap film.
Light waves, like ocean waves, have peaks and valleys, high points and low points, (crests and troughs). Red light has the longest wavelength and violet the shortest. All waves, including light, have a curious property: if two waves combine, the waves can meet each other crest-to-crest, high point to high point, adding up and reinforcing the effect of each other, making the color brighter, or they can meet crest-to-trough, high point to low point, cancelling each other out so that they have no effect, where you won't see that color, but you'll see it's complement on the color wheel. When they meet crest-to-trough, for every "up" vibration in one wave, there is a corresponding "down" vibration in the other wave. This combination of equal ups and downs causes complete cancellation or interference. Interference is responsible for the pearly luster of an abalone shell, the beautiful colors in some bird feathers and insect wings, and the flowing patches of color in an oil slick on the street after a rain shower - and for the color of bubbles.

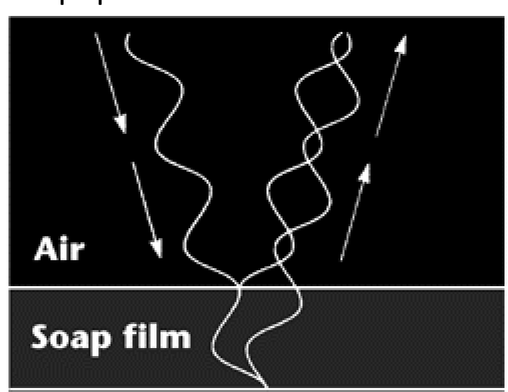


If the crests of two or more waves are in step (yellow and magenta waves top), or almost in step, they can combine into a larger or more intense effect (red wave top.) This is called "constructive interference." If the crest of one wave meets the valley of another (yellow and magenta waves bottom), they cancel each other out (red wave bottom.) When two light waves cancel each other, the result is darkness and this is called "destructive interference."

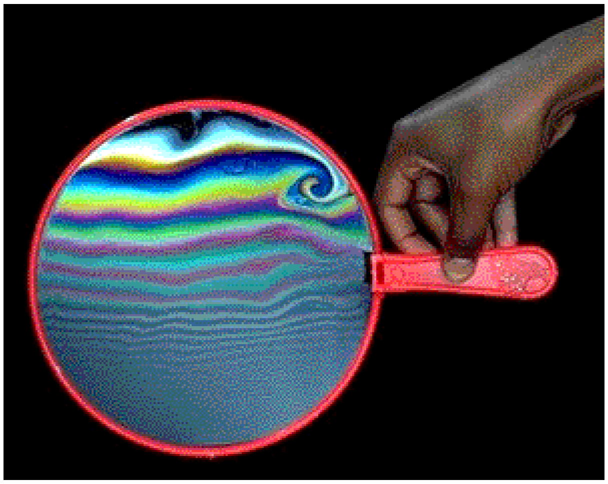
White light is made up of all colors, all wavelengths. If one of these colors is subtracted from white light (by interference, for instance) we see the complementary color. For example, if blue light is subtracted from white light, we see yellow. The skin of a bubble glistens with the complementary colors produced by interference. If we were to look at a highly magnified portion of a soap bubble membrane, we would notice that light reflects off both the front (outside) and rear (inside) surfaces of the bubble, but the ray of light that reflects off the inside surface travels a longer distance than the ray which reflects from the outside surface. When the rays recombine they can get "out of step" with each other and interfere. Given a certain thickness of the bubble wall, a certain wavelength will be cancelled and its complementary color will be seen. Long wavelengths (red) need a thicker bubble wall to get out of step than short wavelengths (violet). When red is cancelled, it leaves a blue-green reflection. As the bubble thins, yellow is cancelled out, leaving blue; then green is cancelled, leaving magenta; and finally blue is cancelled, leaving yellow. Eventually the bubble becomes so thin that cancellation occurs for all wavelengths and the bubble appears black against a black background.

This surprising complete cancellation is due to the different way light reflects from the two surfaces. When light reflects from the outside surface of the bubble (an air-to-water surface) the direction of vibration of the wave is reversed - all "up" vibrations are turned into "down" vibrations and vice versa. (The same thing happens if you send a vibration along a rope tied to a wall; the reflected pulse is upside-down after reflection from the wall.) When light reflects from the inside surface of the bubble (a water-to-air surface) the direction of the vibration is not changed. If the skin of the bubble is very thin, much shorter than the wavelength of visible light, then the two reflected rays of light will always meet crest-to-trough and destructively interfere. There will be no visible reflection, and the bubble looks black. When you see this happening at the top of a soap bubble you know the bubble is only about one millionth of an inch thick and will soon pop.

White light is separated into colors as it reflects from the two surfaces of a thin film. Where the two reflections interfere constructively, they produce a band of color. Where they cancel each other, that color is subtracted from the spectrum.



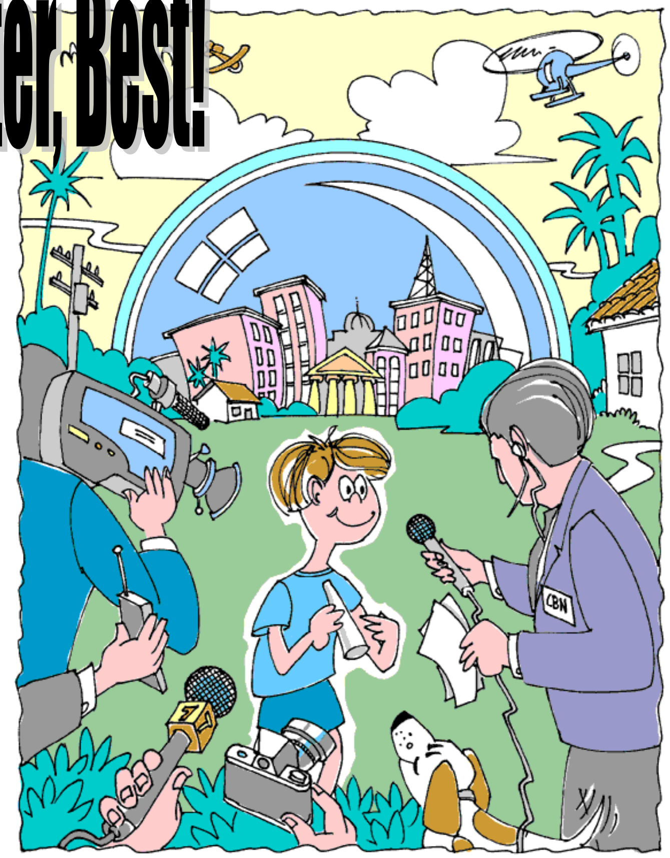
If you let a bubble hang from a bubble wand for awhile, the interference colors begin



The alternating bands of light and dark on this soap film are actually bands of color, produced by the reflection and interference of light waves. The colors depend upon the film's thickness. The film shown here is thinnest at the top, becoming thicker toward the bottom. As the film's thickness changes, the colors also change, forming regular bands.

This soap film is forming horizontal stripes - because the bubble film is thicker at the bottom than at the top, forming a wedge shape. As the bubble drains, the wedge of bubble solution gets thinner and thinner. The black film which then appears at the top of the bubble is a harbinger of an upcoming disaster. The bubble is now so thin only a few moments remain until. . .POP!

Bubble Formulas: Good, Better, Best!



Bubble Invasion Image found at:
http://www.zurqui.com/crinfocus/bubble/poster.gif

Now we are going to make a bubble solution! Commercial solutions such as Mr. Bubbles may be fine for general use, but really big bubbles require lots of solution and can get quite expensive.

Water quality and local climate (especially humidity) will determine what mixture works best in our area, so let's experiment to get the best formula.

Gently stir the ingredients together and leave the solution in an open container overnight. Allow it to sit for a day or so to stabilize. The solution seems to get better with age. Substitute and experiment with the formulas."

1. Detergents: soaps and detergents are the basis for bubble mixtures.
The best detergents are Joy and Dawn. Ivory and Palmolive detergents are not as good.

2. Additives: How long a bubble lasts is dependent on how long it can stay wet. To make really colorful, sturdy long-lasting bubbles, add glycerin to the mix. Glycerin is available at most drug stores, but it is expensive!
Glycerin sold in rose water or other solutions is worthless. More practical and less expensive additives are white Karo syrup (corn sugar syrup), sugar and gelatin. Solutions with glycerin keep better over longer periods of time, but sugar and gelatin are less expensive and readily available in most kitchens. Start experimenting with around .10 parts (1/10 part, NOT 10 parts!) gelatin, or .25 parts Karo syrup, sugar, or glycerin.

3. Water: Water, a key ingredient, varies widely in its quality. The water should be soft or distilled. Hard water or water heavy in mineral content will make fragile bubbles that will not last as long To get the best mixture, try using distilled water unless your tap water is soft. The average range is 10 parts water to one part detergent. Ultra Joy and Ultra Dawn are more sudsy, so less is required, maybe 15 or 20 parts water to one part detergent.

While many people make bubbles out of detergent and water, the biggest, longest lasting bubbles use only liquid detergent and syrup. A mixture of Dawn and Karo Light Syrup works well for most bubbles. With this mixture for every 1/2 cup of Dawn, use about 1 tablespoon of
Karo Syrup.
“When mixing up a batch of bubble mix you should realize that there are several sure fire ‘bubble bursters:’ dirt and other bubbles. We have to make sure that the containers we are using are very clean and that we don't stir too much or too quickly to keep the ‘foaming bubbles’ down. Bubbles also tend to like cold air.”
Let’s look at some recipes to use as a starting point. We must consider environmental conditions (humidity, dust, etc.) and how they can affect the life span of any bubble. Experiment with these formulas. Remember a solution that works well for small bubbles may not always work as well for bigger bubbles. Look over the recipes and formulate some hypotheses to record in your science journal. Then, try these formulas and record your observations.

Formula #1: Chemist’s Bubbles

9 Scoops water
1 Scoop dishwashing detergent
1/2 Scoop glycerin

Formula #2: Big Bubbles, Long-Lasting

1/2 Cup Dawn (NO WATER)
1 Tablespoon white Karo syrup
Bubble Formula #3
2/3 Cup of Dawn or Joy dishwashing detergent
1 Tablespoon glycerin
1 Gallon of distilled water

Bubble Formula # 4

1 Part - Dawn Ultra or Joy Ultra
15 Parts - Water (Distilled Water works best)
.25 Parts - Glycerin or White Karo
Syrup (Optional)

Bubble Formula # 5

1 Part - Regular Dawn or Joy
10 Parts - Water (Distilled Water Works Best)
.25 Parts - Glycerin or White Karo Syrup (Optional)

Formula # 6: Super Bubbles

2 Parts - Regular Dawn or Joy
4 Parts - Glycerin
1 Part - White Karo Syrup

(This formula is an especially stout mixture for very big bubbles. This is serious stuff!)

Bubble Formula #7

(For general blowing and popping fun)
1/2 Gallon Distilled water
8 Ounces Ultra Joy or Dawn
(10-12 ounces non-ultra products)
1 Tablespoon Glycerin

Bubble Formula #8

(For bigger bubbles)
Same as #7 only add 8-16 ounces of quality commercial brand solution
(Mr. Bubbles, Wonder Bubbles)

Bubble Formula #9

(For longer lasting small sculptures; probably too 'heavy' for big bubbles)
same as #8 only add 2 ounces more detergent and 1 more Tablespoon Glycerin

Bubble Formula #10

2/3 Cup Joy dishwashing detergent
1 Gallon water
2 to 3 Tablespoons of glycerin

Bubble Formula #11

1 Cup Ultra Ivory Blue
12 Cups water
3/4 Tablespoon glycerin

Bubble Formula #12

(lasts 3 -12 months when bubbles are sealed inside glass jar)
1/3 Cup commercial bubble solution
(Wonder Bubbles by ChemToy)

1/3 Cup water
1/3 Cup glycerin
This is a much heavier solution with the larger proportion of glycerin.

Bubble Formula #13

(for large class labs, an inexpensive bubble solution)
8 Tablespoons of dishwashing liquid
1 Quart water
1 Drinking straw
A Shallow tray
1 Tin can, open at both ends
Teachers will also want to assign to students to visit bookmarked Internet sites to seek out new recipes and identify factors for success.
Make sure students are meticulous in their journal entries about following the steps of the Scientific Method.

Student Science Journal Entry

Procedure:

1. Mix the dishwashing liquid with the water. Fill the shallow tray.
2. Blow through the straw as you move it slowly across the surface of the solution. How big are the bubbles you get?
3. Try making a very big bubble that covers the surface of the tray.
4. Dip one end of the straw into the sudsy solution; then, hold the straw slightly above the surface of the solution. Blow into it very gently. You may have to try several times to make a really big bubble. When you have made a bubble, touch it gently with a wet finger. What happens?
5. Make another big bubble. Touch this one with a dry finger. What happens?
6. Try making bubbles with a tin can open at both ends. Dip the can into the soapy solution so that you get a soap "window" across one end when you pull it out. Blow gently on the other end to form a bubble. You can use wider tubes such as coffee cans to make still bigger bubbles.
7. Look closely at the bubbles you make. How many colors can you see? Do the colors change?
8. If you have a wand at home that is left over from a bottle of bubbles you bought at the store, you can use it with this bubble solution.

REMEMBER: Glycerin helps slow down the evaporation of water adding more color to the bubbles.

Bubble Blowing Tips:

Great conditions

- After a rain shower – Humidity 70% and higher.
- Near perfect is 90-95%!! That means there's enough water in the air for bubbles not to dry out too quickly.

Good Conditions

- Cloudy days - Humidity 40%- 70%
- At dusk, after the sun sets

Fun Conditions

- Near a pond, stream or just a bigpuddle to float bubbles
- Near a warm house on a cool day (bubbles will rise with cooler air)
- Below 10 degrees Fahrenheit - tofreeze the little ones
- Wait for a calm, still day
- Keep everything wet, even the sides of a straw or bubble blower.

Avoid

- Direct sunlight
- Dusty air
- Strong breezes
- Foamy build-up
- Bar Soap

Colors and Thickness
Discuss the science of color in bubbles.

Color, one of the most beautiful features of bubbles, also provides an extremely accurate tool for measuring the thickness of the soap film. Why do bubbles have color? We see the colors in a bubble through the reflection and the refraction of light waves off the inner and outer surfaces of the bubble wall; it is similar to the way we perceive the colors in a rainbow, or an oil slick. You can't color a bubble since its wall is only a few millionths of an inch thick. A bubble reflects color from its surroundings.

When a light wave hits the surface of a bubble, part of the light is reflected back to a viewer's eye from the outer surface. Part of the light is reflected from the inner surface, which is a few millionths of an inch further. As the two waves of light travel back, they interfere with one another causing what we know as color.

When the waves reinforce each other, the color is more intense. When the waves get close to canceling each other out, there is almost no color. As a bubble wall gets thinner, either from a weak solution or because gravity has pulled its chemical content to the bottom, the distance between the inner surface and the outer surface of the bubble becomes less and less until the two reflected waves of light start to coincide and cancel each other out. The result is that the bubble loses its color and can become nearly invisible.

Water has no color. Yet, whenever a bubble is formed from a mixture of water and soap or detergent, beautiful rainbow colors appear. Where do these colors come from? The answer lies in the nature of light.

Part I. To study the colors in bubbles

Materials:

- short plastic drinking glass half filled with bubble mixture
- a small disposable
- plastic container (such as a film canister without the lid), (The teacher
- needs to punch several holes in the bottom of the canister.)
- liquid soap
- water

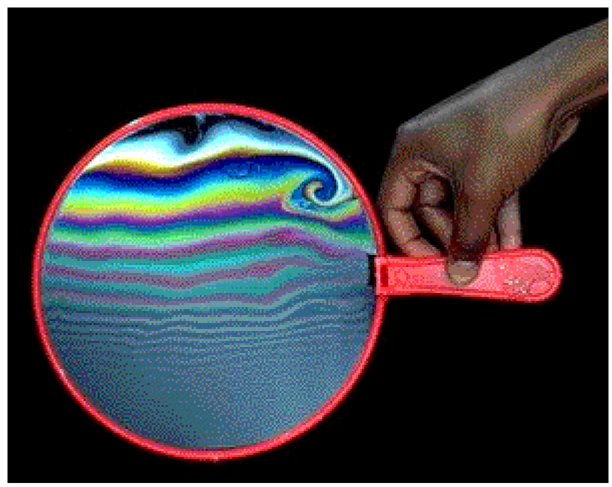
1. Have students quickly dip the open end of the canister into the mixture and then blow through the bottom (where the teacher made the holes) to make a bubble. Note that when the bubble begins to form, there is no color. As you

continue blowing, reds and greens appear.

2. At this stage, free the bubble by moving the canister quickly sideways. The longer the bubble lasts, the more colorful it becomes.
3. The reason for these color changes is that water is constantly evaporating from the bubble, causing its wall to get thinner. The thickness of a bubble's wall determines its color.

Light from the sun is made up of all the colors of the rainbow mixed together. Each color has a slightly different wavelength. When the thickness of the bubble's wall matches the wavelength of a particular color, that color is reflected by the bubble instead of passing through it, and so that color is visible. The waves of light are no farther apart than the thickness of a bubble's wall (a very tiny distance). So, as water evaporates and the bubble's wall thins, the longest wavelength of light (red) is reflected first and the shortest wavelength (purple) is reflected last. When holes seem to appear in the bubble or it stops reflecting altogether, the wall has become so thin that visible light passes straight through.

Soap bubbles are a layer of soap film on the outside, a layer of water molecules in the middle, and a layer of soap film on the inside. Light reflects from the first and second layer of soap film. The light waves interfere with each other, adding to or subtracting from each other's frequencies, which changes the color reflected. The interference colors are determined by how far the light waves that are reflected from the inside layer must travel to meet the waves reflected from the outside layer. So the different colors of the bubble actually correspond to its thickness at different points.



If you let a bubble hang from a bubble wand for awhile, the interference colors begin forming horizontal stripes - because the bubble film is thicker at the bottom than at the top, forming a wedge shape.

As the bubble drains, the wedge of bubble solution gets thinner and thinner. The black film, which then appears at the top of the bubble, is a harbinger of an upcoming disaster.

The bubble is now so thin only a few moments remain until...POP! What do you think? Should we try it?"

Have students record the procedure and their observations in their science journals.

Student’s Procedure:

1. Turn on a flashlight in a dark room and set the flashlight down so it lights your work area.
Record observations in your science journal.
2. Dip a BIG Hoop in a bowl of bubble mixture and insert the handle of the hoop into a bottle so the Hoop stands up and stays steady.
3. Shine the flashlight at the soap film and watch its reflection. Point the flashlight at the top of the film. What colors do you see?
4. Let the soap film drip for 30 seconds. Shine the flashlight at the bottom. What colors do you see? Can you see patterns?
5. Point the flashlight at the top of the soap film again. What does the reflected light look like now?

Explanation of what happens:

Shine white light on clear soap film, and you see colors!! (Pink, green, yellow, blue, orange) Where do they come from?
These colors come from the white light, which is a combination of all colors our eyes can see. Light travels in waves, and each color has a different shape of waves. When light waves of every color come out of the flashlight at once, the light looks white. As you shine the flashlight at the soap film, most of the light passes through the hoop and hits the wall behind. About 4% of light is reflected back by the frontof the film, and 4% more is reflected by the back surface. Even a soap film has a front and back. So you have two sets of light waves bouncing back at you.
Sometimes a light wave from the front of the film interferes with the same color light wave from the back. The top of one pink light wave may line up with the bottom of another pink light wave. The two waves will cancel each other and you won’t see any pink; since the rest of the light bounces back, you see greenish white (every color but pink) instead.
Whether the two light waves cancel each other or not depends on their shape and how far apart the reflecting surfaces are. The thickness of the film determines which wavelengths (colors) reinforce and which cancel. Between the very thin film and 1/4-inch thick film, none of the wavelengths completely cancel and so the film appears white. A soap film of a particular thickness always cancels one color of light. By looking at the tints of soap film, you can tell how thick it is. Pink and green stripes mean the soap film is somewhere between 750-and 1500 billionths of a meter thick. Purple, blue, green, yellow, orange, and red swirls mean the soap film is even thinner, somewhere between 200-and 750-billionths of a meter thick. The swirls

appear because some parts of the film are trying to pull liquid from other parts. Finally, at the top of the soap film, you see only a dim, spotty reflection of the flashlight. That means the film is less than 30-billionths of a meter thick, and it's about to pop!!

Bubble Mysteries

These Bubble Mysteries deal with stray bits of electricity, invisible gases, heat waves, and other scientific marvels that are around us all the time, but we can rarely see them. Adding bubbles makes all these mysteries visible.

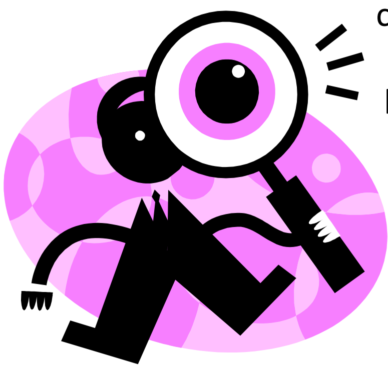
The Bubble Attraction

This experiment should be done on a cool, dry day when there is very little humidity. Humidity causes an electric charge to "leak" away.

1. Have students lay a book flat on the edge of a table.
2. Then have them blow a bubble and catch it on a small loop. Stick the loop handle under the book so the bubble hangs off the table.
3. Next they will rub a balloon on their hair (rubbing a balloon on your hair knocks electrons off your head onto the balloon)
4. Hold the balloon near the bubble. Try moving the balloon closer and further away.

Discussion of what happened: As you moved the balloon to the right, the bubble reaches right; as you moved the bubble to the left, the bubble reached left. What attracted the bubble? Electrons (negative charge) from your hair pushed away other electrons but they attracted protons (positive charge). When the electron-carrying balloon got near the bubble, its electrical charge pushed loose electrons in the soap film to the far side of the bubble.

That left the bubble's near side with extra protons, which were attracted to the electrons on the balloon. That attraction was strong enough to make a light, flexible bubble move.



A Bubble That Blows Up By Itself

1. Have students spoon baking soda into bottom of jar and slowly pour vinegar onto baking soda; the mixture will start to fizz and bubble.
2. While students wait for the fizzing to calm down, use the loop and bubble mixture to blow some bubbles and catch one on the loop.
3. Carefully lower the bubble into the jar and hold it there for a minute. How does the bubble change?

Discussion of what happened: After you lower your soap bubble into the jar, it starts to grow---so big that it could even pop!! What's in the jar that can blow up a bubble, and how It can get inside the bubble without opening the soap film.
Mixing baking soda and vinegar produces a gas called carbon dioxide.
Bubbles are semi-permeable, meaning there are tiny holes in them large enough to let some gas molecules through, but not others. Carbon dioxide can fit through these holes. Gradually, the carbon dioxide gas diffuses into the bubbles, causing them to grow.
Carbon dioxide dissolves in water, but the amount of gas that is dissolved always depends on the amount of gas in the air around the water. When there's less carbon dioxide in the air, those molecules leave the water and join the air again. When you put your bubble into the jar, there's so much carbon dioxide around it that some of that gas dissolves into the water of the soap film. The dissolved molecules spread out within the film and some end up on the film's inner surface. Because there's less carbon dioxide in the air inside the bubble, those molecules leave the water and join the air in there. More carbon dioxide inside the bubble makes it "grow".

Bubble Fountain

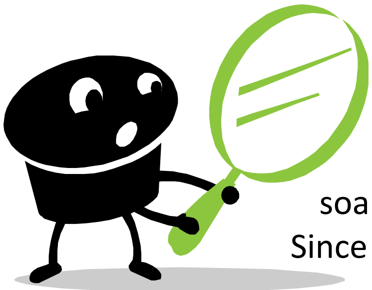
Since carbon dioxide is invisible, you can't see it form, unless you've got a squirt of soap.

1. Have students place a 1-quart bottle in the sink.
2. Swirl 2 cups of water and 1 tablespoon of baking soda together in the bottle.
3. Stir a squirt of liquid soap into a measuring cup holding 1/2 cup of vinegar.
4. Then pour the vinegar and soap into the bottle.
5. Watch the bubbles cascade!! All those bubbles are filled with carbon dioxide created by the combination of the vinegar and the baking soda.
6. Put your hand on the bottom to feel the energy produced inside.

Bubble Thermometer

1. Dip the straw tube in the bubble mixture, and then blow some bubbles inside the bottle; all they need is one soap film across the middle of the bottleneck .
2. Place the bottle in the bowl of hot water. Let it sit for a few seconds and watch how the film in the bottleneck reacts.

3. Take the bottle out of the hot water and put it in the cold water. What does the soap film do now?



Discussion of what happened: When air or any other gas get warmer, it tries to fill more space. The warmer air inside the bottle expands and pushes the soap film up.

When you move the bottle to the cold water, the air cools down. Cool gas needs less space than warm gas, so it pulls the soap film back down.

Since the soap film in your bottle shows temperature changes, you've actually made a very simple thermometer.

Measure a Bubble?

A bubble can be measured outdoors on a sunny day by measuring the shadow (Fig. 5).

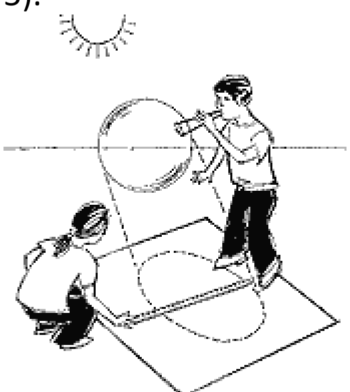
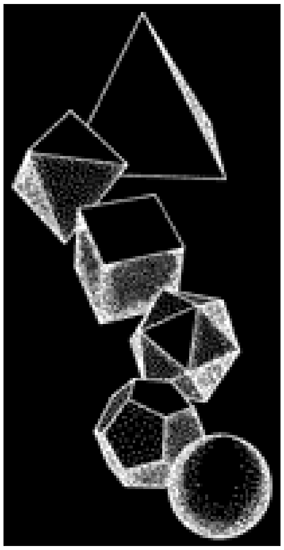


Figure 5

Using the sun is better than a light bulb because a nearby light bulb will cast a shadow larger than the bubble. Light coming from the sun is parallel and the shadow cast will be the same size as the bubble. If the sun is low, the shadow will be oval shaped. Measure the shadow at its narrowest width.



The Many Shapes of Bubbles

Do square bubbles really exist? That's the question of the day and the answer is yes… if you know the science secret. Square bubbles are easy to make and serve as a great learning tool as students explore the concepts of soap films and surface tension.

Objective:

After blowing bubbles, students will be able to test the effect of four differently shape wands and three geometric figures in a bubble mixture.

Hypothesis: Does a bubble always form a sphere?

Materials Needed:

- ☐ Cups
- ☐ Water
- ☐ Dawn Dishwashing Liquid
- ☐ Yarn
- ☐ Scissors
- ☐ Pipecleaners
- ☐ String
- ☐ Straws
- ☐ Trays
- ☐ A Large Container

Bubble Makers:

Individual Wands

Bend pipecleaners to form a circle, square, heart, and triangle.

Rectangular Frame

Materials: two standard drinking straws; a piece of cotton string 11/2m long. Procedure: Feed the string through both straws and tie a knot.

Tetrahedron

Materials: Three standard drinking straws; three half-size straws; and nine pipe cleaners. Procedure: Twist two pipe cleaners together to make a pipe cleaner that is somewhat longer than a standard drinking straw; repeat twice. Put three long pipe cleaners together and twist them together at the top. Slip three standard drinking straws onto the pipe cleaners; bend the pipe cleaners at the bottom to form feet. Insert three standard pipe cleaners through three half-size straws. Make a triangle with them by twisting their corners together. Twist base and top together at corners.

Cube

Materials: Six standard drinking straws, each cut in half and twelve pipecleaners. Procedure: Put three of the pipecleaners together and twist them tightly at one end. Make four complete sets. Slip half-straws onto the pipecleaner; bend the pipecleaner to form feet. Make each set look like the capital letter T. Use two sets to form a square with two extended sides. Repeat the procedure with the other two sets. Make one square bottom of the cube by twisting up the extended straws; make the other square the top by twisting the down the extended straws. Fit the top to the bottom, twisting all corners.

Strategy:

Cooperative Learning

1. Each student receives 4 pipecleaners, a straw, and a cup.
2. Make a circle, square, heart, and triangle with a pipecleaner.
3. Cover the bottom of the cup with Dawn dishwashing liquid.
4. Fill the cup with a 1/2 cup of water.
5. Blow bubbles indoors and outdoors.
6. Record results on Bubbleology worksheet.

7. Form three groups.
8. Build a rectangular frame, tetrahedron, and a cube.
9. Record results on Bubbleology worksheet.

Performance Assessment:

Students are evaluated by completing the bubbleology worksheet. This assignment is graded as a pass or fail lab in class assignment.

Conclusion:

Regardless of the shape of the wand, bubbles always form spheres.

Wand Shape	Predict Shape	Inside Shape	Outside Shape	Draw Shape	Comments
Circle					
Square					
Heart					
Triangle					
Straw					
Pipe Cleaner					
Rectangular Form					
Tetrahedron					
Cube					

Shapely Suds

Create geometric art with soap films.

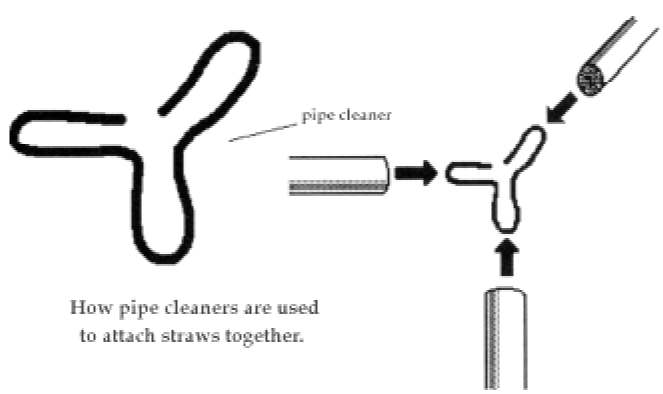
Using pipe cleaners and drinking straws, students can make three-dimensional geometric frames: cubes, tetrahedrons, or shapes of their own design. When they dip these frames in a soap solution, the soap films that form on the frames are fascinating and colorful.

Materials:

- Plastic drinking straws.
- Pipe cleaners (available at school supply, hobby, or party stores).
- A small bucket or container for the bubble solution. The container must be large enough so that bubble frames are entirely covered when they are dipped.
- Bubble solution (You can use a commercial solution like Wonder Bubbles™, or use the Exploratorium's recipe: To each gallon (3.8 1iters) of water add 2/3 cup (160 ml) of Dawn™ or other dishwashing liquid and 1 tablespoon (15 ml) of glycerin, available at your local pharmacy. Bubble solution works best if it is aged at least a day before use.) For crystal-clear bubbles, be sure that you always KEEP THE SURFACE FREE OF FOAM. If the water is hard in your area, add extra detergent.

Assembly:

(30 minutes or less)
Form frames using the drinking straws for the straight pieces. Connect two straws at a corner by inserting a doubled pipe cleaner into the end of each straw. In places where three straws meet, fold the pipe cleaners as shown in the diagram. Attach a pipe cleaner handle to your frame.



How pipe cleaners are used to attach straws together.

Have students try constructing cubes or tetrahedrons, or just let their imagination run wild. Mix the soap solution in the bucket. Make sure that you have enough solution to fully cover the frames when they are dipped.

To Do and Notice:

(15 minutes or more)
Have students dip the frames into the soap solution, and observe the fascinating geometrical shapes that the soap films form. Also notice the shimmering colors in the soap film.

Now Try This!

1. Cut the bulb off of the top of a graduated pipette. Now you have a perfect bubble blower!
2. Shake your square bubble just a litte and you will see that the edges start to collapse and make a new shape inside the square bubble structure.
3. Gently put the larger end of the pipette up to the middle of your square bubble.
4. Very gently blow into the pipette... what starts to happen?
5. You get a bubble inside of a bubble! So cool!

What's Going On?

Bubbles form because of the SURFACE TENSION of water. Hydrogen atoms in one water molecule are attracted to oxygen atoms in other water molecules. They like each other so much, they cling together. Normal bubbles enclose the MAXIMUM VOLUME OF AIR with THE MINIMUM AMOUNT OF BUBBLE SOLUTION, so they are always round. In fact, all square bubbles bubbles are "MINIMUM" surfaces. When stretched between struts, bubbles cling to the structure as you dip into the solution.

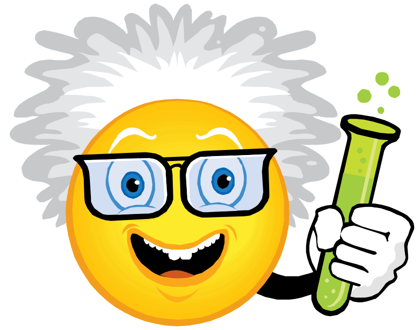
As they lift their frame out of the solution, the soap film flows into a state of minimum energy. The soap film is in a state of minimum energy when it's covering the least possible amount of surface area. The intricate shapes you see inside the frame represent the minimum area the soap film can cover. You may notice that a soap film will sometimes take on different shapes when you dip the frame into the solution again and again. That's because there may be more than one way for the soap film to form a minimum surface area.

When light waves hit the soap film, they reflect and interfere with each other. This interference causes the shimmering colors you see. White light is made of many different colors. When white light shines on the soap film, some light waves reflect from the front surface of the film and some reflect from the back surface of the film. When these two sets of reflected waves meet, they can add together, cancel each other out, or partially cancel, depending on the thickness of the film and the initial color of the light. When light waves of a particular color meet and cancel each other, then that color is subtracted from white light. For example, if the red light waves cancel, then you see white light minus red light, which you perceive as blue-green light.

Etcetera:

Plastic bar straws, which have a smaller diameter than regular drinking straws, hold the pipe cleaners more tightly. But bar straws are more expensive and are sometimes harder to get. If you can't find them at grocery or liquor stores, try restaurant or party supply stores.

Bubble Chemistry



Objectives:

1. Students will understand the chemistry of soap bubble films.
2. Students will build their own model for making large soap bubbles.
3. Students will investigate with prepared geometric wire models to see the maximum number of planes, the maximum number of lines and the sizes of the angles that are produced when the planes and lines intersect.

Materials:

- ☐ Pop-it beads strung into a long chain and in a large jar
- ☐ Straws
- ☐ String
- ☐ Prepared wire and string models
- ☐ Two strings of suckers
- ☐ Prepared soap bubble solution
- ☐ Buckets and trays
- ☐ Protractors

Suggested Strategy:

For an attention-getter, let the pop-it beads pull themselves out of the jar in which they are contained. The last pop-it bead is pushed into a small hole drilled into a racquetball. Starting from the racquetball, count off 18 sections of pop-it beads and separate that from the chain. Ask the students what does this small piece of chain represent (ans. - a soap molecule).

Review soap molecules and how they arrange themselves in water. See diagram that follows.

/\/\/\/\/\/\/\/\/\O (H_2O) O/\/\/\/\/\/\/\/\/\
/\/\/\/\/\/\/\/\/\O (H_2O) O/\/\/\/\/\/\/\/\/\
/\/\/\/\/\/\/\/\/\O (H_2O) O/\/\/\/\/\/\/\/\/\

Present three questions:

1) What is the shortest possible way to connect two points? (Ans. - a straight line.)
2) What is the shortest possible way to connect three points? (Most people would say a triangle, but that is wrong - see diagram 1 below.)
3) What is the shortest possible way to connect four points? (Most people would say a square, but that is wrong - see diagram 2 below.)

Using two plexiglass plates and small rubber suction cups (first two suction cups, then three, then four) and an overhead projector, let the soap bubbles show the answers. Some students may guess that planes of soap bubbles meet at 120 degrees since it will be very clear on the screen; some students may surmise that only a maximum of three planes will ever intersect - and both guesses are correct!

Present another question: what is the maximum number of lines that can intersect a single vertex in a soap bubble model and what angle(s) do these lines form? (Ans. - four lines maximum and the angle is 109.23 degrees - it is very unlikely anyone would know it or guess it.) Bring out the models, give each group a protractor and tell them to go outside to find out. (Soap bubbles are very sloppy.)

Before you turn the students loose, show them how to make a large bubble maker. Take two meters of string, double it up so it is only one meter long, run it through two straws and tie the ends of the string together. Slide the straws so they are opposite each other, dip it into the solution, wave it in the air and you get really big bubbles.

Back in the classroom - follow up! Why do the soap bubble films assume the shapes that they do? The answer is that soap film has the property that its surface area has a minimum value when it has reached equilibrium. What forces are involved? Answer - gravitational potential energy (GPE), surface tension, and the compressional energy of trapped air.

Preparation of Bubble Solution:

85% water
10% liquid detergent
5% glycerin

Ask Students, "Why are additives such as glycerine, white corn syrup or sugar added to water and detergent for bubble mixtures?" Allow students to theorize and discuss. Accept all reasonable responses.

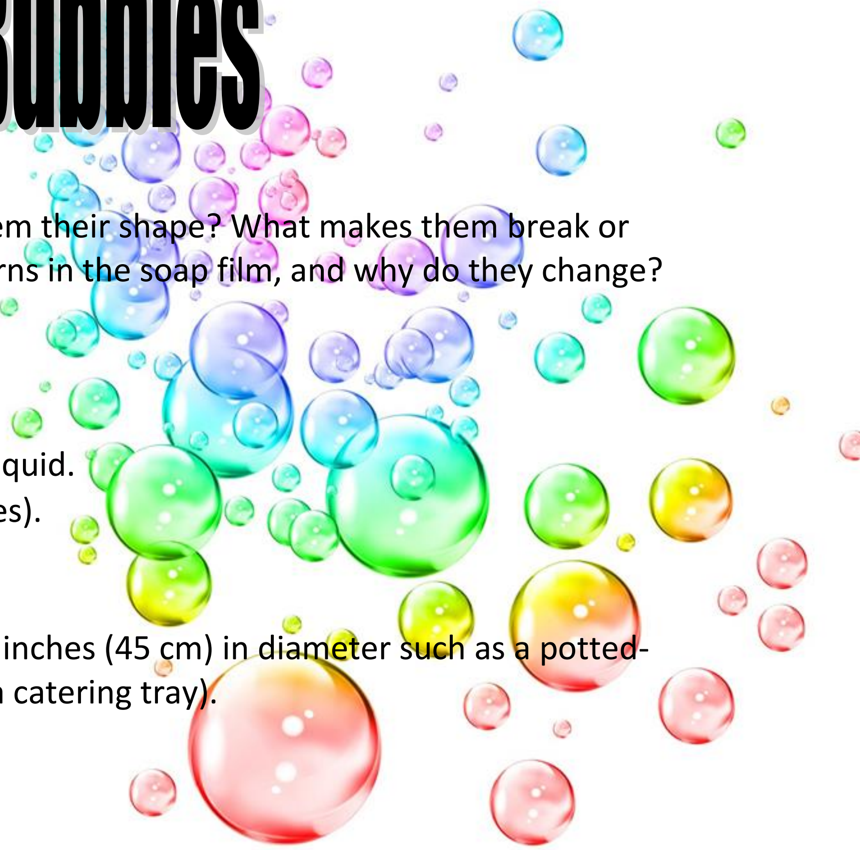
Diagrams:

(See "Suggested Strategy")

```
       Diagram 1

           |
      120  | 120 degrees
          / \
         /   \
          120
Shortest length connecting
     three points.
```

```
         Diagram 2

       \       /
  120 \____/120 degrees
       /120 \
      /       \

Shortest length connecting
     four points.
```

Hang Up Some Bubbles



Bubbles are fascinating. What gives them their shape? What makes them break or last? What causes the colors and patterns in the soap film, and why do they change?

Materials:

- Measuring cups and spoons.
- Dawn™ or other dishwashing liquid.
- Glycerin (available at drugstores).
- Tap water.
- A wire coat hanger.
- A shallow tub or tray about 18 inches (45 cm) in diameter such as a potted-plant drain dish, a pizza pan, or a catering tray).
- Optional: Yarn.

Assembly:

(30 minutes or less)

Have students help you mix up a bubble solution of 2/3 cup (160 ml) Dawn™ dishwashing liquid and 1 tablespoon (15 ml) glycerine in one gallon (3.8 l) of water. We have found that more durable bubbles form if you let this solution age for at least a day, preferably for a week. (Ask students, "Why are additives such as glycerine, white corn syrup or sugar added to water and detergent for bubble mixtures?" Allow students to theorize and discuss. Accept all reasonable responses.)

Bend the coat hanger into a flat hoop with the hook sticking up at an angle to serve as a handle. Bubbles will form more consistently when the hoop is as circular as possible. If you wrap yarn tightly around the wire of the hoop, the yarn will absorb the bubble solution, which will make the hoop easier to use.

If you prefer a store bought apparatus, a bubble tray complete with a bubble hoop is available at local stores.

To Do and Notice:

(15 minutes or more)

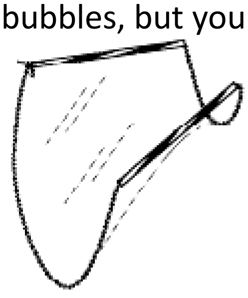
Fill the shallow tray with bubble solution and submerge the hoop in the solution. Then tilt the hoop toward you until it is almost vertical, and lift it from the tray. You should have a bubble film extending across the hoop. Swing the hoop through the air to make a giant bubble. When you have a big bubble, twist the hoop to seal it off at the end.
What shapes do the bubbles take once they are free of the hoop? What roles do convection and air currents play in the bubble's movement? Look for patterns and colors in the bubbles. Dip the hoop in the solution and hold it up to the light without forming a bubble. What patterns (and changes in patterns) do you observe?

What’s going on?

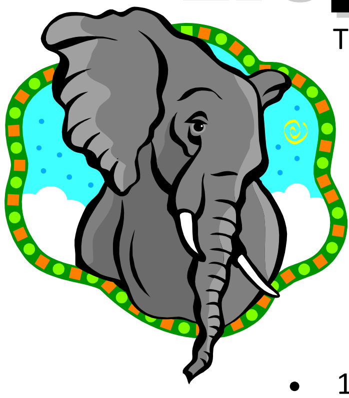
The strong mutual attraction of water molecules for each other is known as surface tension. Normally, surface tension makes it impossible to stretch the water out to make a thin film. Soap reduces the surface tension and allows a film to form. Because of surface tension, a soap film always pulls in as tightly as it can, just like a stretched balloon. A soap film makes the smallest possible surface area for the volume it contains. If the bubble is floating in the air and makes no contact with other objects, it will form a sphere, because a sphere is the shape that has the smallest surface area compared to its volume. (Wind or vibration may distort the sphere.)
The patterns of different colors in a soap bubble are caused by interference. Light waves reflected from the inner and outer surfaces of the soap film interfere with each other constructively or destructively, depending on the thickness of the bubble and the wavelength (that is, the color) of the light. For example, if the soap film is thick enough to cause waves of red light to interfere destructively with each other, the red light is eliminated, leaving only blue and green to reach your eyes.

Etcetera:

You can make other devices to create large bubbles. One of the easiest is a length of string (or, still better, fuzzy yarn) threaded through two drinking straws, with the ends tied to make a loop any size you want. Not only will this device make large bubbles, but you can twist the straws to make film surfaces with different shapes.



Elephant's Toothpaste



This is a kid-friendly version of the popular Elephant's Toothpaste demonstration. A child with a great adult helper can safely do it on their own and the results are wonderful. Note: Students enjoy playing in the bubbles, so this experiment may be best done outside if possible, but can be done inside in a safe area.

Materials

- 16 oz. empty plastic soda bottle (preferably with a narrow neck such as those made by Coca-Cola)
- 1/2 cup hydrogen peroxide
- Squirt of Dawn dish detergent
- 3-4 drops of food coloring
- 1 teaspoon yeast dissolved in ~2 tablespoons very warm water
- Funnel
- Foil cake pan with 2-inch sides
- Lab goggles
- Lab smock

Ask students what they know about hydrogen peroxide. “Have you ever put hydrogen peroxide on a cut? What happens when it comes in contact with the cut?” (It bubbles)

Tell students that they are going to do an activity today that uses hydrogen peroxide.

1. At each student's place: cake pan, plastic bottle, Dawn in small cup, food coloring, funnel, goggles and smock, 1/2 cup peroxide, dissolved yeast mixture.
2. Stand up bottle in the center of the cake pan. Put funnel in opening. Add 3-4 drops of food coloring to the peroxide and pour the peroxide through the funnel into the bottle. Show a water molecule diagram and a peroxide molecule diagram, pointing to the extra oxygen that will be set free.
3. Add the Dawn detergent to the peroxide in the bottle. (Ask students to predict what they think will happen when yeast is added to the peroxide. Students share their prediction with teammates.)
4. Pour the yeast mixture into the bottle and quickly remove the funnel.
5. The students can touch the bottle to feel any changes that take place.

Observations

The reaction creates foam that shoots up out of the bottle and pools in the pan. After a minute or so, it begins to come out in a moving stream that looks like toothpaste being squeezed our of a tube. The students can play with the foam as it is just soap and water with oxygen bubbles. The bottle will feel warm to the touch as this is an exothermic reaction.

How does it work?

Talk about the addition of the yeast as a catalyst which makes the peroxide molecule release the oxygen atom faster. The foam is actually air filled soap bubbles. The teacher who submitted this experiment claims to have done this with hundreds of students from kindergarten through fifth grade and some adults who all loved the experiment. It is very easy and safe to do again at home using regular hydrogen peroxide from the drugstore.

Extensions:

- Make sure to allow students to perform the experiment themselves. Students are much more engaged if they are doing the steps themselves. Even the youngest student can hold the bottle, choose the colors, and help pour in liquids.
- If you do the experiment several times, this is a great way to practice learning colors for the pre-k student.
- Ask students how they might change one of the materials to affect what happened – question 3 of the 4-Question Strategy (more/less yeast, more/less detergent, different detergent). Allow them to test their ideas and keep track of the results.
- Have older students measure the temperature of the mixture before and after the catalyst is added. How much did the temperature rise or fall? Why? If you change the amounts of ingredients does the temperature change or remain constant?

Option: Elephants Toothpaste is an exothermic reaction—meaning it gives off heat/energy.

To demonstrate its opposite, (heat absorbing reactions ex. melting ice cubes, converting frost to water vapor (melting, boiling, and evaporation in general are endothermic processes)) perform an endothermic reaction with the following

Note: at Wal-mart or other stores you will find ctric acid in the canning section, or in the pharmacy in with the vitamin, or ask at the service counter

Most endothermic reactions contain toxic chemicals, but this reaction is safe and easy. Use it as a demonstration and have students vary the amounts of citric acid and sodium bicarbonate to make an experiment and see if they can change the temperature.

What You Need:

- 25 ml citric acid soln (about 2 Tblsp)
- 15 g baking soda (about 3 tsp)
- styrofoam cup
- thermometer
- stirring rod

Here's How:

1. Pour the citric acid solution in a styrofoam coffee cup. Have students Use a thermometer or other temperature probe to record the initial temperature.

2. Stir in the baking soda (sodium bicarbonate). Track the change in temperature as a function of time.

3. The reaction is: $H_3C_6H_5O_7(aq) + 3\ NaHCO_3(s) \text{ --> } 3\ CO_2(g) + 3\ H_2O(l) + NaC_6H_5O_7(aq)$

4. When you have completed your demonstration or experiment, simply wash the cup out in a sink. No toxic chemicals to mess with!

Tips:

1. Feel free to vary the concentration of the citric acid solution or the quantity of sodium bicarbonate.

2. An endothermic is a reaction that requires energy to proceed. The intake of energy may be observed as a decrease in temperature as the reaction proceeds. Once the reaction is complete, the temperature of the mixture will return to room temperature.

Bouncing Bubbles

There's something magical about a bubble. It's just a little puff of air trapped in a thin film of soap and water, but its precise spherical shape and beautiful, swirling colors make it a true wonder of science. A bubble's life expectancy is usually measured in seconds unless you know how to make a SUPER BUBBLE!

Examples of Correlating Standards:

Kinder 7.11.1 Use a variety of objects to demonstrate different types of movement (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).

3rd 7.9.1 Use physical properties to compare and contrast substances.

4th 7.10.3 Gather and organize information about a variety of materials to categorize them as translucent, transparent, or opaque.

Materials

- 1 cup of distilled water (240 mL)
- 2 tablespoons of Dawn® dish soap (30 mL)
- 1 tablespoon of Glycerin (15 mL)
- Make up a batch of Bouncing Bubble Solution (see above).
- Purchase a pair of inexpensive children's gloves from your local department store (100% cotton gloves or socks also work well).

- Blow a bubble about the size of a baseball.
- Bounce the bubble off of your gloves or socks. Try bouncing the bubble off of your shirt or pants. As you'll soon see, some fabrics work better than others.

Another Method:

Bounce a Bubble

Have students use a square bubble frame and soap film to make a trampoline for bubbles!!

1. Dip the bubble frame in bubble mixture and hold it out like a tray.

2. Have a friend blow a bubble from the smaller loop into the air in front of you.

3. Move the bubble frame under the bubble and gently move your arms upward. It may take some practice, but you can get the bubble to bounce on the sheet of soap film.

Ask students: How many times can you bounce a bubble? What happens if the bubble lands on one of the strings?

About the Ingredients...

Water - The single most important part of the bubble solution is the water. Good quality water that does not contain high levels of iron or minerals is best. If you're uncertain as to the quality of your tap water, invest in a gallon of distilled water from the grocery store.

Soap - When it comes to soap, Dawn® dish soap just seems to work the best for home-made bubble solutions.

Glycerin - Glycerin is the secret additive that gives a bubble its extra strength. Don't be too shocked by the price on a bottle of high quality Glycerin. Contact the pharmacist at your local grocery store for availability. (Note: Some bubble recipes substitute Karo® Syrup for Glycerin due to the expense and availability of Glycerin.)

Bubble Colors - Similar to the way we perceive the colors in a rainbow or an oil slick, we see the colors in a bubble through the reflection and the refraction of light waves off the inner and outer surfaces of the bubble wall. You can't color a bubble since its wall is only a few millionths of an inch thick. A bubble reflects color from its surroundings.

Bouncing Bubbles - Experience tells you that regular bubbles burst when they come in contact with just about anything. Why? A bubble's worst enemies are oil and dirt. A "super" bubble will bounce off of a surface if it is free of oil or dirt particles that would normally breakdown the soap film.

Super Strong Bubbles

Time and again, science has shown us that first impressions can't be trusted. Consider the bubble: At first glance, it looks like the most fragile thing in the world. Yet under the right circumstances, it can be surprisingly difficult, if not impossible, to burst -- as the two tricks here illustrate.

Materials:

- 8 1/2- by 11-inch sheets of card stock or copy paper
- Tape
- Scissors
- Bowl and spoon
- 1 cup plus 2 tablespoons water
- 2 tablespoons dishwashing liquid
- 2 tablespoons glycerin (sold at craft and drug stores)
- Plastic drinking straw

1. Make a bubble blower by rolling the card stock into a cone and securing it with tape, as shown in the following directions. Evenly trim the narrow end so it measures 1/2 inch in diameter. Trim the wide opening to even it.

2. In the bowl, gently stir together the water, dishwashing liquid, and glycerin.

Constructing a high-technology bubble blowing tube

Directions found at http://www.zurqui.com/crinfocus/bubble/tube.html

1. 

2. 

1. You don't have to look in cereal boxes for an amazing bubble blowing tube because you can make your own with only two sheets of writing or photocopy paper, masking tape and scissors.

2. Start by rolling the two paper sheets into a funnel shape.

3. 

4. 

3. The small end may be without an opening if necessary as the tip will later be snipped off.

4. Roll the two sheets into a tight cone or tube with the opening at the large end approximately 3 to 4 cm. in diameter (1 1/4 - 1 1/2 in.)

5.


5. Tape with masking tape. Position the tape high enough so that it will never be submerged in the soap solution.

6.


6. Cut the mouth or small end of the cone so there is an opening approximately 1 cm. in diameter.

7.


7. Look down the opening of the tube and judge the distance to where there are various layers of paper. Cut down to this level and then start cutting around the tube, making the final cut where you started.

8.


8. The edge of the cone should be completely smooth. You can check this by running your finger around the edge to detect high or rough edges. Any rough edges should be trimmed off.

9.


9. After cutting, the cone should stand upright. If it does not, trim to adjust until it does.

10.


10. The finished cone ready for bubble making. The cone can be used repeatedly, just set it out to dry after each use.

Using Your High Tech Bubble Blower!

http://www.zurqui.com/crinfocus/bubble/skil.html

After the first time you dip (for 30 seconds) you will only need to submerge it for a couple of seconds. When you retrieve the cone tilt it slightly and tap it on the side of the dish to remove the excess solution. Start blowing the bubble downward. You will notice that the bubble drips excess solution at the start.

As the bubble grows you will observe that it becomes more buoyant and you will be able to lift the blowing tube to a horizontal position (Fig. 2).

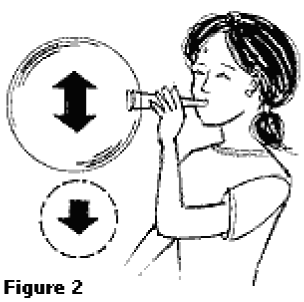


Figure 2

This is because the warm air from your lungs is filling the bubble making it weigh less.

When the bubble gets really large you will notice that it wants to rise as if it was a balloon filled with helium gas (Fig. 3).

This is because the bubble is now filled with a large volume of warm air, surrounded with cooler air. If you are outdoors it may even become uncontrollable. I recommend that if you want to blow really large bubbles, start indoors with the windows closed so that you can learn to control the bubble. Even the slightest draft will try to move a large bubble. It is more difficult to control large bubbles than small ones.

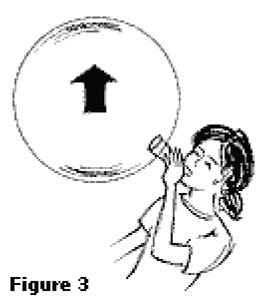


Figure 3

When the bubble is the size you want, you can separate it from the cone by rapidly flipping the cone up or down (Fig. 4).

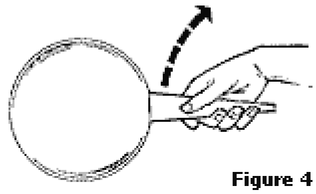


Figure 4

Do not pull the cone straight away from the bubble as it will be more likely to burst.

Now you are ready to do the following experiments!

Experiment 1 -- The Unpoppable Bubble: Dip the wide end of the cone into the bubble solution and hold it there for a few seconds to absorb the mixture. Tap off the excess liquid and then quickly dip the cone again. With the cone pointed toward the ground, gently blow a large bubble. Leave it attached to the end of the cone, using your finger to cover the cone's tip.

Now stick the point of the scissors into the bubble. It should pop instantly. Try it again, but this time first dip the scissor points into the bubble solution. They should pass right through the bubble's "delicate" skin without breaking it.

What's Happening: There are two main ways a bubble pops. The first is when its watery wall evaporates (adding some glycerin to the bubble solution slows down this process). The second is when something dry tears a hole in the wall, as when you poke it with the bare points of a pair of scissors. Dipping the blades into the bubble solution beforehand, however, gives them liquid edges, and the bubble wall simply flows around them.

Experiment 2 -- Inside-Out Bubbles: Blow a large bubble as you did in the first trick.

1. Dip the plastic drinking straw into the liquid (be sure to wet at least 2 inches of it). Insert the end of the straw into the bubble and gently blow to create one or more smaller bubbles inside it.

2. Then watch. The interior bubbles will pass through the skin at the bottom of the large bubble and cling to the outside.

What's Happening: As with the scissors, coating the straw with solution allows you to insert it in the big bubble and blow smaller bubbles inside. But why don't those small bubbles stay in there? Because their proportion of air to liquid is smaller than the bigger bubble's, they are denser. Consequently, they sink and fall through the bottom of the bigger bubble. Still, they don't weigh quite enough to break free completely, so they simply hang in place.

Bigger is Even Better

Everyone knows that small bubbles are amazing... you can blow them, bounce them, catch them... the fun never ends! But what if you could a make a giant bubble over 1 meter (3 ft) tall? Once you know the secret behind these super bubbles, you can amaze your audience by surrounding them in a human-sized bubble!

Materials

- Pipette or other bubble blowing device
- Dawn dish soap (not anti-bacterial)
- Distilled Water
- Hula Hoops, small and large
- PVC pipe
- String
- Scissors
- Children's swimming pool
- Glycerin (optional)

Bubble Solution Recipe

In the swimming pool mix 19 L (5 gallons) of distilled water with 2.5 L (10 cups) of Dawn® Dish Soap. The best bubble solution ages with time, so allow your mixture to sit overnight before using it. For even stronger bubbles, add 1.2 L (5 cups) of Glycerin to the solution.

Blowing Bubbles with a Pipette

An ordinary plastic eyedropper, called a pipette, makes the perfect bubble blower. Just snip the round end off of the pipette and dip it in the bubble solution. Blow through the skinny end of the pipette and you will get a perfect bubble nearly every time!

Making a Bubble Wall

1. Take two pieces of PVC pipe (available at a hardware store... they will even cut it for you) 30-60 cm (1-2 ft) long.
2. Attach the two pipes with a long loop of string. Thread the string through the top pipe, down into the other pipe and back up to the original pipe. Tie the ends string together. The two pieces of pipe should be hanging about 90 cm (3 ft) apart. Dip the entire contraption into the bubble solution and slowly pull it back out. You will find that the bubble solution is in between the pipes like a bubble wall!
3. If you blow lightly into the wall, a bubble will pop out. Or, try putting your hand in the bubble solution so it is coated with solution. Now, put your hand through the bubble wall.... it goes right through without breaking the wall! Because you coated your hand with bubble solution first, the oils on your skin won't break the bubble.
4. You can also try this trick with a small hula hoop. You will have a bubble ring that you can put your hand through or blow out smaller bubbles.
5. Your audience will already be on their feet and you haven't even made it to the grand finale!

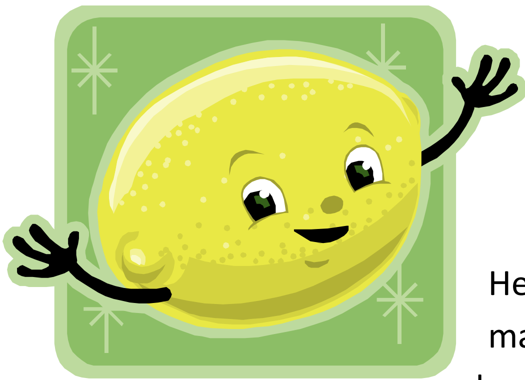
GIANT Bubbles

1. Place the larger hula hoop in the bottom of the swimming pool.
2. Ask for one or two brave volunteers to take off their shoes and step into the swimming pool and into the center of the hula hoop.

3. Now, very slowly, and with a steady hand, pull the hula hoop straight out of the pool and to the top of your volunteer(s) head.
4. Before they can say "No way!" Your volunteer is trapped inside a human-sized bubble!
5. Your audience will go wild with applause and you can take your well-deserved bow... after you release your volunteer from their bubble cage!

How does it work?

Bubbles form because of the SURFACE TENSION of water. Hydrogen atoms in one water molecule are attracted to oxygen atoms in other water molecules. They like each other so much, they cling together. Normal bubbles enclose the MAXIMUM VOLUME OF AIR with THE MINIMUM AMOUNT OF BUBBLE SOLUTION, so they are always round. When you stretch your bubbles across contraptions like the Bubble Wall or a hula hoop bubbles cling to the sides as you dip into the solution, making the bubbles all sorts of shapes. The surface tension of water, alone, is TOO STRONG to make good bubbles, ADDING SOAP REDUCES THE SURFACE TENSION. It also adds oily film that slows down the evaporation process, so you get longer-lasting bubbles!



Lemon Suds

Here's a twist on a classroom chemical reaction made for young children. Just squeeze a little lemon juice into the container and stir the concoction… lemon suds appear like magic! It's so simple to do and kids scream, "Do it again!" When you're finished making a mountain of bubbles, use the lemon-scented suds as a great cleaner.

Materials

- Lemon (cut into quarters) or lemon juice
- Plastic cup (8 oz.)
- Liquid soap (Ivory or Dawn)
- Baking soda
- Measuring spoon
- Straw
- Safety glasses
- Paper towel (you can't be a messy scientist)

- Measure 1 teaspoon of baking soda into the empty cup.
- Add a squirt (okay, about a teaspoon) of liquid soap to the cup. Use the straw to stir the mixture. Your set-up is complete!
- It's show time! Hold the cup in your left hand – being careful to conceal the secret mixture in the bottom of the cup with your hand – and pick-up the piece of lemon with your right hand. "Some people use lemon to flavor their ice tea… I use lemon to make soap. Watch this…"
- Put on your safety glasses (this only adds to the suspense!) Squeeze the lemon into the cup (squeeze hard to get as much lemon juice as possible) and stir the mixture with your straw. In just a few seconds, a chemical

reaction occurs and the cup fills with lemon suds! "Can you guess what I made? No, not a drink… it's lemon suds soap!"

- Scoop out some of the suds with your hands to show the incredible cleaning power of your new concoction. "So, what do you think I used to make the lemon suds?" After your audience has exhausted all of their guesses, pull out a new cup and show them your secret recipe.
- When you're finished, this mixture can be poured down the drain.

How does it work?

This is a simple but elegant example of a classroomic chemical reaction between baking soda and citric acid (lemon juice). When the citric acid combines with the baking soda, a chemical reaction takes place producing carbon dioxide gas (those are the bubbles) and water. You also produce a small amount of sodium citrate (just in case you were wondering).

Additional Info

This was a favorite demonstration of the late Dr. Babu George from Sacred Heart University in Connecticut. Dr. George was a highly respected organic chemist who had a passion for getting elementary teachers excited about teaching science. Dr. George used simple demonstrations like "Lemon Suds" to introduce both students and teachers to the magic of chemistry. Thanks to Laura Slocum from University High School of Indiana for sharing this idea.

Bubble Bomb!

(aka: CO2 Sandwich) Don't worry…we're simply popping a plastic bag with the awesome power of baking soda and vinegar!

Materials

- Safety glasses
- Measuring cup and spoons
- Vinegar
- Baking soda
- Re-closable bag (a quart-size zipper-lock bag)
- Toilet Paper

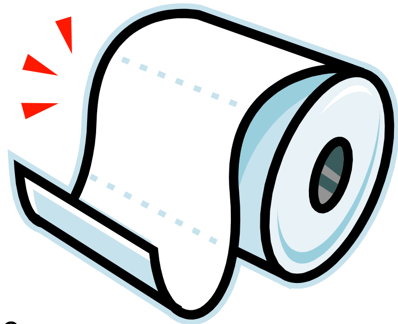
1. It's very important to use a bag without holes. To test the zipper-lock bag, put about half a cup of water into it. Zip it closed and turn it upside down. If no water leaks out, you can use that bag. Unzip it and pour out the water. If the bag leaks, try another one. Keep testing bags until you find one that doesn't leak.

2. Tear off a square of toilet paper.

3. Twist or fold the toilet paper around the pile of baking soda making a small packet.

4. It's best to have someone help you with the next few steps. Open the zipper-lock bag and measure a 1/4 cup of vinegar into the bag. Add a 1/4 cup of warm water to the bag.

5. Zip the bag closed, but not all the way. You want a small opening just large enough to sneak in the wrapped up baking soda.



6. IT'S TIME FOR A FIELD TRIP. Move the experiment to the sink, or better yet OUTSIDE! Remember, it's all about teamwork. Drop the baking soda bundle into the bag and quickly seal the bag closed. Place the bag on the ground (or in the sink if you're indoors) and get out of the way. Watch closely as the bag begins to puff up… it gets bigger and bigger until… BAM! Pop goes the sandwich bag.

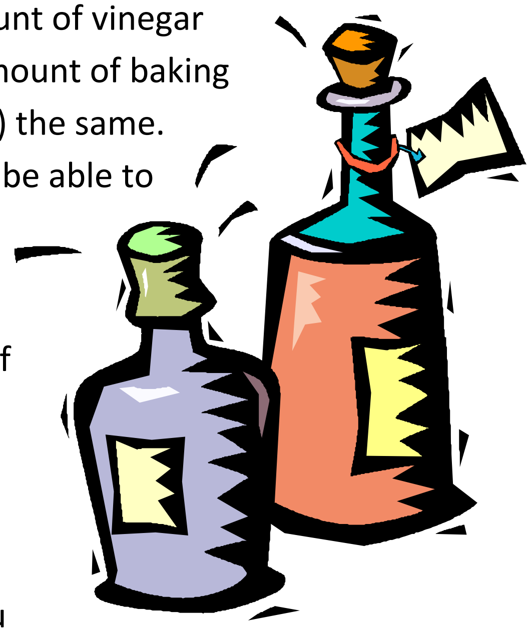
How does it work?

Sure, bubbling liquids and popping bags are fun, but what's the science behind the exploding lunch bag? When you mix vinegar and baking soda, a chemical reaction takes place producing a gas called carbon dioxide (CO2). If you really want to impress your friends, use the chemical names for each of the ingredients. Acetic acid (that's vinegar) plus sodium bicarbonate (baking soda) produces carbon dioxide gas and water. The bag puffs up because the carbon dioxide gas takes up lots of space, eventually filling the bag. If there's more gas than the bag can hold… KABOOM! If you're lucky, the zipper-lock seal will bust open, but the bag will not break. Now you can reuse the bag to make another CO2 sandwich. Wrapping the baking soda in tissue paper is a clever way of slowing down the reaction. It takes a few seconds more for tissue paper to dissolve so that the vinegar and baking soda mix.

Why separate the materials? Because it slows down the reaction so you can study it…plus it's a lot of fun.

But Wait! There's More to do! . . .

- How does the temperature of the water affect the pop? Repeat the experiment using cold water instead of warm water.
- Try changing the amount of vinegar and baking soda you use to see how the reaction changes. Remember to only change one thing (variable at a time). For example, you can increase the amount of vinegar you use to 1/2 cup, but be sure to keep the amount of baking soda (one tablespoon) and the water (1/4 cup) the same. By changing only one variable at a time, you'll be able to determine which ingredient has the most impact on the POP!



- Wrap the baking soda in two or three pieces of tissue. How will this affect the reaction?
- What are 3 more variables you can change?
- Try using a different size of zipper-lock plastic bag. What do you think might happen? Do you think you'll need to use more baking soda, vinegar, and water to make the bag explode? Try it and see.
- In the original experiment, we asked you to use warm water. Try using cold water or hot water. Does changing the temperature change your results? How?
- The first time you tried this, you mixed the vinegar with water. Try doing the experiment again with just vinegar. How did this change your experiment?
- Instead of using paper towel, make your "time release packet" using a different kind of paper, like toilet paper, tissue paper or notebook paper. What happened?
- What if you didn't have tissue? Try the following variation and measure which version gets the biggest bang!

Zipper-lock Bag Variation

1. Fill three, quart-size zipper-lock bags with approximately 1 tablespoon of baking soda.

2. Fill three, snack-size zipper-lock bags with varying amounts of vinegar. For example, fill one bag with 60 mL (1/4 cup) of vinegar, the next bag with 80 mL (1/3 cup) of vinegar and the last bag with 120 mL (1/2 cup) of vinegar.
3. Seal the vinegar bags and place them in the bags with the baking soda.
4. Make sure the baking soda bags are tightly sealed and put on your safety glasses.
5. Put the bags on a table where it's okay for things to get a little wet and messy (maybe even outside).
6. Now get ready for the fun... Punch the vinegar bags inside the baking soda bags to break them open and then shake the baking soda bags to make sure the substances mix.
7. Make observations about how large each bag gets and how long it takes before you hear the giant POP!
8. How could you make a control and compare the toilet paper version vs. the zipper snack bag. Could you test them with the exact same amounts of ingredients (vinegar, water, and baking soda). Were there different amounts of gas or not? If there was a difference what do you think caused it?

Further Discussion:

Why does the Bubble Bomb explode?

The bubbles in the Bubble Bomb are filled with carbon dioxide, a gas that forms when the vinegar (an acid) reacts with the baking soda (a base).

If you've ever made a cake or baked a loaf of quick bread (the kind that doesn't use yeast), you've already done some experimenting with the bubbles that come from an acid-base reaction. Most cakes and quick breads rise because of bubbles in their batter. Those bubbles, like the ones in your Bubble Bomb, are created by the chemical reaction of an acid and a base.

Take a look at a recipe for quick bread. If the recipe includes baking soda but no baking powder, it will probably also include an ingredient that's acidic-such as buttermilk, sour milk, or orange juice.

Quick-bread recipes may call for baking powder in addition to or instead of baking soda. Baking powder is made by combining baking soda with an acidic ingredient, such as tartaric acid or calcium acid phosphate. When you add water to baking powder, it will fizz as the acid and base interact. In fact, if you ever run out of baking powder, you can make your own by mixing two teaspoons cream of tartar (it provides the acid), one teaspoon of baking soda (it's the base), and a half-teaspoon of salt.

Any baked goods that rise rely on carbon dioxide bubbles to get the job done. You can make these bubbles either by using yeast or by using the acid-base reaction like you did in the experiment.

Yeast is a one-celled fungus which converts sugar to carbon dioxide gas. Because this process takes a while, bakers use yeast in doughs that they leave alone for several hours.

Another method that cooks use to make something rise is a combination of baking soda and an acidic ingredient, like orange juice or buttermilk. This is the same kind of chemical reaction that took place in your bubble bomb.

Next time someone you know is baking, check the recipe to see if you can figure out what ingredients make the bubbles that make the cake or bread or cookies rise.

Building a Bubblearium

http://www.sdahq.org/new1198/kids/bubbles/page08.htm

How does temperature affect the life of a bubble?

Materials needed:

- Bubble solution
- Two clear jars or glasses,
- Drinking straw
- Plastic wrap

1.Make sure the insides of the jar and rim are wet. Place a little bubble solution in the bottom of the jar.

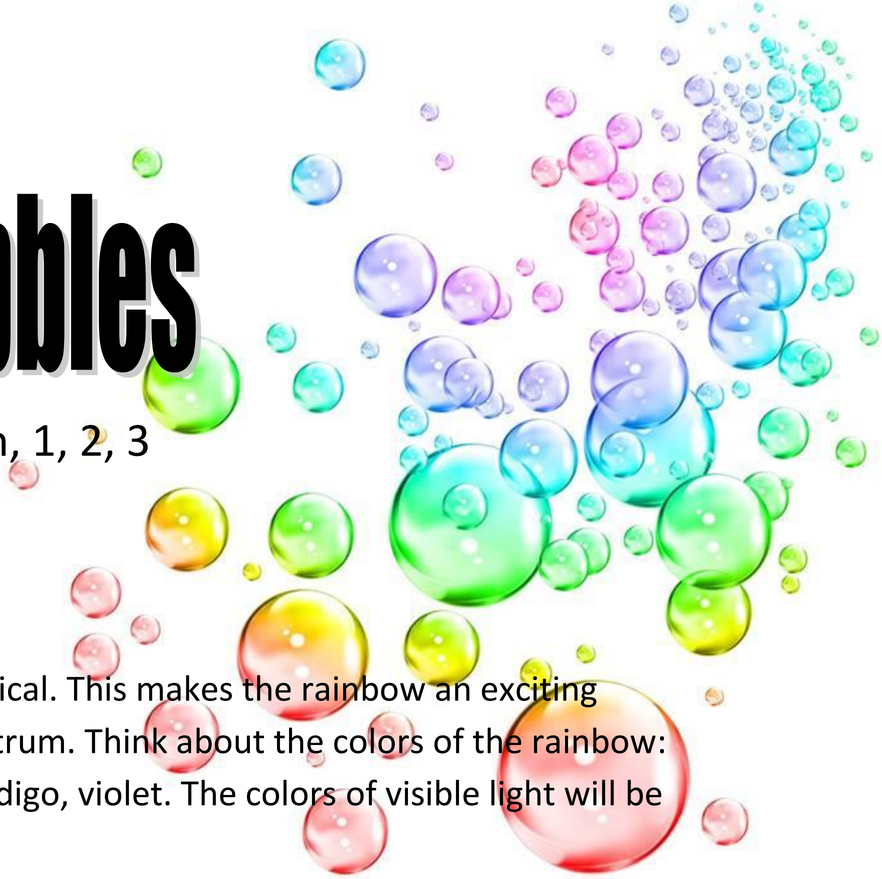
2.With a wet straw just above the bubble solution, blow bubbles until the jar is filled. Cover with plastic wrap and place in the refrigerator or freezer. Time how long your bubbles last.

3.Repeat step 2, but this time put the “Bubblearium” in direct sunlight. Time how long those bubbles last.

What did you discover about the life of a bubble?

Answer: Bubbles last longer in cool temperatures. Heat makes them evaporate faster.

Rainbow Bubbles



Grade Level(s): Kindergarten, 1, 2, 3

Subject(s):

- Science

Overview:

We often think of rainbows as magical. This makes the rainbow an exciting starting point for study of the spectrum. Think about the colors of the rainbow: red, orange, yellow, green, blue, indigo, violet. The colors of visible light will be seen in this enjoyable experiment.

Purpose:

To teach beginning grades to be aware of the fascination of astronomy and teach elementary scientific principles.

Objectives:

- To have children observe a visible spectrum.
- Light demonstrates existence of a spectrum.
- Notice that light hits bubble and is reflected off the top and bottom of surfaces.
- Reflected light separates into rainbow colors known as inference color.
- Finally, as bubbles get thinner the colors become redder.

Materials:

1. Five 1 gallon containers of water
2. Five cups liquid washing detergent
3. Light source- Sunlight or 1 or 2 light filament with sockets.

Activities and Procedures:

1. Take children outdoors on a sunny day and divide children into science groups.(5)
2. Use cooperative learning techniques and assign children their job.(record keeper, time keeper, materials, clean-up, etc.)
3. In pans gently mix water and detergent.
4. Have children use straws to blow large bubbles.
5. Observe bubbles while in sunlight and examine colors that appear on surface of bubbles.
6. Have children record colors of spectrum observed, draw pictures, then graph results.
7. Have each group report its observations and display results for all to see.

Tying It All Together:

Encourage children to share their discoveries and results of their experiments with their classmates, families and friends. Use this lesson as a springboard to introduce a future unit on astronomy and space. Discuss the importance of color and how it plays an important role in our lives as we make many color decisions each day. Each of us have different color preferences and we make others aware of it by the colors we choose in our lives daily.

Additional Activities:

Language - Look up spectrum in the dictionary and have children discover its meaning, syllables, part of speech. etc.

Creative writing - Have children make up their own Rainbow Legend and share it with classmates.

Art - Different colors of light and different colors of paint can be mixed: red, green and blue combine to form white light. Primary colors red, blue and yellow make black. Have kids experiment by mixing colors and then paint their spectrum.

Home activities - In afternoon or early morning have children use a hose with a sprayer to create a rainbow.

Soap Bubble Prints

Normally, blowing bubbles with a drinking straw is taboo for kids. Not this time! In fact, that's half the thrill of making these marbleized prints.

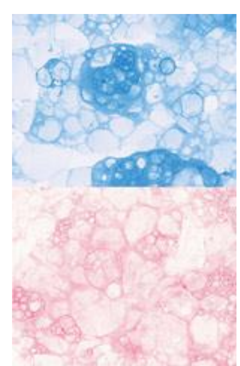
Materials:

- Store-bought or homemade bubble solution (see Step 2 for homemade recipe)
- Copier paper or light-colored construction paper
- Plastic drinking straws
- Newspaper or plastic tablecloth
- Several shallow disposable containers, such as aluminum pie tins

Instructions:

1. Cover your work surface with a thick layer of newspaper or a plastic tablecloth.
2. Gather several shallow disposable containers, such as aluminum pie tins. In each, blend 1 cup of store-bought or homemade bubble solution with 1/2 cup of tempera paint. (To make your own bubble solution, mix 3 cups of water, 1 cup of dish soap, and 1/4 cup of corn syrup.)
3. Set out your paper (try copier paper or light-colored construction paper) and several plastic drinking straws. For younger children, pierce a small hole halfway up the straw with a pin; this will help prevent accidental swallowing of the paint but won't interfere with the bubble-blowing process.

4. Now for the fun. With one end of the straw submerged in the bubble solution, the kids blow until bubbles mound up in the container.



5. The best time to take a print is just as the bubbles begin to overflow. Gently touch the paper to the bubbles and then lift to see your print, repeating until the paper is sufficiently covered.
6. Blow more bubbles as needed. For a different effect, try printing one color over another.

Options:

Partner Art

For the beginner bubble blower

This art project works best when two people are working together.

Materials:

- Tempera or poster paint in 3 or 4 colors
- White or light-colored construction paper
- Bubble solution
- Bubble wand or drinking straw
- 3 or 4 small containers
- A teaspoon and cup

1.This is fun, but can be messy! Spread newspaper around the area and have students wear an old T-shirt.
2.Pour about one cup of bubble solution in each container. Add one teaspoon of paint to each container. Stir gently until mixed.
3.Take turns blowing bubbles while your partner “catches” them on paper. As they break, you’ll get a design of brightly colored splotches! For darker colors, add more paint.

Anti-Bubbles
http://www.antibubble.org/

Everyone is familiar with bubbles! Here are the three basic types:

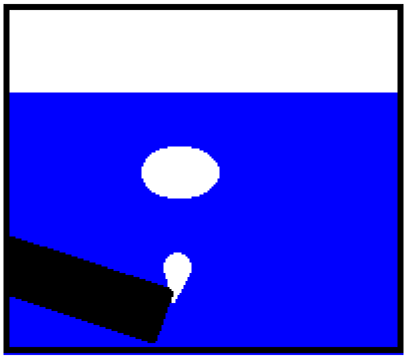


fig. 1
Pockets of air under water

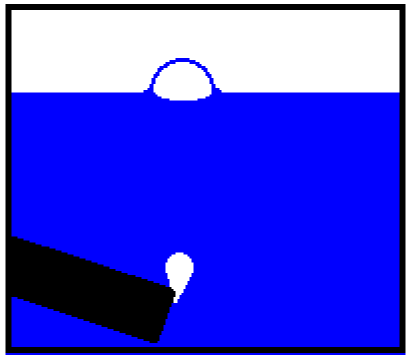


fig 2.
Air trapped under a water film

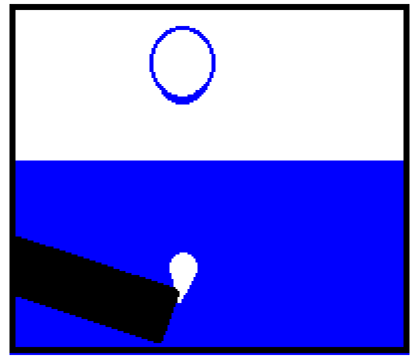
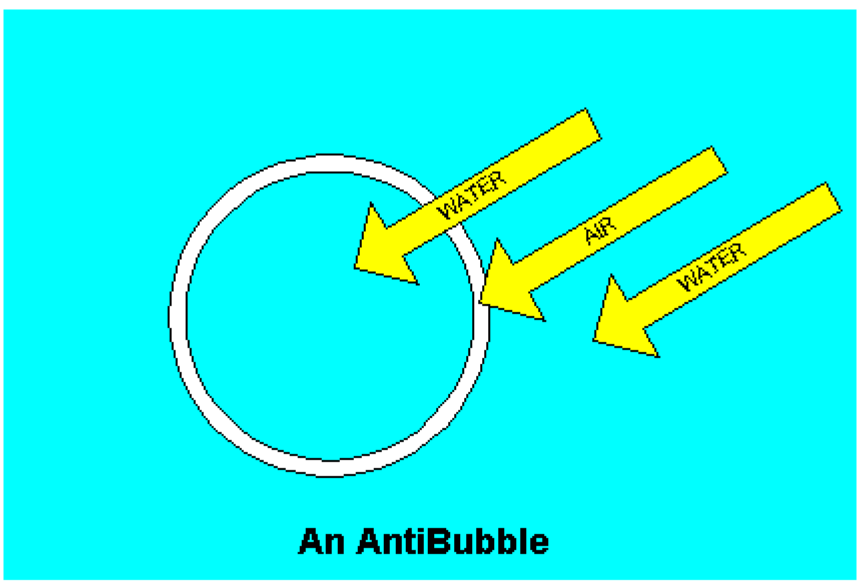


fig. 3
Bubbles which float in the air

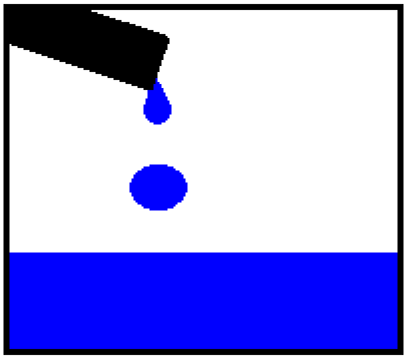
Besides the above bubbles, there are three other kinds which are not as familiar. These are the Antibubbles.



What is an Antibubble?

An Antibubble is similar to a bubble, but the roles of the water and the air are reversed. An ordinary air bubble is simply some air surrounded by liquid.

The first type of antibubble is familiar. it is simply a drop of water falling through the air. It is the opposite of an underwater bubble: rather than being a blob of air in the water, it is a blob of water in the air.


Falling droplet of water

When a drop of water falls into water, we expect it to vanish. But sometimes it does not. If the water is very clean, then a thin skin of air will become trapped between the water droplet and the rest of the water. This effect is sometimes called a "Water Globule" or "floating drops." If you've spent any time sitting in a car on a rainy day, you will have seen water globules skittering across the hood. When raindrops splash on the car hood, you'll see the splashing droplets roll across the wet surface without melding into the rest of the water.

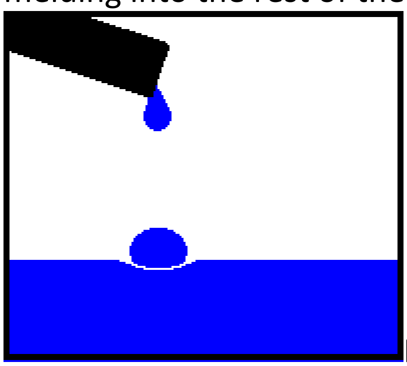
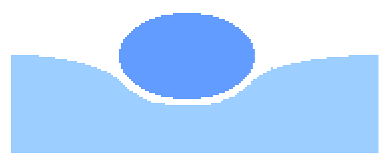
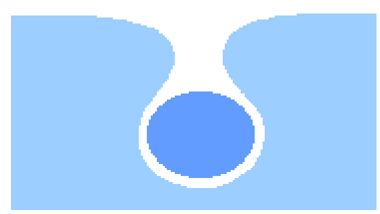


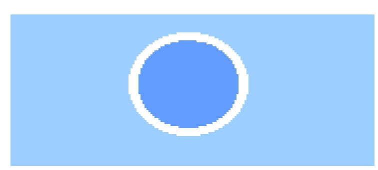
Fig. 5 "Water Globule" on the surface

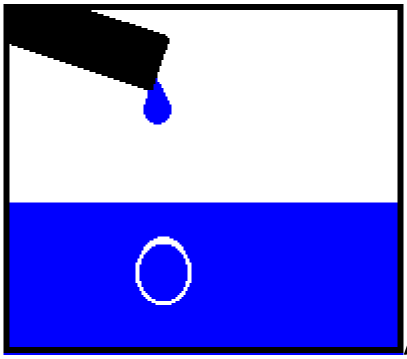


A water globule is the opposite of an air bubble on the surface of water. Rather than being a pocket of air with a thin skin of water separating it from the air, it is a blob of water with a thin skin of air separating it from the water.



The last type of Antibubble is usually called by the name... "Antibubble." It is a very thin skin of air which floats around under the water. (This is nicely illustrated to the right in the drawing from Chang.)
Antibubbles don't form easily, and they usually pop quickly, so most people have never seen them. However, it is possible with a little practice to create them yourself.




Antibubble" floats underwater

Antibubbles have many of the characteristics of soap bubbles. They float underwater weightlessly, and will only rise to the surface of the water very slowly. When poked, they will pop. When a soap bubble pops it leaves behind a tiny drop of water, but when an antibubble pops it leaves behind a tiny normal bubble. Antibubbles also display rainbow colors. Normal soap bubbles have rings of color at the top of the bubble where the soap film is thinnest, while antibubbles have their colors at their bottom.

What Are Some Properties of Antibubbles?

Since they are mostly water with a very thin skin of air, antibubbles are just slightly lighter than the surrounding fluid. This is how you can easily spot one. Ordinary air bubbles quickly rise to the surface; antibubbles take a long time to rise to the top. In fact, if the inner fluid in an antibubble is somewhat heavier than the surrounding fluid, the antibubble will actually sink. When an antibubble pops, all that remains are some very tiny air bubbles that rapidly rise.

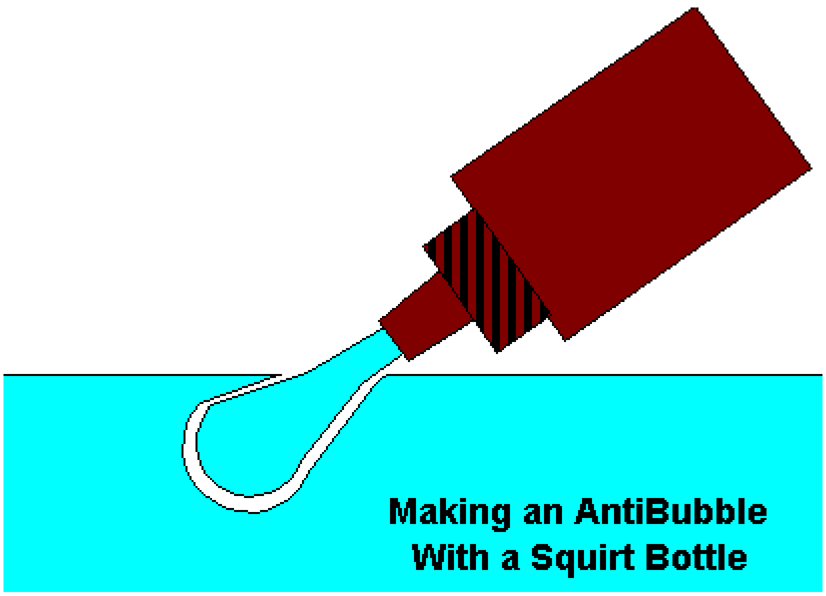
How Do I Make Antibubbles?

Method 1:

It takes a bit of a knack to make antibubbles, but with some practice anybody can do it reliably. Use a plastic bottle with a squirt nozzle. Something like a plastic ketchup bottle is good. Clean it well. The nozzle needs to have a pretty big hole. About 2-3 mm seems to work well.

Fill a clear glass bowl with water and add a little dish detergent. Some people like to use the same mix as for ordinary bubbles, but it may be a bit too strong for antibubbles, test it out and try adding more water.

Pour some of the soapy water into the squirt bottle. Clear off any suds that have formed on the top of the water in the bowl. Now you are ready.
You need to squirt the water from the bottle into the water in the bowl at about a 45 degree angle. A fairly strong stream is needed, but not too strong. The idea is to squirt strong enough to force a sphere of fluid from the bottle into the fluid of the bowl without breaking the surface tension.
Be gentle at first and you'll make blobs of water that don't break the surface tension. You'll see them sliding around on top of the liquid till they "pop" and become part of the main body of liquid. Next, push a little harder and they will start to be forced down inside the liquid to become antibubbles.



If you fail, don't give up right away; it takes a while to get it right. Most people figure out the correct angle and velocity for their particular nozzle in about 15 minutes or so. The temperature of the water is important, as is the amount of soap. The pH and the hardness of the water, and the relative humidity of the air, are also factors. If antibubbles don't seem to form, vary the soap mixture, use your other hand to hold the bottle, change rooms, or let somebody else try. Don't get frustrated or they will never form.

Method 2:

Blow Your Own Underwater Antibubbles

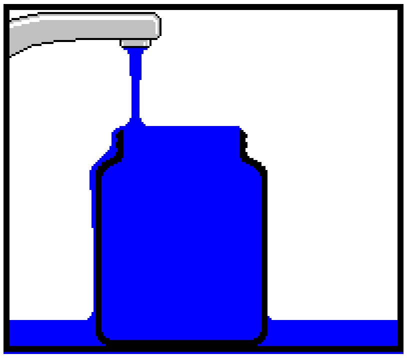
http://www.eskimo.com/~billb/amateur/antibub/antibub1.html 1997 by William J. Beaty

Materials:

- Kitchen sink
- Large clean jar
- Elmer's (tm) glue bottle, emptied and cleaned

• Dishwashing detergent

The key to creating antibubbles is to make a very clean water surface. The tiniest bit of surface dirt will prevent antibubbles from forming, or will make them quickly pop. To create a clean surface, allow a container of water to continuously overflow.



(Fig. 7 Constant overflow cleans the surface.) The overflow causes the surface of the water to stretch and be pulled sideways, and any dirt on the water surface will be skimmed off. Fill your large jar, place it in the sink, and adjust your faucet to allow a continuous stream of water to pour in and overflow the jar.

Add a little dish-soap (household detergent) to the jar of water and stir well. Fill your glue bottle with soapy water from the jar.

To become familiar with how antibubbles behave, first try making some "globules." Spray some droplets up from below, so the droplets land on the surface of the water. If you can build up lots of globules, you'll see them bounce off each other, or "pop" and join the rest of the water. Sometimes they'll join together into larger and larger ones.

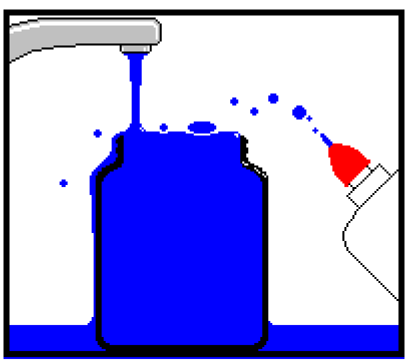


Fig. 8 Squirt some globules onto the water

You can demonstrate that the thin film of air is disrupted by electrostatic forces. Comb your hair to give the comb an electric charge imbalance. Spray some globules on the surface of the water, then wave the charged comb near them. They will abruptly vanish! They all "pop" and rejoin the water. The electrified comb causes the water in the globule to split into areas of positive and negative charge. This imbalanced charge attracts the water below the globule, and the globule crashes into the water below. On a dry day, your body can become electrified from walking on the floor, and this can disrupt antibubbles and globules. If your globules and antibubbles refuse to form, try touching the metal faucet to remove any charge imbalance from yourself. "Static electric" page

OK, let's make some real antibubbles. Follow the three steps below.

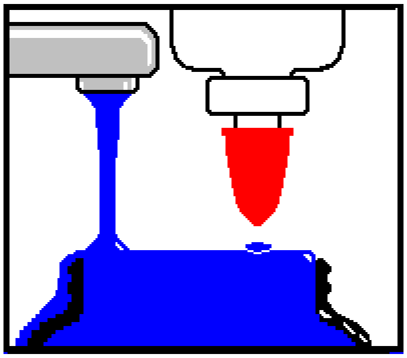


Fig. 9 Make a globule.

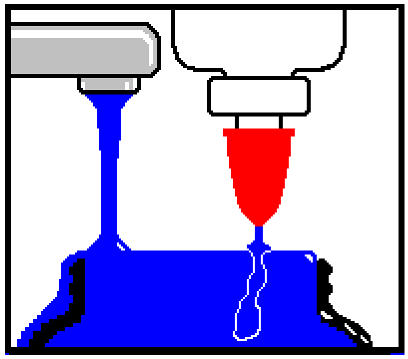


Fig. 10 Squirt through the globule.

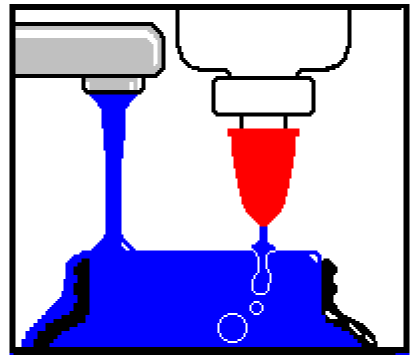


Fig. 11 Watch for antibubbles!

First place the tip of your water-filled squirt bottle very near the water surface. Give it a gentle puff and create a single water globule. Immediately give a longer squeeze. This will send a jet of water through the globule and down into the jar. If your squeeze is gentle and brief, the water jet will take the air layer along. A long silvery worm will extend into the water. This "worm" is water which is coated with air. Do this several times, and sometimes the worm will break up into antibubbles of different sizes.

Your first underwater antibubbles will probably be small, under 1/8 inch across. With practice it is possible to blow 1/4" antibubbles, and occasionally 1/2" antibubbles. To prove that this is no ordinary bubble, poke it with a pencil or fork. It will instantly vanish.

Antibubbles will slowly rise to the surface, where they will often pop. To extend their life time, stick the bottle tip in the water and squirt at them to drive them deeper into the jar. Vibration is supposed to extend their lifetimes, so squirting them with underwater jets may keep them alive longer. Temperature difference is also said to lengthen their lifetimes. Try filling your glue bottle with hot water, while putting cold water in your overflowing jar.

Antibubbles display rings of color, but these colors appear at the bottom of the bubbles rather than at the top. Look closely at your antibubbles under bright light, and you'll see that each one has "soap film colors." But in this case we should call them "air film colors." The color of soap films (and of oil on water) are caused by light reflections from a very thin, transparent layer. Light reflects from the front of the thin layer and from the back. If the layer is almost as thin as light waves, the certain colors of light waves from the two reflections cancel out, producing a "subtractive rainbow" with cyan/magenta/yellow instead of red/green/blue. In a normal bubble the thin water layer creates the colors. In an antibubble, the colors are created by the thin layer of air.

Conventional bubbles can be filled with cigarette smoke, and they release a little cloud when they pop. Antibubbles can also be filled with colors. Just put some food coloring in your squirt bottle. If several kids have squirt bottles with differing colors of water, everyone can keep track of their own antibubbles in the same jar.

Oil Bottle:

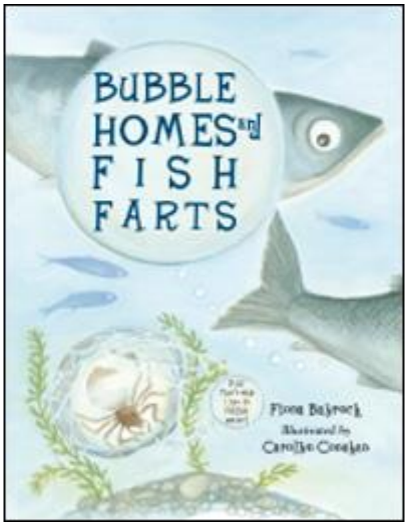
To demonstrate all the various bubbles (antibubbles, bubbles, globules, antibubbles inside bubbles, anti-foams, etc.) make yourself an oil/alcohol bottle. Clean out a small jar and fill it half with salad oil, then fill the rest with rubbing alcohol. Try to fill it perfectly, right up to the top, so no air is trapped. Screw on the cap, then slosh it gently to create waves, or a bit harder to create all sorts of bubbles-within- bubbles. (Don't shake it hard, or it will take hours for the misty mixture to settle out.)

What Are Some Antibubble Tricks?

- If you add a little salt to the water in the bottle, your antibubbles will sink.
- If you put food coloring in the bottle water, the antibubbles will be colored. This is another way to prove to your friends that antibubbles do not contain air, but rather, they contain water.
- A layer of honey on the bottom of the bowl will cushion the fall of salt filled antibubbles and stop them from popping when they hit the bottom. This way you can liesurely contemplate your antibubbles.

Bubble Homes and Fish Farts

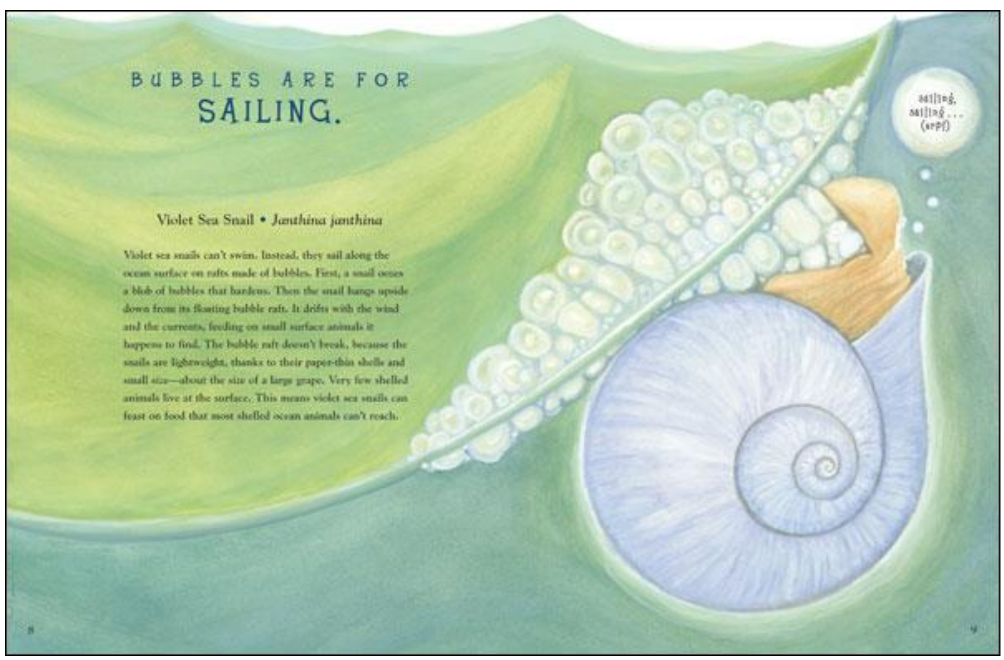
By Fiona Bayrock (Author) and Carolyn Conahan (Illustrator)



Bubbles have far reaching applications in the natural world, above and beyond their usual uses and ramifications. And somehow or other she has managed to find not one, not two, not three or four or five but SIXTEEN examples in the wild where animals and insects have used bubbles to save, play, help, and harm.

Bubbles are for popping, fishing, talking-and for sailing, keeping warm, and even shooting hoops! Who knew animals used bubbles in so many ways?
Learn how the water spider builds an underwater bubble home, how snapping shrimp pop bubbles to scare other animals, and how dolphins play with bubbles as if it's a game. Whether they are riding, breathing, or making bubbles, one thing is for sure-animals use bubbles in amazing ways.

Real-world science meets tongue-in-cheek humor to describe how animals use bubbles. Includes back matter and a glossary and index.



Internet Resources

http://www.sdahq.org/new1198/kids/bubbles/
Explore the fun and mystery of bubbles; provides a bubble recipe, details about bubble sculptures, and a riddle section.

http://dynotech.com/bubbles.htm
This puzzle game plays upside down! Maneuver the rising bubbles so they float into matching bubble pods. Watch out for nasty soap scum! See awesome digital graphics, listen to favorite classical music, save games, pause play when you need a break.

http://www.lastword.com/lastword/answers/lwa243bubbles.html
Bubble Trouble: Behavior of bubbles relative to size

http://www.lastword.com/lastword/answers/lwa237bubbles.html
Bubbly attraction: Why do bubbles appear to be attracted to each other?

http://math.ucdavis.edu/~hass/bubbles.html
Bubbles are nature's way of finding optimal shapes to enclose certain volumes.

http://www.ozemail.com.au/~macinnis/scifun/bubbles.htm

Bubbles and string ; cubic bubbles; cylindrical bubbles; fast bubbles; lifting with surface tension; spiral bubbles; surface tension bits and pieces; fluids and their behavior

http://www.internet-ad.com/fan-yang/

Bubbles from the Yang family

http://www.physics.ohiostate.edu/~maarten/work/soapflow/soapintro/basicsoap.html.

Forces in Fluids