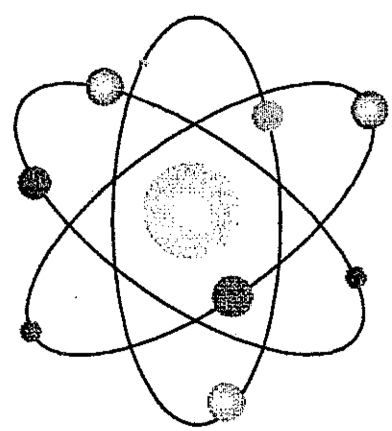
150 Captivating Chemistry Experiments Using Household Substances



by Brian Rohrig

illustrated by Lydia Cooper

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DENSITY: Experiment # 5 - **Is Salt Water Denser than Pure Water?**

OBJECTIVE: To demonstrate that salt water is more dense than pure water.

MATERIALS: Egg
Water
Salt
Beaker or drinking glass

SAFETY PRECAUTIONS: None

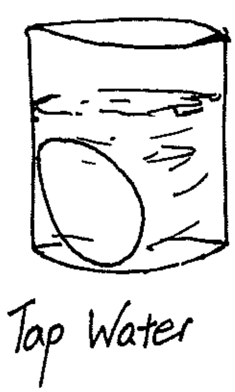
PROCEDURE: 1. Place an egg in a glass of water. The egg should sink. (If the egg floats, try another egg. When eggs get old, they fill with gas and may float)

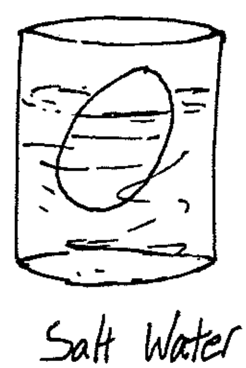
2. Remove the egg and add several tablespoons of salt. Stir until most of it is dissolved.

3. Place the egg in the salt water. It should float. If it does not, add more salt and stir until dissolved.

EXPLANATION: This is a classic experiment demonstrating the fact that salt water is more dense than pure water. Any object floats because the liquid is exerting a buoyant force on the floating object. If the buoyant force is greater than the force of gravity, or weight, on that object, then that object will float. The denser the liquid, the greater the buoyant force it can exert. Salt water, being more dense than pure water, can exert a greater buoyant force, enough to cause the egg to float. This is why it is much easier for people to float in salt water than fresh water. In some very salty lakes, such as the Dead Sea, it is nearly impossible to sink.

RELATED EXPERIMENTS: The next time you visit the ocean, bring back a bottle of salt water to experiment with.





AIR PRESSURE: Experiment # 1 - **The Imploding Soda Can**

OBJECTIVE: To crush a soda can using air pressure.

MATERIALS: Empty soda can
Heat source
Water
Shallow metal pie pan
Pot holder or tongs
Ice

SAFETY PRECAUTIONS: Wear safety goggles. Be careful with boiling water. Do not grasp hot soda can without the use of tongs or a potholder.

PROCEDURE: 1. Fill an empty soda can to approximately one inch with water.

2. Place the can on a burner or hot plate.

3. While the can is heating, fill a shallow pie pan approximately halfway with water. Add some ice cubes to the water.

4. After you see steam rising from the can, continue to heat for 2-3 minutes.

5. Grasp the can with tongs or a potholder and quickly invert the can in the pan of cold water. The can should instantly implode.

EXPLANATION: As the can is heated the air in the can is also heated, expanding and rising out of the can. The can then fills with steam, and this steam pushes out most of the air that remains. When the can is inverted into the pan of cold water, the steam immediately condenses back into liquid water. A can "full" of steam will condense into only a few drops of water, so what is left in the can is a partial vacuum - nearly nothing. Since the opening of the can is under water, air cannot rush in to fill this vacuum. However, the outside of the can is still surrounded by air, and air pressure pushes down with a force of 14.7 lbs. per square inch. Normally, air on the inside of a can will push outward and balance out this air pressure. However, since we have removed the air from inside the can, and the outside air pressure is still acting around the can, the can is instantly crushed by this outside air pressure of 14.7 lbs. per square inch. This is an excellent example of the tremendous power of the air that is all around us.

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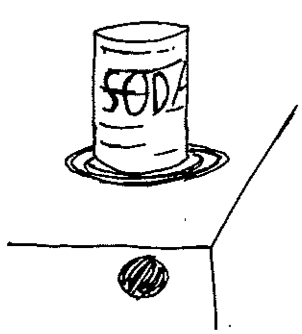

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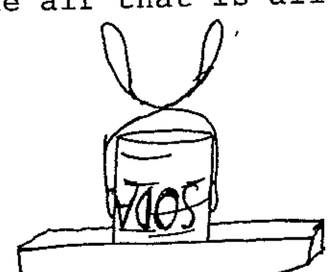

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AIR PRESSURE: Experiment # 9 - **Levitating a Person**

OBJECTIVE: To "levitate" a person using only air.

MATERIALS: Large trash bag
10 drinking straws
Duct tape
13 people

SAFETY PRECAUTIONS: 2 people should act as spotters and stand on either side of the person being levitated, to insure that he or she does not fall.

PROCEDURE: 1. Poke 4 of the straws an equal distance apart along the seam of one side of the trash bag. Allow approximately an inch or so of the straw to remain inside the bag.

2. Repeat the above procedure with the other side of the bag, and then insert 2 straws into the sealed end.

3. Using duct tape, completely seal the open end of the bag. Also tape around each straw with the duct tape so as to make an air-tight seal.

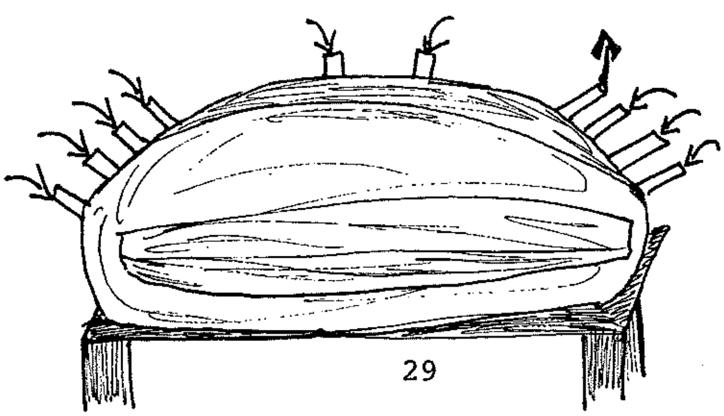
4. Place the bag on a table.

5. Have a person sit on the bag and bring their knees toward their chest, so that their entire body is on the bag.

6. Have 10 people blow into the straws until the bag is completely inflated and the person rises into the air!

7. If the bag tears, simply repair with duct tape - this will only serve to make the bag that much stronger in the future.

EXPLANATION: It should be no mystery as to what is happening here. As the bag inflates with air, it begins to exert its incredible power. This method has been used to free the wreckage from atop the victims of automobile crashes. A flat, deflated, heavy duty "balloon" is inserted underneath the wreckage and then pumped up with air. The bag you inflated is capable of lifting over 400 lbs.



AIR PRESSURE: Experiment # 16 - **Creating a Siphon**

OBJECTIVE: To demonstrate how a siphon works.

MATERIALS: 2 2-liter bottles
Water
3 feet of plastic aquarium tubing
Food coloring

SAFETY PRECAUTIONS: None

PROCEDURE: 1. Fill 1 bottle with water, add a few drops of food coloring, and place on a table.

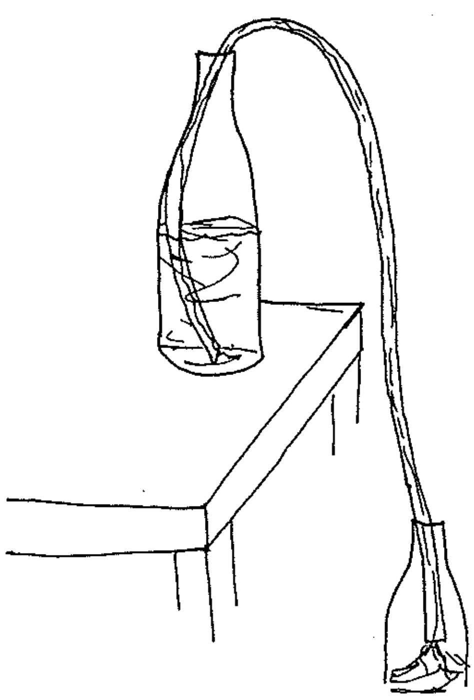
2. Place the other bottle on the floor.

3. Insert the tubing in the bottle of water and begin sucking the air out of the tubing.

4. When all of the air is removed from the tubing, water will begin to come out of the tubing. At this point, quickly insert the end of the tubing into the empty bottle.

5. As long as the empty bottle stays below the level of the filled bottle, the siphon will continue to operate, and one bottle will completely empty into another. If the empty bottle is raised above the level of the first bottle, the siphon will cease to work.

EXPLANATION: As the air is sucked out of the tubing, a vacuum is created in the tubing, much the same way as drinking from a straw. Therefore, air pressure pushing on the surface of the water forces the water up the tube and into the other bottle. Gravity will keep the siphon operating, but this siphon cannot operate against gravity and cause water to flow uphill if the position of the 2 bottles are switched.



AIR PRESSURE: Experiment # 15 -
<u>How To Get a Balloon in a Bottle</u>

OBJECTIVE: To force a balloon inside a bottle using air pressure.

MATERIALS: 32 oz. lemon juice bottle (or equivalent)
Balloon
Teakettle
Water
Stove or hot plate

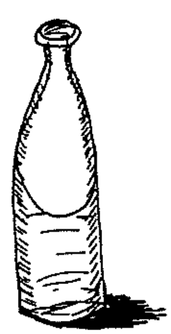
SAFETY PRECAUTIONS: Exercise caution when using the stove and when handling boiling water. Make sure you use a sturdy glass bottle which can withstand the boiling water. Place bottle in sink when pouring the boiling water into it, in case of breakage. Wear safety goggles.

PROCEDURE: 1. Heat 32 oz. of water to boiling.

2. Fill the bottle with boiling water, then immediately empty it.

3. Immediately place a balloon over the mouth of the bottle and observe for several minutes. The entire balloon will appear to be "sucked" into the bottle.

EXPLANATION: This experiment is well worth taking the time to master, since the results are so dramatic. By filling the bottle with boiling water and emptying it, the air in the bottle is heated. Hot air takes up more space than cold air, since the molecules are moving faster, causing it to expand. As the bottle cools, the air also cools, thus the air molecules begin to slow down, occupying less space. A partial vacuum is then created in the bottle - a region of lower air pressure than its surroundings. Since outside air pressure is greater, it pushes down on the balloon, causing it to completely inflate inside the bottle - a condition that we demonstrated to be "impossible" in a previous experiment!
A good challenge to present to your students is to show them the balloon in the bottle - without telling them how you did it - and then challenge them to duplicate it!



AIR PRESSURE: Experiment # 17 - **<u>The Mysterious Ping Pong Ball</u>**

OBJECTIVE: To cause a ping pong ball to descend to the bottom of an aquarium without touching it, and to cause the same ping pong ball to rise up out of the aquarium without touching it.

MATERIALS: 2 gallon aquarium or larger.
Water
2-liter bottle
Scissors
Ping pong ball

PROCEDURE: 1. Cut the bottom from the 2-liter bottle.

2. Fill an aquarium about 3/4 full with water.

3. Place the ping pong ball in the aquarium.

4. With the lid on the bottomless 2-liter bottle, place it over the ping pong ball and push downward. The ball will be pushed to the bottom.

5. Now take the cap off, and allow water to fill in the bottle. When the water and the ball have reached the top of the bottle, replace the cap, and pull the bottle out of the water. As long as the bottle does not come completely out of the water, the ping pong ball will rest on top of the water at a height of about 1 foot above the aquarium!

EXPLANATION: Air takes up space. Since the bottle is filled with air, water cannot enter the bottle, and this column of air forces the ping pong ball to the bottom of the aquarium. As to the ball rising up out of the water, it is simply floating on top of the water in the bottle. The water does not fall out of the bottle due to the buoyant force of the water below it. Water acts like the air in that it exerts a pressure in all directions, even upwards.

ACKNOWLEDGMENTS: I first saw this experiment performed by a group of students from Michigan State University at the Chem. Ed. Conference at Old Dominion University in Norfolk, Va., in 1995.

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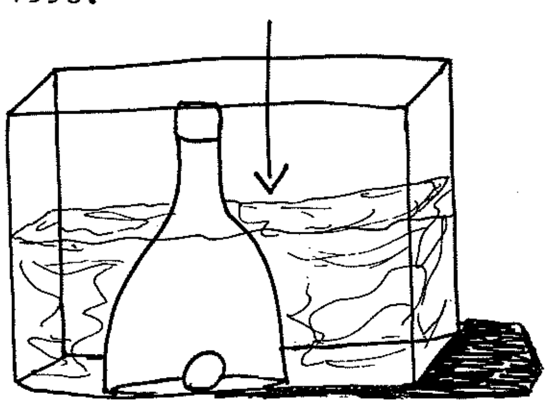

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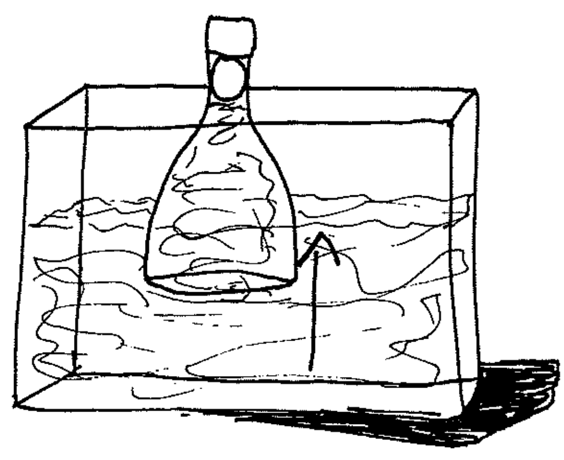


AIR PRESSURE: Experiment # 19 - **Forcing a Straw Through a Potato**

OBJECTIVE: To force a straw through a potato by use of air pressure.

MATERIALS: Straw
Potato

SAFETY PRECAUTIONS: None

PROCEDURE: 1. Try to force a straw through a potato, making sure to leave the end of the straw uncovered. You will have little success.

2. Now, holding your thumb over the end of the straw, attempt to force the straw through the balloon. After several attempts, you should be successful.

EXPLANATION: The straw is much too flimsy to penetrate the potato by itself. However, by holding your thumb over one end of the straw, the straw is now filled with air. This column of air represents a formidable force that allows the straw to easily pass through the potato. It is almost the same as penetrating the potato with a solid rod, which would not be too difficult.

COMBUSTION: Experiment # 1 - **Products of Combustion**

OBJECTIVE: To observe the by-products of the combustion of a candle.

MATERIALS: Large candle
Matches
Glass jar

SAFETY PRECAUTIONS: Always exercise caution when using matches and open flames.

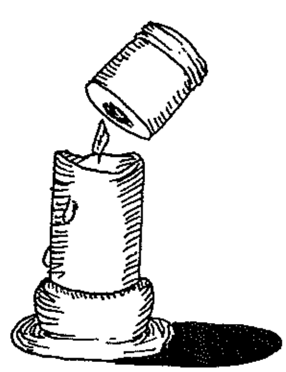
PROCEDURE: 1. Hold a glass jar just over the tip of a candle flame. You will notice that a thin layer of condensation immediately forms.

2. Continue to hold the jar over the flame for about 10 seconds.You will notice a thick, black film build up on the jar.

EXPLANATION: A typical candle is composed of paraffin or wax - which is a hydrocarbon. A hydrocarbon is a compound composed of hydrogen and carbon. A typical paraffin molecule will have a formula of $C_{25}H_{52}$. When a candle burns, it reacts with oxygen in the air to yield carbon dioxide and water vapor.
The equation is as follows:

$$C_{25}H_{52} + 38\ O_2 \longrightarrow 25\ CO_2 + 26\ H_2O$$

The first substance you observed on the jar should have been a thin layer of condensation, water droplets that condensed from water vapor given off during the combustion of the candle. You may have noticed condensation dripping from the tailpipe of a car - this is the same principle, since gasoline is also a hydrocarbon.
As the candle is allowed to remain in contact with the glass, it becomes covered with a thick black layer of what is commonly known as "soot". Soot in actuality is unburned carbon particles that have collected on the glass. This is what causes the candle flame to burn a yellow color.
You will notice that gas stoves always burn with a blue flame - which is much cleaner and hotter than a yellow flame. A blue flame will seldom leave a soot deposit on your pots and pans, since nearly all of the carbon is consumed in the flame.



MIXTURES: Experiment # 14 - **What Will Dissolve in Oil?**

OBJECTIVE: To determine why certain substances will not dissolve in oil.

MATERIALS: Vegetable oil
Resealable 20 oz. clear beverage container
Salt
Food coloring
Sugar

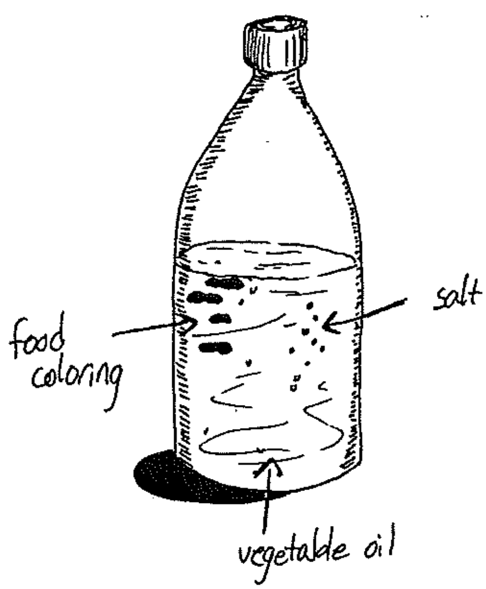
SAFETY PRECAUTIONS: None

PROCEDURE: 1. Fill the bottle about half full with vegetable oil.

2. Place small amounts of each of the above substances in the bottle and shake.

3. Observe the results. Experiment with other substances.

EXPLANATION: The oil, being non-polar, will not dissolve any liquids or solids that are polar. You may have noticed from previous experiments that salt, sugar, and food coloring dissolve in water, therefore these substances must be polar. A non-polar substance cannot dissolve a polar substance.
In this experiment, the behavior of the food coloring is particularly interesting - it remains in the shape of perfect spheres.



MIXTURES: Experiment # 15 - **Make Your Own Handwarmer**

OBJECTIVE: To make a hot pack due to adding a substance to water.

MATERIALS: Calcium Chloride (available in hardware stores as an ice melter)
Quart-sized freezer bag
Water

SAFETY PRECAUTIONS: Calcium chloride will sting if it gets in your eyes. Wear safety goggles. May be toxic if ingested.

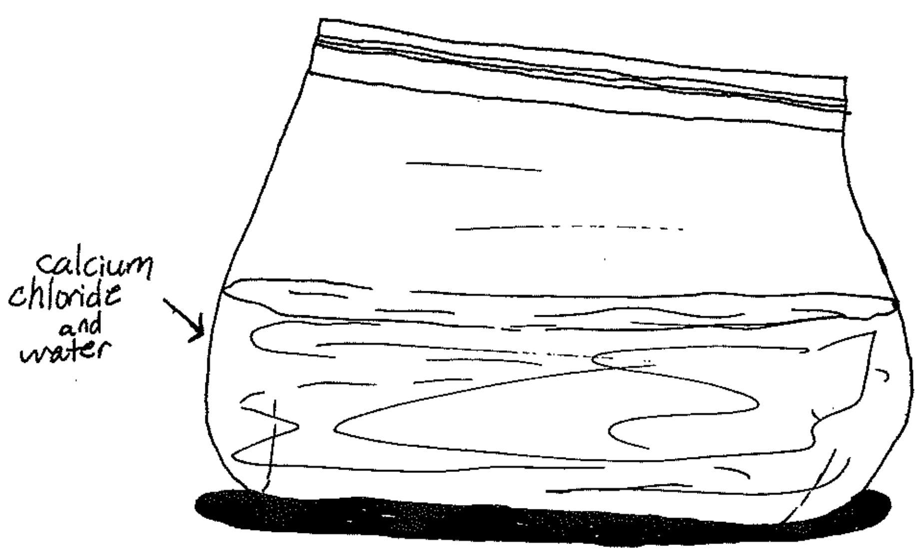
PROCEDURE: 1. Place several teaspoons of calcium chloride in a freezer bag.

2. Add about a cup of water.

3. Seal the baggie. Knead with your fingers until all of the salt has dissolved.

4. Note the change in temperature of the water.

EXPLANATION: This experiment is an excellent example of an exothermic process - where heat is released. When calcium chloride is dissolved in water, energy is required to break the bonds of the calcium chloride ions that are bonded to one another. However, as the calcium chloride ions bond to the the water molecules, heat is released. This heat that is released is far greater than the heat that was initially absorbed. In short, as calcium chloride is dissolved in water, a tremendous amount of energy is released. This same exothermic process can be observed with many other substances as well.



MIXTURES: Experiment # 17 - **Making Meringue: A Colloid**

OBJECTIVE: To form meringue, which is a type of colloid.

MATERIALS: 1 egg
Baking soda
Measuring cup
Citric acid
Large bowl

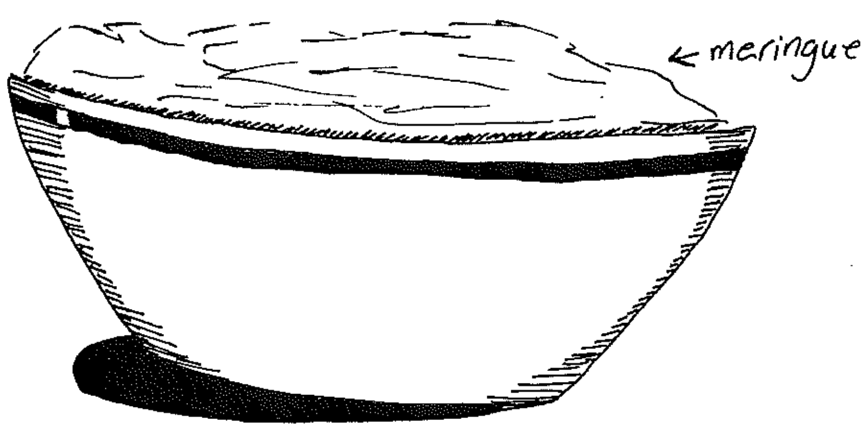
SAFETY PRECAUTIONS: None

PROCEDURE: 1. Place an egg white in a large mixing bowl.

2. Add a half cup of water and 2 teaspoons of baking soda. Mix thoroughly.

3. Add 2 teaspoons of citric acid and mix thoroughly. Observe.

EXPLANATION: You should observe a tremendous amount of meringue being formed. Meringue is an example of a foam, which is a type of colloid. A foam is formed when a gas is dispersed in a liquid. In this case, carbon dioxide is formed when the citric acid reacts with baking soda. This gas is trapped inside of the egg white, causing it to expand into a foam.



MIXTURES: Experiment # 18 - **Making Rock Candy**

OBJECTIVE: To make rock candy due to the crystallization of sugar.

MATERIALS: Stove or hot plate
Sugar
Pan
Water
Heat-resistant glass jar
String
Paperclip
Pencil
Wooden spoon for stirring

PROCEDURE: 1. To determine the amount of water to use, fill the glass jar and pour into the pan.

2. Gently heat the water, and continually add sugar as long as it is dissolving. The sugar is no longer dissolving when it begins to settle on the bottom. Stir constantly.

3. As the water warms, it will be able to dissolve more sugar. You will most likely be surprised at how much sugar that can be added, but continue doing so until the water boils.

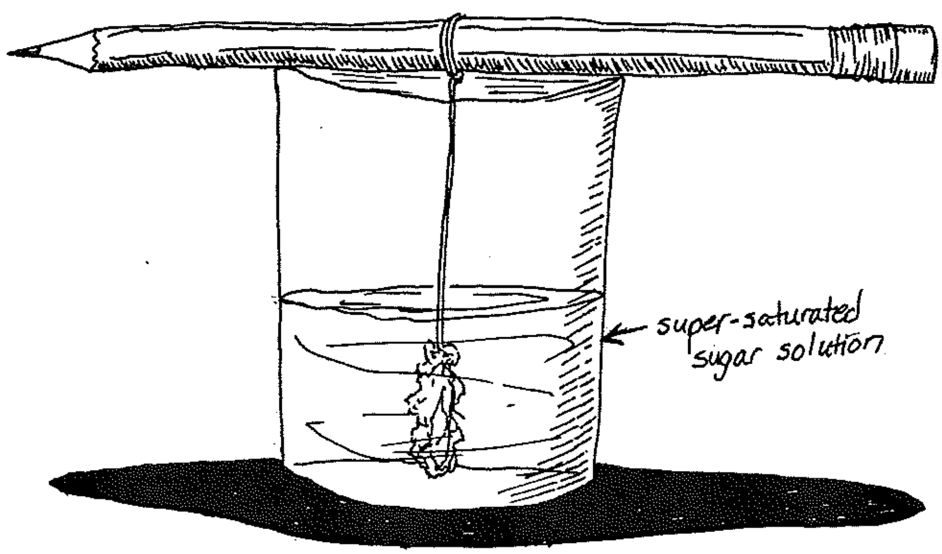
4. Once the water boils, add no more sugar. Allow to boil for approximately one minute, then remove from the heat and pour into the jar.

5. Tie the string to the pencil and suspend a paperclip from the end of the string. Place in the jar, making sure that the paperclip does not touch the sides or the bottom of the jar.

6. Allow to remain undisturbed for several weeks. As a crust forms on top, break it up daily. This will allow the water to evaporate. As this happens, the sugar will go out of solution and begin to adhere to the paperclip. These crystals will continue to form until all of the water has completely evaporated. The end result is an edible treat!

EXPLANATION: As the sugar dissolves in the water, it forms a saturated solution. As the water is heated, more sugar crystals are able to be dissolved, forming a supersaturated solution - which is a solution that holds more than it normally would due to the heating of the solution. As the water evaporates, the remaining water cannot hold as much sugar, so it falls out of solution and crystallizes onto the paperclip and string. A crystal is simply a solid that forms in a regular repeating pattern. Sugar crystals assume a very specific shape, and there are several different types of crystal patterns. Examination under a magnifying glass may reveal a very beautiful pattern.

RELATED EXPERIMENTS: The same procedure outlined above can be tried with a variety of substances. Good results can generally be obtained with table salt, epsom salts, and alum. Experiment with different substances to see which will form the best crystals.



MIXTURES: Experiment # 19 - **Making Ice Cream in a Baggie**

OBJECTIVE: To make ice cream in a baggie.

MATERIALS: Gallon-sized freezer bag
2 quart-sized freezer bags
Rock salt
Crushed ice
Measuring spoons
Milk
Evaporated milk
Sugar
Vanilla extract

SAFETY PRECAUTIONS: None

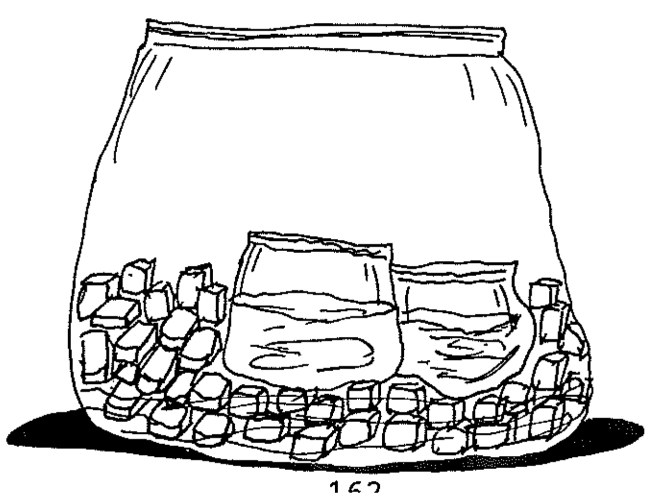
PROCEDURE: 1. In the quart-sized freezer bag, place the following: ½ cup milk, ¼ cup evaporated milk, 4 teaspoons sugar, and ½ teaspoon vanilla extract.

2. Seal this baggie, and then double bag with another baggie of the same size. Seal this baggie also.

3. To the gallon-sized bag, fill about ½ full with crushed ice. Add 1 cup of rock salt.

4. Place the baggie of solution in the 1 gallon bag containing the ice and salt. Seal the gallon bag and then knead with your hands for at least a half-hour, until the mixture in the baggie is the consistency of ice-cream. If it doesn't harden thoroughly, dump out the melted ice and replace with fresh ice and salt, and then repeat the kneading process. Your hands will get very cold! You may want to wear gloves.

EXPLANATION: The salt melts the ice, lowering its freezing point. Since melting absorbs energy, the temperature of the solution in the baggie is lowered. This solution must be below freezing in order to melt, since the dissolved sugar lowers the freezing point of the milk. Since the solution in the baggie is surrounded by sub-zero water, it freezes into ice cream. The constant kneading introduces another substance into ice cream that is of vital importance - air. This gives ice cream its distinctive texture and taste.



MIXTURES: Experiment # 20 - **Make Your Own Cold Pack**

OBJECTIVE: To make a cold pack by dissolving a substance in water.

MATERIALS: Potassium Nitrate or Saltpetre (available in drug stores. Ammonium Nitrate can also be used, which is a component of some fertilizers.)
Quart-sized freezer bag
Water

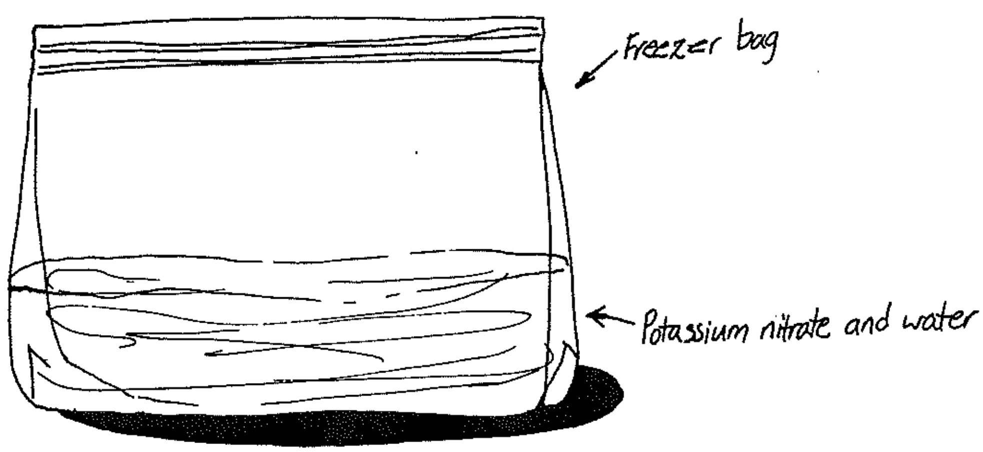
SAFETY PRECAUTIONS: Potassium nitrate is toxic if ingested - exercise caution. It should also be kept away from all flames,since it could potentially explode if heated.

PROCEDURE: 1. Place several teaspoonfuls of potassium nitrate in the freezer bag.

2. Add a half cup of water.

3. Knead until it dissolves completely. Note the temperature.

EXPLANATION: As the potassium nitrate dissolves in the water, it absorbs energy from its surroundings. This is an example of an endothermic process. Since it absorbs energy from its surroundings, the baggie feels cold to the touch.



POLYMERS: Experiment # 1 - **Dissolving a Styrofoam Cup**

OBJECTIVE: To dissolve a styrofoam cup using acetone.

MATERIALS: Acetone (available as fingernail polish remover, or from the hardware store in the paint section)
Small aluminum pie pan
Styrofoam cups

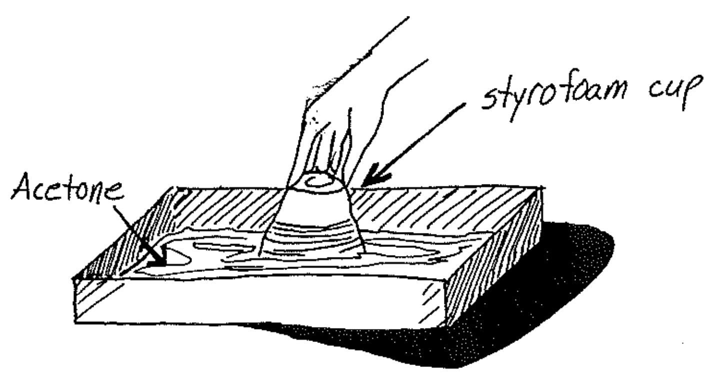
SAFETY PRECAUTIONS: Acetone is very flammable - keep away from open flames. Inhaling the vapors may be harmful - do this experiment outdoors or in a well ventilated area. Acetone may be fatal if ingested. Wash hands thoroughly when finished with this experiment.

PROCEDURE: 1. Pour about an inch of acetone into the aluminum pie pan. A metal pan must be used, because acetone will react with many other substances.

2. Place a styrofoam cup mouth down into the acetone and gently push down with your finger.

3. The cup will completely dissolve. The dissolved cup can be scooped up with the fingers, rinsed with water, and shaped into a ball. Upon drying, it becomes hard again.

EXPLANATION: The styrofoam cup is made of polystyrene, a long chain of styrene molecules bonded together. The acetone breaks the bonds between the styrene molecules, causing the cup to dissolve. When the styrofoam cup is manufactured, air is pumped into it to increase its insulating abilities. This air is released as the cup dissolves, forming bubbles in the acetone.



POLYMERS: Experiment # 2 - **Poking a Needle Through a Balloon**

OBJECTIVE: To pass a needle through both sides of a balloon without the balloon breaking.

MATERIALS: Large furniture needle or wooden bamboo skewer
Balloon
Vaseline

SAFETY PRECAUTIONS: None

PROCEDURE: 1. Lubricate the end of the needle with vaseline.

2. Inflate a balloon only partially, and then tie it off.

3. Gently and slowly begin to pass the needle through the thick end of the balloon, and then pass it through the other end near to where it is tied. The balloon should not pop!

EXPLANATION: The rubber of the balloon is a polymer - a very long chain of the same molecule that is repeated over and over. The needle slips through and between these polymer chains, causing the balloon not to pop. The polymer chain will close back around the entry point of the needle, forming somewhat of a seal for a short time. This experiment is a good example of chemical "magic", which can be used to impress your friends.