EXPERIMENT MANUAL

Candy Chemistry

THAMES & KOSMOS

WARNING — This is not a toy. Only for use by children 10 years of age or older with continuous adult supervision and assistance. Components in this kit may be sharp, breakable, or have sharp edges. Some experiments require the use of a stove, electric mixer, and high temperatures.

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WARNING!

Only for use by children over 10 years of age. To be used solely under the strict supervision of adults who have studied the precautions given in the experimental set.

CAUTION! Individual parts in this kit may have sharp points, corners, or edges. Do not injure yourself!

Please note: Read the important information about first aid in case of accidents on the outer back cover, rules for safe experimentation below, and note to parents on page 1.

Rules for Safe Experimentation

→ Read through each experiment before you begin. Follow the instructions and have them ready for reference.

→ Keep young children and pets away from the work place and stove at all times.

→ Maintain a safe distance from the pot so that no hot liquid can splash onto your face or hands. When boiling, sugar gets very hot and can cause serious burns if it comes in contact with skin.

→ Do not use any utensils or ingredients other than those supplied with the kit and specifically recommended by the kit. Ask your parents before using any kitchen utensils or ingredients.

→ Clean all pots and utensils with hot water and soap.

→ The plastic molds for chocolate figures, gummy candies, and chocolate eggs are not dishwasher safe. They will be deformed by high temperatures, so wash them by hand.

→ Clean the work surface carefully after you are finished and always wash your hands thoroughly — before and after you work.

→ If you are allergic to certain foods (for example, nuts) you must avoid sweets that contain such ingredients. Therefore, always begin by checking the list of ingredients. If you are diabetic, you must only eat the amount of sugar allowed by your diet plan.

→ It goes without saying that there can be no smoking in a confectionery shop. Also, do not eat other types of food while working with these recipes. For everything to turn out well, you must stay very focused on your work.

→ Store the contents of the kit away from young children. Your kit contains small parts that could be swallowed by a child, and the glass thermometer is very fragile.

→ If the thermometer should break, be careful when picking up the splinters and dispose of them in a safe place. The thermometer is filled with alcohol, not mercury.

→ Save packaging and instructions, as they contain important information.

→ We reserve the right to make technical changes.

Dear Parents,

This experiment kit is intended only for children over 10 years of age. It provides an exciting introduction to the world of chemistry through fun candy making experiments.

The work of a candy maker is fun and exciting, but it is not always easy. This is why we would like to thoroughly inform you of safety precautions, so that you can guide your child with advice and help. You must supervise and assist him or her with all of the activities in this kit, but especially when using the stove and working with very hot ingredients. This also applies to the use of the electric mixer, sharp knives, and other kitchen utensils.

Take a look through this instruction manual and pay particular attention to the

→ **Rules for safe experimentation** (inside front cover),
→ **Safety notes that accompany each experiment**, and
→ **First aid in case of accidents** (outside back cover).

Discuss the recipes and the individual work steps with your child before beginning. Use only the recommended ingredients, and always use fresh ingredients.

Candy making requires several different talents and skills. Candy recipes can be affected by the weather, temperature, and the specific equipment used. Don't get discouraged if a particular recipe does not work out as expected. Having some experiments "fail" is an important part of science.

Select the recipes that appear suitable for your child and supervise him or her during the cooking, packaging, and storage of the candy. Your own candies will not keep as long as commercially available candies that often contain preservatives.

Tell your child to read these instructions, safety rules, and first aid information, to follow them, to keep them on hand for reference, and to perform only those experiments that are described in the manual.

Pick an area in the kitchen that can tolerate spills, remembering that food coloring can make intense stains, even in very small quantities. When working with hot pots, have a trivet and pot holders available, and make your child aware of the danger of burns.

To keep the tools in this kit in good condition, they should always be washed by hand and not in the dishwasher. The high temperatures used in a dishwasher might deform the plastic forms. Also the mercury-free, alcohol-filled glass thermometer must be handled with care and cleaned carefully by hand.

If your child has to stay away from certain sweets or avoid some ingredients (for example because of an allergy), you will have to alter the recipe or not use it. Always check the contents of purchased ingredients.

We wish you and your young kitchen chemist lots of fun with making and enjoying candy together.

665003-02-161020

What's in your experiment kit:

Checklist: Find – Inspect – Check off

✔	No.	Description	Qty.	Item No.
☐	1	Forked tool	1	703338
☐	2	Flat stirring tool	1	703339
☐	3	Pick tool	1	703340
☐	4	Chocolate egg mold	1	703341
☐	5	Small shape cutter, flower	1	703342
☐	6	Small shape cutter, diamond	1	703343
☐	7	Dipping fork	1	703344
☐	8	Set of small baking cups	1	703345
☐	9	Sugar spatula	1	703347
☐	10	Set of lollipop sticks	1	771223
☐	11	Candy thermometer	1	703182
		Plastic bag containing:		771221
☐	12	Gummy candy mold, plastic	1	
☐	13	Chocolate mold, plastic	1	
☐	14	Set of plastic wrappers, transparent	1	
☐	15	Set of aluminum foil sheets, red/silver	1	
☐	16	Set candy label stickers (not shown)	1	

It is assumed that you have a stove, electric mixer, and regularly well-equipped kitchen. Read through each experiment to make sure you have everything you need for the experiment.

Additional things you will need:

Ceramic mug, chocolate chips, kettle, spoon, desk lamp, napkin, measuring cups, measuring spoons, food coloring, various bowls, cooking pots, spatula, marble slab or baking sheet, glass jar, pencil or skewer, string, plastic wrap, baking pan, knife, fork, wax paper, vegetable oil, scissors, gum drops, toothpicks, diet cola, Mentos candy, index card, paper, hand mixer, sieve or sifter, storage containers, rice paper, whisk, rolling pin, adhesive tape

Any materials not contained in the kit are marked in *black italic script* in the "You will need" boxes.

Refer to each experiment for the recipe ingredients. Ingredients for the recipes are marked in *pink italic script* in the "You will need" boxes.

→ Before doing anything else, please check all the parts against the list to make sure that nothing is missing.

→ If you are missing any parts, please contact Thames & Kosmos customer service.

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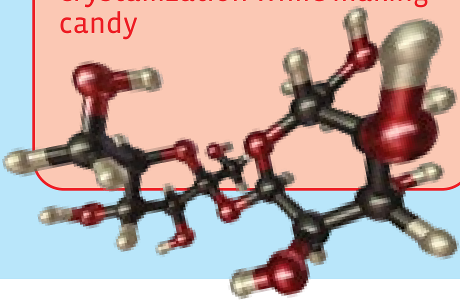


CHECK IT OUT

You will find supplemental information on pages 7, 9, 15, 16, 19, 23, 24, 28, 33, 36, 37, and 44.

Physical Science and Cooking

Experiment with fundamental topics in kitchen chemistry including temperature, heat, volume, and unit conversions.

EXPERIMENT 1

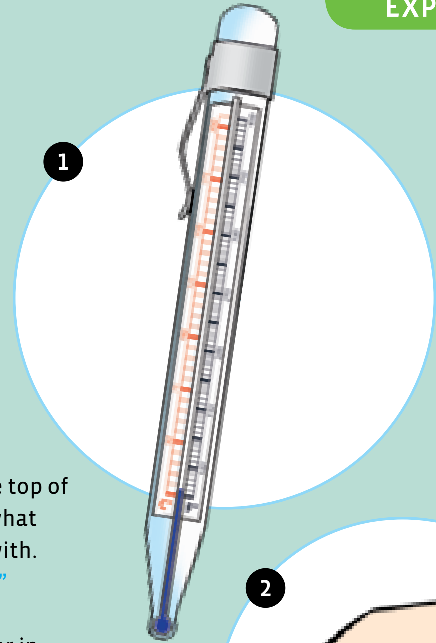
Measuring temperature

YOU WILL NEED

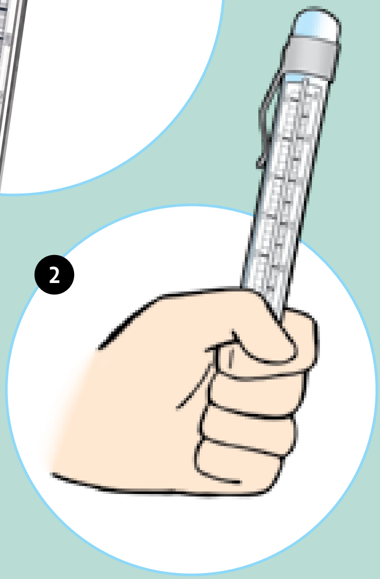
→ candy thermometer
→ *ceramic mug*
→ *hot water from the tap*

HERE'S HOW

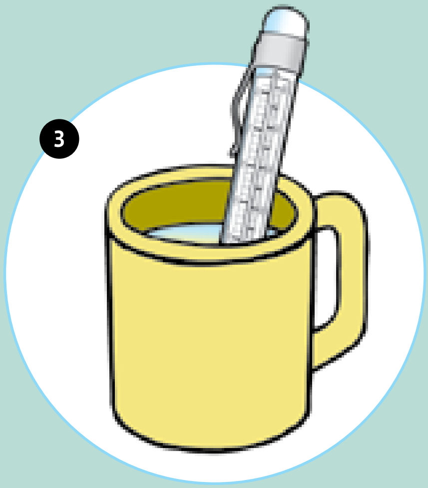
1. Read the temperature from the thermometer. To do this, find the top of the colored bar and determine what number on the scale it lines up with.
   What is the "room temperature?"



2. Hold the bulb of the thermometer in your fist tightly. Wait two minutes and then read the temperature.
   What is the temperature in your fist?



3. Fill a ceramic mug with the hottest water you can get from your kitchen tap. Gently place the thermometer in the cup and watch the colored bar.
   What is the temperature of the hot tap water?



→ WHAT'S HAPPENING?

The colored liquid inside the thermometer is alcohol with a dye in it. When alcohol gets warmer, it expands. Because the alcohol is sealed up inside a narrow tube, when it expands it has nowhere to go but up the tube. Because it always expands to the same volume at a given temperature, the thermometer manufacturer was able to place a scale of numbers along the tube, indicating the corresponding temperature at each point.

EXPERIMENT 2

Transferring heat

Safety Note: Caution! High temperatures. There is a risk of burns.

YOU WILL NEED

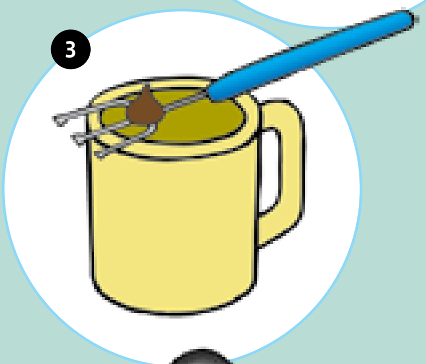
→ dipping fork
→ *2 chocolate chips*
→ *boiling hot water (kettle and stove)*
→ *ceramic mug*
→ *metal spoon*
→ *desk lamp*
→ *napkin*

HERE'S HOW

1. Boil water in a kettle on the stove.

2. Fill the mug with the hot water. Place the metal spoon in the mug. Wait three minutes. Touch the spoon's handle.
   Is it hot to the touch?

3. Replace the water in the mug with fresh hot water from the kettle. Balance the dipping fork on the rim of the mug, as shown. Place a single chocolate chip on the dipping fork. Wait a few minutes.
   What happens to the chocolate chip?



4. Place a chocolate chip on a napkin, and put it on a table. Position a desk lamp so its light shines on the chip from only an inch away. Wait a few minutes, then touch the chip.
   What happens to the chocolate chip?

→ WHAT'S HAPPENING?

Heat was transferred in each step of this experiment. In step 2, you saw conduction; step 3, convection; and step 4, radiation. See the next page for more information.

CHECK IT OUT

What is temperature?

Temperature is the measure of the average kinetic energy of the particles in a sample of matter. The temperature of a cup of hot cocoa is higher than the temperature of a scoop of ice cream. This means that the particles in the hot cocoa have a higher average kinetic energy than those in the ice cream. Kinetic energy is simply motion energy. So the particles in the hot cocoa are moving faster than those in the ice cream.

WHAT IS HEAT?

Temperature and heat are not the same thing. While temperature is a measure of the average kinetic energy of a sample of matter, heat is the total kinetic energy of all particles in the sample.

Imagine filling up a bucket of water from a pond and immediately measuring the temperature of the water in the bucket and the water in the pond. The temperature would be the same for both. But, because there are far fewer particles in the bucket than in the pond, the amount of heat in the bucket is far lower. Heat takes into account the total amount of matter.

How is heat transferred?

Conduction is the transfer of heat through solids. In the experiment, heat was conducted through the metal spoon up to the top of the handle. The heat is transferred directly from particle to particle as they bump together. Metals are examples of good conductors, and wood and plastic are examples of poor conductors.

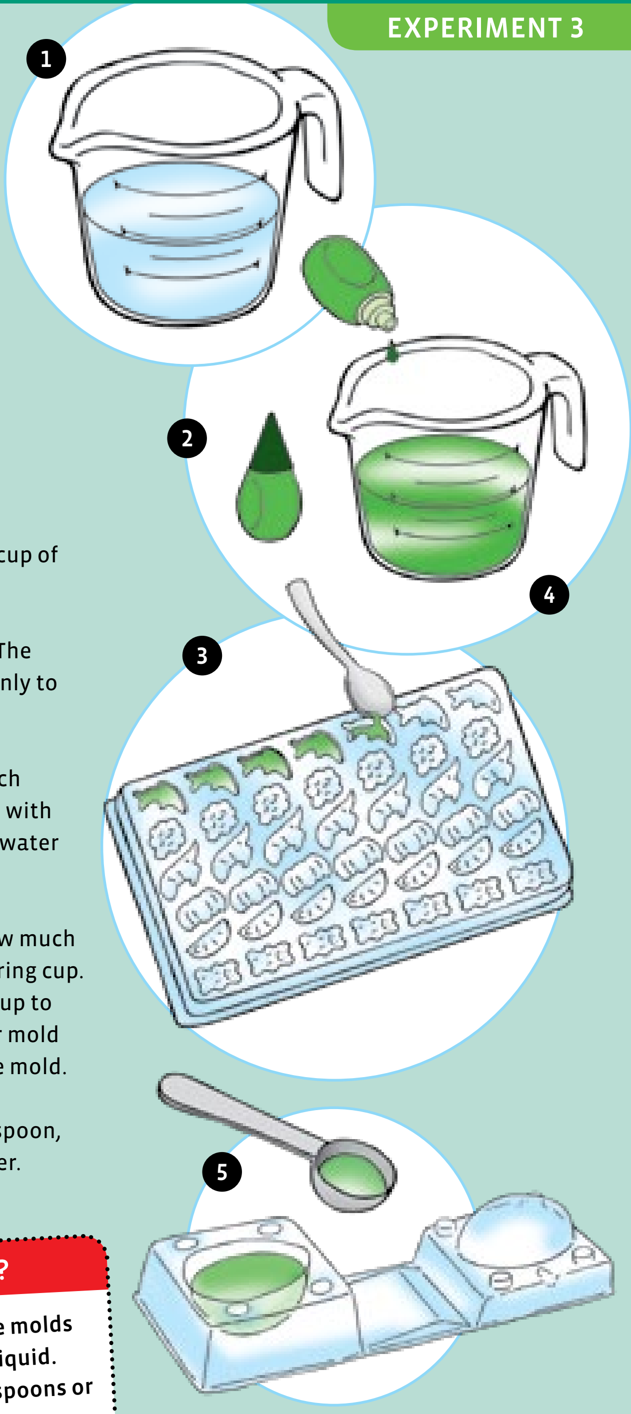
Convection is the transfer of heat through liquids and gases. When liquids and gases heat up, the particles move faster and faster. Because they are free to move around, the faster moving particles move farther apart. This makes the liquid or gas less dense, and thus it will rise above cooler liquids or gases. This is why warm air rises.

Radiation is the transfer of energy through empty space. Instead of particles moving around as in conduction and convection, radiation is transmitted by electromagnetic waves, like light. This is how the light from the light bulb was able to heat up the chocolate chip.

Volume

YOU WILL NEED

→ gummy candy mold
→ chocolate shapes mold
→ chocolate egg mold
→ *measuring cup*
→ *food coloring*
→ *spoon*
→ *tablespoon and teaspoon*



HERE'S HOW

1. Fill the measuring cup with one cup of water exactly.

2. Add two drops of food coloring. The purpose of the food coloring is only to make the water easier to see.

3. Using the spoon, carefully fill each cavity in the gummy candy mold with colored water. Try not to let any water drip outside of the molds.

4. When the mold is full, look at how much water is remaining in the measuring cup. Subtract this number from one cup to determine how much water your mold holds. Repeat with the chocolate mold.

5. Using the tablespoon or the teaspoon, fill the egg mold cavity with water. How much water does it hold?

→ WHAT'S HAPPENING?

The gummy candy and chocolate molds each hold about 2/3 of a cup of liquid. The egg mold holds about 4 teaspoons or 1 and 1/2 tablespoons of liquid.

CHECK IT OUT

Common Cooking Conversions

In cooking as in science, you use a ton of measurements. But sometimes the units are a bit different. In the United States, we usually use United State Customary Units for cooking measurements. Scientists around the world however have agreed to use the International System of Units (also called the metric system) so that everyone can communicate data more easily. This table helps you convert between the two systems.

When you know this:	Multiply by this:	To get the metric equivalent:
cups	236.6	milliliters (ml)
cups	0.236	liters (l)
teaspoons	4.93	milliliters (ml)
tablespoons	14.79	milliliters (ml)
quarts	0.946	liters (l)
gallons	3.785	liters (l)
fluid ounces	29.57	milliliters (ml)
ounces (mass)	28.35	grams (g)
Fahrenheit (°F)	subtract 32, multiply by 5, and divide by 9	Celsius (°C)

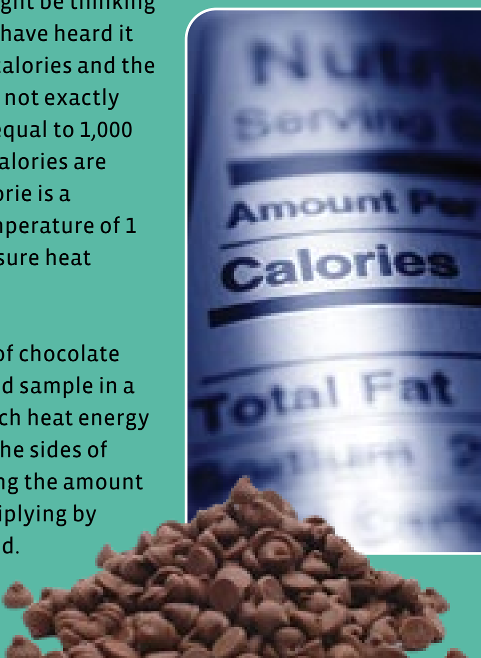
Other Helpful Conversions

1 gallon = 4 quarts = 8 pints = 16 cups = 128 fluid ounces

1 cup = 8 fluid ounces = 16 tablespoons = 48 teaspoons

CALORIES MEASURE HEAT

Scientists measure heat in units called **calories**. You might be thinking to yourself that this term sounds familiar and that you have heard it when people talk about food. And you are right! Food calories and the calories scientists use to measure heat are related, but not exactly equal. A food calorie (or large calorie, or kilocalorie) is equal to 1,000 times a scientific calorie (or small calorie). Often food calories are called kcals or Calories with a capital C. A scientific calorie is a measure of the heat energy needed to increase the temperature of 1 gram of water by 1 °C. Scientists also use joules to measure heat energy. One calorie equals 4.18 joules.



A single chocolate chip has about 2 to 3 calories. A cup of chocolate chips has 800 to 1200 calories. Scientists can burn a food sample in a special device called a calorimeter to measure how much heat energy it gives off. The calorie counts that you see printed on the sides of packaged foods are often obtained simply by calculating the amount of fat, protein, and carbohydrates in the food and multiplying by average caloric values for those three categories of food.

Phases of Matter* (*Chocolate)

In this chapter, you will explore the different phases of matter — solid, liquid, and gas — by melting and molding chocolate!

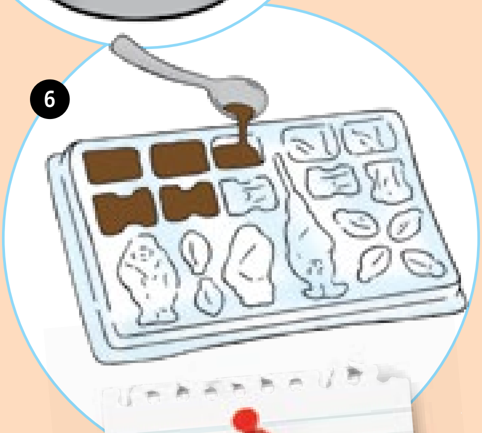
EXPERIMENT 4

Chocolate shapes

Safety Note: Caution! High temperatures. There is a risk of burns.

YOU WILL NEED

- → chocolate mold
- → candy thermometer
- → *metal cooking pot*
- → *metal bowl (that fits in the pot as shown)*
- → *spoons, measuring spoons*
- → *spatula*
- → *water*
- → *1 cup of chocolate: couverture chocolate is recommended. This is high-quality, real chocolate.*



HERE'S HOW

1. Set up the pot and bowl as shown. Put a few inches of water in the pot. This setup is called a **double boiler.**

2. Put 2/3 cup of chocolate into the bowl. Melt it on low heat. The water in the double boiler should be just simmering. Don't let any water get in the bowl.

3. Allow all the chocolate to melt and reach a temperature of 110 °F, and no higher!

4. Turn off the heat and add the remaining 1/3 cup of chocolate, finely chopped.

5. Stir the chocolate until it has all melted. Once the chocolate has cooled to 80 °F, turn the stove on again and bring it back up to 90 °F, and no higher!

6. Carefully spoon the melted chocolate into the cavities in the mold.

Note
You can use **chocolate coating** instead of couverture chocolate. In chocolate coating, some or all of the cocoa butter has been replaced by vegetable fats. It is usually easier to work with, melts faster, does not require tempering, and solidifies better.

→ → →

Chocolate shapes

HERE'S HOW IT CONTINUES

7. When the mold is filled with chocolate, tap it a few times on the side and shake it gently on the table to get the chocolate to settle into the shapes.

8. Let the chocolate cool and harden for a number of hours. To speed up this process, you can put the mold in the freezer.

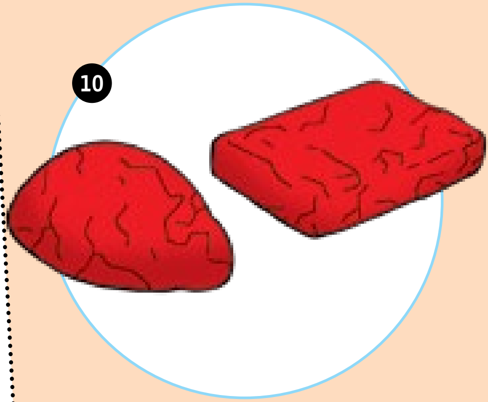
9. Once the chocolate is hard, you can carefully push it out of the mold with your fingers, or you can pry it loose with the pick tool.

10. Wrap your chocolate shapes in foil.

7

9

10



WHAT'S HAPPENING?

The double boiler allows for the slow, controlled heating of the chocolate. You had to bring the chocolate from 110 °F, to 80 °F, and then to 90 °F, so that it would harden into smooth, hard, shiny chocolate when it finally cooled. This process is called tempering. Tempering allows the cocoa butter crystals in the chocolate to form uniformly, which makes the chocolate smooth instead of sticky, hard instead of crumbly, and shiny instead of dull.

EXPERIMENT 5

Chocolate bunny

YOU WILL NEED

→ everything from Experiment 4
→ lollipop sticks

HERE'S HOW

1. Melt and temper the chocolate as you did in Experiment 4.
2. Fill the bunny cavity halfway.
3. Carefully place the lollipop stick in its spot in the bunny cavity.
4. Fill the bunny cavity the rest of the way.
5. Wait for the chocolate to harden, and then carefully remove the bunny from the mold.

EXPERIMENT 6

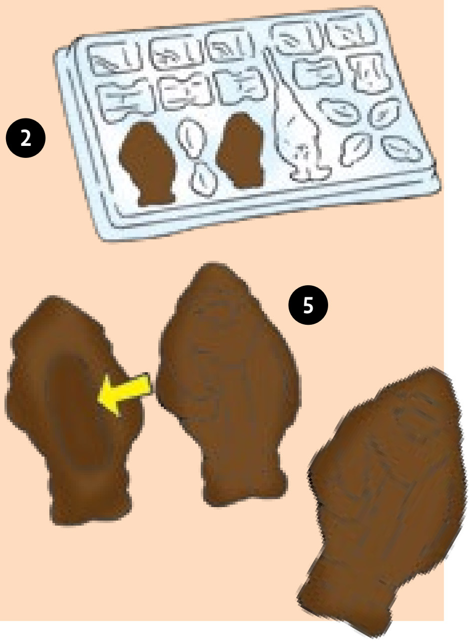
Chocolate Santa

YOU WILL NEED

→ everything from Experiment 4

HERE'S HOW

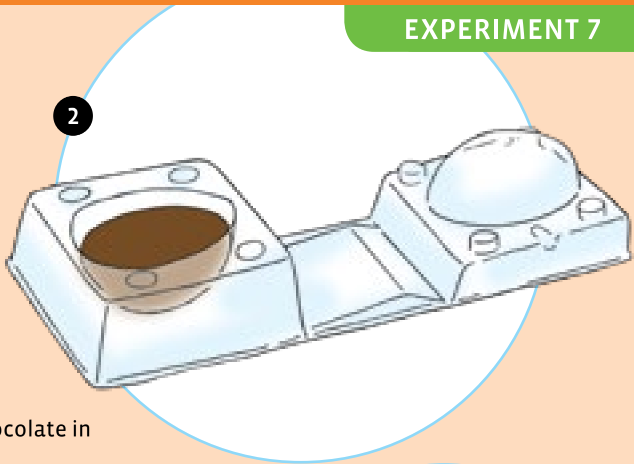
1. Melt and temper the chocolate as you did in Experiment 4.
2. Fill the two halves of the santa cavity.
3. Wait for the chocolate to harden. Carefully remove the two halves from the mold.
4. With a little bit of melted chocolate, “glue” the two halves of the santa together.



Chocolate Egg

YOU WILL NEED

→ everything from Experiment 4
→ egg mold



HERE'S HOW

1. Melt and temper 1/4 cup of chocolate in the double boiler.

2. Pour about 4 teaspoons or 1 and 1/2 tablespoons of melted chocolate into the egg mold, up to the fill line marked in the plastic.

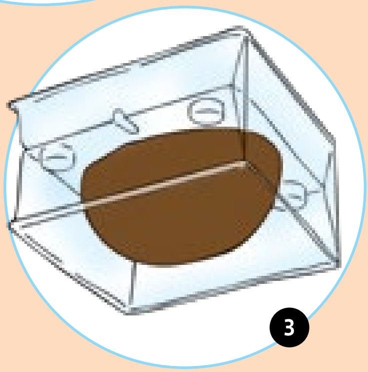
3. Close the mold. Let the chocolate cool completely. Again, you can put it in the freezer to speed the hardening.

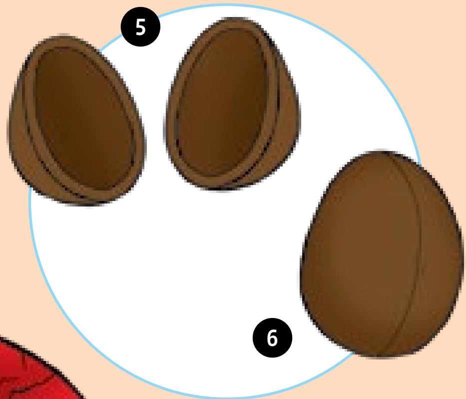
4. Carefully remove the egg half from the mold.

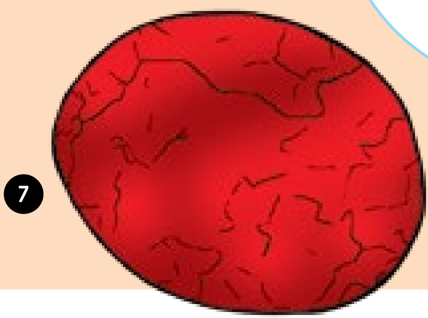
5. Repeat to mold a second egg half.

6. “Glue” the two egg halves together using a little melted chocolate placed along their edges.

7. Wrap your egg in foil.







PHASES OF MATTER

There are three phases of matter: solid, liquid, and gas. (There are actually others, like plasma and Bose-Einstein condensate, but they're much less common.) This means that pretty much all the stuff you see in the world can be characterized as being in either a solid, liquid, or gas phase.

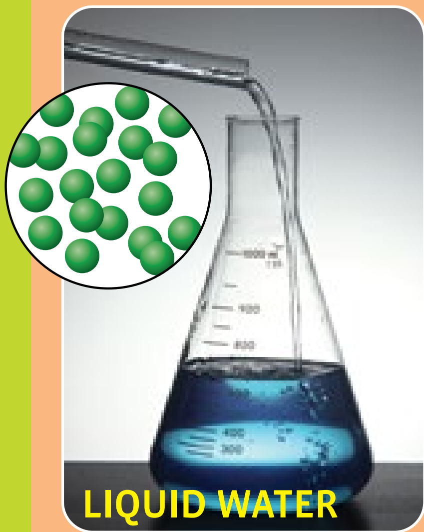
The atoms of **solids** are packed together densely and have fixed positions in space relative to each other (like bricks in a wall), which makes solids rigid.

Liquids have atoms that are packed less densely than are those of solids, and while solids form a rigid shape, liquids move freely. But when liquids are poured into a container, they must conform to the shape of the container, except for possibly one surface (like the surface of water in a fish tank).

This is not the case for **gases**, which must conform to the shape of the container entirely (like water vapor in a fish tank, which would have no surface different from the walls of the tank). The atoms of gases are packed the least densely of all three phases, and are in relatively random motion. Gases have no definite shape or volume, can expand and contract greatly with changes in temperature and pressure, and spread easily to distribute themselves evenly throughout a container — hence their total conformity to the shapes of containers.

CHECK IT OUT


SOLID WATER (ICE)


LIQUID WATER


GASEOUS WATER

FREEZING AND MELTING

When a liquid freezes, it turns to a solid. The temperature at which this happens is called the **freezing point**.

When a solid melts, it turns into a liquid. This is the opposite of freezing. The temperature at which this happens is the **melting point**. The melting point and freezing point of a substance are often the same.

Water freezes and ice melts at the same temperature, 0 °C or 32 °F. But in your chocolate molding experiments, you saw that chocolate behaves a little differently. Chocolate is a mixture of different ingredients, not just one compound like water. Because of this, different types of chocolate will have different melting points. Dark chocolate that has been tempered has a melting point around 95 °F.

Tempering is a process by which chocolate is heated up to specific temperatures and then cooled in a controlled way to yield uniform crystals. Yes, chocolate contains crystals of cocoa butter!

Chocolate that has not been tempered has a lower melting point, as low as 63 °F. Tempered chocolate has a glossier sheen, a crisper bite, and molds into firmer shapes.

CHECK IT OUT

BOILING AND CONDENSATION

When a liquid boils, it changes to a gas. The temperature at which this happens is called the **boiling point**. Scientists also refer to boiling as vaporization.

When a gas changes to a liquid, it condenses. The temperature at which this happens is called the **condensation point**.

Water boils at 100 °C or 212 °F. Chocolate on the other hand does not have a specific boiling point: Its various ingredients will all vaporize at different temperatures, much higher than 212 °F.

Cocoa Butter

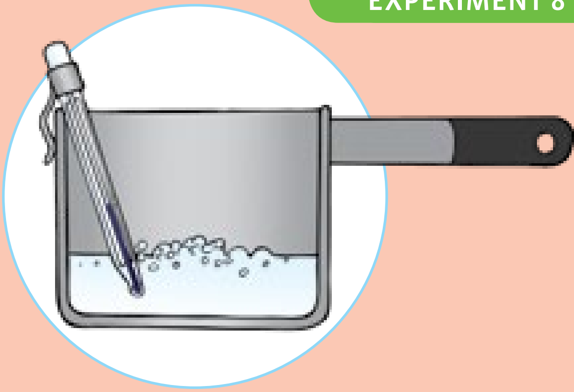
Most fats are mixtures of many different fat molecules. **Cocoa butter** is special because it contains relatively few types of fat molecules arranged in an orderly way. Because of this, cocoa butter melts uniformly at a specific temperature, while other fats melt gradually over a range of temperatures. This unique property is what gives chocolate its wonderful texture.

Sugar Solutions and Crystals

Experimenting with sugar is a tasty way to learn about how substances dissolve into solutions, how they crystallize out of solutions, and how heat affects these processes. In this chapter, you will make different kinds of sugar-based candy — hard candy, rock candy, caramels, taffy (a type of toffee), and pralines — to explore sugar's chemical properties.

EXPERIMENT 8

Getting ready to boil sugar



YOU WILL NEED

- → candy thermometer
- → sugar spatula
- → *heavy-bottom cooking pot*
- → *metal spoon*
- → *marble slab or baking sheet*
- → *(sugar, water, and other ingredients will be specified in Experiments 9 and 10)*

HERE'S HOW

1. The most important tool for a candy maker is the candy thermometer, because knowing the temperature of sugar is crucial. Depending on what kind of candy you want to make, whether soft chewing caramels or hard lollipops, you will need a specific sugar syrup. There is often only a few degrees difference between soft, hard, and burnt candies. Keep a close eye on the temperature.

2. To make hard candy, all you really have to do is heat a mixture of sugar and water. With increasing temperature, the consistency (texture) of the sugar syrup changes. Professionals have defined **sugar stages,** which help to determine what kind of candy is made by sugar syrup heated to different temperatures.

3. You should familiarize yourself with the sugar stages. The table to the right will help you do this. Do not refer to any temperature instructions printed on the thermometer itself.

4. Warm the clean candy thermometer with hot water before you hang it into the sugar pot. Do not let the thermometer rest on the bottom of the pan. Otherwise it might crack. After use, put it aside to cool off.

5. Boiling sugar works best in a large stainless steel pot with a thick bottom, which conducts the heat well, and preferably with an insulated handle. Sugar bubbles up during boiling.

6. Heat the sugar syrup quickly and over high heat. Slow or frequently interrupted boiling can make the sugar turn yellow.

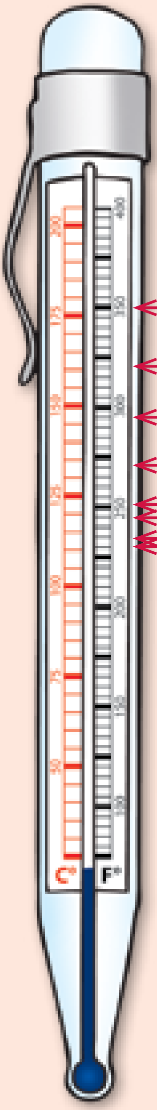
7. Sugar crystals or impurities stuck to the side of the pot should immediately be scraped off with a spoon. Otherwise undesirable crystals might form in the syrup.

8. An oiled, warm marble surface is ideal for mixing and forming syrups into candies. An oiled, non-coated baking sheet is also sufficient. If your surface is too cold, the candy will harden too fast for you to work with it.

Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.

CHECK IT OUT

Sugar Stages



Temperature	Grade of Sugar — Consistency	Uses
>350 °F >176 °C	**Burnt Sugar** — the syrup turns black, gives off smoke, and smells bad	Should not be eaten
320-330 °F 160-166 °C	**Caramel** — the syrup is now golden and gives off the typical caramel smell	Caramel, pralines
295-310 °F 146-154 °C	**Hard Crack** — the light yel-low syrup breaks like glass as soon as it is cooled off	Hard candy, drops, lollipops
270-290 °F 132-143 °C	**Soft Crack** — the syrup can be drawn into elastic strings that will partly break	Taffy, toffee, cream candy, butterscotch
250-266 °F 121-130 °C	**Hard Ball** — the syrup can be formed with wet fingers into a sphere	Nougat, gummy candy
244-248 °F 118-120 °C	**Firm Ball** — easily formed, but still sticky	Soft caramels, chewy candy, marshmallows
234-240 °F 112-115 °C	**Soft Ball** — the syrup can be formed, but will lose its shape again	Fondant (a soft, creamy sugar base for icing)
230-233 °F 110-111 °C	**Thread** — the syrup runs in strings from the spoon	Candied fruits

Safety Note: Caution! Very high temperatures. There is a risk of burns.

Cold Water Test

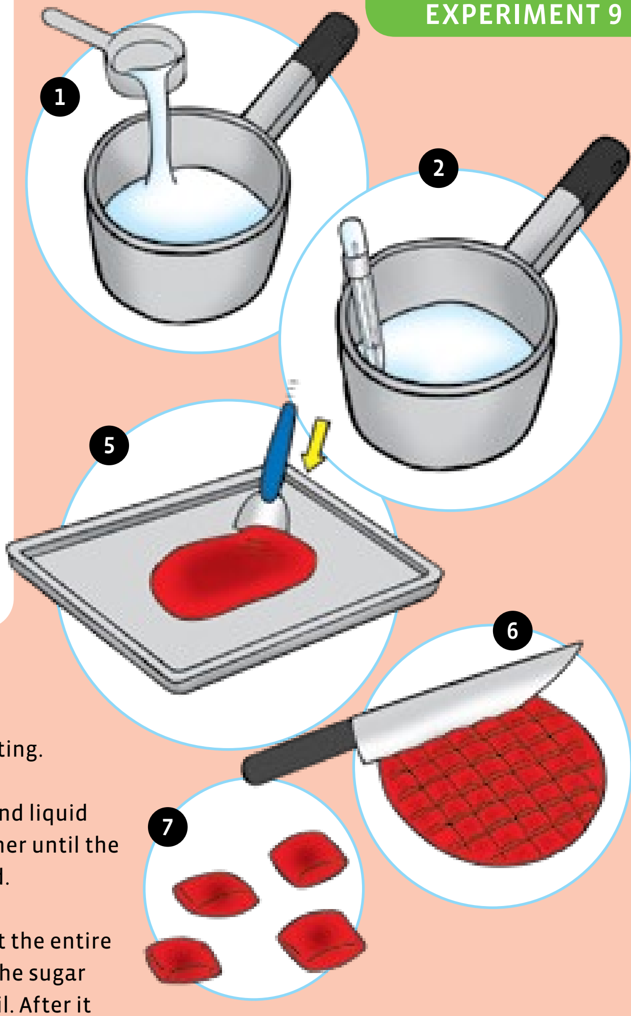
To test hot sugar syrup, place a tiny amount in a bowl of cold water. Remove it with your fingers and test it according to the descriptions above.

EXPERIMENT 9

Hard candy drops

YOU WILL NEED

- → everything from Experiment 8
- → *knife*
- → *1 and 1/4 cup granulated sugar*
- → *2 tablespoons light corn syrup*
- → *6 tablespoons liquid (water or fruit juice)*
- → *1 pinch of cream of tartar*
- → *any food coloring*
- → *any flavor extract*



HERE'S HOW

Read Experiment 8 before starting.

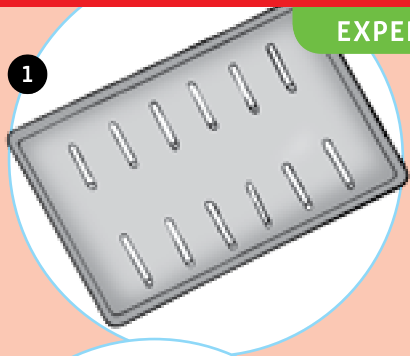
1. Pour the sugar, corn syrup, and liquid into the pot and stir it together until the sugar crystals are moistened.
2. Add the cream of tartar. Heat the entire mixture while stirring until the sugar has melted and begins to boil. After it boils up, do not stir anymore. Hang the candy thermometer from the edge of the pot into the syrup.
3. The syrup must now be heated to **Hard Crack** stage (295 °F). When this temperature is reached, immediately take the pot off the heat and let it cool for a moment.
4. Quickly add a few drops of food coloring and a few drops of flavor extract.
5. Pour the syrup onto the well-oiled, smooth work surface. Now you have to be quick, because the syrup will start to harden. Fold the candy mixture a few times with the sugar spatula, forming a flat circular mound.
6. While the mound is still soft, score it with the knife to make a grid pattern.
7. Once the candy has cooled, break it along the scored lines to make small candy drops.

EXPERIMENT 10

Hard candy lollipops

YOU WILL NEED

→ everything from Experiment 8
→ lollipop sticks
→ *1 and 1/4 cup sugar*
→ *2 tablespoons light corn syrup*
→ *6 tablespoons liquid (water or fruit juice)*
→ *1 pinch of cream of tartar*
→ *any food coloring*
→ *any flavor extract*



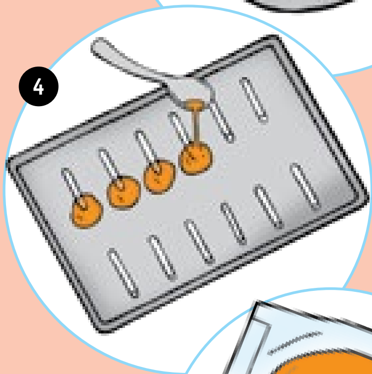
HERE'S HOW

Read Experiment 8 before starting.

1. Prepare your oiled marble surface or baking sheet. Position some lollipop sticks on the surface, at least a couple inches from one another.

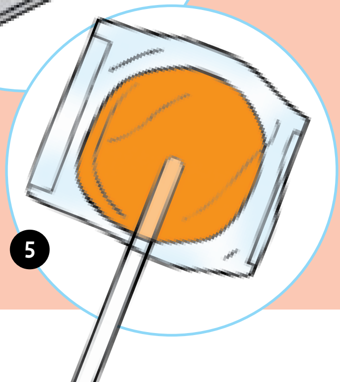
2. Make a candy syrup according to the hard candy drops recipe on the previous page, leaving it in the pot.

3. Let the finished syrup cool for just a moment. It should begin to thicken, but still be pourable.



4. Pour about a tablespoon on the end of each stick. The candy will spread out in a circle if you pour carefully.

5. When the candy has hardened, carefully pry the lollipops loose and wrap them individually in plastic wrappers.

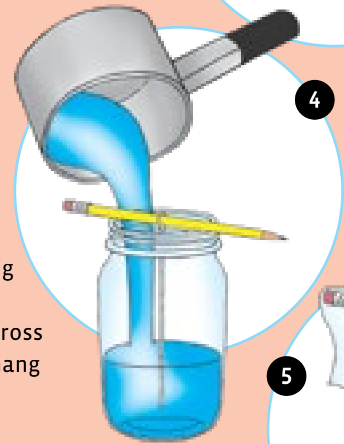


EXPERIMENT 11

Rock candy

YOU WILL NEED

→ *cooking pot*
→ *metal spoon*
→ *large glass canning jar*
→ *pencil or wooden skewer*
→ *kitchen string*
→ *plastic wrap*
→ *2 cups of water*
→ *4 cups of granulated sugar*
→ *food coloring*



Safety Note: Caution! High temperatures. There is a risk of burns.

HERE'S HOW

1. Prepare the jar setup by tying a string around the middle of the pencil or skewer. When the pencil is placed across the top of the jar, the string should hang down into the jar but not touch the bottom of the jar.

2. Wet the string and roll it in some of the granulated sugar. Let it dry. The string should be coated with sugar crystals.

3. Put 2 cups of water and 4 cups of sugar into the pot. Bring this solution to a boil.

4. When all of the sugar has dissolved into the water, remove it from the heat and pour it into the jar.

5. Gently place the string in the solution. Cover the jar with plastic wrap.

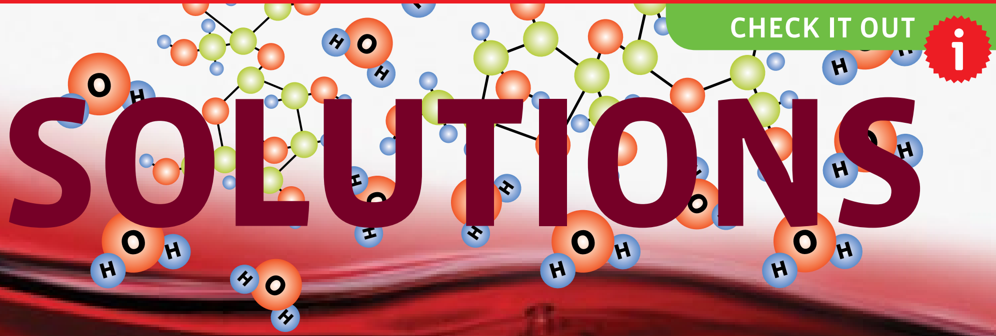
6. Leave the jar in a spot where it will not be disturbed. After a day, you should see some small crystals on the string. For large crystals, wait a week or longer.

→ WHAT'S HAPPENING?

You made a supersaturated solution of sugar and water. Over time, the sugar crystallized out of the solution, adhering to the small starter crystals on the string and forming into larger crystals.

CHECK IT OUT

SOLUTIONS



A **solution** is a mixture of substances in which the particles of one substance are evenly mixed with the particles of the other substance. When you put a spoonful of sugar into water and stir it around, it seems to vanish into the water. In actuality, you're creating a solution of sugar and water. The sugar dissolves into the water. But, we don't call sugar-water a compound, because the sugar and water molecules are not bonded together, and can be separated by physical means.

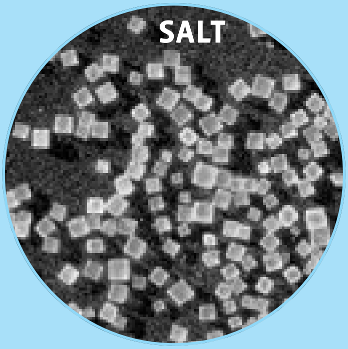
Solutions can be made of different combinations of phases of matter. A solid can be dissolved in a liquid, gas, or another solid. Liquids and gases can also be dissolved in each of the three phases of matter. Saltwater is an example of a solid dissolved in a liquid, and Earth's atmosphere is an example of many gases (like oxygen) dissolved in another gas (nitrogen).

A solution consists of a **solute**, the substance that is dissolved, and a **solvent**, the substance that dissolves the solute. If something can be dissolved, we say that it's soluble. If something cannot, we say that it's insoluble. The solubility of a solution is a measure of the amount of solute than can go into the solvent at a given temperature.

Water is a particularly good solvent, because water molecules are like little magnets with positively and negatively charged sides. Molecules with positively and negatively charged sides are referred to as polar. The charged sides help pull molecules of solute apart to dissolve them. Some molecules, like sugar, dissolve into water without the molecule actually breaking apart, while others, like salt, break apart into their component atoms. The former is called a molecular solution, and the latter is called an ionic solution.

SUGAR VS. SALT

Sugar and salt molecules both form crystals, but if you look closely with a magnifying glass, you will see that salt crystals are little cubes, while sugar crystals are oblong with slanted angles on their sides.



CHECK IT OUT

CRYSTALLIZATION

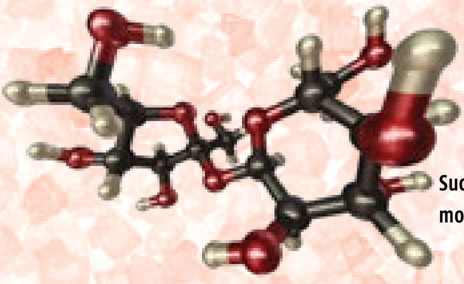
← Ice crystals

When solutes fall out of solution, scientists say they **precipitate** out of the solution. This can happen when the amounts of solvent or solute change, or when the conditions such as pressure or temperature change. When the solute precipitates out of solution, sometimes it will do so molecule by molecule, in a slow, orderly way. Because the molecules are all the same, they tend to fit together, or stack, in the same way, forming solid crystals with organized shapes. This process is called **crystallization**. Crystals can also form when molten items solidify or freeze.

The Chemistry of Sugar Crystals

Common table sugar, or sucrose, is a molecule called a **carbohydrate** because it contains carbon, hydrogen, and oxygen atoms. The simplest carbohydrates are called **monosaccharides**, such as fructose and glucose, which are the building blocks of all other sugars and carbohydrates. Sucrose is actually made of a fructose molecule combined with a glucose molecule.

The molecular structure of sucrose causes it to form monoclinic crystals when dry. This basically means they form elongated and skewed cubic crystals. When put into water, sugar crystals will dissolve. The amount of sugar that will dissolve in water depends on the temperature of the water: the hotter the water, the more sugar can fit into it, to a point. A very hot solution that has a lot of sugar in it is called a supersaturated solution. These solutions are used in candy making.



Sucrose molecule

Unfortunately, it is hard to keep sugar in supersaturated solutions when they start to cool. The sugar wants to crystallize. These crystals are desirable in some candy, such as rock candy, and undesirable in other candies, such as hard candy and caramels. So for these candies, methods have been developed to keep the crystals from forming. Methods include adding simple sugars to the solution which block the sucrose from crystallizing, and adding acids to the solution which break down the sucrose a little to keep it from crystallizing.

EXPERIMENT 12

Recipe: Caramels

YOU WILL NEED

- → candy thermometer
- → candy shape cutters
- → pick tool and forked tool
- → *baking pan (9 x 9 inches)*
- → *butter or vegetable oil*
- → *cooking pot*
- → *spoon*
- → *knife*
- → *wax paper*
- → *1 cup granulated sugar*
- → *1/2 cup packed brown sugar*
- → *1/2 cup light corn syrup*
- → *1/2 cup evaporated milk*
- → *1 cup heavy whipping cream*
- → *1/2 cup butter*
- → *1/2 teaspoon vanilla extract*

HERE'S HOW

1. Grease the pan with butter or vegetable oil, or line with greased wax paper.

2. In a heavy, medium-sized cooking pot, stir together the sugar, brown sugar, corn syrup, evaporated milk, whipping cream, and butter. Begin to heat the mixture on low to medium heat.

3. With a spoon, stir the mixture often while monitoring the heat level. As the mixture heats up, you will have to stir it constantly to keep it from burning.

Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.

4. When the syrup reaches **Firm Ball** stage (244 °F), remove the pot from the heat. It may take up to 30 minutes to reach this temperature on low heat.

5. Stir in the vanilla. Pour your mixture into the prepared pan and let it cool for several hours.

6. When the caramel mass is about half solid, cut the caramel into small squares with an oiled knife, or cut out pieces with the help of the small shape cutters. You can also inscribe designs in them with the pick tool and forked tool.

7. Wrap your individual caramels in wax paper. They will continue to harden, but the warmth of your mouth will soften them up again when you eat them.

→ WHAT'S HAPPENING?

You don't actually heat sugar to the caramel sugar stage to make caramel candies. By heating it to the Firm Ball sugar stage, you caramelize the milk, but not the sugar. The caramel taste comes from the milk, while the gooey texture is achieved by bringing the sugar to the Firm Ball stage.

Recipe: Saltwater Taffy (a type of toffee)

YOU WILL NEED

- → candy thermometer
- → *baking sheet*
- → *cooking pot*
- → *spoon*
- → *bowl of cold water*
- → *knife or kitchen scissors*
- → *2 cups granulated sugar*
- → *2 tablespoons cornstarch*
- → *1 cup light corn syrup*
- → *3/4 cup water*
- → *2 tablespoons butter*
- → *1 teaspoon salt*
- → *flavor extracts*
- → *food coloring*

HERE'S HOW

1. Grease the baking sheet with a little butter.

2. Pour the sugar and cornstarch into the cooking pot and mix together.

3. Stir in the corn syrup, butter, salt, and water.

4. Heat the mixture on medium heat, and stir often until it begins to boil. This will take about 15 minutes.

5. Once the mixture reaches a boil, stop stirring and let it boil until it reaches **Soft Crack** stage (270 °F). You can test the mixture at this point by putting a small amount into a bowl of cool water. You want it to be a little flexible. If you can form it into a ball, it's not hot enough, but if it's really brittle, it's too hot.

Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.

6. Remove the cooking pot from the heat. Stir in several drops of food coloring and your desired flavor extract.

7. Pour the mixture onto the baking sheet and let it cool at room temperature for about 10 to 20 minutes.

8. Stretch the taffy. You will want to grease your hands and do this for 10 to 15 minutes or until the taffy has a satiny appearance, is light in color, and gets tougher to pull.

9. Roll the pulled taffy into a long rope, about half an inch in diameter, and cut it with oiled scissors or a knife into one-inch long pieces.

10. Let these sit for 30 minutes and then wrap them in wax paper.

→ WHAT'S HAPPENING?

Saltwater taffy is a popular U.S. candy that was invented in Atlantic City, New Jersey, in the late 1800s. Despite the name, it's not made with seawater.

The reason you have to pull the taffy is to get very small air bubbles distributed evenly throughout it. The air bubbles make the candy softer, lighter, and chewier. They also give it its signature pastel color, because the many air bubbles break up the clear crystalline sugar and diffuse the light.

EXPERIMENT 14

Recipe: Almond pralines

YOU WILL NEED

- → candy thermometer
- → *cooking pot*
- → *fork*
- → *baking sheet*
- → *wax paper*
- → *1/2 cup granulated sugar*
- → *1/2 cup coarsely chopped almonds*

HERE'S HOW

1. Spread the sugar evenly over the bottom of the cooking pot.
2. Heat the pot on medium heat and stir constantly until all of the sugar melts.
3. Let the sugar continue to cook without stirring, but you can swirl the pot slightly if necessary to spread the sugar evenly over the bottom of the pot. Cook until the sugar is a golden brown color, and then remove the pot from the heat. What temperature is the sugar at this stage?
4. Add the almonds and stir until they are well coated in the sugar.
5. Place a piece of wax paper over the baking sheet.
6. Spread the mixture out onto the wax paper and let it cool for 15 minutes. When it has cooled, break it apart and serve.

→ WHAT'S HAPPENING?

In this recipe, you heated the sugar up to about 320 to 330 °F. This is the stage at which the sugar starts to get brown and begins to smell like caramel.

Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.

CHECK IT OUT

Sugar cane

Where does sugar come from?

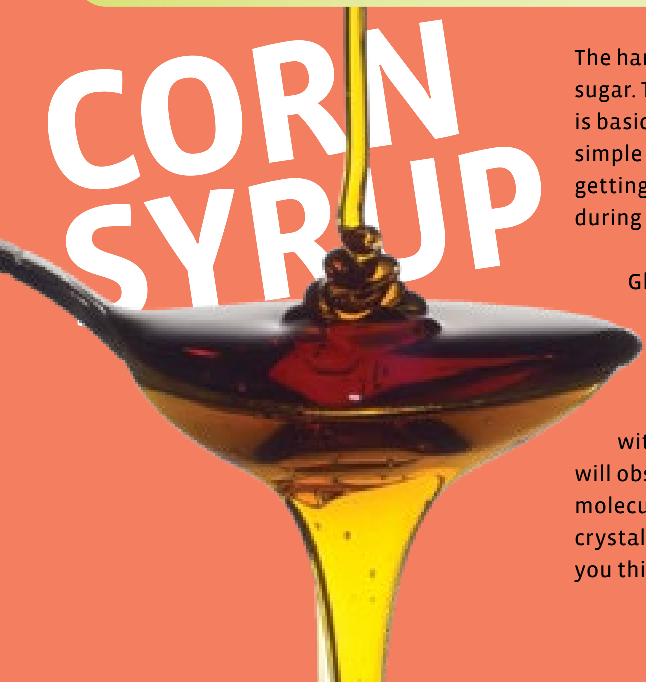
Sugar beet

Most sugar is derived from **sugar cane** or **sugar beets**. This household or white sugar can be found as granulated sugar, sugar cubes, finely ground confectioner's sugar, in large crystals as rock candy, and sometimes even as liquid sugar (dissolved in water).

Sugar was originally only derived from sugar cane, which grows in tropical countries. Well over 200 years ago, it was realized that this desirable ingredient could be derived more economically from sugar beets. Now, 30% of sugar comes from beets. Chemically, however, the two kinds of sugar are exactly the same, namely **sucrose**.

In fruit, there are two other types of sugar: glucose and fructose. These are simple sugars. Both of these can be made chemically by splitting sucrose, because sucrose is a complex sugar composed of glucose and fructose.

CORN SYRUP



The hard candy recipes call for two types of sugar. The addition of light corn syrup, which is basically pure glucose, in the recipes is a simple trick to prevent the syrup from getting solid or forming crystals too quickly during boiling. How does this work?

Glucose crystals are shaped differently than "normal" sucrose crystals. They simply have the wrong size to fit into the crystal lattice of the sucrose. They will form long chains with other glucose molecules, but these will obstruct the mobility of the sucrose molecules and thereby prevent unwanted crystal formation. Rather refined, don't you think?

Organic Chemistry:
Sugars, Fats, Proteins

Organic compounds make up a huge category of chemical substances that all share one important trait. They all contain carbon. Organic compounds are necessary for life as we know it, and not surprisingly, most foods are made of organic compounds. In this chapter, you will experiment with some of the most important types of organic compounds to make delicious candies!

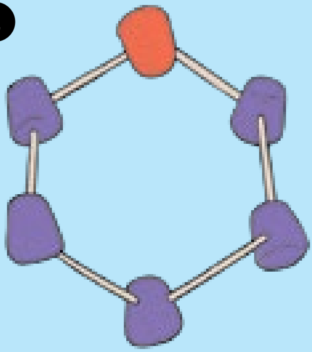
EXPERIMENT 15

Sugar molecules

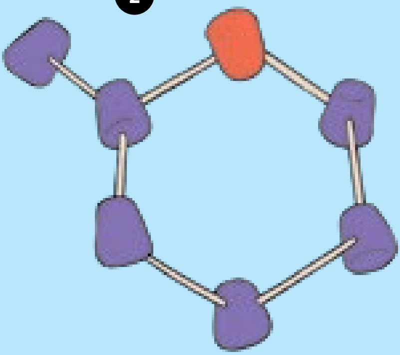
YOU WILL NEED

→ *12 white gum drops*
→ *6 red gum drops*
→ *6 purple gum drops*
→ *24 toothpicks*

HERE'S HOW

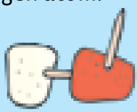
1


1. First assemble a ring of five purple carbon atoms and one red oxygen atom. You can substitute gum drops of any color for the suggested colors.

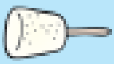
2


2. Add one more carbon atom sticking off one of the carbon atoms in the ring.

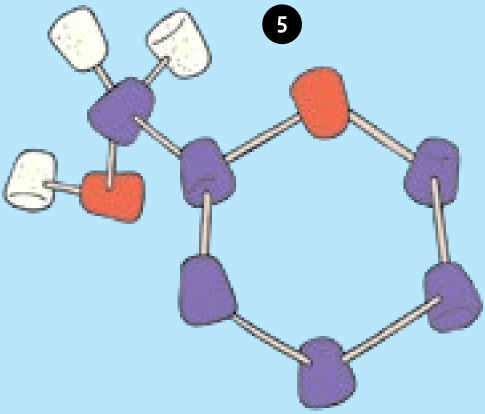
3. Assemble six of these hydroxyl groups, consisting of one red oxygen and one white hydrogen atom:

3


4. Prepare six of these hydrogen atoms by inserting toothpicks into six hydrogens:

4


5. Attach two hydrogens and one hydroxyl group to the sixth carbon atom.

5


EXPERIMENT 15

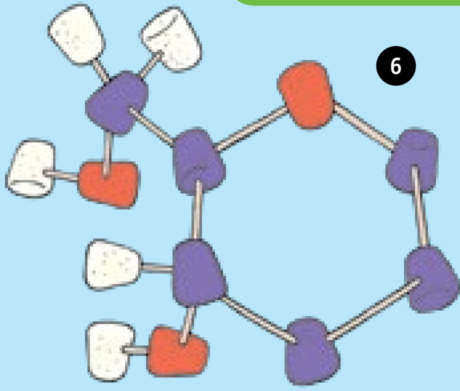
Sugar molecules

HERE'S HOW IT CONTINUES

6. Attach one hydrogen and one oxygen to all of the other carbon atoms in the ring.

7. To the carbon atom in the ring that has the sixth carbon atom sticking off of it, attach one more hydrogen.

8. This is how the finished molecule looks. Note that the red oxygen atom in the ring has nothing else attached to it, except the two carbons holding it in the ring.



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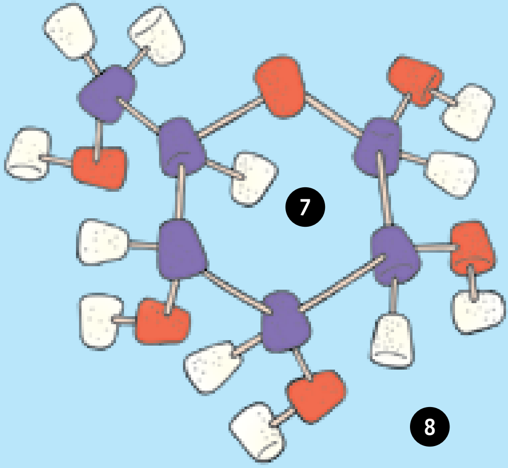


7

8

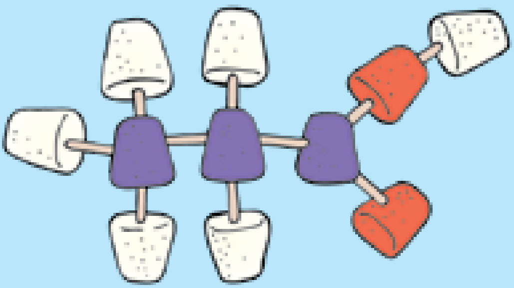
→ WHAT'S HAPPENING?

This model represents one glucose molecule, only much, much bigger than it is in reality. Glucose is a simple sugar. A single glucose molecule has six carbon atoms, six oxygen atoms, and 12 hydrogen atoms. It is considered an organic compound, and is used by cells to produce energy. This particular molecular configuration is one way that glucose can be oriented.

EXPERIMENT 16

Fatty acid molecules

Try to recreate this fat molecule (called a fatty acid) on your own. It uses the same atoms as glucose: carbon, hydrogen, and oxygen.

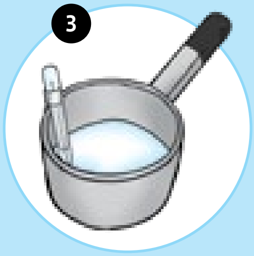


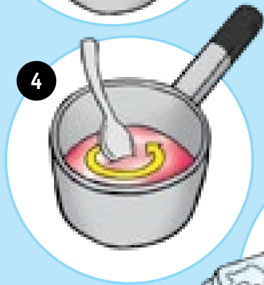
EXPERIMENT 17

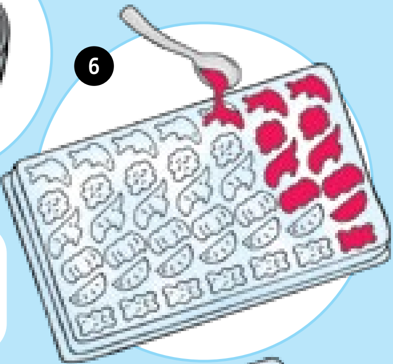
Gummy shapes

YOU WILL NEED

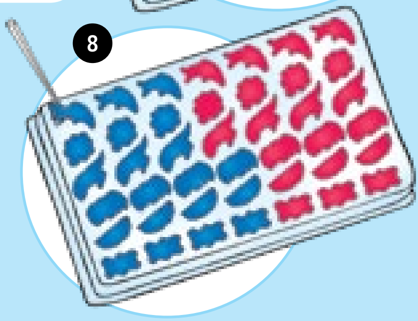
→ candy thermometer
→ gummy candy mold
→ pick tool
→ *cooking pot*
→ *spoon*
→ *mixing bowl*
→ *vegetable oil*
→ *1 packet of gelatin (1 tbsp)*
→ *4 tablespoons water or juice*
→ *1 tablespoon granulated sugar*
→ *1/2 teaspoon of honey*
→ *food coloring*
→ *flavor extract*







Safety Note: Caution! High temperatures. There is a risk of burns.



HERE'S HOW

1. Combine the gelatin and 3 tablespoons of water or juice in the pot, and let it soak for 15 minutes.

2. In the bowl, dissolve the sugar in 1 tablespoon of water.

3. While stirring, heat the gelatin in the pot to a maximum of 165 °F, or until it has just become liquid. Remove from heat.

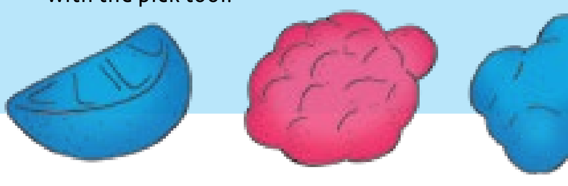
4. Stir in the sugar solution, the honey, a few drops of food coloring, and a few drops of flavor extract.

5. Lightly coat the gummy candy mold with vegetable oil.

6. Spoon the gelatin mixture into the molds.

7. You can fill about half the cavities in the gummy candy mold with this recipe. We suggest repeating the recipe with a different food coloring to fill the second half.

8. Let the gummy candies harden for three hours, and then pry them out of the mold with the pick tool.



CHECK IT OUT

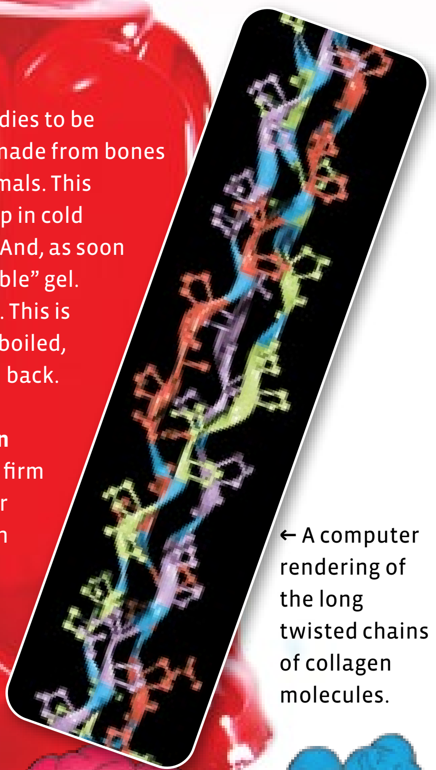
Why do Wint-O-Green Life Saver® candies and Polo® Mints (in the UK) spark when you bite them in the dark?

This spark effect, which all hard sugary candies exhibit, is called **triboluminescence**. It happens when something emits light by being smashed or torn. In this case, your teeth smash the sugar molecules, forcing some electrons out of their atomic fields so that they bump into nitrogen molecules (N_2) in the air, giving the nitrogen molecules energy. This causes them to emit a little bit of visible light plus non-visible ultraviolet light that the fluorescent flavoring of these candies — methyl salicylate, or oil of wintergreen — absorbs and re-emits as additional visible light.

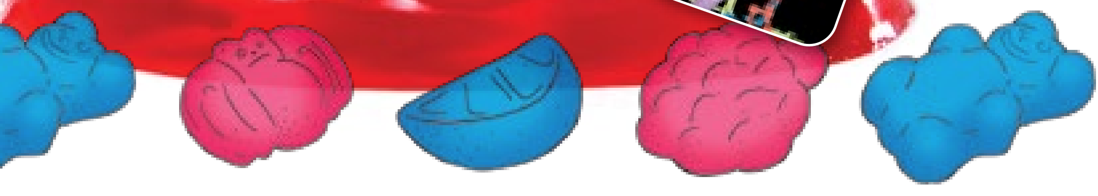
Gelatin

The ingredient that causes these candies to be "gummy" is called **gelatin**. Gelatin is made from bones and connective tissue (the hide) of animals. This animal protein has the ability to swell up in cold water, and to be dissolved when heated. And, as soon as it is cooled off again, it forms a "reversible" gel. That means it can return to an earlier state. This is different from the gelatin in eggs. Once it is boiled, egg white remains firm and cannot be turned back.

Gelatin consists of many long chains of **collagen** molecules. Parts of them are responsible for the firm structure, other parts for the contact to the water molecules. In warm water, the water molecules can slide in between the collagen molecules and fold their inner structure together. This is when the gelatin is dissolved. When cooled off, the collagen molecules connect themselves together again and as a result form a network that can make liquids firm.



← A computer rendering of the long twisted chains of collagen molecules.



EXPERIMENT 18

Sour gummies with citric acid

YOU WILL NEED

→ everything from Experiment 17
→ *plastic wrap*
→ *small baking pan*
→ *knife*
→ ***flavored drink mix powder containing citric acid (for example, powdered lemonade)***

HERE'S HOW

1. Prepare the gelatin syrup as in Experiment 17.

2. Line a small baking pan with plastic wrap.

3. Put the gelatin syrup into the pan. Let it cool until the gummy candy is very firm.

4. Turn the pan over to release the gummy candy sheet onto a cutting surface.

5. Remove the plastic wrap and cut long, thin slices of the gummy candy sheet.

6. Coat the gummy candy strips in the flavored drink mix powder.

→ WHAT'S HAPPENING?

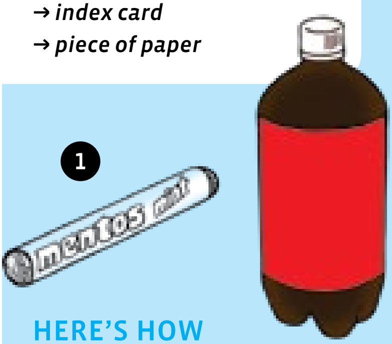
Sour gummy candy tastes sour because of citric acid, an acid found naturally in citrus fruits like lemons. Most powdered drink mixes contain citric acid and sugar, to make them sweet and tangy.

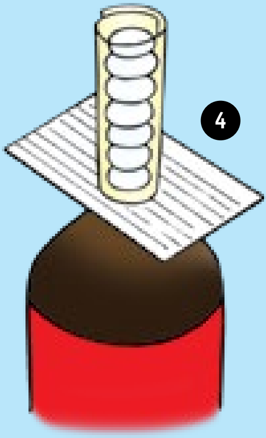
EXPERIMENT 19

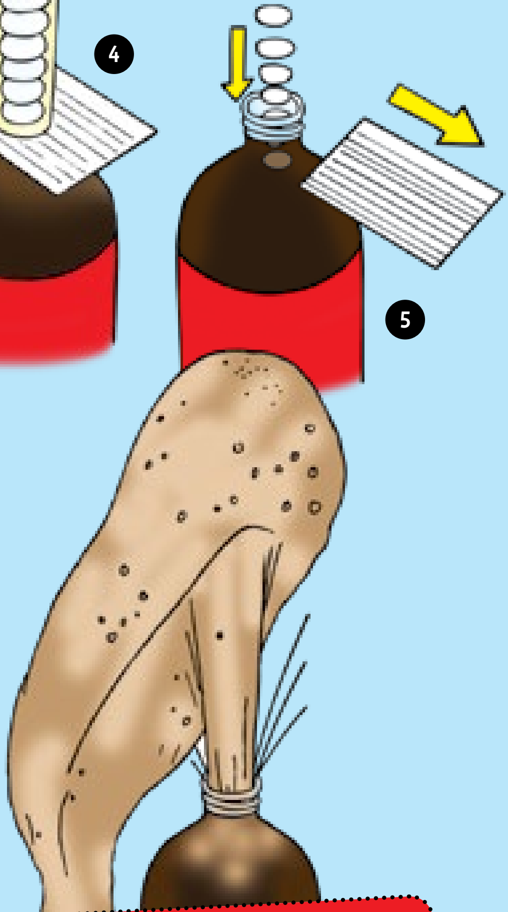
Soda geyser experiment

YOU WILL NEED

→ *2 liter bottle of diet cola*
→ *pack of mint Mentos® candy*
→ *index card*
→ *piece of paper*







HERE'S HOW

1. Roll the piece of paper into a tube so that it fits around the rolled pack of Mentos candies.

2. Remove the Mentos from their wrapper and arrange them to they are stacked neatly inside the paper tube. The tube should be loose enough for the Mentos to move freely inside it.

3. Open the diet cola bottle and rest the index card on the mouth of the bottle.

4. Align the paper tube of Mentos vertically with the mouth of the bottle, and hold it there, with one end resting on the index card. The index card is preventing the candies from falling into the soda.

5. With one quick motion, remove the index card and all the Mentos will fall into the bottle. Stand back immediately!

→ WHAT'S HAPPENING?

A reaction occurs between chemicals in the Mentos and in the diet cola, causing a massive release of carbon dioxide gas, which foams up out of the bottle. The shape of the Mentos also helps produce the foam. They have tiny indentations all over them that increase the surface area for the reaction to occur. And, because of their size, the candies get trapped inside the bottle to continue to react instead of being pushed out of the bottle by the eruption.

Chemical Reactions in the Kitchen

In science, it's important to distinguish between **physical changes** and **chemical changes**. Simply put, a physical change doesn't produce new substances, while a chemical change does. Breaking an egg is an example of a physical change, while cooking an egg is an example of a chemical change. When you mix flour and baking soda, no chemical changes occur; but when you mix baking soda and vinegar, you get a fizzy chemical reaction.

A special reaction called the **Maillard reaction** gives caramel candies their brown color and unique taste. In this reaction, part of the sugar molecule reacts with the nitrogen in protein (from the cream) when they are heated up. This same reaction gives color and flavor to browned meats, french fries, crusty breads, and roasted coffee.

When sugar is heated to 320 °F, it starts to **caramelize**, converting into new substances and flavor compounds. When the sugar gets up to 350 °F, it starts to break down into pure carbon, which is why it turns black like charcoal or soot and tastes burnt.

Because **oil and butter** don't evaporate like water does when the temperature increases, they are added to baked goods to keep them moist.

When **eggs** are heated, they coagulate (or become solid) because the heat causes the proteins in the egg to unfold and then reconfigure themselves with strong bonds between them.

Baking soda and baking powder are used as **leavening agents** in baking, to make baked goods light and fluffy. When baking soda reacts with acids, it produces carbon dioxide gas. This gas is what makes cakes and cookies rise. Baking powder is usually made of baking soda combined with dry acids so that as soon as water is added, the reaction begins. Heat actually speeds up this reaction.

Sugar is added to meringue, whipped cream, and custard, to make them firmer, because the sugar molecules link to the protein molecules, strengthening the connections.

CHECK IT OUT

YOU'RE SUSPENDED!

You already learned about solutions. But what happens when you mix a substance into another and it doesn't dissolve? A **suspension** is a mixture of substances that do not dissolve into each other, but rather one substance is held within the other. Over time the substances will separate. Solutions are therefore more stable than suspensions: Once dissolved, the solute will remain in the solution indefinitely.

You can, however, treat suspensions to make them permanent. Permanent suspensions are called **colloids**. Colloids can be solid, liquid, or gas. For example, milk is a liquid colloid, in which butterfat globules are permanently suspended in a water-based fluid. A colloid composed of a liquid suspended in another liquid is called an **emulsion**. Examples of emulsions include butter, jelly, salad dressing, and milk. **Emulsifiers** are substances used to make solutions permanent, including egg yolks, honey, and soy lecithin. You can find these in the ingredients lists of many chocolates and candies.

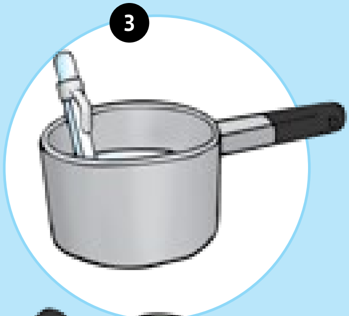
Colloids play a huge role in the candy world because they give foods special textures. Marshmallows, nougats, meringues, and solid foams are examples of colloids in which a gas is suspended inside a solid. Gelatins and gummies are examples of liquid-in-solid colloids. Whipped cream is an example of a gas-in-liquid colloid. Ice cream is an example of a liquid-in-solid colloid that transforms into a liquid-in-liquid colloid as the ice melts.

EXPERIMENT 20

Marshmallows

YOU WILL NEED

- → candy thermometer
- → *mixing bowl*
- → *hand mixer or stand mixer*
- → *small cooking pot*
- → *parchment or wax paper*
- → *baking pan*
- → *mesh sieve or flour sifter*
- → *knife*
- → *air-tight storage container*
- → *3 packs (or 3 tablespoons) unflavored gelatin*
- → *1 cup cold water*
- → *1 and 1/2 cups granulated sugar*
- → *1 cup light corn syrup*
- → *1/4 teaspoon salt*
- → *1/4 cup powdered sugar*
- → *vegetable oil*
- → *1 teaspoon vanilla extract*
- → *food coloring (optional)*

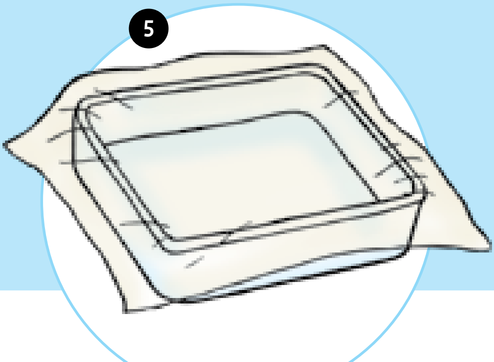


HERE'S HOW

1. Combine the unflavored gelatin and 1/2 cup of cold water in the mixing bowl.

2. Combine the granulated sugar, light corn syrup , salt, and 1/2 cup of cold water in the cooking pot. Stir the ingredients together.

3. Place the pot on medium to high heat. Place your candy thermometer in the pot and watch it until it reaches a temperature of 240 °F. Do not let the thermometer touch the bottom of the pot as you are measuring. As soon as it reaches 240 °F, remove it from the heat.



EXPERIMENT 20

Marshmallows

HERE'S HOW IT CONTINUES

4. Set the mixer on low and slowly pour the sugar mixture into the bowl of dissolved gelatin. Once all of the sugar mixture is in the bowl, set the mixer on high. Leave the mixer on high for 10 minutes. During the last minute, add a teaspoon of vanilla extract. The mixture is ready when it's thick and white and it forms peaks when you lift the beaters up.

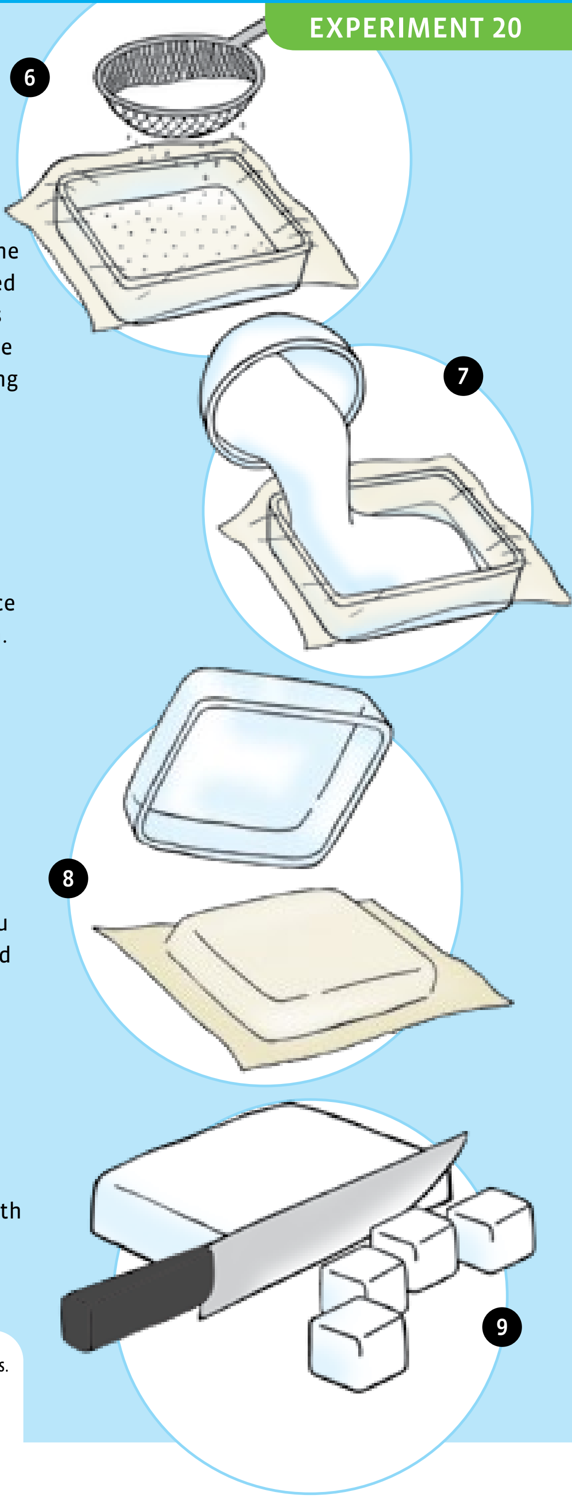
5. Lightly coat the bottom of the baking pan with vegetable oil and place a piece of wax paper on the bottom of the pan.

6. Using the sieve, sprinkle powdered sugar to lightly coat the pan.

7. Pour and spread the contents of the mixing bowl into the pan. Dust the top of this with powdered sugar. Leave it uncovered at room temperature to settle for at least four hours. When you touch the top of the marshmallows and they feel rubbery and dry, they are ready.

8. Dust a cutting surface with more powdered sugar and turn the pan over onto the board.

9. Cut the marshmallows into squares with an oiled knife, dusting each with powdered sugar.



Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.

Nutty nougat

YOU WILL NEED

- → candy thermometer
- → *edible rice paper or wax paper*
- → *small baking pan*
- → *mixing bowl*
- → *whisk*
- → *small cooking pot*
- → *knife*
- → *air-tight storage container*
- → *1 egg white*
- → *2 cups powdered sugar*
- → *1 teaspoon light corn syrup*
- → *2 tablespoons honey*
- → *2 tablespoons water*
- → *1 cup roasted peanuts, chopped*
- → *vegetable oil*

HERE'S HOW

1. Line the sides and base of a small baking pan with edible rice paper. If you can't find rice paper, use oiled wax paper.

2. Whisk the egg white in a heat-proof bowl until stiff.

3. Combine the sugar, light corn syrup, honey, and water in the cooking pot. Stir over very low heat until the mixture reaches the **Hard Ball** stage, or 265 °F on a candy thermometer. It will take about 3 to 5 minutes.

Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.

EXPERIMENT 21

Nutty nougat

HERE'S HOW IT CONTINUES

4. Remove from the heat. While whisking, drizzle the syrup mixture into the egg white and continue whisking until glossy. The mixture will begin to stiffen.

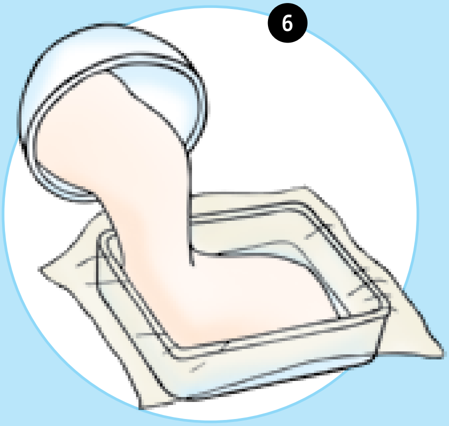
5. Stir in the chopped peanuts.

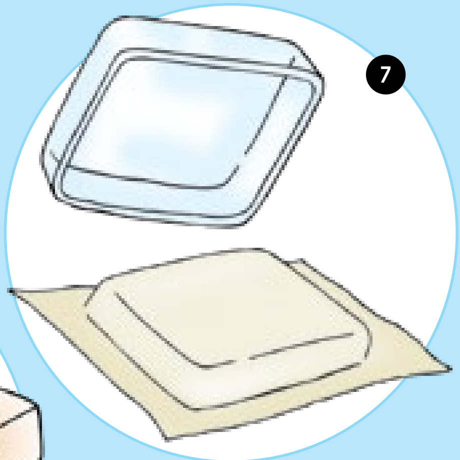
6. Spread the mixture over the rice paper in the prepared pan, pressing it down well. Cover it with another layer of rice paper, and place a light weight evenly over the top.

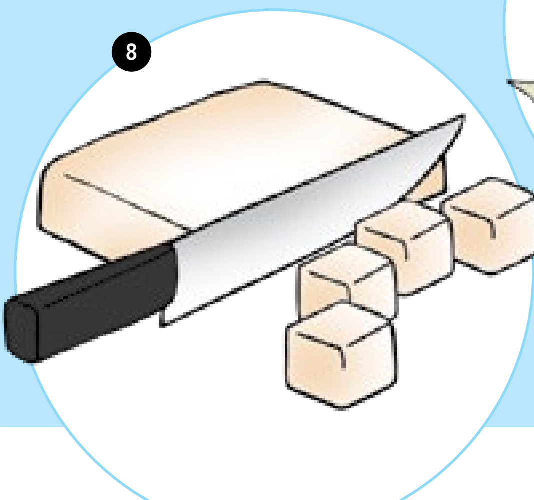
7. Let the nougat sit until it cools completely, then turn it out of the pan.

8. Cut the nougat into squares, wrap in waxed paper, and store in an airtight container.

9. You can also coat the nougat in chocolate. Follow the instructions at the end of Experiment 22.







Peppermint patties

YOU WILL NEED

→ candy thermometer
→ small shape cutters
→ dipping fork
→ candy spatula
→ *cooking pots*
→ *rolling pin*
→ *wax paper*
→ *baking sheet*
→ *1 cup granulated sugar*
→ *1/4 cup water*
→ *1 tablespoon light corn syrup*
→ *5 drops peppermint oil (or extract)*
→ *1/2 cup powdered sugar*
→ *1 cup semisweet chocolate (or chocolate coating)*

HERE'S HOW

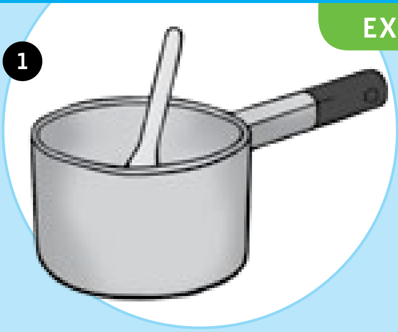
1. Combine the granulated sugar, water, and light corn syrup in the pot. Heat the pot on medium-high heat until the mixture reaches the **Soft Ball** stage (240 °F).

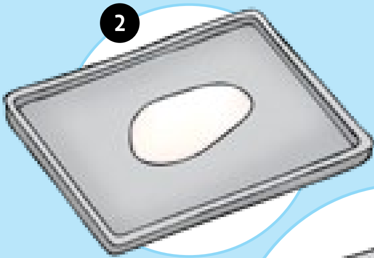
2. Pour the sugar mass onto a warm baking sheet. Let it cool for a minute or two.

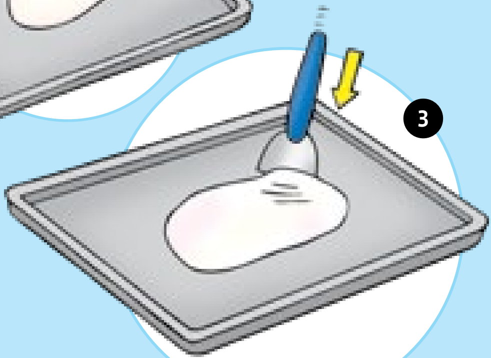
3. With the candy spatula, start scrapping the sugar mass to blend it.

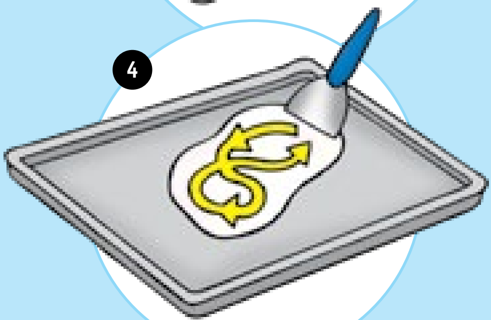
4. Work the sugar mass in a figure-eight pattern with the spatula. It will start to become a crumbly, opaque white mass.

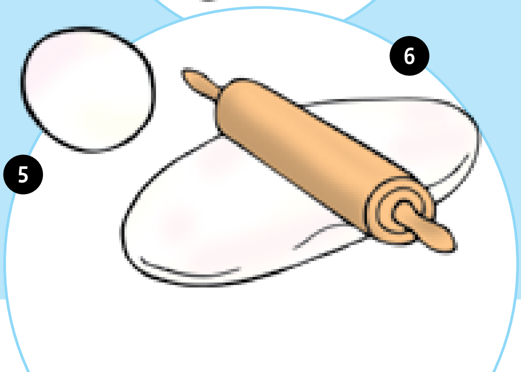
Safety Note: Caution! Very high temperatures. There is a risk of burns. Boiling sugar and candy syrups are extremely hot. An adult should perform all operations involving the hot sugar and candy syrups.











EXPERIMENT 22

Peppermint patties

HERE'S HOW IT CONTINUES

You are in the process of making a confectionery substance called **fondant**.

5. When the fondant becomes too hard to push with the spatula, start kneading the crumbly mass with wet hands. As you knead it, it will get softer and smoother. Knead it until you can form it into a ball. Add the peppermint oil or extract, and roll the fondant into a ball.

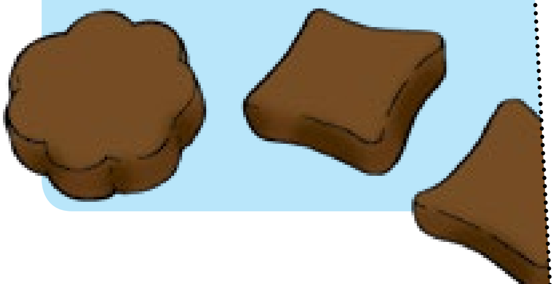
6. With the rolling pin, roll out the fondant on a clean surface covered with powdered sugar. You want the fondant sheet to be about a quarter of an inch thick.

7. Use the shape cutters to cut out as many patties as you can, and let them dry.

8. Melt the chocolate in a cooking pot or double boiler.

9. Using the dipping fork, dip the patties, one by one, into the melted chocolate to coat them.

10. Place the coated patties on a rack to dry and harden, and then store them in an air-tight container.



→ WHAT'S HAPPENING?

Candy makers often work with this candy mixture that contains lots of sugar and is mainly used for filling chocolate candies. This tough white paste is called fondant. Constantly agitating the sugar during cooling never allows the sugar crystals to get very large. Instead, very small crystals are mixed with air bubbles to form the thick white paste.

ORIGIN OF CHOCOLATE

The Aztecs brewed a thick beverage from cocoa pods, water, vanilla, and honey, which they called **Xocoatl** (pronounced shockolatle). The main ingredient, the fruit pods from the **cacao tree**, was valued so highly that the Aztecs even used these fruits as money. The valuable beans came to Europe via Spain, first as a beverage. To make it, cocoa powder was grated into hot water or milk, sugar or honey was added, and the brown liquid was whipped until foamy. The delicious beverage spread all over Europe and is the ancestor of what we now call hot cocoa.

The perennial cacao tree will grow to be about 26 feet tall in plantations. Its yellow flowers are half an inch long and sit in bundles directly on its trunk. From these will grow eight-inch long cucumber-like fruit pods (top photograph), which will change color from green to yellow to red. Inside these, embedded in white, sweet-and-sour flesh, there are about 30 seeds, called **cocoa beans** (bottom photograph), although they are not actually beans. These seeds are highly nourishing. They are almost 50% fat, or **cocoa butter**. They also contain a chemical similar to caffeine called **theobromine**, at levels that are safe for humans but dangerous for dogs and cats.

Cocoa fruits are harvested today similar to how they were in the days of the Aztecs. The fruits are cut from the tree with sharp knives and immediately split to extract the seeds, which are then fermented. During this process, they are heated by the effect of bacteria, yeast, and enzymes, to about 45 °C (113 °F) and develop the fine, recognizable cocoa aroma. Finally, the beans are dried, roasted, and shipped as raw cocoa beans (background photograph).

To be processed into cocoa powder, the raw cocoa is ground up into cocoa mass. This is exposed to high pressure in presses heated with steam, which releases the cocoa butter fat. The remainder is ground into fine cocoa powder ready to be packaged and sold.

Just for Fun!

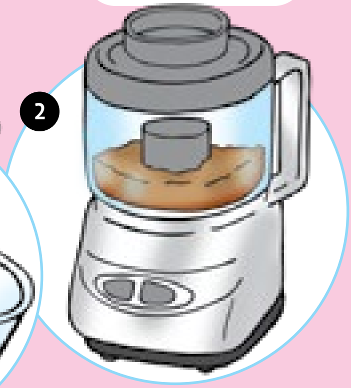
Here are a couple fun, science-themed candy making activities to finish off your adventures in confectionery science.

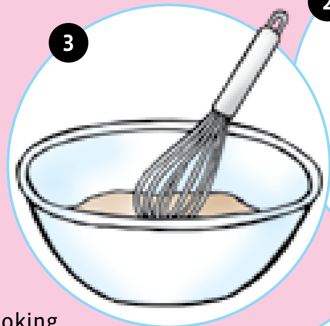
Marzipan solar system

Safety Note: Caution! High temperatures. There is a risk of burns.

YOU WILL NEED

- → *1 and 3/4 cups granulated sugar*
- → *1/2 cup water*
- → *1 and 1/2 cups almonds, peeled or blanched*
- → *2 egg whites*
- → *confectioners sugar*
- → *food coloring*





HERE'S HOW

1. Heat the sugar and water in a cooking pot to 118 °F. Remove from heat.

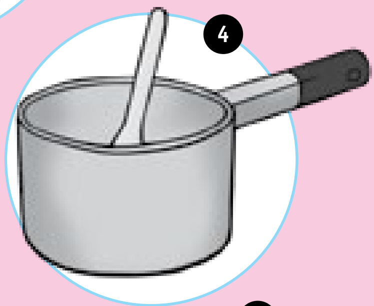
2. Grind the almonds in a food processor until they turn into a very fine paste.

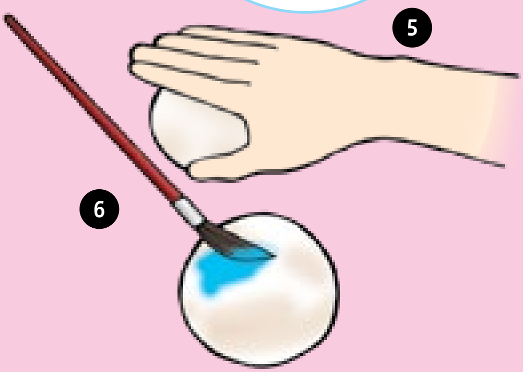
3. Whisk the egg whites together in a bowl to until they form a soft foam.

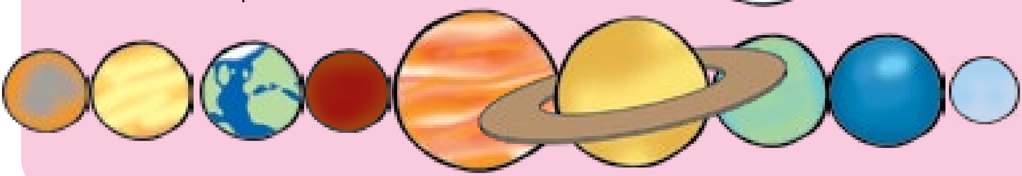
4. Add the almond paste and the egg whites to the sugar syrup. Stir to form a thick paste.

5. Take a small amount of the marzipan paste and roll it out into a ball with your hand. Form a ball for each planet.

6. Using a new paint brush and food coloring, paint the surfaces of the balls to resemble the planets!







EXPERIMENT 24

Candy circuit board

YOU WILL NEED

→ *graham cracker (UK - digestive biscuit)*
→ *frosting*
→ *food coloring*
→ *assorted candies as shown*

HERE'S HOW

1. Start with a graham cracker (called a digestive biscuit in the UK) and cover it with green frosting to make your circuit board.

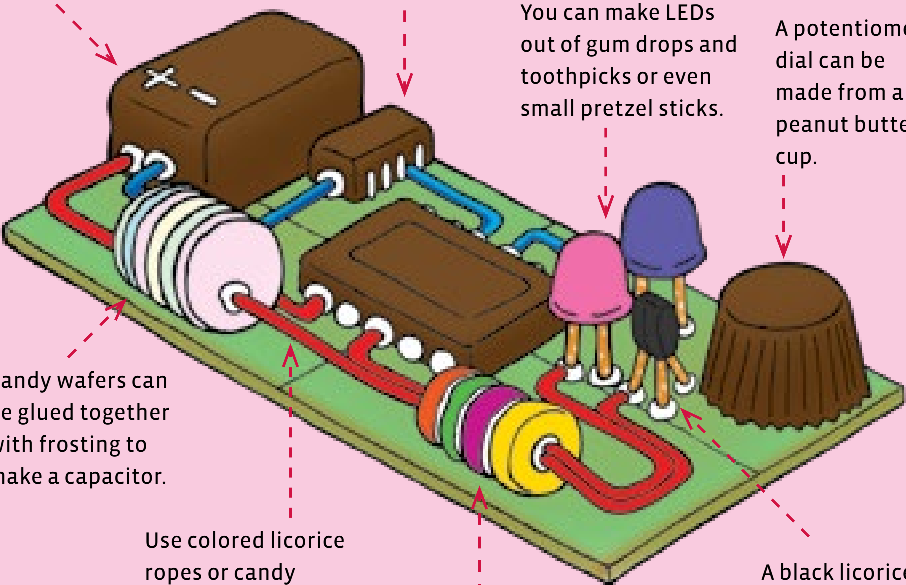
2. Now, assemble various candies as described below, or using your imagination, to create a fantastic candy circuit board!

Use a small candy bar to make the battery pack. Mark "+" and "-" on it using frosting.

Squares from chocolate bars can become microchips with a little bit of white frosting "solder" to represent their metal prongs.

You can make LEDs out of gum drops and toothpicks or even small pretzel sticks.

A potentiometer dial can be made from a peanut butter cup.



Candy wafers can be glued together with frosting to make a capacitor.

Use colored licorice ropes or candy vines to form the wires and contacts.

Life Savers candies can be cemented together with frosting to become resistors.

A black licorice candy can become a tiny transistor.

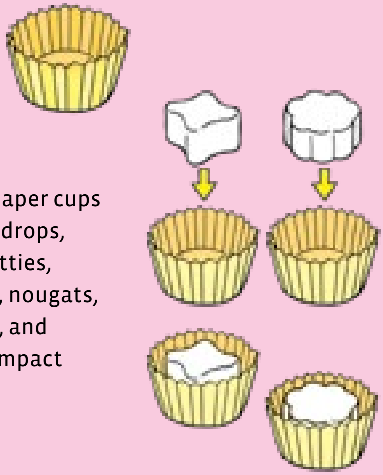
EXPERIMENT 25

How to wrap your candies

YOU WILL NEED

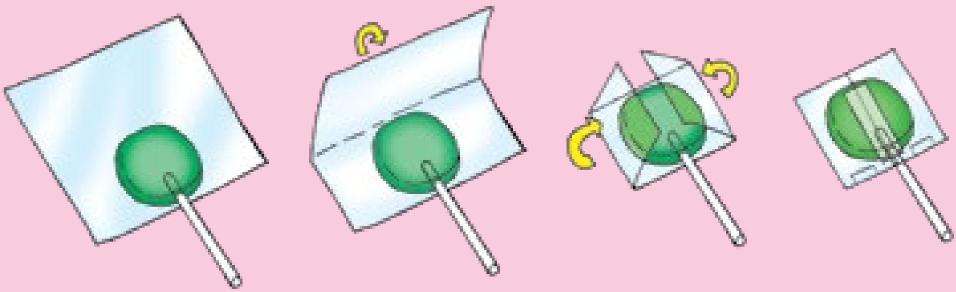
→ transparent plastic wrappers
→ aluminum foil sheets
→ small paper baking cups
→ candy label stickers
→ *tape*

HERE'S HOW



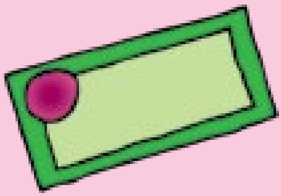
1. Use the small paper cups for hard candy drops, peppermint patties, marshmallows, nougats, marzipan balls, and other small, compact candies.

2. Wrap the lollipops and other hard candies in the transparent plastic wrappers like this.



3. Wrap the chocolates in the aluminum foil sheets like this.

3. Write the names of your candy creations on the candy labels and stick them on your candy wrappers.



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First Aid

Important: In case of injury, always seek medical help.

When conducting experiments with chemicals:

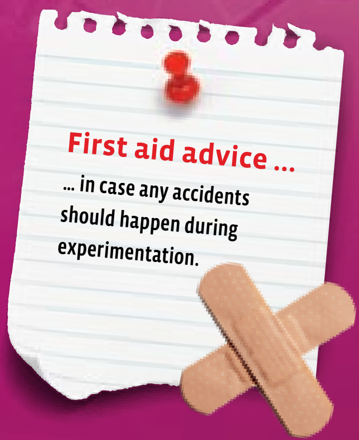
→ In case of eye contact: Wash out eye with plenty of water, holding eye open if necessary. Rinse from the nose outward. Seek immediate medical advice.

→ If swallowed: Wash out mouth with water, and drink some fresh water. Do not induce vomiting. Seek immediate medical advice.

→ In case of inhalation: Move person into fresh air, for example, into another room with open windows or outside.

→ In case of skin contact and burns: Wash affected area with plenty of water for five minutes. Cover burns with a bandage. Never apply oil, powder, or flour to the wound. Do not lance blisters. For larger burns, seek immediate medical help.

→ In case of cuts: Do not touch or rinse with water. Do not apply any ointments, powders, or the like. Dress the wound with a germ-free, dry first-aid bandage. Foreign objects such as glass splinters should only be removed from the wound by a doctor. Seek the advice of a doctor if you feel a sharp or throbbing pain.



→ When in doubt, seek medical advice without delay. For accidents involving chemicals, always take the chemical with its container to the doctor or tell the doctor the name of the chemical.

In case of emergency, contact the United States Poison Control Center at

1-800-222-1222

Record the telephone number of your local hospital or poison center here:

665003-03-230321