GEEK & CO. SCIENCE!

PROJECT KIT

Ages 8+

GuMMY CANDY LAB

IN COLLABORATION WITH GLEE gum

THAMES & KOSMOS

WARNING. Only for use by children 8 years of age or older with continuous adult supervision and assistance. Adult supervision required at all times. Use of a microwave or stove is required. Hot mixtures and stove tops can cause severe burns.

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Safety information

Warning! Not suitable for children under 8 years. For use under adult supervision. Read the instructions before use, follow them and keep them for reference.
Keep small children and animals away from experiments. Keep the experimental set out of reach of children under 8 years old.
Warning. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.
Keep the packaging and instructions as they contain important information.
The gummy pieces should be wrapped in the plastic bags before labeling them with the stickers.
All of the plastic parts should be cleaned by hand before use.

Ingredients

Sour Mixture: Sugar, citric acid

Seaweed Powder: Corn syrup solids, agar gum, carrageenan, tara gum

Cherry Flavoring and Sugar Mixture: Sugar, beet juice powder (as color), natural flavors

Lemon Flavoring and Sugar Mixture: Sugar, beta-carotene (as color), natural flavors

Safety rules

Read this before starting any experiments.

1. Read these instructions before use, follow them and keep them for reference.
2. Keep young children and animals away from the work area and stove at all times.
3. Store this kit out of reach of children under 8 years of age.
4. Clean all equipment after use. Clean all pots and utensils with hot water and soap.
5. Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.
6. Never work alone. An adult should always be present. Pay attention to the information provided with each experiment.
7. Pay special attention to the quantity specifications and the sequence of the individual steps. Only perform experiments that are described in this instruction manual.
8. The included plastic mold for the gummy shapes is not dishwasher safe. It will be deformed by high temperatures, so wash it by hand.
9. Clean the work surface carefully after you are finished and always wash your hands thoroughly — before and after you work.
10. If you are allergic to certain foods 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.
11. It goes without saying that there can be no smoking in a confectionery shop.

Advice for parents and supervising adults

This experiment kit is not suitable for children under 8 years. It must be used with an adult at all times. The kit provides a fun introduction to physical science topics through gummy candy making activities and 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, microwave, and working with hot ingredients. This also applies to the use of sharp knives and other kitchen utensils (e.g. breakable glasses).

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

→ Safety information and rules (inside front cover),
→ Safety notes that accompany each experiment (marked with an exclamation point symbol), and
→ First aid in case of accidents (inside back cover).

Discuss the experiments and the individual work steps with your child before beginning. Use only the recommended ingredients.

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

Select the working steps that appear suitable for your child and supervise him or her during the melting, pouring, packaging, and storage of the gummy candies. Your own gummy shapes will not keep as long as commercially available gummies, which often contain preservatives. Write the production date on the packaging and store in the refrigerator. Make sure that the candies are consumed within one week after they are made.

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

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

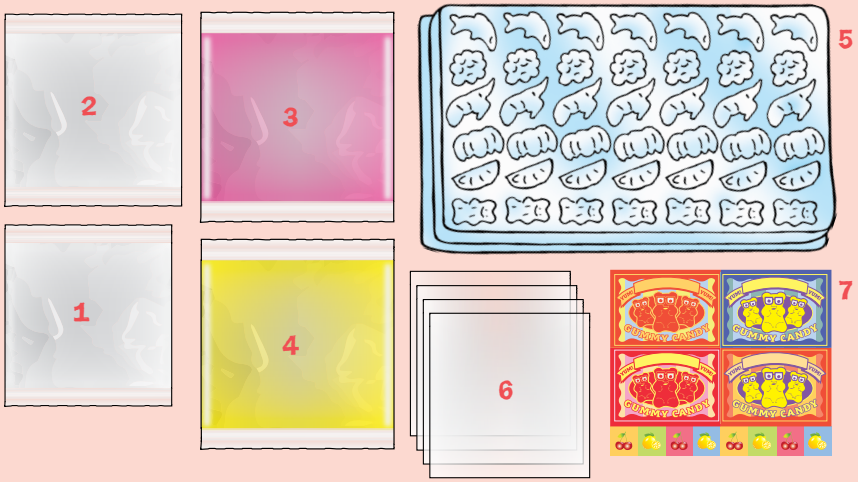
To keep the mold in this kit in good condition, it should always be washed by hand and not in the dishwasher. The high temperatures used in a dishwasher might deform the plastic mold.

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 hope you and your young candy maker have lots of fun with this kit!

NOTE! *The additionally required items are highlighted in italic script in the individual experiments. Before starting the experiments, carefully read through everything that will be required and make sure to have all the materials ready.*

KIT CONTENTS



1 | Sour mixture (Net Wt. 33.6 g/1.18 oz)
2 | Seaweed powder (Net Wt. 50 g/1.76 oz)
3 | Cherry flavoring and sugar mixture (Net Wt. 80 g/2.82 oz)
4 | Lemon flavoring and sugar mixture (Net Wt. 80 g/2.82 oz)
5 | Plastic gummy candy mold
6 | Plastic storage bags (4)
7 | Sticker sheet with labels

For the ingredient lists, see the inside front cover.

TO MAKE THE GUMMIES, YOU WILL ALSO NEED: *Water, measuring spoons, microwave-safe container or cooking pot, spoon, toothpick or fork*
FOR SOME EXPERIMENTS, YOU WILL ALSO NEED: *Drinking glass or jar, measuring cup, food coloring, tablespoon and teaspoon, microwave-safe plates, small red cabbage, knife, cooking pot, strainer, bowl, baking powder, pencil, kitchen string, granulated sugar*
KITCHEN EQUIPMENT: *You will need a microwave, stove, sink, and a regularly equipped kitchen. Read through each experiment to make sure you have everything you need for the experiment.*

Hey Gummy Scientists!

Want to make yummy gummy candy treats and learn some physical science while you're at it? Then let's get started! After you've made your gummy shapes, you can wrap them in a plastic bag and label it with the included labels. Then you can give them to your family and friends! Gumbi the Geeker will be your guide!

PART 1

MAKE YOUR OWN GUMMY CANDIES

Follow these instructions to make one batch of gummies in one flavor.

You will need:

Seaweed powder, cherry or lemon flavoring and sugar mixture, plastic gummy candy mold, sour mixture, plastic storage bags, stickers, *scissors, measuring spoons, water, microwave-safe container or cooking pot, toothpick or fork*

Here's how:

1. Cut a corner off of the seaweed powder packet. Mix half of the seaweed powder (about 2 tablespoons and 2 teaspoons) with a quarter of a cup of water in a microwave-safe container or cooking pot. Stir the mixture well. Don't worry about lumps as they will dissolve when heated.
   Microwave: Heat the mixture in a microwave-safe container until it foams up (about 2 minutes at high power).
   Stove: Heat the mixture in the cooking pot on medium heat until the mixture foams up, stirring occasionally. Remove from heat.

2. Cut a corner off of a flavoring and sugar mixture packet. Stir half of the mixture (about 3 tablespoons) into the hot mixture of seaweed powder and water.

NOTE!

There is enough flavoring and sugar mixture to make either two batches of cherry- or lemon-flavored gummies, or a single batch of each flavor. To make two batches of one flavor at one time, use all of the dry ingredients (80 grams of one of the flavoring and sugar mixtures and 50 grams of seaweed powder) and use twice the amount of water (a half cup). There will be extra flavoring and sugar mixture left over in both cases, which can be used in the rock candy experiment.

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

Here's how it continues:

3 Put the mixture back onto the heat or in the microwave for about 1 minute, or until it foams up again. Stir the mixture well.

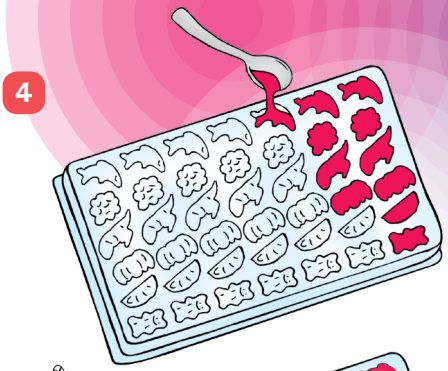
4 Pour the mixture into the impressions in the plastic tray. Let the gummies cool in the refrigerator for at least 10 minutes. If the mixture becomes too solid, heat it up again in the microwave for a few seconds.

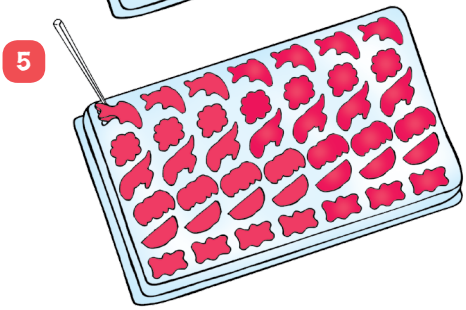
5 After the gummies have solidified, remove them from the mold using a toothpick or fork. Do not bend the plastic tray to remove the gummies.

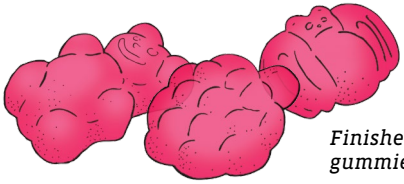
6 If you want to make your gummies into sour gummies, cut the corner off of the sour mixture packet and place the gummies and half of the sour mixture (about 1 tablespoon and 1½ teaspoons) together into a plastic bag. Shake the bag to coat with the sour mixture. If the sour mixture is too sour, add sugar. Save a small amount (about 2–3 grams) of the sour mixture for Experiment 5.

7 Place the gummies in a plastic bag. Close the bags using a sticker from the sticker sheet. Store the gummies in the plastic bags in the refrigerator. Consume the gummies within one week.

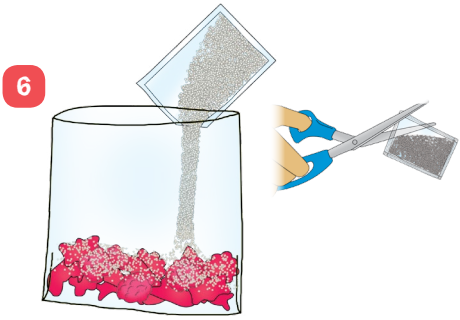
If you made one batch, now make the second batch with the other flavor!

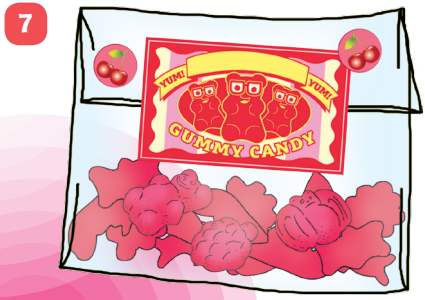






Finished gummies!





PART 2

GUMMY EXPERIMENTS

Now that you have made your gummies, do you think there is a way to remove the flavoring and sugar from the gummies while still keeping them intact?

1. Removing the color from gummies

You will need:

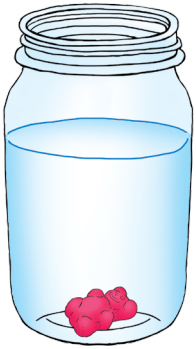
A gummy shape, *a drinking glass or jar, water*

Here's how:

1. Fill a glass or jar with 150 mL of water (about two-thirds of a cup) and place the gummy into the water.
   What do you think will happen to gummy when you place it in the water?

2. Let the cup or jar sit in an out-of-the-way location for a day. Remove the gummy from the water and record what happened to the gummy on a piece of paper.

Safety Note: Do not eat the gummy candy after this experiment, because it has been sitting unrefrigerated in water for a day. As a rule, never eat or drink materials with which you conduct science experiments.



GEEK OUT!

WHAT'S HAPPENING?

From your experiment you found that leaving the gummy in water turns the gummy clear, and the red coloring and sugar spread out into the water. This is because the universe has a natural tendency to go from order to disorder. This is why after cleaning up your room it gets messy again within a few days!

So, the colored flavoring in your gummy will spread out from inside the gummy where there is a lot of flavoring (ordered) into the water where there is no flavoring (disordered). This process is called **diffusion.**

2. Measuring volume

You will need:

Gummy candy mold, *measuring cup, food coloring, spoon, tablespoon and teaspoon*

Here's how:

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

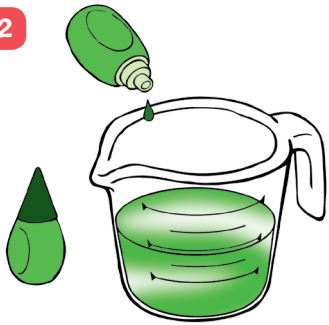
2. Add two drops of food coloring. The purpose of the food coloring is only to make the water easier to see.

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 liquid your mold holds.
   How much water does it hold?
   How might you calculate how much water each cavity holds?

1

2



3

GEEK OUT!

WHAT'S HAPPENING?

The gummy candy mold holds about two-thirds of a cup of liquid. To calculate the volume of each cavity, you could use a small measuring spoon to measure each cavity separately, or you could assume each cavity is approximately the same size and divide the total volume by the number of cavities. In science, you can make assumptions but you must always state them.

3. Melting and freezing gummies

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

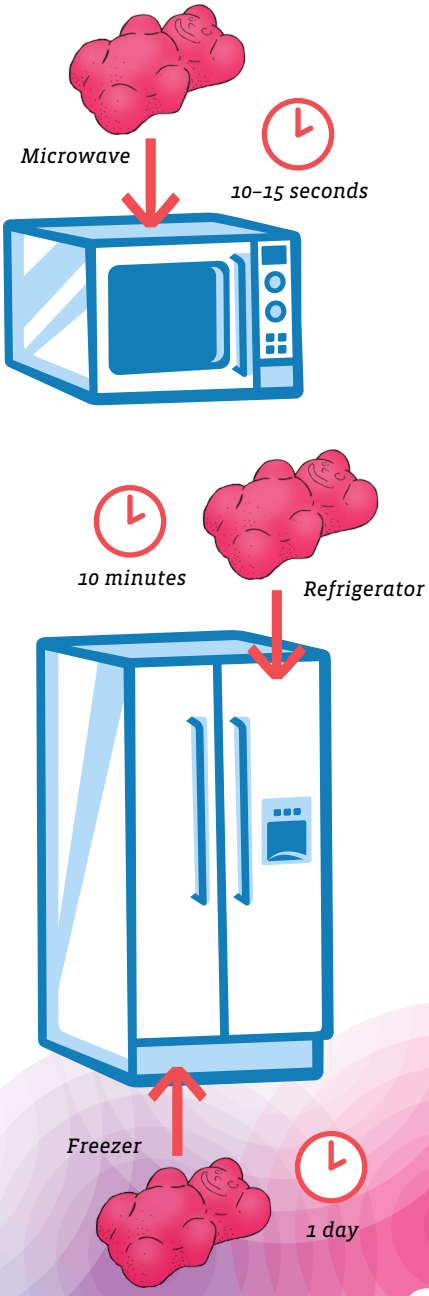
You will need:

Two gummy candies, *two microwave-safe plates*

Here's how:

1. Take one of the gummies and place it on a microwave-safe plate.
2. Place the plate in the microwave for 10–15 seconds.
3. Take the plate out of the microwave. Be careful as the plate may be hot! Record your observations of what happened to the gummy.
4. Place your microwaved gummy into the refrigerator for 10 minutes. Then take it out again. Record your observations again.
5. Take the second gummy and place it on a plate.
6. Place the gummy in the freezer and let it sit there for one day.
7. Take the plate with the gummy out of the freezer. Write down your observations.

How is the gummy able to melt and then reform into a gummy again? See the next page.



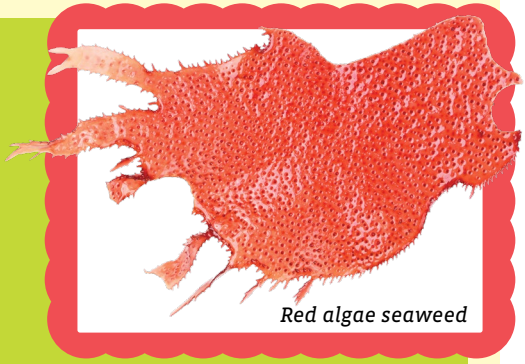
GEEK OUT!

WHAT MAKES GUMMIES GUMMY?

How is the gummy candy able to melt and then reform into a gummy again? It is because of two ingredients in the seaweed powder: carrageenan and agar-agar. They are what make a gummy candy gummy!

CARRAGEENAN

Carrageenan comes from certain types of red algae and contains long molecules that are made up of many repeating parts, like the links of a chain. Each molecule can also connect to other long molecules, forming a web. These molecules are called **polysaccharides.** One key property of this big tangled web of molecules is its ability to hold a lot of water!



Red algae seaweed

Red algae seaweed

When carrageenan is mixed with water it forms what is called a **gel,** or a gelatinous substance. Gels contain mostly liquids, but behave more like solids. When you heat up a gel, the molecules start moving around more which lets them slide past each other more easily. This causes the gel to become more like a liquid. But when you cool the gel back down again, the molecules re-form their web and become more like a solid.

GELATIN

A molded gelatin dessert

Another ingredient that is commonly used to make gels is **gelatin.** Gelatin is made from the bones and connective tissue 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.

Gelatin consists of many long chains of **collagen** molecules. These are different from the long chains of polysaccharides in carrageenan, but they produce similar results.

Parts of a collagen molecule are responsible for its firm structure, while other parts bond with 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.

AGAR-AGAR

Agar-agar is another gelling agent that comes from polysaccharides in red seaweed. In the seaweed plant cells, agar-agar forms part of the cell wall, or the outer protective layer of the cell. Agar-agar molecules form a spiral shape called a double helix.

← Agar-agar powder

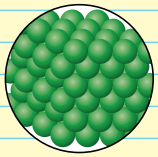
↓ A dessert made with agar-agar

GEEK OUT!

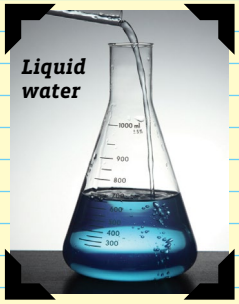
THE PHASES OF MATTER

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.

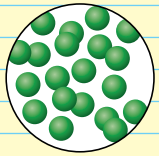


Solid water (ice)

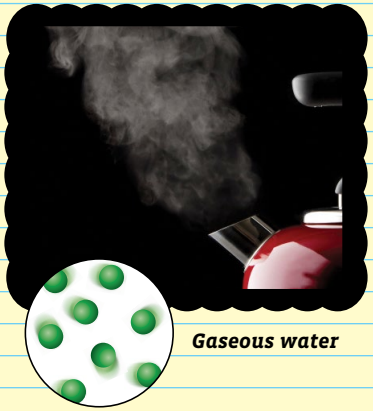


Liquid water

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.



Gaseous water

GEEK OUT!

FREEZING AND MELTING

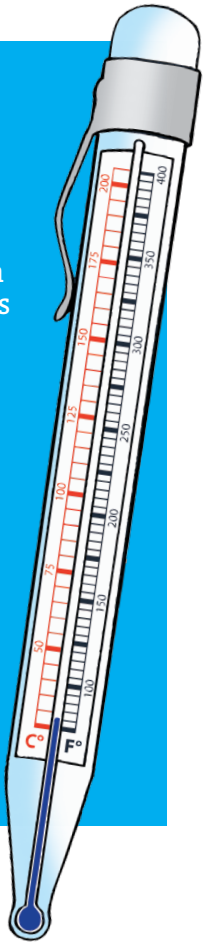
When a liquid **freezes,** it turns to a solid. The temperature at which this happens is called the **freezing point.**

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.

Your gummy shapes are composed primarily of water, sugar, and the gel holding it all together. The gel and sugar have much higher melting points than water, so they are solid at room temperature. While the melting point of gummy candies will vary based on many factors, it is likely to be above 40 °C or 104 °F.

Can you devise an experiment to measure the melting point of your gummy shapes?



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.

PART 2

CHEMISTRY WITH GUMMIES

4. Red cabbage indicator

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

You will need:

Small red cabbage, knife, cooking pot, spoon, water, strainer, glass jar

Here's how:

1. Ask an adult to help you with this experiment.
2. Chop up the leaves of a small red cabbage.
3. Place the chopped cabbage in a cooking pot and add enough water to completely submerge the cabbage.
4. Place the pot on the stove. Set the stove burner to high and bring the contents of the pot to a boil. Let them boil for about 15 minutes. Then, remove it from the heat and let it cool.
5. After the pot has cooled, use the strainer to separate the cabbage from the liquid in the sink, keeping the liquid.
6. Store the liquid in a small, clean glass jar. Attach a label to the jar.

GEEK OUT!

WHAT'S HAPPENING?

In this experiment, you made a purple solution called an **indicator.** You will use this indicator in the next experiment. Red cabbage contains substances called **anthocyanins.** These substances are pigment molecules that change color depending on the acidity of a solution. By cutting up the cabbage and boiling it, you broke down the cabbage tissue that contained the anthocyanins. The anthocyanins were released into the solution, turning the water purple. In the solution, the anthocyanins can easily move around and react to chemicals added to the solution.

5. Sour and bitter

You will need:

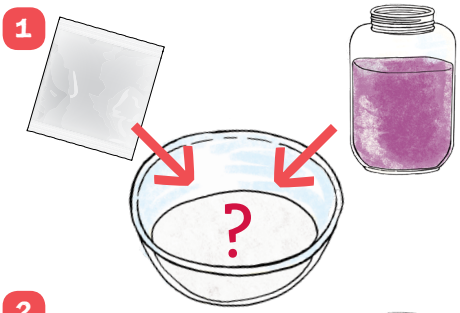
Sour mixture, *water, red cabbage indicator, small bowl, baking powder*

Here's how:

1. Take a pinch (about 2–3 grams) of the sour mixture and mix it in 2 mL of water. Add the red cabbage indicator to the solution. What do you observe?

2. Pour half a cup of water into a bowl and mix in 1 tablespoon of baking soda. Add red cabbage indicator to the solution. What do you observe?

With adult supervision as always, test these other substances from your home with the red cabbage indicator. What do you observe?



GEEK OUT!

WHAT'S HAPPENING?

When red cabbage indicator is added to the sour mixture and water solution, it changes to a red color. The reason the red cabbage solution turns red is because there is **acid** in the sour mixture. The acid in the sour mixture is citric acid, which occurs naturally in citrus fruits like lemons and limes. That is why the sour mixture tastes sour!

When the red cabbage indicator is added to the water and baking soda solution, it turns green. That is because baking soda is a **base.** Bases are slippery to the touch and have a bitter taste. Don't eat the baking soda and water solution — it will not taste good!

GEEK OUT!

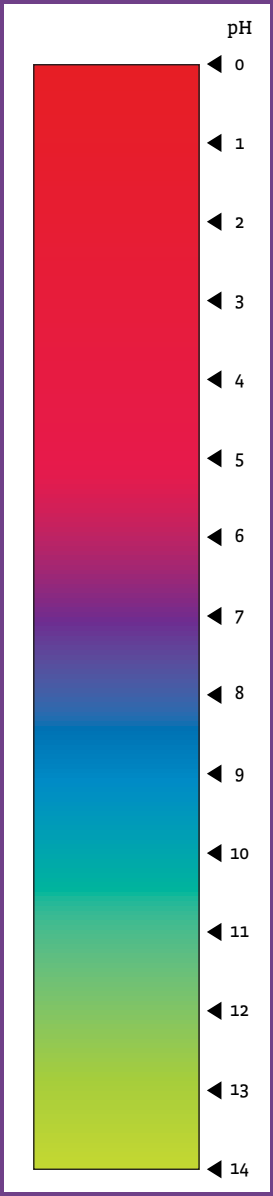
DETECTING ACIDS AND BASES

An **acid** is a substance that gives off hydrogen ions (H^+) when dissolved in water. **Bases** are substances that give off hydroxide ions (OH^-) when dissolved in water. You encounter many acids and bases every day. The vinegar and lemon juice you use to flavor food, the hydrochloric acid in your stomach used to digest food, and the sulfuric acid in car batteries are acids. Baking soda, ammonia, and many household detergents are bases.

How do you know if a liquid is an acid or a base? One way to identify if a liquid is an acid or a base is to use an **indicator.** An indicator will change color if it is placed in an acid or a base. Many plants, such as cherries, violets, blueberries, and black currants contain natural dyes that change color in acids and bases. These dyes are grouped under the name **anthocyanins.**

Chemists use the **pH** system to measure acidic and basic solutions. pH stands for "potential of hydrogen," and the p is lowercase while the H is capitalized. The pH scale goes from 0 to 14. Values below 7 are acidic and values above 7 are alkaline. Pure water has a pH of 7, which is considered **neutral** — neither acidic or alkaline.

As you already learned, red cabbage contains anthocyanins allowing it to be used as an indicator. The image to the right shows how chemicals with different pH levels make red cabbage juice turn different colors — acids make it turn reddish, and bases make it turn more bluish or greenish. It is purple when the pH is 7 and the solution is neutral. This means you can use red cabbage to tell the pH of a substance, which is exactly what you did in this experiment: You added different acids and bases to the cabbage juice, and the juice told you their pH levels by changing color.



6. Rock candy

You will need:

Half of a flavoring and sugar packet, *tablespoon, water, pencil, large glass jar (2-liter volume), kitchen string, cooking pot, granulated sugar*

Here's how:

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

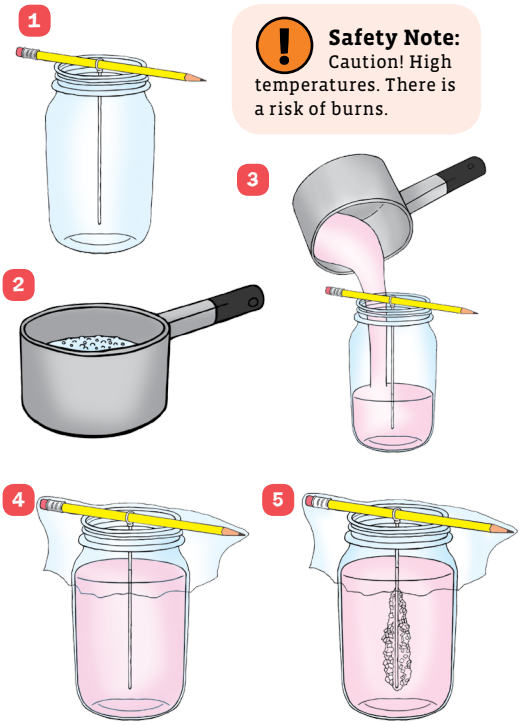
2. Wet the string. Roll it in some of the granulated sugar. Let the string dry.

3. Mix half of a packet of the flavoring and sugar mixture, 4 cups of sugar, and 2 cups of water in a cooking pot. Heat the solution on the stove until it boils.

4. Mix the solution until all of the sugar has dissolved. Remove it from the heat. Pour the solution into the jar.

5. Gently place the string into the solution. Cover the jar loosely with plastic wrap, but do not make it airtight.

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



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

GEEK OUT!

WHAT'S HAPPENING?

You are making what is called a supersaturated solution of sugar and water. Over time, the sugar will adhere to the smaller crystals on the string, forming larger crystals.

TIP!

If the crystals do not form, heat the mixture up again until it boils and add more sugar until no more dissolves in the water. Then replace the string.

GEEK OUT!

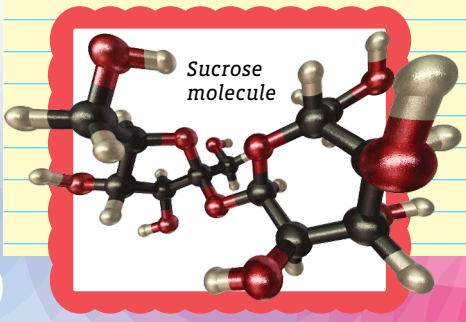
SWEET SCIENCE

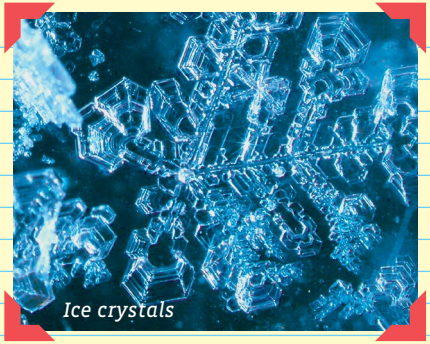
CRYSTALLIZATION

A **solution** is a mixture of substances in which the particles of one substance are evenly mixed with the particles of the other substance. A solution consists of a **solute,** the substance that is dissolved, and a **solvent,** the substance that dissolves the solute.

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.




Ice crystals

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.

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.

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First aid information

Advice in case any accidents should happen during experimentation.

1. In case of burns: Wash affected area with plenty of water for at least 10 minutes.
2. In case of doubt or larger burns, seek medical advice without delay.
3. **In case of injury (e.g. cuts)** always seek medical advice.

Nutrition facts for the remaining flavoring and sugar mixture packet:

Nutrition Facts

Serving Size (6g)
Servings Per Container : 14

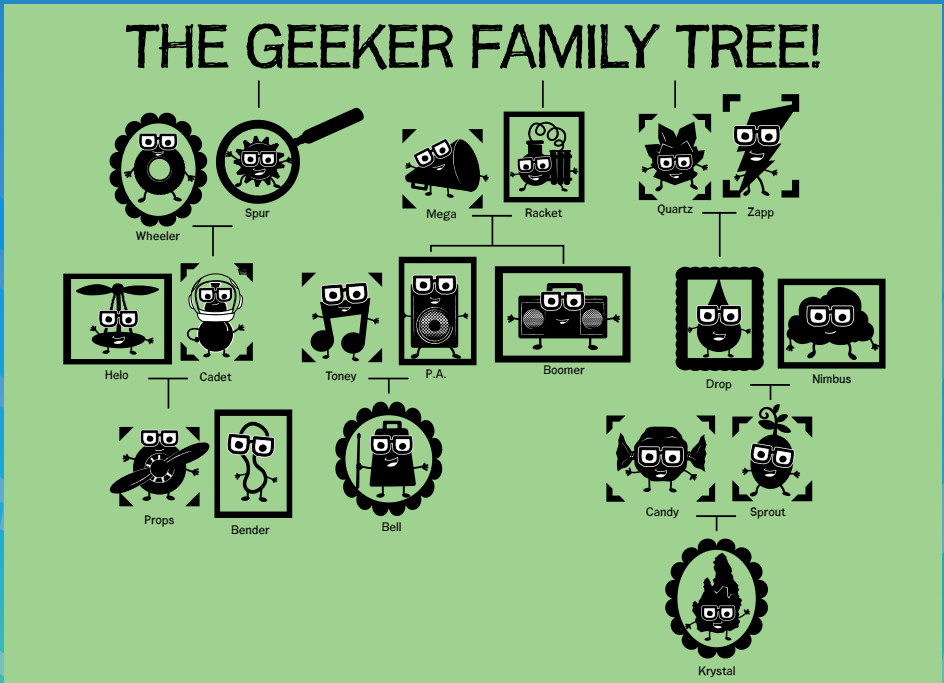
Amount Per Serving	
Calories 25	Calories from Fat 0
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Total Carbohydrate 6g	**2%**
Dietary Fiber 0g	**0%**
Sugars 5g	
Protein 0g	

Vitamin A 0%	• Vitamin C 0%
Calcium 0%	• Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4



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