GEEK & CO. SCIENCE!

PROJECT KIT

Ages 8+

CHeWiNG GUM LAB

IN COLLABORATION WITH GLEE gum

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.

Franckh-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 301 Friendship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com
Thames & Kosmos UK Ltd, Goudhurst, Kent, TN17 2QZ, United Kingdom | 01580 212000 | www.thamesandkosmos.co.uk

THAMES & KOSMOS

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 gum pieces should be wrapped in the wax paper wrappers or plastic wrap before labeling them with the stickers or placing them in the metal tin.
All of the metal parts should be cleaned by hand before use.

Ingredients

Chewing gum base: Natural rubber, calcium carbonate, hydrogenated soybean oil, soybean lecithin, vegetable oil, beeswax, carnauba wax. Contains soy.

Powdered Sugar: Sugar, food starch

Corn Syrup: Corn syrup

Natural Cherry Flavor: Natural flavors

Natural Grape Flavor: 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. Clean the work surface carefully after you are finished and always wash your hands thoroughly — before and after you work.
9. 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.
10. 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 chewing gum 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, cutting, packaging, and storage of the chewing gum. Your own chewing gum might not keep as long as commercially available chewing gum, which generally is not required by law to be labeled with an expiration date. Write the production date on the packaging.

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.

Make sure that you wrap the gum pieces completely in the wax paper wrappers before labeling them with the stickers or storing them in the metal tin.

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 gum 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	Gum base (Net Wt. 56 g/1.97 oz)
2	Powdered sugar (Net Wt. 70 g/2.47 oz)
3	Corn syrup (Net Wt. 60 g/2.12 oz)
4	Natural cherry flavor (Net Wt. 6 g/0.21 oz)
5	Natural grape flavor (Net Wt. 6 g/0.21 oz)
6	Metal tin
7	Wax paper sheets (15)
8	Sticker sheets for gum (2)
9	Sticker sheet for tin

For the ingredient lists, see the inside front cover.

TO MAKE THE GUM, YOU WILL ALSO NEED: *Scissors, microwave-safe container, water, cup or bowl, cutting board or flat work surface, spoon, scissors or knife*

FOR SOME EXPERIMENTS, YOU WILL ALSO NEED: *Two glass jars or drinking glasses, paper, pen, tape, tissue paper or paper towels, kitchen scale, clean rubber band*

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 Gum Makers!

Want to make delicious chewing gum and learn some physical science while you're at it? Then let's get started! After you've made your gum pieces, you can wrap them in wax paper wrappers and pack them in a metal tin. Decorate the wrapped gum and tin with sticker labels. Then you can give them to your family and friends! Candy the Geeker will be your guide!

PART 1

MAKE YOUR OWN CHEWING GUM

Mixing the gum

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

You will need:

Gum base, powdered sugar, corn syrup, flavor packet, *scissors, microwave safe container, water, cup or bowl, cutting board or flat work surface, spoon, scissors or knife*

Here's how:

1. An adult should supervise this activity, especially when hot water and sharp knives are involved.

2. Soften the corn syrup by placing the packet of corn syrup into a cup or bowl and covering it with boiling water. Handle the boiling water with caution.

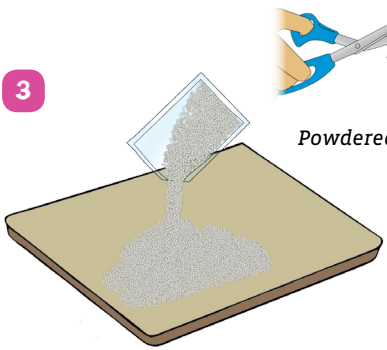
3. Cut a corner off of the powdered sugar packet. Dust a cutting board or flat work surface with a small amount of the powdered sugar. This will make handling the gum easier later.

4. Cut open the packet of gum base. Divide the gum base into equal halves (28 grams each). One half will be used for each flavor.

2

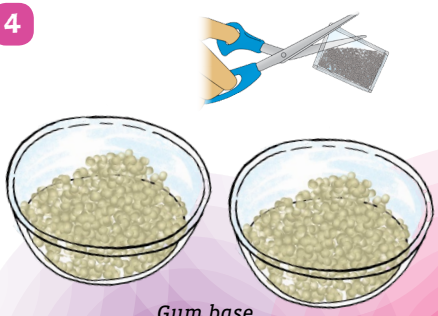
Corn syrup packet

3



Powdered sugar

4



Gum base

Here's how it continues:

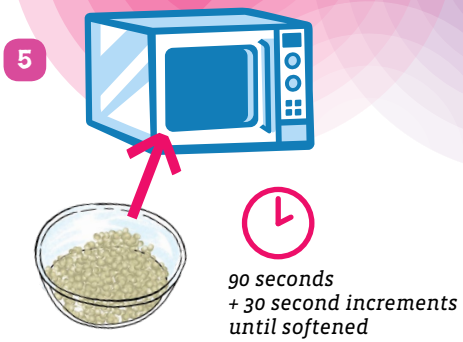
5 Heat half of the gum base in a microwave-safe container. The sticky gum base will leave a residue that will be difficult to clean out of the container, so you may want to use a disposable container if you do not want to spend the time cleaning it. Start with one and a half minutes (90 seconds) at high power and then check to see if the gum base has softened. Continue to microwave the gum base in 30 second increments until the gum base has melted into a thick gooey liquid. This may take up to five minutes in the microwave. Be careful removing the tray from the microwave as it is hot.

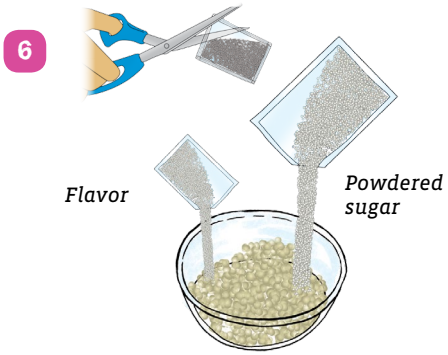
6 Cut the corner off of one of the flavor packets. Pour all of the flavor powder and about half of the powdered sugar onto the melted gum base.

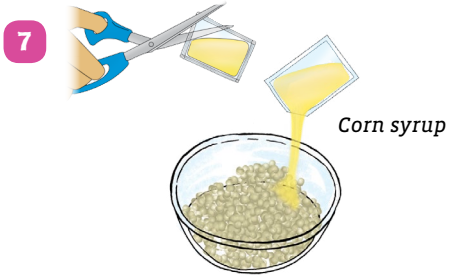
7 Cut the corner off of the corn syrup packet. Pour half of the corn syrup onto the melted gum base.

8 Mix everything together with the spoon. The mixture will become very sticky. As it cools, the gum base will also become more solid.

TIP!
To clean the spoon and container after the experiment, use hot water to melt the gum base again.





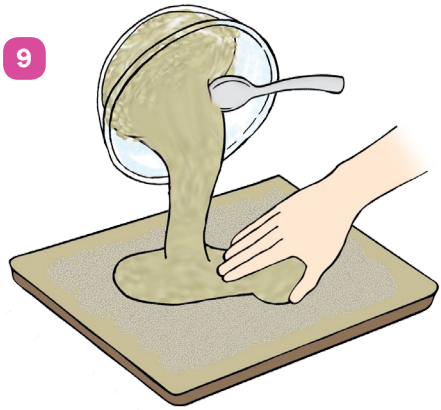


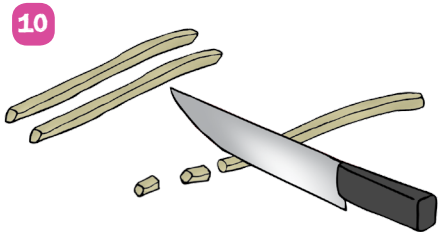
Here's how it continues:

9 Spoon the mixture onto your prepared work surface. Knead the gum for a few minutes by stretching it and flattening it out, and then folding it over, repeatedly.

10 Roll the gum between your hands into a six- to eight-inch-long and half-inch-thick cylinder. (The longer and thinner the cylinder, the smaller the pieces of gum will be.) Use scissors or a knife to cut the gum into small pieces.

Repeat steps 5–10 to make the second flavor of gum. Continue to the next page for instructions on wrapping and labeling your gum.





GEEK OUT!

WHAT'S HAPPENING?

The gum base is a solid at room temperature. It is made of long molecular chains called polymers that are all intertwined like a bowl of noodles. When you heat up the gum base, you add energy to these molecules. With more energy, the molecules start to vibrate around more. This vibration allows the long chains to untangle from each other a little, and move around more freely. This is how the gum softens up and becomes fluid like a liquid. In this liquid state, it is easier to mix in the other ingredients that sweeten and flavor the gum. When the gum hardens again, the sweetener and flavoring is now mixed throughout the gum.

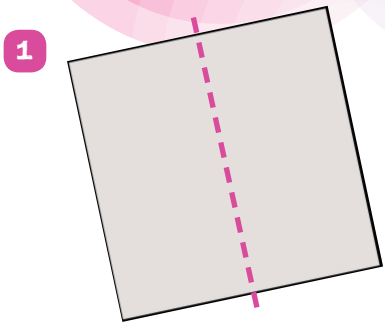
Wrapping your gum

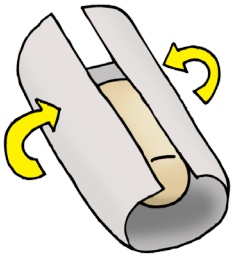
You will need:

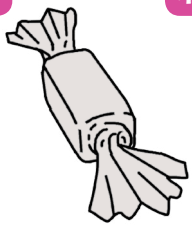
Wax paper, gum pieces, sticker sheet, metal tin, *scissors*

Here's how:

1. Cut the wax paper pieces in half to make 30 wrappers for your gum pieces. Save a piece of wax paper for Experiment 3.
2. Place a piece of gum in the center of a piece of wax paper. Fold the wax paper over the piece of gum.
3. Gently twist the sides to enclose the gum.
4. Use a sticker from the sticker sheet to keep the wax paper wrapped around the gum and to decorate your gum.
5. Place a sticker on the top of your tin. You can name your gum creations! Now you can share the gum you made with your friends and family.
6. Save a few pieces of gum for your experiments.

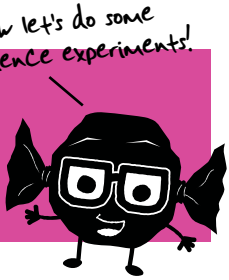






PART 2

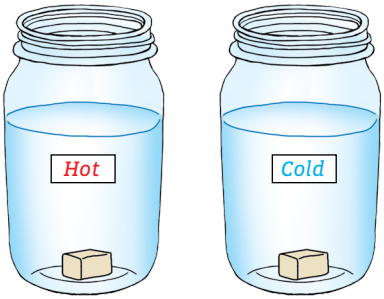
EXPERIMENTS WITH GUM



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

Now that you have made your pieces of gum, let's do some science experiments with them.

1. Removing the flavor from the gum



You will need:

Two pieces of your gum, *two glass jars or drinking glasses, water, paper, pen, tape*

Here's how:

1. Fill one glass jar or drinking glass with hot water and one glass jar or drinking glass with cold water. Label the jars by writing "Hot" and "Cold" with the pen on strips of paper and taping them to the jars.
2. Place one piece of gum in each jar. Let the gum sit for about one day.
3. Remove the pieces of gum from their respective jars. Record your observations.

GEEK OUT!

WHAT'S HAPPENING?

From your experiment, you found that leaving the gum in water removes the flavoring and sugar from the gum, leaving only the gum base. This is because the universe has a natural tendency to go from order to disorder. In physics, the measure of the degree of disorder within a system is called **entropy.** This is why after cleaning up your room, it gets messy again within a few days!

So, the sugar and flavor will spread out from inside the gum where there is a lot of flavoring (ordered) into the water where there is no sugar or flavoring (disordered). This process is called **diffusion.**

2. Finding the volume of a piece of gum

How can you find out how much space something takes up?

You will need:

A piece of gum, *glass jar or drinking glass, water, pen, tape*

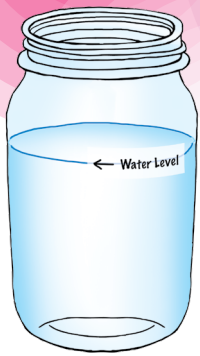
Here's how:

1. Fill the jar or glass with water. Use the tape and pen to mark the top of the water level. Look closely at the surface of the water. You will see it curves up slightly around the sides where it touches the jar. Place your mark at the bottom of the curve in the surface of the water. This curve in the upper surface of a liquid is called the **meniscus.**

2. Drop a piece of gum into the jar. What happens to the water level?

3. Try adding more objects to the jar of water. Observe what happens to the water level when you add them.

1



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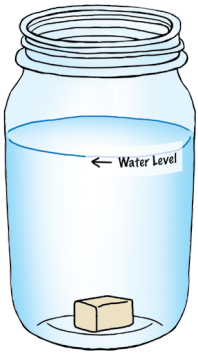


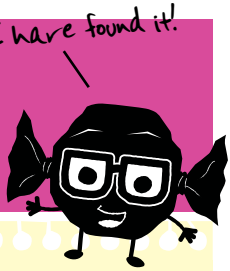
GEEK OUT!

WHAT'S HAPPENING?

When you place the gum into the jar, the water level rises. The water is displaced by the gum, causing the water level to rise. The amount of water appears to increase, but really it is the same amount of water as before, only now it is pushed up by the gum. The amount that the water appears to increase is actually equal to the amount of space that the gum takes up. This amount is called the **volume.**

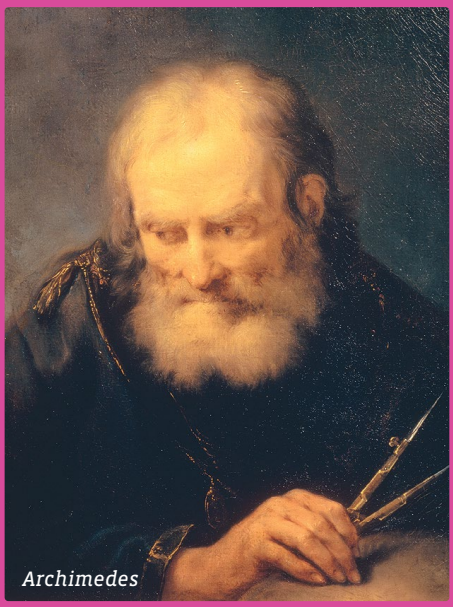
GEEK OUT!

EUREKA!



There is a story that the Ancient Greek scholar Archimedes was taking a bath and noticed that the deeper he sank into the bath, the higher the water level rose. He realized that he had discovered a way to measure the volume of an object. Archimedes was said to have been so excited by his discovery that he leapt out of his bathtub and ran through the streets of Syracuse yelling, "Eureka! Eureka!" which is Ancient Greek for "I have found it."

Archimedes then used this knowledge to find out if the crown of the king of Syracuse was pure gold. He did this by comparing the amount of water that was displaced by the crown and the amount of water that was displaced by a bar of pure gold that had the same weight as the crown. If the crown and the bar of gold were made from different materials, most likely they would have different **densities.** Two objects of the same weight but with different densities would have different volumes, and therefore displace different amounts of water. If a crown and a bar of pure gold have the same weight and the same volume, then they must have the same density. Eureka!



Archimedes

3. Weighing gum

Which do you think will weigh more: an unchewed piece of gum or a chewed piece of gum? Why?

You will need:

One or two pieces of gum (weighing about 5-8 grams total), piece of wax paper, *tissue paper or paper towels, digital kitchen scale or postage-stamp scale*

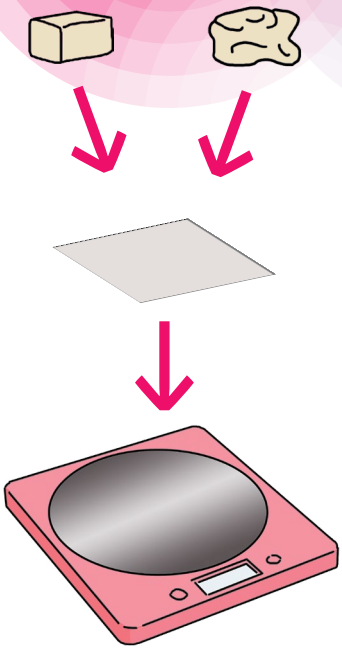
Here's how:

1. Turn on the scale. Place a piece of wax paper, or tissue paper or paper towel, on the scale. Press the tare button to zero the scale so that it is ready to weigh the gum.

2. Place the gum on the scale. Record the weight of the unchewed gum on a piece of paper.

3. Chew the gum for about five minutes.

4. Weigh the gum again and record the weight of the chewed gum. What happened to the weight of the gum after you chewed it? Why?



GEEK OUT!

WHAT'S HAPPENING?

As you found in the dissolving gum experiment, water pulls the sugar and flavoring out of the gum leaving only the gum base. Since saliva is 99.5% percent water, the same thing is happening here! The ability of water to remove the sugar and flavoring from gum is how you are able to taste the flavoring in gum.

4. Rubber bands and chewing gum

You will need:

A clean rubber band (a thick flat rubber band works best)

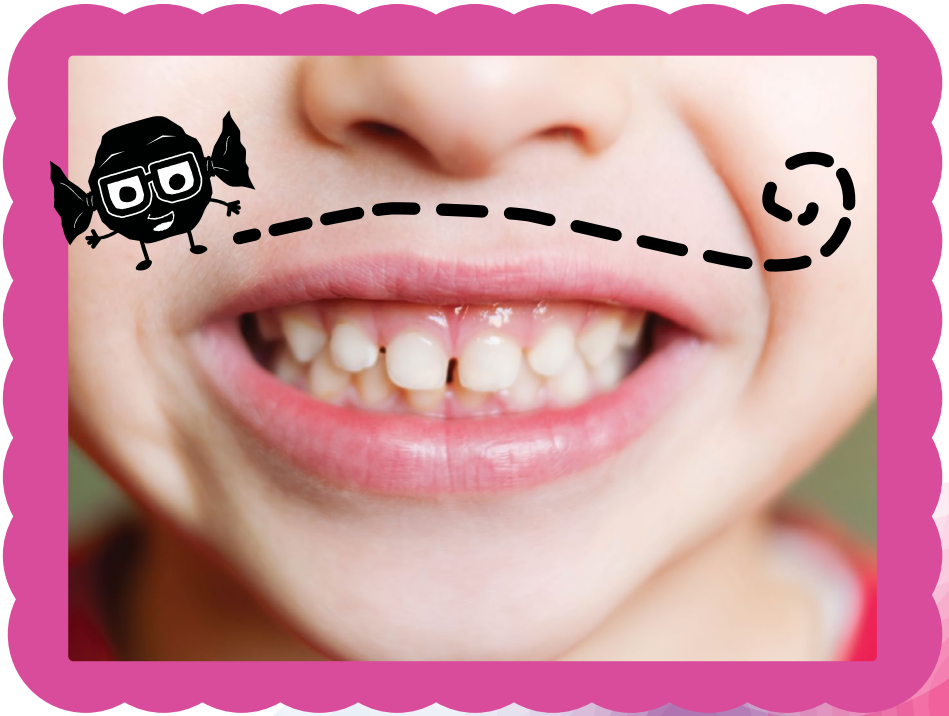
Here's how:

1. Hold the rubber band flat on the top edge of your lips, and then stretch the rubber band. Repeat a few times.
   What do you notice?

GEEK OUT!

WHAT'S HAPPENING?

When you stretch the rubber band, you can feel it heat up a little bit. Your lips are very sensitive to heat, so they can feel this small increase in heat. Heat is generated because the rubber band contains long molecules called **polymers,** which are all tangled up in a web like spaghetti — just like gum! When you stretch the rubber band, the molecules slide past each other and they generate heat as they do this. Chewing gum is a form of natural or synthetic rubber.



GEEK OUT!

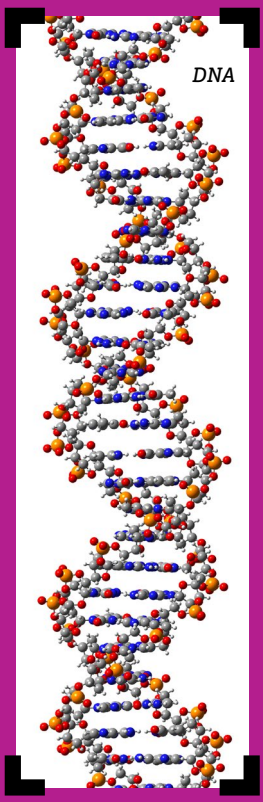
ALL ABOUT POLYMERS

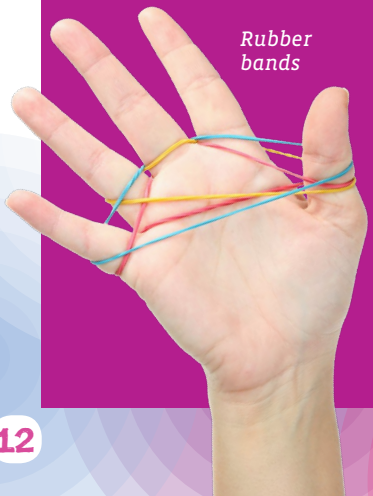
How are rubber tires, granulated sugar, and wool similar? They are all made up of **polymers!**

Polymers are long molecules that are made up many repeating parts, like a chain with many chain links. Small changes in these repeating units, the links of the chain, are what create such different materials. This illustrates a common theme in chemistry: Small changes in a molecule's structure can result in big changes in the properties of a substance made up of that molecule.

There are two general types of polymers: natural polymers and synthetic polymers. A very important example of a natural polymer is deoxyribonucleic acid, or DNA. DNA stores all the biological information about a living thing. So, polymers are essential for living things!

Synthetic polymers are made by humans using natural raw materials including oil, coal, natural gas, minerals, and plants.


DNA


Rubber bands


Industrial plastic granules in a factory

GEEK OUT!

NATURAL GUM FROM A TREE

Most chewing gum today is made from synthetic rubber, but some chewing gum is still made from natural rubber.

Natural chewing gum uses a gum base called **chicle,** which is harvested from trees in the *Manilkara* genus, including *Manilkara zapota* and *Manilkara chicle*. These trees are native to Central America and grow in tropical and sub-tropical climates.

The gum is harvested from these trees using zig-zag or diagonal gashes in the tree trunk, out of which liquid gum oozes. The dripping gum is collected in small bags or buckets. The sap is then boiled until it reaches the desired thickness.

Chicle is a natural gum which contains **polysaccharides,** which are molecules that are capable of increasing a solution's viscosity. They are used as thickening agents, gelling agents, emulsifying agents, and stabilizers.

↑ Natural rubber is harvest from a tapped tree.

← A grove of tapped rubber trees.

GEEK OUT!

A BRIEF HISTORY OF CHEWING GUM

- There is evidence that prehistoric humans chewed saps and waxes from plants.
- Toothmarks left in birch bark tar suggest people in Finland chewed gum 5,000 years ago.
- The ancient Aztec people in Central America made rubbery glues with natural chicle from trees.
- The ancient Greeks chewed gum made out of the resin from the mastic tree thousands of years ago.
- Native Americans chewed a gum made from the sap of spruce trees. European settlers picked up this practice in the 1800s.
- John B. Curtis created and marketed the first commercial chewing gum in 1848. It was called The State of Maine Pure Spruce Gum.
- In 1850, a sweetened form of paraffin wax was introduced. It soon became more popular than the spruce gum.
- An American named William F. Semple was the first person to patent chewing gum. His gum contained chalk and licorice root. It was not a candy; it was designed to clean teeth and strengthen one's jaw!
- In the 1860s, John Colgan created the first flavored chewing gum. He made gum using extract from balsam trees and sugar. Later on, he made gum from chicle.
- By the early 1870s, chicle was widely used as a chewing gum base and the number of chewing gum products grew rapidly. Some of the first were Adams New York Chewing Gum (1871), Black Jack (1884), and Chiclets (1899).
- In the early 1900s, synthetic gum started replacing natural chicle.
- By the mid-1900s, gum manufacturers switched to a synthetic rubber made from butadiene because it lasted longer and was less expensive than natural chicle. Butadiene-based gum is still the most common type of gum made today.

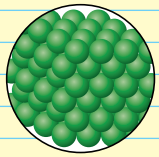
Gum brands from the past several decades.

GEEK OUT!

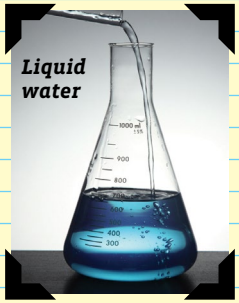
THE PHASES OF MATTER

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.

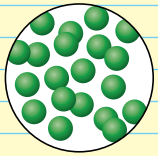


Solid water (ice)

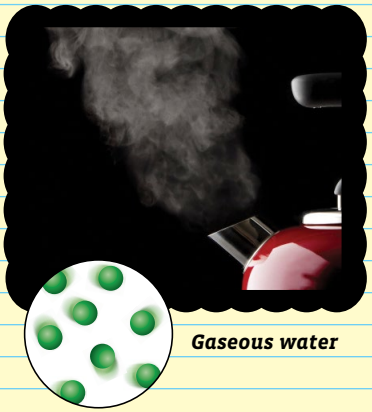


Liquid water

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!

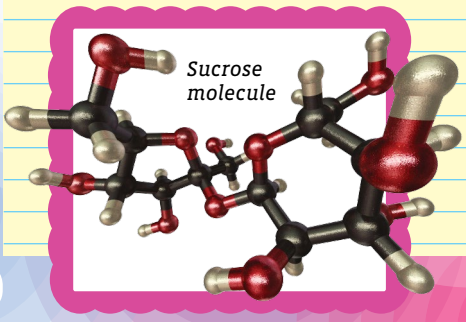
HOW SWEET IT IS: SCIENCE

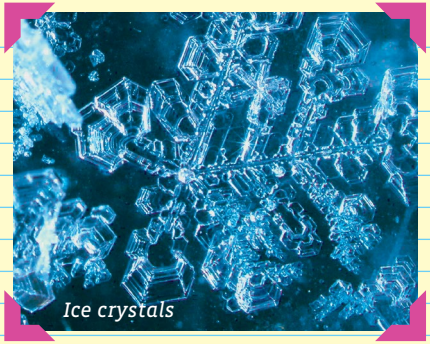
CRYSTALLIZATION

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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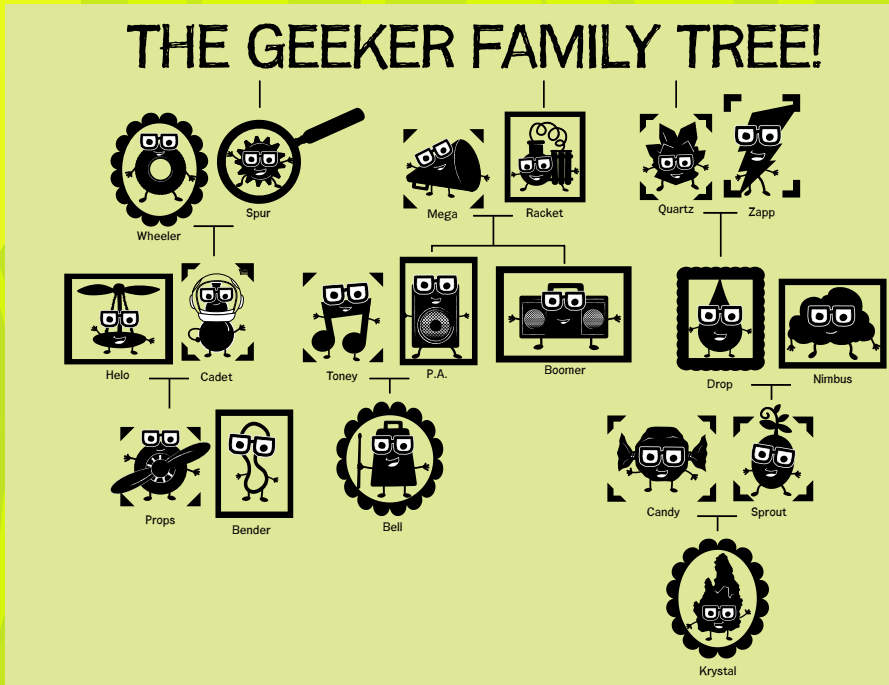
First aid information

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.



Original concept: Deborah Schimberg, Verve, Inc. (Makers of Glee Gum), Providence, RI
Technical product development and project management: Ben Britton, Christa Cronin
Manual writing and editing: Ted McGuire and Camille Duhamel
Manual layout and artwork: Ted McGuire, Dan Freitas

Manual photos: p. 5 (plastic spaghetti) Grigorios Moraitis, iStockphoto.com; p. 9 (Archimedes) public domain image; p. 11 (smile) Carlos Gomez Bové, iStockphoto.com; p. 12 (DNA) chromatos, iStockphoto.com; p. 12 (plastic granules) AppleEyesStudio, iStockphoto.com; p. 12 (hand) serezniy, iStockphoto.com; p. 13 (all) wuttichok, iStockphoto.com; p. 14 (gum) nmsamore, iStockphoto.com; p. 15 (all photos) iStockphoto.com; p. 16 (ice crystal) yellowcloud CC-BY-2.0 flickr.com; p. 16 (sucrose) iStockphoto.com
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Distributed in North America by Thames & Kosmos, LLC. Providence, RI 02903
Phone: 800-587-2872; Web: www.thamesandkosmos.com

Distributed in United Kingdom by Thames & Kosmos UK, LP. Goudhurst, Kent TN17 2QZ
Phone: 01580 212000; Web: www.thamesandkosmos.co.uk

We reserve the right to make technical changes.

Printed in USA / Imprimé aux États-Unis

550023-03-230516
POR2L001D2216