EXPERIMENT MANUAL

Ooze Labs BIG BOX OF SCIENCE

Please observe the safety information, first aid information, information about hazardous substances, and poison control information on the inside front cover; the advice for supervising adults on page 2; and the safety rules on page 3.

WARNING. Not suitable for children under 6 years. For use under adult supervision. Read the instructions before use, follow them and keep them for reference.

WARNING — Chemistry Set. This set contains chemicals and/or parts that may be harmful if misused. Read cautions on individual containers and in manual carefully. Not to be used by children except under adult supervision.

THAMES & KOSMOS

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Thames & Kosmos, 89 Ship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com

››› SAFETY INFORMATION

Safety Information

- ››› **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.

First Aid Information

- ››› In case of eye contact: Wash out eye with plenty of water, holding eye open. Seek immediate medical advice.
- ››› If swallowed: Wash out mouth with water, drink some fresh water. Do not induce vomiting. Seek immediate medical advice.
- ››› In case of inhalation: Remove person to fresh air.
- ››› In case of skin contact and burns: Wash affected area with plenty of water for at least 10 minutes.
- ››› 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 clean, dry first-aid bandage. Foreign objects (e.g. glass splinters) should only be removed by a doctor. Seek the medical advice if you feel a sharp or throbbing pain.
- ››› In case of doubt, seek medical advice without delay. Take the chemical and/or product together with the container with you. For household substances, take the retail packaging with you.
- ››› In case of injury always seek medical advice.

Poison Control Centers (United States)

In case of emergency, your nearest poison control center can be reached everywhere in the United States by dialing the number:

1-800-222-1222

Information about Hazardous Substances

None of the substances in this kit are classified as hazardous substances in the quantities included and the applications presented in this kit. However, you must read these safety instructions before use, follow them, and keep them for reference.

WARNING. The following applies to all chemicals:

- Do not inhale or ingest.
- Wash hands thoroughly after handling.
- Use only as instructed. Read cautions in this manual carefully.
- Store locked up. Keep out of reach of children. This primarily applies to young children, but also to older children who — unlike the experimenter — have not been appropriately instructed by adults.

The following applies to all powdered chemicals:

- Do not get in eyes, on skin, or on clothing.
- Avoid breathing dust.

Also follow this precautionary statement:

- IF SWALLOWED: Get immediate medical advice/attention and have product container or label of chemical substance at hand.

Here is information specific to each chemical in this kit:

• Glow-in-the-dark slime powder (Ingredients: Locust bean gum, guar gum, silica, sodium phosphate, sodium benzoate, glow-in-the-dark color pigment)

• Thermocolor slime powder (Ingredients: Locust bean gum, guar gum, silica, sodium phosphate, hypercolor dye, sodium benzoate, color pigment

• Instant Snow powder (Ingredients: Sodium polyacrylate (superabsorbent polymer))

• Quicksand Oozebleck powder (Ingredients: Corn starch)

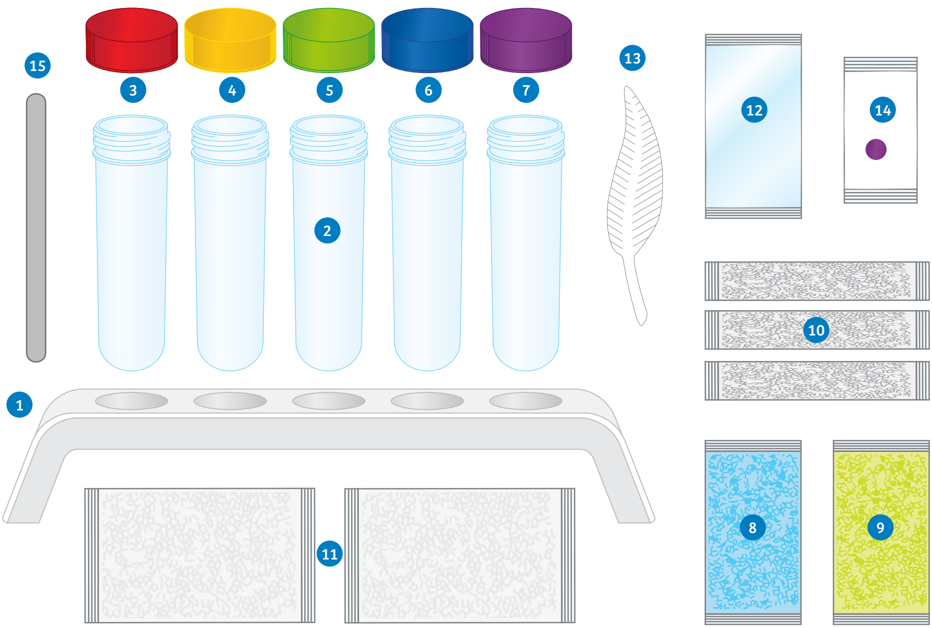
•Purple dye tablet (Ingredients: Food coloring)

• “Magic Water” Crystal solution (Ingredients: Aqueous solution of Potassium dihydrogen phosphate (KH_2PO_4))

How to dispose of waste: Leftover chemicals and materials can be placed in the household trash.

››› KIT CONTENTS

What's inside your experiment kit:



Checklist: Find – Inspect – Check off

✔	No.	Description	Qty.	Item No.
❍	1	Test tube rack	1	724455
❍	2	Large test tubes	5	717120
❍	3	Red test tube lid	1	717686
❍	4	Yellow test tube lid	1	717690
❍	5	Green test tube lid	1	723159
❍	6	Blue test tube lid	1	717111
❍	7	Purple test tube lid	1	717949
❍	8	Thermocolor slime powder (7 g / 0.24 oz)	1	717710
❍	9	Glow-in-the-dark slime powder (7 g / 0.24 oz)	1	717691
❍	10	Instant snow powder (5 g / 0.17 oz)	3	721616
❍	11	Corn starch (10 g / 0.35 oz)	2	723163
❍	12	Crystal solution ("Magic Water") (20 g / 0.70 oz)	1	706185
❍	13	Die-cut paper feather	1	719150
❍	14	Purple dye tablet	1	775714
❍	15	Spatula	1	722970

Do you have any questions?
Our tech support team will be glad to help you!
USA: support@thamesandkosmos.com
or 1-800-587-2872
UK: support@thamesandkosmos.co.uk
or 01580 713000

Some of the parts are packed inside the test tubes. Please check all of the test tubes for the parts.

Any materials not included in the kit are marked *in italics* under the "You will need" heading at the beginning of each experiment.

You will also need: *Water, scissors, permanent marker, cooking pot, shallow bowl or pan, paper towels, spoon, big plastic tub, dropper (pipette), measuring cup, food coloring, 6 plastic cups, sugar, red cabbage, empty jelly jar, lemon juice, household vinegar, baking soda, olive oil or vegetable oil, liquid dish detergent*

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Advice for Supervising Adults

With this experiment kit, you will be accompanying your child on an introductory exploration of the fascinating world of chemistry. Please support your child in his or her first chemistry experiments and help him or her with both advice and in physically performing experimental steps when help is needed.

Please read and follow these instructions as well as the safety rules, the first aid information, and the information regarding the safe handling of the chemicals. Please keep this information for reference.

A. This chemical toy is not suitable for children under 6 years. For use under adult supervision. Keep this chemical toy set out of reach of children under 6 years old.

B. Read and follow these instructions, the safety rules and the first aid information and keep them for reference.

C. Incorrect use of chemicals can cause injury and damage to health. Only carry out those activities which are listed in the instructions.

D. Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which activities are suitable and safe for them. The instructions enable supervisors to assess any activity to establish its suitability for a particular child.

E. The supervising adult should discuss the warnings, safety information and the possible hazards with the child or children before commencing the activities. Particular attention should be paid to the safe handling of alkalies, acids and flammable liquids.

F. The area surrounding the activity should be kept clear of any obstructions and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.

G. The working area should be cleaned immediately after carrying out the activity.

››› Emphasize to your child the importance of following all instructions and warnings, and the importance of carrying out only those experiments that are described in this manual. Inform your child, but do not frighten him or her — there's no need for that.

››› Devote special care to information about the safe handling of acids (such as lemon juice and household vinegar) and bases (such as solutions of baking soda or detergents) and to experimenting with hot liquids.

››› A dedicated "laboratory" room will not be necessary for these simple experiments. A sturdy table with a washable, heat-resistant surface is good enough. It should be well lit and ventilated, equipped with a nearby water tap, and not too close to any stored foods. The surroundings should be free of all obstacles. Always get any required equipment and chemicals ready before beginning an experiment. Your child should wear old clothes (or an old smock). After completing the experiments, he or she should pick up and clean the work area and thoroughly wash his or her hands.

››› Be careful not to let the chemicals get into the hands of young children.

We hope you and your child have a lot of fun doing these experiments!

Safety Rules

The first thing a lab researcher does is get an overview of what he or she will be doing in the lab. All of the experiments described in this manual can be performed without risk, as long as you conscientiously adhere to the advice and instructions. Read through the following information very carefully. Think about everything that you will need. Always pay attention to the safety notes that accompany an experiment.

1. Read these instructions before use, follow them and keep them for reference.

2. Keep younger children under the specified age limit and animals away from the activity area.

3. Store chemical toys out of reach of young children.

4. Wash hands after carrying out activities.

5. Clean all equipment after use.

6. Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.

7. Do not eat, drink or smoke in the activity area.

8. Make sure that all containers are fully closed and properly stored after use.

9. Ensure that all empty containers are disposed of properly.

10. Do not allow chemicals to come into contact with the eyes or mouth.

11. Do not replace foodstuffs in original container. Dispose of immediately.

12. Do not apply any substances or solutions to the body.

13. Store this experimental set and the additional materials out of reach of children under 6 years of age, e.g. in a cabinet that can be locked.

14. Carefully prepare your work area for the experiments. Clear off the table and gather everything you will need.

15. Always leave your work area in clean condition. Always pay attention to proper disposal of any residues.

16. Always work slowly and carefully. Do not stir up plaster dust and do not squirt or spill any solutions. If you get something in your eye by mistake, such as a squirt of lemon juice or vinegar, rinse out your eye with plenty of water. Have an adult help you.

17. When experimenting, wear old clothes that can take a little abuse, or wear something over your clothes (such as an apron or old shirt).

18. Take care while handling hot water or hot solutions. Store solutions out of the reach of small children (under 6 years of age).

19. Pay special attention to the quantity specifications and the sequence of the individual steps. Only perform experiments that are described in this instruction manual.

20. Do not use any eating, drinking, or other kitchen utensils for your experiments. Any containers or equipment used in your experiments should not be used in the kitchen afterward.

21. Immediately wipe up any spills with a paper towel to avoid leaving any stains.

22. If chemicals should come in contact with eyes, mouth, or skin, follow the first aid advice (inside front cover of this manual) and contact a doctor if necessary.

23. Handle additionally required items made of glass carefully. Do not use broken test tubes or glassware. Throw away broken test tubes and glassware.

If you have any questions about the experiments, your parents or older siblings will be able to help you.

Now let's get started. Have fun with the experiments!

››› EXPERIMENT 1

Thermocolor slime

YOU WILL NEED

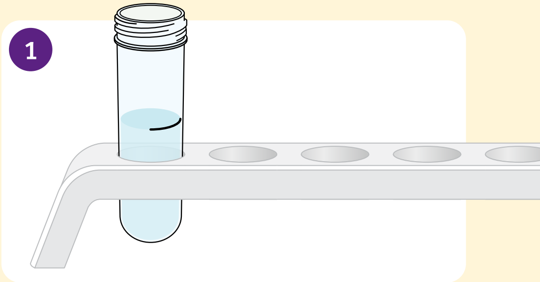
Test tube, lid, packet of thermocolor slime powder, spatula, test tube rack, *permanent marker, room-temperature water, scissors, hot water, pot*

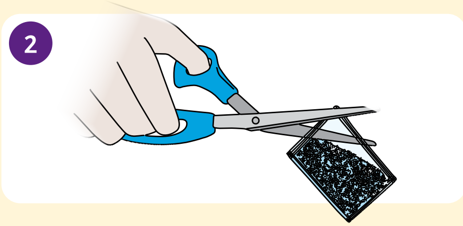
HERE'S HOW

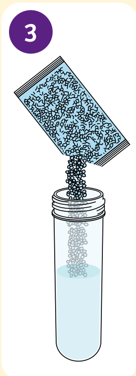
1. Fill the test tube with 75 ml of water. To measure this, use the test tube guide printed on the opposite page to make a mark on the test tube. Fill the test tube up to the line with water. (You can also just eyeball it.) Place the test tube in the test tube rack.
2. Open the packet of powder using a pair of scissors. Do not use your teeth. Do not get any of the powder in your eyes or mouth.
3. Pour all of the powder slowly into the tube and avoid creating airborne dust.
4. Stir the mixture with the spatula.
5. Close the test tube with the lid and shake it for 30 seconds. Let the contents sit, shaking the tube every few minutes, until they have solidified. This takes at least 15–20 minutes.
6. With the slime in the test tube, place the test tube in a pot of hot water. Have an adult help you heat the water safely. Be careful not to burn yourself. Observe the slime for a period of five to ten minutes. What do you notice?

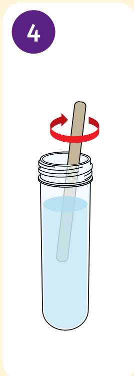
››› EXPERIMENT 2

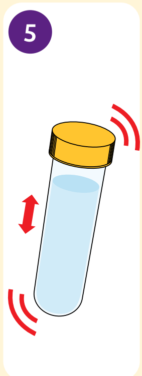
7. Remove the test tube from the hot water, wipe it dry, and place it into the holder. Let the slime cool down to room temperature. What happens when the slime has cooled down? Dispose of the slime after use.

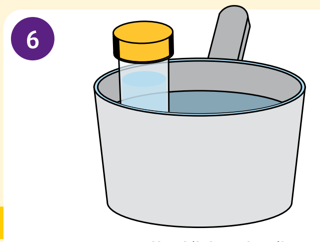






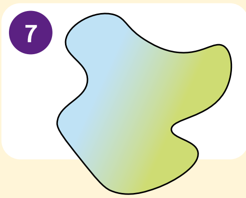






Safety Note: Caution! High temperatures. There is a risk of burns. Adult supervision is required.

TIP: You can use other kitchen utensils, such as large kitchen spoons and rubber bands, to prop up the test tube in the pot.



Disposal: Because it does not contain harmful preservatives, the slime liquefies and disintegrates after four days. Dispose of it in a paper towel in the trash!

CHECK IT OUT

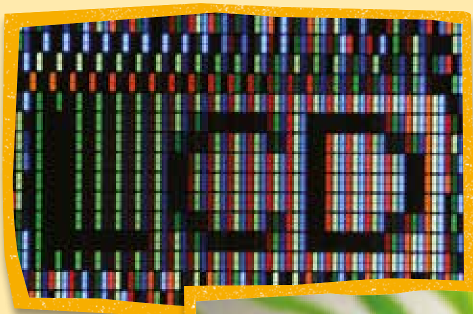
A sensitive slime

The thermocolor slime has a pigment in it that changes color according to heat. A material that changes color due to a change in temperature is called **thermochromic.** A thermochromic material changes color because when it is heated, the way that its molecules absorb and release light changes. This process is reversible because it does not involve a change in the structure of the molecules in the material. This type of change is called a **physical change.** A classic example of a thermochromic material is a mood ring which changes color in response to the wearer's body heat.

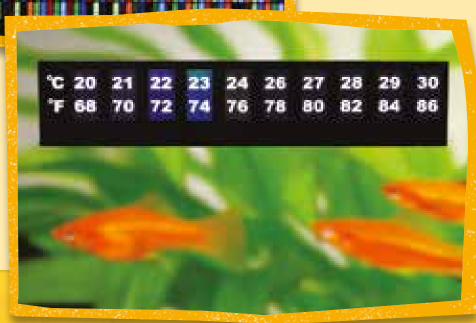
Mood ring

There are two common groups of thermochromic materials: **liquid crystals** and **leuco dyes.** As the name suggests, liquid crystals are materials that are in a state between a liquid and a crystal solid. A common use for liquid crystals is in liquid crystal displays (LCDs), which are used in TVs and computer monitors. Leuco dyes are chemicals that can switch between two different forms, one of which is colorless, depending on exposure to light, heat, or pH.

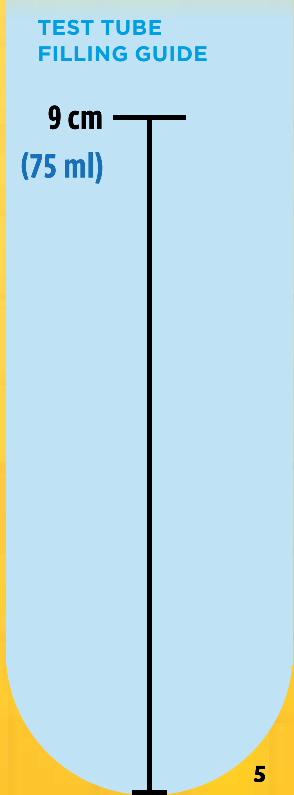
Other examples of thermochromic items are aquarium thermometers, color-changing plastic cups, and clothing made with thermocolor dyes.



LCD screen



Aquarium thermometer



››› EXPERIMENT 3

Glow-in-the-dark slime

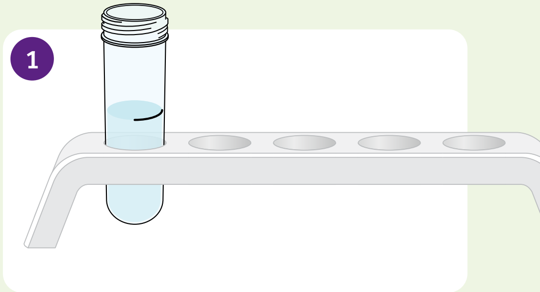
YOU WILL NEED

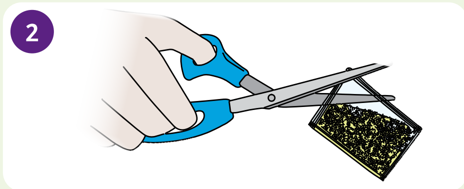
Test tube, lid, packet of glow-in-the-dark slime powder, spatula, test tube rack, *permanent marker, water, scissors*

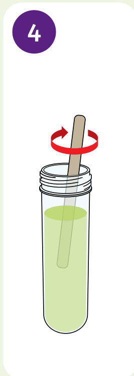
HERE'S HOW

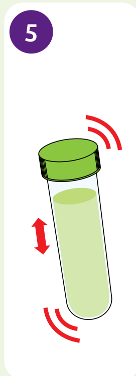
1. Fill the test tube with 75 ml of water. To measure this, use the test tube guide printed on the opposite page to make a mark on the test tube. Fill the test tube up to the line with water. (You can also just eyeball it.) Place the test tube in the test tube rack.
2. Open the packet of powder using a pair of scissors. Do not use your teeth. Be careful not to get any of the powder in your eyes or mouth.
3. Pour all of the powder slowly into the tube and avoid creating airborne dust.
4. Use the spatula to mix the powder into the water.
5. Close the test tube with the lid and shake it for 30 seconds. Let the contents sit, shaking the tube every few minutes, until they have solidified. This takes at least 15–20 minutes. Afterward, you can open up the test tube and have fun experimenting with the slime.
6. Place the slime under a light source, like direct sunlight or a light bulb, for a few minutes.
7. Immediately bring the slime into a dark room. What happens? Dispose of the slime after use.

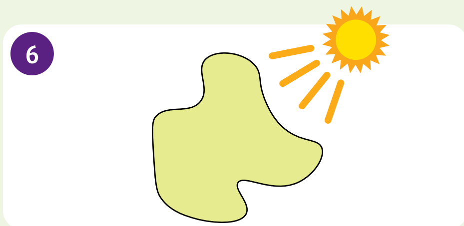
Disposal: Because it does not contain harmful preservatives, the slime liquefies and disintegrates after four days. Dispose of it in a paper towel in the trash!

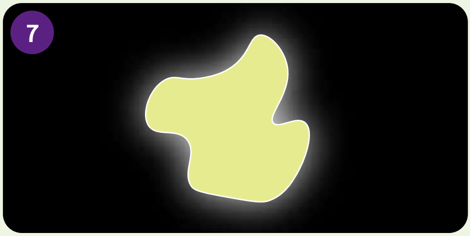












CHECK IT OUT

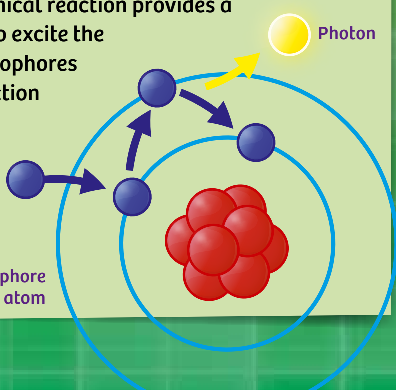
Seeing the light

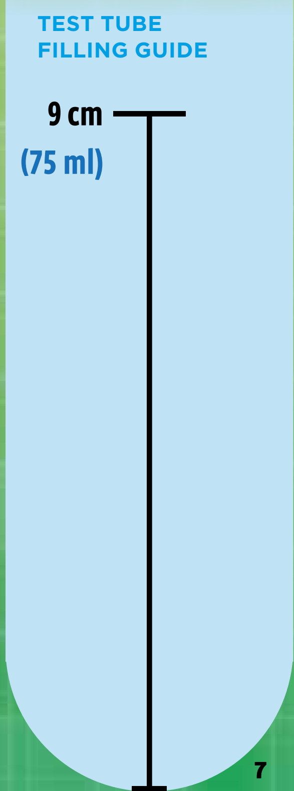
A solid substance that lights up when exposed to energy, like light or electricity, is called a **phosphor.** A phosphor can be **phosphorescent,** which stays glowing after the energy source is removed, or **fluorescent,** which only glows while the energy is present and for a brief moment after. The reason that a phosphorescent material glows after the light source has been removed is because the molecules in the material store the incoming light energy and then gradually emit it in the form of light. Phosphorescent materials are used in warning signs that must be visible in the dark, and in alarm clocks meant to be visible in a dark bedroom. There are even winter coats that come with a glowing element, so the wearers are easier to see in the dark!


Glow sticks

The chemical element **phosphorus** was discovered with the help of the light that it emits when exposed to air. Over 300 years ago, an alchemist named Henning Brand attempted to make a philosopher's stone (which was supposed to grant eternal life and wealth) out of urine. To do this, he heated urine for a long time until all the water evaporated, and then heated what remained in an enclosed glass flask. When he opened the cooled flask, it suddenly emitted bright light. Brand called this substance phosphorus, after the Greek word *phosphoros*, meaning light-bearer. Today, we understand that Brand converted phosphorous compounds in the urine into white phosphorous, which emits light photons when it comes into contact with oxygen in the air.

You have probably seen glow sticks on Halloween or at nighttime parties. They are also used during emergencies and rescue operations. Glow sticks contain chemicals called **fluorophores** that produce light when a chemical reaction occurs inside the glow stick. Energy from the reaction excites electrons in the atoms of the fluorophores causing them to jump up to another energy level. When they fall back down, they release light energy, or **photons.** The chemical reaction provides a continuous cycle of energy to excite the electrons and make the fluorophores glow steadily. When the reaction stops, the fluorophores stop glowing. However, they may still glow under a UV light, which also provides the energy they need to glow.





››› EXPERIMENT 4

Quicksand oozebleck

YOU WILL NEED

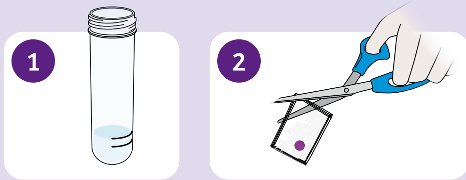
Test tube, lid, 2 corn starch packets (10 g each), dye tablet, test tube rack, spatula, *permanent marker, shallow bowl or pan, water, scissors, paper towels, spoon*

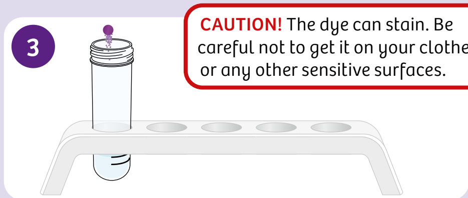
HERE'S HOW

1. Fill the test tube with 10 ml of water. To measure this, use the test tube guide printed on the opposite page to make marks on the test tube at the 5-ml and 10-ml lines.
2. Open the dye packet with scissors. Do not use your teeth.
3. Place the test tube into the rack. Break off a portion of the dye tablet and put it into the tube.
4. Screw the lid onto the tube and shake to mix the dye and water together.
5. Open one packet of starch using a pair of scissors. Do not use your teeth.
6. Pour all of the starch from the packet into a shallow bowl or pan.
7. Pour the 10 ml of colored water from the test tube onto the starch in the bowl.
8. Mix the starch and water together. It is best (and the most fun) to mix the material with your hands, but you can also use the stirring stick or a spoon if you don't want to get your hands messy. Your oozebleck should be very runny at this point.

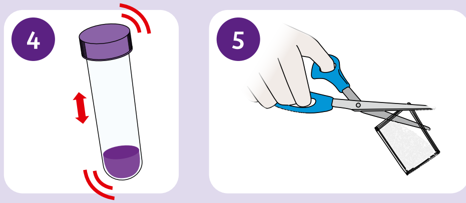
Note: If you mix it with your hands, it is normal to notice some temporary discoloration of your skin from the dye.

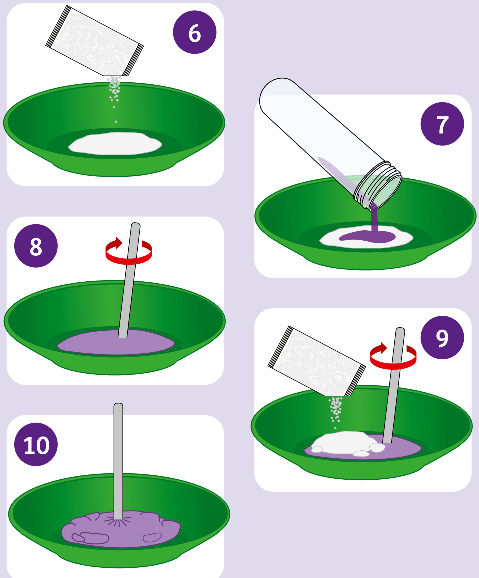
9. Open the second packet of starch, pour it into the bowl, and mix. Use a spoon if the mixture is too stiff to stir with the stirring stick.





CAUTION! The dye can stain. Be careful not to get it on your clothes or any other sensitive surfaces.

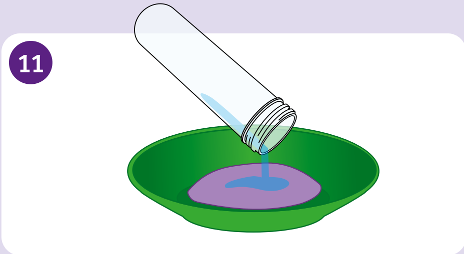




10. Now, you should have very stiff, lumpy oozebleck. Observe how it behaves when you press on it with the stirring stick, or when you squeeze it in your hand. How does it behave when you don't apply any force to it? Continue immediately to the next experiment.

››› EXPERIMENT 5

11. Now, let's balance the amount of water and starch to get the perfect oozebleck! To do this, fill the test tube to the 5-ml line, pour about half of this over the oozebleck, and mix it together. If the oozebleck is still not runny enough, add the rest of the water and mix. The goal is to end up with a smooth mixture that is solid when you press on it and runny when you leave it alone.



Disposal: Dispose of the oozebleck and unused dye powder in the household trash.

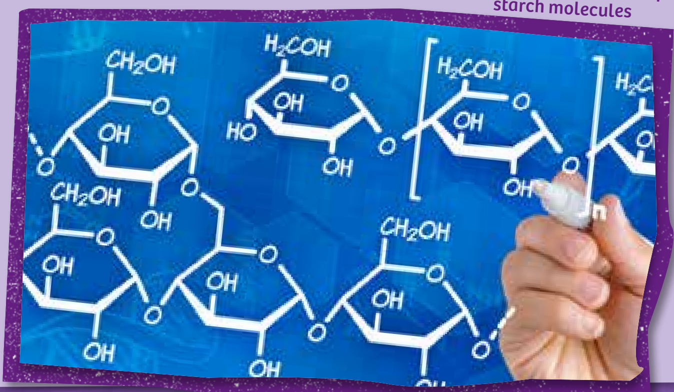
CHECK IT OUT

Tangled up in goo

You mixed starch, water, and dye to make a mud-like material commonly known as **oobleck.** The name oobleck comes from the Dr. Seuss book *Bartholomew and the Oobleck*, a fictional story in which a boy must save his kingdom from a slimy substance called oobleck.

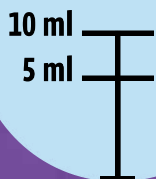
Oobleck is a **"non-Newtonian" fluid** suspension that stiffens when pressure is applied to it and softens and flows when no pressure is applied. Sir Isaac Newton was a famous scientist who came up with a law about the behavior of fluids. Non-Newtonian fluids are fluids that don't follow Newton's law of viscosity, which is a measure of how a fluid flows and resists deformation. Most fluids get less viscous when force is applied to them, but oobleck gets more viscous because the **starch molecules** in it get all tangled up and trap water molecules between them when they are pushed together under force.

Chemical diagram of starch molecules



TEST TUBE FILLING GUIDE

A note about the amount of water needed: The oozebleck mixture requires just the right amount of water, which can be different depending on the humidity and the accuracy of the measured amounts of water and starch. For this reason, the instructions tell you to add the water in two steps, so that you don't add too much.



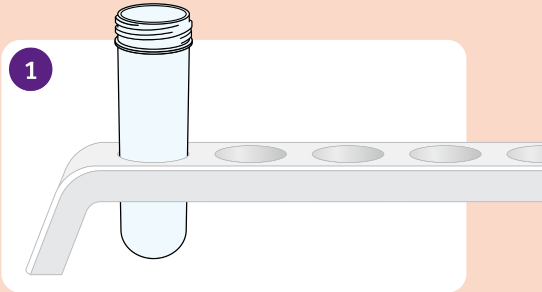
Crystal feather

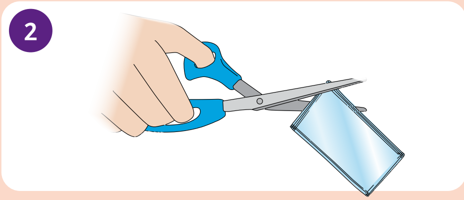
YOU WILL NEED

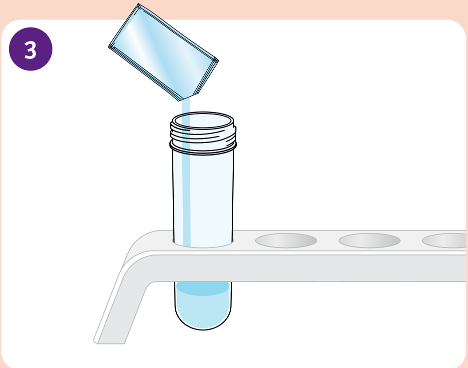
Test tube, test tube rack, crystal solution ("Magic Water"), paper feather, test tube lid, *scissors*

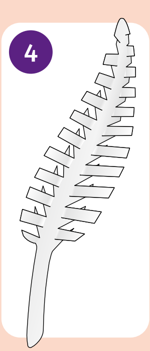
HERE'S HOW

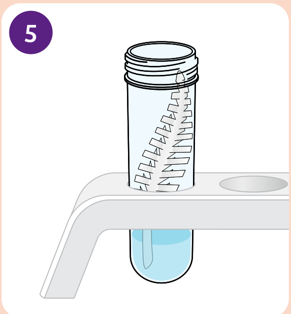
1. Put the test tube into the test tube rack.
2. Cut the corner off of the packet of crystal solution.
3. Pour all of the crystal solution into the test tube.
4. Fold the barbs of the paper feather so that adjacent barbs are folded away from each other, as shown.
5. Place the paper feather into the test tube. Do not put the lid on the test tube! The solution must be allowed to evaporate. Wait for a number of hours. Check back often to monitor the crystal growth.
6. When the solution has entirely crystallized, examine the final crystal structure. Look closely at it. What do you see?

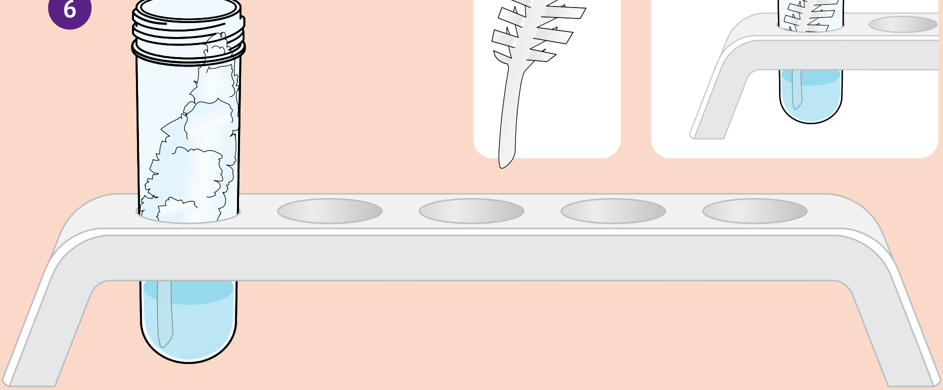












CHECK IT OUT

The magic of crystals

You won't need all that much patience, because you will start to see **crystals** growing pretty quickly. The exact rate of growth depends on how fast the water evaporates from the crystal solution, which depends on the temperature and humidity.

The liquid will first start to rise up the paper feather. You will see that the paper turns darker when it's wet. After as little as a few hours, you will notice that most of the liquid has disappeared from the tube. You will start to see a few fine needles at the edges of the paper feather, which will proceed to grow in size and number as time passes. Eventually, all the edges and some of the flat surfaces will be coated with a thick layer of white needles. Your feather has grown a pretty, glittering center.

The crystal growing solution contains a chemical called **potassium dihydrogen phosphate,** which is a type of salt that quickly forms into crystals.

But what are crystals? Some minerals possess a very special quality: They form cubes, sharp needle shapes, crooked squares, octagons, or other complicated shapes with smooth faces that reflect light. They form in all sorts of different colors. These regular shapes are called **crystals.** They form when atoms or molecules line themselves up in ordered ways. The atoms in crystals arrange themselves in organized, repeating patterns. You can find crystals all around you — salt and sugar both consist of crystals. In winter, you can marvel over ice and snow crystals.


Sugar crystals

Salt crystals


Ice crystals


››› EXPERIMENT 7

Let it snow

YOU WILL NEED

Test tube, lid, test tube rack, 3 packets of instant snow powder, spatula, *water, permanent marker, paper towels, scissors, big plastic tub*

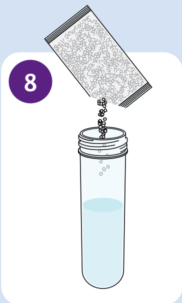
HERE'S HOW

1. Use the test tube filling guide printed on the opposite page to make three marks on the test tube with the permanent marker.
2. Place the test tube into the rack.
   Note: The rack may not be shown in every illustration, but you can always place the test tube in the rack when needed.
3. Open a packet of instant snow powder using a pair of scissors. Do not use your teeth. Be careful not to get any of the powder in your eyes or mouth.
4. Fill the test tube with instant snow powder up to the 13-mm line, which is approximately 5 ml.
5. Add water up to the 42-mm line (about 30 ml). The powder will instantly start expanding.
   Note: The snow gives off a plastic-like smell when expanding. This is normal and will dissipate.
6. Now add water up to the 80-ml line (about another 30 ml). Do you see how the snow continues to expand to absorb the water?
7. Dump the contents of the test tube into a big plastic bin. Use the spatula if necessary. Immediately proceed to the next experiment.

››› EXPERIMENT 8

Slushy snow

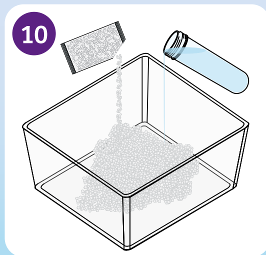
8. Rinse and fill the test tube with water up to the 80-mm line. Sprinkle a small amount of snow powder into the water. Stir and observe for a few minutes. What happens?
9. Pour the entire contents of the test tube out onto the snow in the plastic bin. Immediately proceed to the next experiment.



››› EXPERIMENT 9

A winter wonderland

10. Pour the rest of the snow powder from the open packet into the bin. Using the test tube, add water to the snow powder 60 ml at a time. How much water does the snow absorb?
11. Now, leave the bin uncovered for a number of days and let the water evaporate. What happens to the snow? How many days does it take for the snow to completely dry out?
12. You can use the additional snow packets for your own experiments.

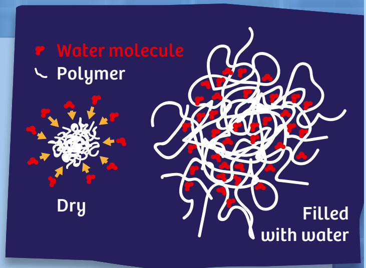


Disposal: When you are done, you can dispose of the instant snow in the household trash.

CHECK IT OUT

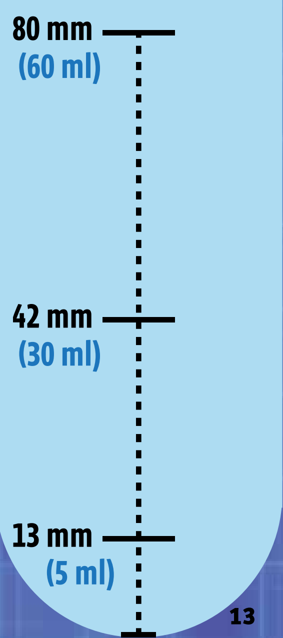
Thirsty polymers

Instant snow powder is a material called sodium **polyacrylate.** It is a superabsorbent polymer. **Superabsorbent** means that it can absorb hundreds of times its weight in water, and expand to hundreds of times its dry size. A **polymer** is a material made of long chains of stretchy molecules, like plastics.



Superabsorbent polymers have a special chemical property: Inside, they have areas that strongly attract water. They are permeable, which means that water can enter them. Once inside, the water gets trapped there. The elastic polymer can expand and stretch out to hold a lot of water. Water can evaporate from the polymer. As the polymer dries, it shrinks again. It can be used over and over again. Superabsorbent polymers like this are used in everyday products like baby diapers, bandages, and spill-control products.

TEST TUBE FILLING GUIDE



Test tube rainbow

YOU WILL NEED

Test tube, test tube rack, *dropper (pipette) or spoon, measuring cup, food coloring, water, 6 plastic cups, paper towels, sugar*

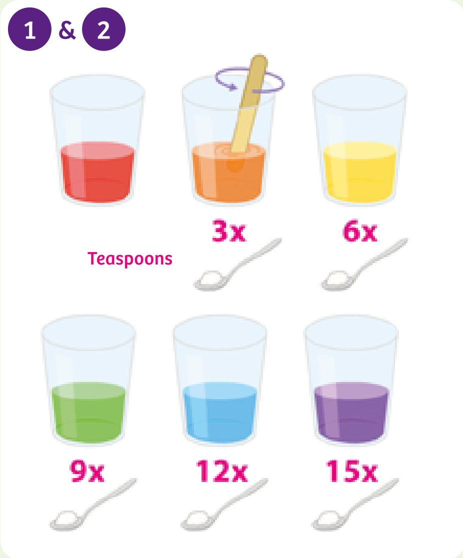
HERE'S HOW

1. Put 1/2 cup of water into each plastic cup. Use the food coloring to color the water in the cups red, orange, yellow, green, blue, and violet. For orange, mix red and yellow. For green, mix yellow and blue. For violet, mix red and blue. Start with just a few drops of coloring and gradually add more as needed. Stir with the spoon and wipe it clean with the paper towel between colors.

2. Add teaspoons of sugar to the colored water according to the amounts listed in the diagram to the right. Stir to dissolve the sugar in the water completely. It takes a while, especially for the cups with a lot of sugar. Wipe the spoon in between.

3. Use a dropper (pipette) or a spoon to carefully put equal amounts of the solutions into the test tube in the following order: violet, blue, green, yellow, orange, and red. Add the liquid slowly, so as to disrupt the layers below as little as possible. Hold the dropper just above the surface of the liquid against the inner wall of the test tube and slowly let the color run down it. If you are using a spoon, tilt the test tube and carefully let the color run down the inner wall of the test tube.

4. Observe the test tube. What happens to the colors?



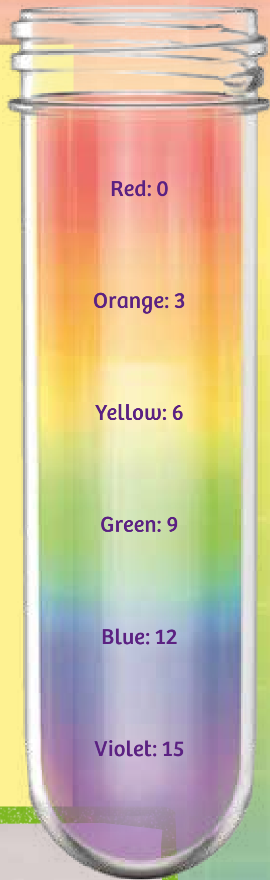
CHECK IT OUT

Rainbow bright

Why did the rainbow form in the test tube? How do the liquid layers sit on top of each other without mixing? The answer lies in the different densities of the liquids. **Density** is a measure of how much a given **volume** of material **weighs**.

Volume is a measure of how much space a particular object or fluid occupies. One way volume can be measured is in **milliliters (ml)**. The liquids in your experiment have a volume of 100 ml each. Pure water has a density of one gram (1 g) per milliliter. If you dissolve sugar in water, the density of the water increases. One milliliter of sugar solution is heavier than one milliliter of water. And the more sugar is dissolved, the greater the density. The violet liquid with 15 teaspoons of sugar therefore has the highest density, the blue liquid has the second highest density, and so on.

When you carefully pour the liquids of different densities, the less dense, "lighter" liquid floats on top and the denser, "heavier" liquids are at the bottom. You must make sure that the layers do not mix right away, otherwise the effect will be lost.



4

Rainbow in a test tube

Rainbow in the sky

Why do rainbows appear in the sky? White light (sunlight) is made of many different colors of light. It can be separated into different colors of light through a phenomenon called **dispersion**. Dispersion is the spreading out of the different colors of light as it passes through a material, like a glass prism or a raindrop, which bends each wavelength of light a different amount, causing them to travel in diverging paths. A rainbow is formed when light from the sun hits droplets of water that are in the atmosphere, causing the white light to separate into all the colors of the rainbow.

Walking water rainbow

YOU WILL NEED

5 test tubes, test tube rack, *food coloring, water, paper towels*

HERE'S HOW

1. Completely fill three of the test tubes with water and place them in the first, third, and fifth locations in the test tube rack. Place empty tests tubes in the second and fourth locations in the test tube rack.

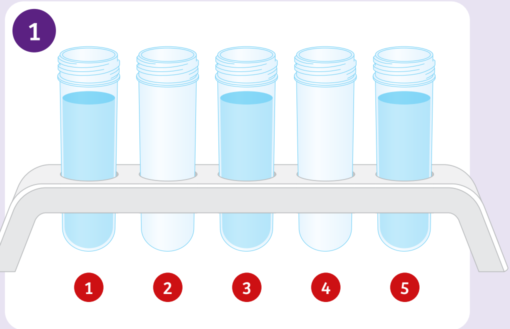
2. Add a few drops of red food coloring to the first test tube. Add a few drops of yellow food coloring to the third test tube. Add a few drops of blue food coloring to the fifth test tube.

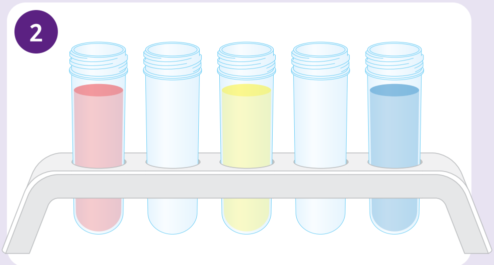
3. Twist four paper towel sheets into four separate twisted cords.

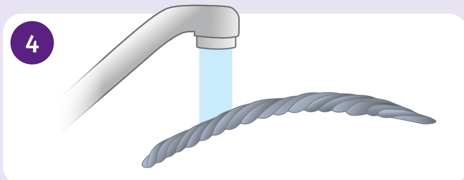
4. Wet the four paper towel cords until they are completely soaked with water.

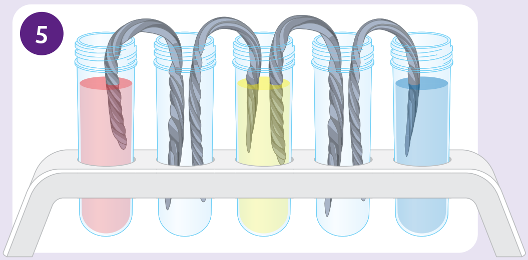
5. Place one paper towel cord so it bridges the gap between each test tube, as shown. Make sure the paper towel is well submerged in the water in the red, yellow, and blue test tubes, and make sure the other end of each paper towel is hanging lower into the uncolored test tubes than it is into the colored test tubes. Refer to the picture.

6. Observe what happens in the test tubes after each hour for a whole day.





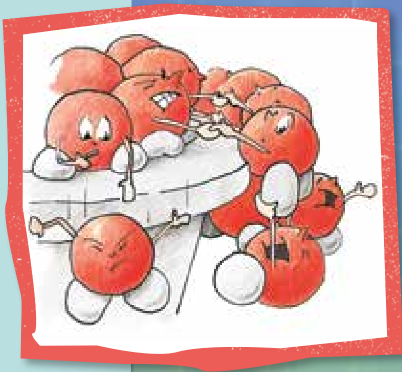




CHECK IT OUT

Water over the bridge

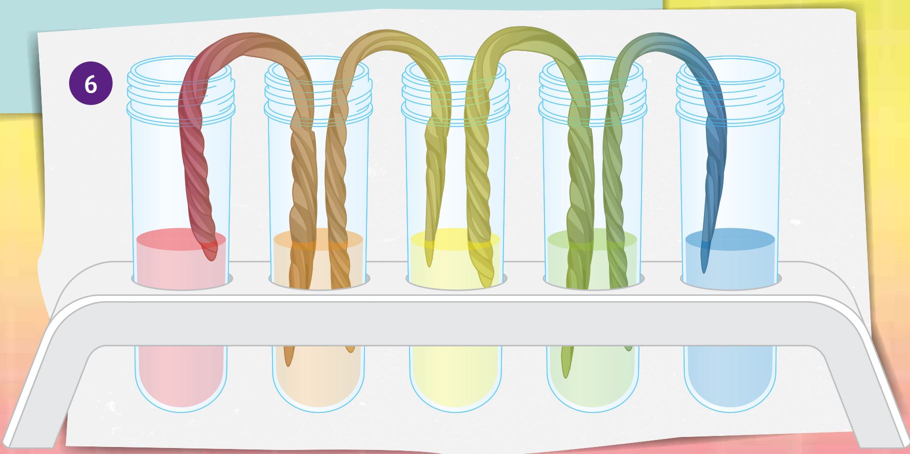
The colored water from the red, yellow, and blue test tubes crawled up the paper towel bridges, crossed the spaces between the test tubes, and dripped down into the empty test tubes. The red and yellow water mixed to yield orange water, and the blue and yellow water mixed to yield green water.



A cartoon representation of water molecules cohering to each other and adhering to the edge of a cup

This happens because paper towel consists of many tiny individual fibers woven together with small spaces between them. These small spaces allow it to soak up water like a sponge. Over time, the volume of water in the towel becomes too much for the paper towel to hold, and the water drips from the lower end. Since the water level is higher in the filled test tube than in the empty one, the water slowly drips out of the paper towel, filling the empty test tube. The paper towel then sucks up more water from the filled test tube. Eventually, the water levels in all five test tubes should be the same.

There are two properties of water that allow this to happen: adhesion and cohesion. **Adhesion** is the property of a material to stick to other materials, like glue sticking to paper. **Cohesion** is the property of a material to stick to itself, like glue sticking to itself. Water exhibits both adhesion and cohesion. It sticks to the paper towel with cohesion, and then pulls more water upward with adhesion. You could imagine a little chain of water molecules holding hands and pulling each other along as they climb across the paper towel bridges!



››› EXPERIMENT 12

Color-changing indicator

YOU WILL NEED

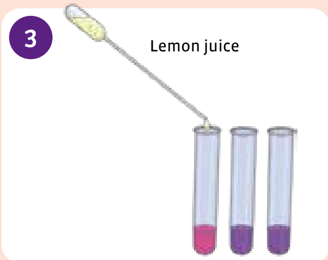
3 test tubes, test tube rack, spatula, *spoon, measuring cup, dropper, finely chopped red cabbage, empty jelly jar, lemon juice, household vinegar, baking soda (sodium hydrogen carbonate), water*

HERE'S HOW

1. Add three tablespoons of finely chopped red cabbage to the clean jelly jar. You can do this in the kitchen. Just be sure you didn't already use the spoon or the jelly jar for your other experiments! Take the jelly jar with you when you proceed to your experiment area.
   Fill a test tube with water and then pour the water over the red cabbage. Stir it vigorously with the spoon and let it sit for 30 minutes.

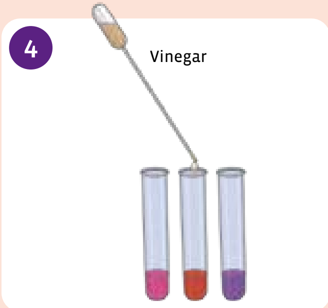
2. Pour the cabbage juice out of the jar into a measuring cup, leaving all of the solid cabbage material in the jar. If you have less than half a cup of juice, add a little more water to the measuring cup so you have half a cup of juice.

3. Place three test tubes in the test tube rack. Fill each test tube about a third of the way full of cabbage juice. Use the dropper (or a spoon) to add a few drops of lemon juice to one of the test tubes. Observe the change in color.



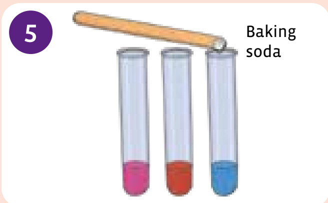
››› EXPERIMENT 13

4. Clean the dropper or spoon and add a few drops of vinegar to the second test tube. Observe the change in color.



››› EXPERIMENT 14

5. Add some baking soda to the third test tube. Observe the change in color. Compare the liquids in the three test tubes.



CHECK IT OUT

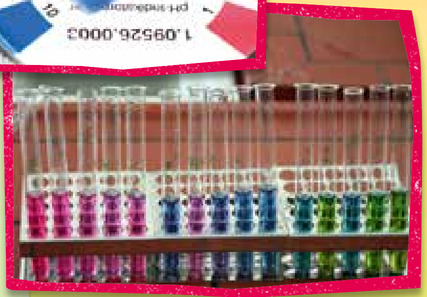
Acids, bases, and indicators

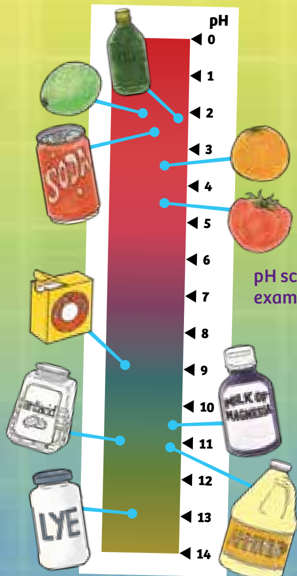
There are pigments in nature that change their colors in the presence of an **acid** or a **base.** The pigment in the cabbage juice turns red and pink in an acidic solution, purple in a neutral solution, and blue and green in basic solutions. Pigments that can be used to detect acids and bases due to their color-changing effects are called **indicators**. Chemists use them to determine whether a solution is acidic, neutral, or alkaline (basic).

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.

Acids taste sour. Vinegar, citrus fruits like lemons and limes, apple cider, tomatoes, pickled vegetables, and soda are all acidic. While bases are not usually used for flavor in cooking, they are often used to make gas-producing reactions for leavening dough in baked goods. Lye, a strong base, is used to make the dark skin of pretzels and to cure foods like olives, fish, and eggs. The basic mineral lime is used to make corn tortillas and the alkaline mineral carbonate is used in the production of cocoa powder. Bases are even used to make chocolate sandwich cookies!


pH test strip


Indicators in test tubes



pH scale with examples


Red cabbage

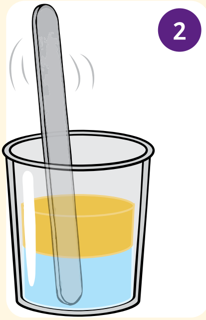

Sour lime

››› EXPERIMENT 15

Oil and water

YOU WILL NEED

Test tube with lid, spatula, *measuring cup, small drinking glass, olive oil or vegetable oil, water, liquid dish detergent*

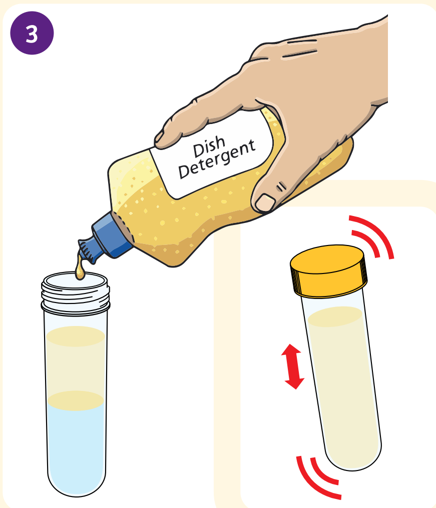


HERE'S HOW

1. Use a measuring cup to measure out 1/8 cup of water. Pour it into the drinking glass. Then measure out 1/8 cup of oil and pour it into the drinking glass. What do you notice about how the oil and water interact?

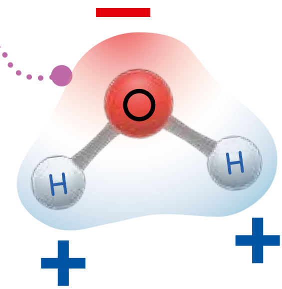
2. Use the spatula to mix the oil and water together. Pour the mixture into the test tube, screw on the lid, and shake it vigorously to mix it. Then let the liquid sit for 30 minutes. Observe what happens to the oil and water.

3. Open the test tube. Add a few drops of liquid dish detergent to the oil and water mixture. Screw the lid onto the test tube again and shake the contents until the oil and water appear to be mixed. What do you observe happens to the oil and water now?



WHAT'S HAPPENING?

Oil and water do not mix because water molecules are **polar** while oil molecules are **nonpolar.** Polar means that one side of the molecule has a slight positive charge while the other has a slight negative charge. Water is polar because the oxygen atom is much larger than the hydrogen atom, and pulls the negative electrons toward itself. This influences the way that water interacts with other molecules.



Unlike water, oils are nonpolar. This is because oils have long chains of carbons and hydrogens, which don't have different positively and negatively charged ends like water.

The oil and water are able to stay mixed when you add the dish detergent because the detergent acts as an **emulsifier.** An emulsifier makes it so that the water and oil are able to mix on a molecular level. This ability of detergent is what allows it to dissolve oily dirt particles, like greasy food stuck on a dish, in water so that they can be washed away.

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