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KITCHEN CHEMISTRY

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Acids and Bases

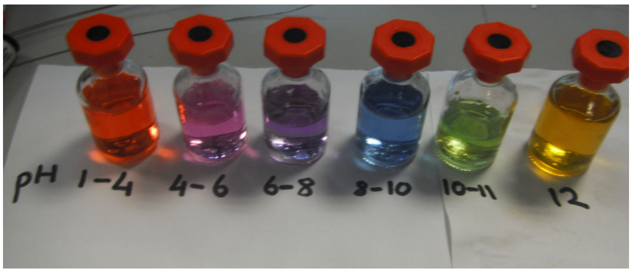
Every liquid you see will probably have either acidic or basic traits. In your body there are small compounds called amino acids. Those are acids. In fruits there is something called citric acid. That's an acid, too. But what about baking soda? When you put that in water, it creates a basic solution. Vinegar? Acid. Scientists use something called the **pH scale** to measure how acidic or basic a liquid is. Although there may be many types of ions in a solution, pH focuses on concentrations of hydrogen ions (H+) and hydroxide ions (OH-). The scale goes from values very close to 0 through 14. Distilled water is 7 (right in the middle). Acids are found between a number very close to 0 and 7. Bases are from 7 to 14. Most of the liquids you find every day have a pH near 7. They are either a little below or a little above that mark. When you start looking at the pH of chemicals, the numbers go to the extremes. If you ever go into a chemistry lab, you could find solutions with a pH of 1 and others with a pH of 14. There are also very stong acids with pH values below one such as battery acid. Bases with pH values near 14 include drain cleaner and sodium hydroxide (NaOH). Those chemicals are very dangerous.

This section includes some experiments that look at the properties of acids and bases and how they react together.

Red Cabbage Indicator

You will need:

Red cabbage (1/4 head)
Water
White vinegar
Baking soda
Other liquids of your choice



What to do:

The first step in this experiment is to prepare an extract of red cabbage, so you can investigate its colour changes.

- Place the red cabbage, cut into 1 inch cubes, into a blender or food processor.
- Add about 250 millilitres (1 cup) of water and blend the mixture until the cabbage has been chopped into uniformly tiny pieces.
- Strain the mixture by pouring it through a sieve. This strained liquid, the red-cabbage extract, will be used for exploring acids and bases.

Examine the label of a bottle of white vinegar. The label probably says that it contains acetic acid. This indicates that vinegar is an acid and has properties of an acid. Let's see what effect an acid has on the colour of the red cabbage extract.

- Pour 125 millilitres (½ cup) of vinegar into a colourless drinking glass.
- Add 5 millilitres (1 teaspoon) of red cabbage extract, stir the mixture, and note its colour.

What is the colour of the mixture? (Write your answer in the box.)

The colour of the cabbage extract with vinegar is the colour the extract has when it is mixed with an acid. Save the mixture in this glass to use as a reference in the rest of the experiment.

Now examine the effect of baking soda on the colour of red cabbage.

- Place 1 teaspoon of baking soda in a glass and add 125 millilitres (½ cup) of water.
- Stir the mixture until the baking soda has dissolved.
- Add 1 teaspoon of red cabbage extract to the solution.

Write the colour of the mixture in the box.

The colour obtained with baking soda is different from the colour obtained with vinegar. Baking soda is a base (alkali). The colour of this mixture is the colour of cabbage extract when it is mixed with a base. The colour of cabbage extract indicates whether something mixed with it is an acid or a base. Cabbage extract can be called an acid-base indicator. Save the mixture in this second glass to use as a reference.

How does it work?

Acids are materials that have certain properties in common. Bases (also called alkalis) are other substances with a different set of properties

The most striking property of both acids and bases is their ability to change the colour of certain vegetable materials. A common vegetable whose colour responds to acids and bases is red cabbage.

Red cabbage extract can indicate whether a substance is an acid (like vinegar) or a base (like baking soda). It can also show how strong an acid or a base a substance is. Chemists use the pH scale to express how acidic (like an acid) or basic (like a base) a substance is.

A pH value below 7 means that a substance is acidic, and the smaller the number, the more acidic it is. A pH value above 7 means that a substance is basic, and the larger the number, the more basic it is. Red cabbage extract has different colours at different pH values. These colours and approximate pH values are:

approximate pH:	2	4	6	8	10	12
colour of extract:	red	purple	violet	blue	blue-green	yellow

Based on this information, what is the approximate pH of vinegar?

What is the approximate pH of the baking soda mixture?

Use the instructions for testing vinegar and baking soda to test the pH of several other nearly colourless liquids, such as lemon-lime soft drink (Sprite or 7-Up) and lemon juice. Record your observations. Liquids that are white, such as milk, can be tested in the same way. You can also test solids that dissolve in water by following the instructions for baking soda. This will also work with viscous liquids such as liquid detergents.

Test other substances around the house, such as sugar, table salt, shampoo, milk of magnesia, antacid tablets, and aspirin.

Material	Extract colour	pH		Material	Extract colour	pH

CAUTION: Some household products can cause skin irritations. Do not allow these to contact skin; rinse thoroughly with water if they do.

Baking Soda Volcano

You will need:

Newspaper strips
Wallpaper paste (or make a thick paste using flour and water)
Plastic bottle
Baking Soda
Vinegar
Red and Yellow Food Colouring (optional)
Liquid dish washing soap

What to do:

- Make a papier mache volcano around the plastic bottle using the newspaper strips and paste.
- Wait for the volcano to dry out completely.
- Place your volcano in a container to catch any mess.
- Add some baking soda into the bottle.
- Add a small amount of liquid soap and a few drops of food colouring.
- Pour some vinegar in and watch your volcano erupt.

You can even get creative by painting your volcano to look like a real one or by adding different colour food colourings in.

How does it work?

The chemical reaction between baking soda (sodium bicarbonate) and vinegar (acetic acid) produces carbon dioxide gas (CO_2). As the carbon dioxide gas is produced, pressure builds up inside the plastic bottle, until the gas bubbles (thanks to the soap) out of the 'volcano'.

Real volcanoes also produce carbon dioxide (CO_2), along with a lot of other different gases such as water vapour (H_2O), sulphur dioxide (SO_2), nitrogen gas (N_2), hydrogen gas (H_2) and carbon monoxide (CO).

Cork Rocket

You will need:

Plastic bottle
Cork that fits the bottle tightly
Toilet paper
Baking soda
Lemon juice

What to do:

- Take a square of toilet paper and put some baking soda onto it.
- Fold in the sides to make a little packet
- Pour about an inch of lemon juice into the bottle.
- Drop the baking soda packet in.
- Close the bottle with the cork.
- Shake the bottle and watch the cork take flight!

How does it work?

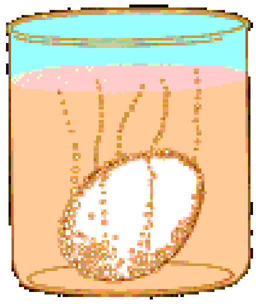
The lemon juice and the baking soda react to produce carbon dioxide (CO_2) which is a gas. As more gas is produced, the pressure inside the bottle builds up and the cork will pop.

Now try this experiment with other acids. You can use the results from the Red Cabbage pH Indicator experiment to figure out what you might be able to use.

Try using weaker and stronger acids and see if there's any difference.

Caution: It is best to do this experiment outside. Do not point the bottle at anyone!

Disappearing Shell



You will need:

Egg
Cup or jar
Bowl
White vinegar

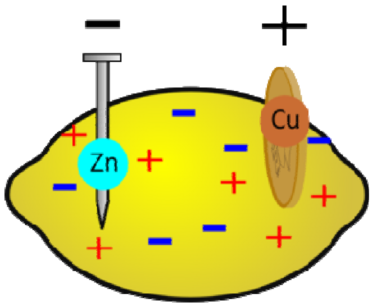
What to do:

- Place the egg in a cup and cover with vinegar.
- Leave overnight.
- Remove the egg from the cup and examine it.
- The shell will have disappeared and it now floats! The outside of the egg may also be covered in small bubbles.

How does it work?

Bird eggshells are made from calcium carbonate. Acid is corrosive to calcium carbonate, so vinegar dissolves the shell. All that is left is the membrane that lines the inside of the shell. Since the egg isn't as dense without its shell, it now floats. Air bubbles form when the dissolved carbonate from the shell reacts to form carbon dioxide gas (CO_2).

Fruit Battery



You will need:

Citrus fruit (lemon, orange, grapefruit)
Copper nail, screw, wire or coin (2 inches)
Zinc nail or screw or galvanized nail (2 inches)
Holiday light with enough wire to connect it to the nails

What to do:

- Roll the fruit around on a table to get the juices flowing.
- Insert the copper and zinc nails 2 inches apart.
- Remove enough insulation from the wire so that you can wrap one lead around each nail. You can use electrical tape or alligator clips to keep the wires from falling off.
- When you connect the second wire the light should turn on!

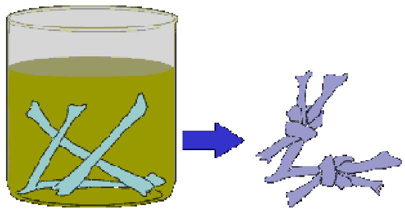
How does it work?

The energy for the battery does not come from the lemon, but rather the energy comes from the chemical change in the zinc (or other metal). The zinc is oxidized inside the lemon, exchanging some of its electrons in order to reach a lower energy state, and the energy released provides the power. The lemon merely provides an environment where this can happen i.e. an acidic environment. The copper coin serves as the positive electrode or cathode and the galvanized nail as the electron-producing negative electrode or anode. These two objects work as electrodes, causing an electrochemical reaction which generates a small potential difference.

Try this experiment with other fruit to see what happens.

Rubber Bones

You will need:



Clean chicken bones
Large jar
Vinegar

What to do:

- Put the chicken bones into the jar.
- Cover with vinegar.
- Leave for 3 - 4 days.
- Remove the bones from the vinegar. They will be bendy and can be tied in knots if long enough.

How does it work?

As you might know, bones have something in them called calcium. This is attached to carbon and oxygen atoms to give a form of calcium called calcium carbonate.

This calcium carbonate is what makes bones hard and strong (that is why you are often told to drink milk when you are young). When the bones are in the vinegar, the calcium carbonate and the vinegar (which is a weak acid) react. If you look at the jar over the 4 days you will even be able to see the reaction taking place (look for small bubbles on the surface of the vinegar).

These bubbles are carbon dioxide gas (CO_2), which is formed by the reaction between the calcium carbonate and vinegar. Without the calcium carbonate in the bones they become much softer. This is why we can bend them and tie knots in them.

Shiny coins

You will need:

An old penny
Lemon juice
Plastic cup/bowl
Paper towel

What to do:

- Put some lemon juice in the cup or bowl.
- Put the dirty penny in the bowl and leave for a few minutes.
- Remove the coin from the bowl, dry using the paper towel and see what has happened.

How does it work?

Pennies become dirty when the oxygen in the air reacts with the copper, making a copper oxide coating. The acid in the lemon juice reacts with the copper oxide and removes it from the coins making them shiny.

Use other acids (check your red cabbage indicator results!) to see if they do the same job.

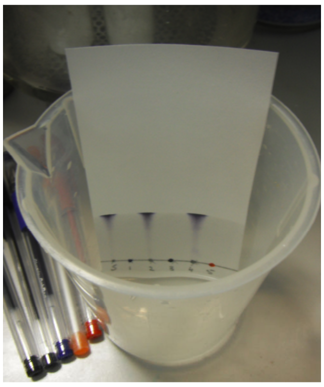
Chromatography

Chromatography is a way of separating mixtures of different chemicals. For example, pen inks are often made up of a range of different colours. The different molecules in the ink have different characteristics such as size and solubility. Solubility is their ability to dissolve in different fluids such as water or nail polish remover. The fluids that the molecules dissolve in are called solvents. Because of the different characteristics of the molecules in the ink, they travel at different speeds when pulled along a piece of paper by a solvent. For example, black ink contains several colours. When the solvent flows through a word written in black, the molecules of each one of the colours behave differently, resulting in a sort of “rainbow” effect. Chemists use a lot of different types of Chromatography in the lab to separate out mixtures of chemicals.

The next 3 experiments explain how to do some chromatography using materials found around the house.

CSI Fido

Teacher has received a note this morning saying Fido the dog has gone missing. The note was signed love Fido. Now everyone knows Fido is a dog and cannot write notes so teacher thinks that someone is playing a trick on her. She has 3 suspects, the neighbour, the gardener and the milkman, and she has their pens so she can use some Chemistry to figure out who wrote the note!



You will need:

3 different types of pen ideally of different makes
Chromatography paper in strips about 15cm long and 4cm width (you can also use coffee filters).
Beakers/Containers to hold a small amount of liquid.
Solvent – alcohol/acetone i.e. Nail polish remover would be good.
Cling film and rubber bands – will ensure no solvent lost from evaporation,
Pencils
Ruler.

What to do:

- Draw a line using a **<u>pencil</u>** and ruler about 1 cm from bottom of paper.
- The student then makes a mark with each of the four pens at equal distances apart and underneath each mark writes whose pen it is, in **<u>pencil</u>**.
- The strips of chromatography paper are then sat gently into the containers containing about 0.5cm height solvent.

- The strips can be left for a half hour and by the separation of each ink into its components, it can be determined who wrote the note.

How does it work?

This process is called chromatography. (The word “chromatography” is derived from two Greek words: "chroma" meaning colour and "graphein" to write.) Chromatography methods are used to physically separate mixtures of gases, liquids or dissolved substances. Substances of similar composition will show separation in a similar manner. In all forms of chromatography there is a stationary phase (chromatography paper) and a mobile phase (solvent).

The components of the ink will travel at different speeds past the stationary phase, some components are more tightly held by the stationary phase and will travel more slowly, other components are less tightly bound to the stationary phase and will travel more quickly with the solvent.

If using different brands of pen, you will be able to see a different pattern for each ink, indicating that each ink has a different composition. By examining these patterns we can tell which pen was used in the crime!

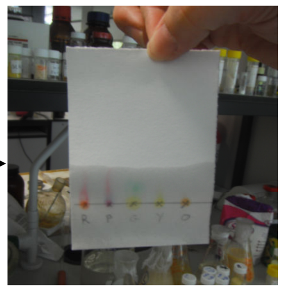
The next 2 experiments also use Chromatrography to examine the dyes in candy and how a piece of chalk can be used as the stationary phase.

Candy Chromatography

Ever wondered why candies are different colours? Bags of M&Ms or Skittles contain candies of various colours. The labels tell us the names of the dyes used in the candies. But which dyes are used in which candies? We can answer this by dissolving the dyes out of the candies and separating them using chromatography.

You will need:

M&M or Skittles candies (1 of each colour)
Coffee filter paper
A tall glass
Water
Table salt
A pencil (**not a pen**)
Scissors
Ruler
6 toothpicks
Aluminium foil
an empty 2 litre bottle with cap



What to do:

- Cut the coffee filter paper into a 3 inch by 3 inch (8 cm by 8 cm) square.
- Draw a line with the **pencil** about ½ inch (1 cm) from one edge of the paper. Make six dots with the pencil equally spaced along the line, leaving about ¼ inch (0.5 cm) between the first and last dots and the edge of the paper.
- Below the line, use the **pencil** to label each dot for the different colours of candy that you have. For example, Y for yellow, G for green, BU for blue, BR for brown, etc.

Next we'll make solutions of the colours in each candy:

- Take an 8 inch by 4 inch (20 cm by 10 cm) piece of aluminium foil and lay it flat on a table.
- Place six drops of water spaced evenly along the foil.
- Place one colour of candy on each drop.
- Wait about a minute for the colour to come off the candy and dissolve in the water.
- Remove and dispose of the candies.

Now we'll "spot" the colours onto the filter paper:

- Dampen the tip of one of the toothpicks in one of the coloured solutions and lightly touch it to the corresponding labelled dot on your coffee filter paper.
- Use a light touch, so that the dot of colour stays small - less than 1/16 inch (2 mm) is best.
- Then using a different toothpick for each colour, similarly place a different colour solution on each of the other five dots.
- After all the colour spots on the filter paper have dried, go back and repeat the process with the toothpicks to get more colour on each spot. Do this three times, waiting for the spots to dry each time.
- When the paper is dry, fold it in half so that it stands up on its own, with the fold standing vertically and the dots on the bottom.

Next we will make what is called a developing solution:

- Put 1 teaspoon of salt into a cup and add 100ml water.
- Mix until all of the salt is dissolved in the water.

Pour the salt solution into the tall glass to a depth of about ¼ inch (0.5 cm). The level of the solution should be low enough so that when you put the filter paper in, the dots will initially be above the water level. Hold the filter paper with the dots at the bottom and set it in the glass with the salt solution.

What does the salt solution do? It climbs up the paper! It seems to defy gravity, while in fact it is really moving through the paper by a process called capillary action.
As the solution climbs up the filter paper, what do you begin to see?

The colour spots climb up the paper along with the salt solution, and some colours start to separate into different bands.
When the salt solution is about ½ inch (1 cm) from the top edge of the paper, remove the paper from the solution. Lay the paper on a clean, flat surface to dry.

How does it work?

The colours of some candies are made from more than one dye, and the colours that are mixtures separate as the bands move up the paper. The dyes separate because some dyes stick more to the paper while other dyes are more soluble in the salt solution. These differences will lead to the dyes ending up at different heights on the paper.

Compare the spots from the different candies, noting similarities and differences. Which candies contained mixtures of dyes? Which ones seem to have just one dye? Can you match any of the colours on the paper with the names of the dyes on the label? Do similar colours from different candies travel up the paper the same distance?

You can do another experiment with a different type of candy. If you used Skittles the first time, repeat the experiment with M&Ms. If you used M&Ms first, try doing the experiment with Skittles. Do you get the same results for the different kinds of candy, or are they different? For example, do green M&Ms give the same results as green Skittles?

You can also use chromatography to separate the colours in products like coloured markers and food colouring. Try the experiment again using these products. What similarities and differences do you see?

Chalk Chromatography

You will need:

White chalk (not dustless chalk)
Alcohol or nail polish remover (solvent)
Ink, dye or food colouring
Small jar or cup
Cling film

What to do:

- Apply your ink, dye or food colouring to a piece of chalk about 1 cm from the end of the chalk. You can place a dot of colour or stripe a band of colour all the way around the chalk.
- Pour enough solvent into the bottom of a jar or cup so that the liquid level is about half a centimetre. You want the liquid level to be below the dot or line on your piece of chalk.
- Place the chalk in the cup so that the dot or line is about half a centimetre higher than the liquid line.
- Seal the jar or put a piece of plastic wrap over the cup to prevent evaporation.
- You should be able to observe the colour rising up the chalk within a few minutes. You can remove the chalk whenever you are satisfied with your chromatogram.
- Let the chalk dry before using it for writing.

How does it work?

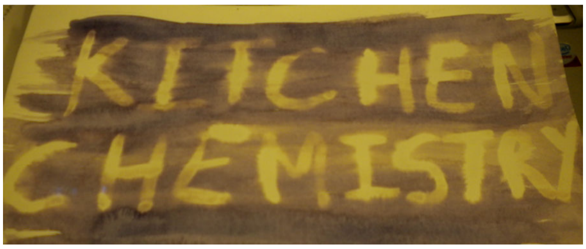
This experiment uses the same principles as the last 2 experiments. In this case, the stationary phase is the chalk. The dyes move up the chalk, separating into each of their components, leaving an interesting pattern on the chalk.

Material Chemistry

Chemists are involved in making almost everything that you are surrounded by – the chairs you sit on, the pens you write with and even the medicines you take when you are sick.

This section describes some experiments that involve different materials found around the house and shows how different materials behave in different ways.

Invisible Ink



Lemon Juice
Paintbrushes
Containers to hold liquids.
Art paper.
Iodine solution

What to do:

- The students paint pictures on the art paper with lemon juice.
- Once dry, typically an hour, the student then quickly washes over their painting using the Iodine solution to reveal their painting in white with a blue background.
- The Iodine solution can be made by diluting a few drops of Iodine in some water.

How does it work?

Paper has starch in it, which reacts with iodine to form a blue complex. The vitamin C in lemon juice blocks this reaction, so areas of the paper coated in lemon juice remain white. Scientists use iodine as an indicator to tell whether or not vitamin C is present. If they measure carefully, they can even find out how much vitamin C is present.

You can also use your iodine vitamin C indicator to find out if other juices contain vitamin C. Just paint a patch of liquid onto paper as you did the lemon juice, and coat the paper with iodine solution to see if the patch remains white. You might want to try milk, white vinegar, and dissolved solid foods as well. Some foods naturally contain vitamin C, and sometimes vitamin C is added to food. To find out if vitamin C has been added, check the ingredient list (note: vitamin C is also called ascorbic acid).

Non-Newtonian Fluid

You will need:

Cornstarch
Some water (2 parts cornstarch : 1 part water roughly)
Food colouring (optional)
Large tray to hold mixture.

What to do:

- Mix all of the cornstarch with some water, containing food colouring if using, with your hands until it resembles liquid.
- When touched and grabbed with your hand it should turn solid-like, this means it's ready. This takes about 10-15 mins of good mixing with your hands to achieve this.
- The mixture will look like a liquid and move from side to side when the container holding it is tilted.
- Try to punch the liquid or grab the liquid into a ball. What happens?

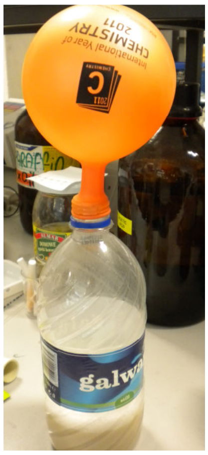
How does it work?

When a pressure is applied to the mixture either by trying to punch the liquid or grab the liquid into a ball the fluid mixture becomes solid like. This is due to the sudden pressure your hand is applying to the mixture. Pressing your hand slowly through the mixture allows the mixture particles to move out of the way but sudden movements like punching the mixture does not allow the particles to slide past each other and out of the way out of your hand.

"Viscosity" is a term used to describe the resistance of a liquid to flow. Water, which has a low viscosity, flows easily. Honey, at room temperature, has a higher viscosity and flows more slowly than water. However, if you warm honey up, its viscosity drops and it flows more easily. Most fluids behave like water and honey, in that their viscosity depends only on temperature. We call such fluids "Newtonian," since their behaviour was first described by Isaac Newton. The cornstarch mixture is "non-Newtonian" since its viscosity also depends on the force applied to the liquid or how fast an object is moving through the liquid.

Other examples of non-Newtonian fluids include ketchup, silly putty, and quicksand. Quicksand is like the cornstarch mixture: if you struggle to escape quicksand, you apply pressure to it and it becomes hard, making it more difficult to escape. The recommended way to escape quicksand is to slowly move toward solid ground; you might also lie down on it, thus distributing your weight over a wider area and reducing the pressure.

Using Yeast to Blow up a Balloon



You will need:

Bakers yeast
Cup of hot (not boiling) water
Sugar
Balloon
Small plastic bottle

What to do:

- Stretch out the balloon by blowing it up and then releasing the air.
- Set the balloon aside for now.
- Add two tablespoons of sugar to the cup of warm water and stir until the sugar dissolves.
- Add one tablespoon of yeast to the cup and stir briefly.
- Carefully pour the contents of the cup into the water bottle. You may want to use a funnel to prevent spills.
- Stretch the balloon over the opening of the bottle.
- Watch the balloon closely. Be patient – it may take a few minutes before you see any changes. If nothing happens, add some more yeast.

How does it work?

Yeast is a type of single-celled fungus that is used in baking to make bread rise. Yeast does this by feeding on sugars in the flour and releasing carbon dioxide gas as waste. The process of breaking down sugar molecules into alcohol and carbon dioxide is called fermentation. This same process occurred inside the water bottle. The yeast began to feed on the sugar in the water, releasing carbon dioxide gas. The carbon dioxide gas caused the balloon to fill up.

Ever wondered why there are little holes in your bread? The carbon dioxide from the yeast makes thousands of bubbles in the dough. These air bubbles are what give the loaf of bread its fluffy texture.

Try the same experiment using hotter and colder water. Does the temperature of the water affect how long it takes for the balloon to inflate? What if you substituted juice or soda for the sugar water solution? Would you get the same result? Try it and find out.

Slime

You will need:

White liquid glue
Borax powder
Water
Food Colouring (optional)

What to do:

- Fill a quarter of a cup with glue and add the same amount of water.
- Stir until mixed.
- Add a few drops of food colouring.
- Put 1 teaspoon of Borax into another cup and half fill with water. Mix well.
- Add a few drops of Borax solution to your cup of glue and stir.
- You will see slime starting to form.
- Add Borax solution until all the liquid has turned into slime.

Slime can be stored in a zip lock bag.

How does it work?

When you make slime, you are making polymers. The borax is acting as the crosslinking agent or "connector" for the glue (polyvinyl acetate) molecules. Once the glue molecules join together to form even larger molecules called polymers, you get a thickened gel very similar to slime.

All plastics are polymers. Other polymers you might find around your home include nylon, polyester, Teflon and Styrofoam.

Caution: If you do not use food colouring, your slime should wash off most surfaces and out of most washable fabrics. Food colouring will stain your skin for quite a while and may stain clothing permanently, so use care if you create coloured slime. You can use disposable gloves to handle to the slime until it dries a bit.

Borax Crystal Snowflakes

You will need:

Borax
Pipe cleaners
Hot water
Cup or glass
Scissors
Food dye (optional)

What to do:

- Make the snowflake by cutting a pipe cleaner into three pieces. You can use a coloured pipe cleaner if you want a coloured crystal snowflake.
- Twist the pieces together at their centres and bend the ends outward to make a snowflake shape.
- Trim the snowflake so that it will fit inside your cup. Leave one arm long so that you can hang the snowflake in the cup.
- Stir 3 tablespoons of borax into 1 cup of very hot water. It's fine if there is a little undissolved borax.
- Pour the crystal growing solution into the cup, hang the snowflake so that it doesn't touch the sides or bottom of the container.
- Allow the crystals to grow undisturbed for several hours or overnight.
- Remove the borax crystal snowflake and use it however you like. The snowflakes make pretty decorations.
- You can twist the pipe cleaners into any shape you like e.g. stars, hearts etc. You can also use a few drops of food colouring to colour your crystals or coloured pipe cleaners as we have done.

How does it work?

Borax is an example of crystal. Every crystal has a repeating pattern based on its unique shape. They may be big or little. Salt, sugar, and Epsom salts are all examples of crystals. Salt crystals are always cube-shaped while snow crystals form a six-sided structure.

Hot water holds more borax crystals than cold water. That's because heated water molecules move farther apart, making room for more of the borax crystals to dissolve. When no more of the borax can be dissolved, you have reached saturation. As this solution cools, the water molecules move closer together again. Now there's less room for the solution to hold onto as much of the dissolved borax. Crystals begin to form and build on one another as the water lets go of the excess and evaporates. This also applies to snowflakes - As water cools the molecules move closer together. Since all water molecules are shaped the same (H_2O) they align in a six sided crystal.

What happens when you cool the solution quickly? The faster the solution is cooled, the smaller the crystals. Try varying how quickly the solution cools.

Lava Lamp

You will need:

Clean 1 litre plastic bottle
150ml water
Vegetable Oil
Food colouring
Alka Seltzer tablets

What to do:

- Pour the water into the bottle.
- Use a funnel to pour the oil into the bottle until it is almost full.
- Wait for the water and oil to separate.
- Add 10 drops of food colouring to the bottle. The drops will pass through the oil and then mix with the water below.
- Break a tablet in half and drop it into the water. The tablet will sink to the bottom.
- To keep the effect going, just add another tablet piece.
- For a true lava lamp effect, shine a flashlight through the bottom of the bottle.

How does it work?

To begin, the oil stays above the water because the oil is lighter than the water or, more specifically, less dense than water. Water molecules are attracted to other water molecules. They get along fine, and can loosely bond together (drops). Oil molecules are attracted to other oil molecules. But the structures of the two molecules do not allow them to bond together.
When you added the tablet piece, it sank to the bottom and started dissolving and creating a gas. As the gas bubbles rose, they took some of the coloured water with them. When the blob of water reached the top, the gas escaped and down went the water.

By the way, you can store your "Lava Lamp" with the cap on, and then anytime you want to bring it back to life, just add another tablet piece.

Layered Liquids

Have you ever heard the phrase "oil and water don't mix"? First we will test that expression, and then look at interesting combinations of several other liquids.

Oil and Water

You will need:

¼ cup (60 ml) water
¼ cup (60 ml) vegetable oil
a small glass
Food colouring

What to do:

- First pour the water into the glass.
- Add a couple of drops of food colouring and mix.
- Next add the oil.

What do you see? Which layer is on top?

- Tightly cover the glass with plastic wrap or your hand (if it's big enough).
- While holding the glass over a sink (in case you spill), shake the glass so that the two liquids are thoroughly mixed.
- Set the glass down and watch what happens.

Do oil and water mix?

How does it work?

The word "miscibility" describes how well two substances mix. Oil and water are said to be "immiscible," because they do not mix. The oil layer is on top of the water because of the difference in density of the two liquids. The density of a substance is the ratio of its mass (weight) to its volume. The oil is less dense than the water and so is on top.

The next experiment examines the miscibility and density of several liquids.

Layered Liquids

You will need:

dark corn syrup or honey
dishwashing liquid
water
vegetable oil
rubbing alcohol
a tall glass or clear plastic cup

two other cups for mixing
Food colouring

- Being careful not get syrup on the side of the glass; pour the syrup into the middle of the glass. Pour enough syrup in to fill the glass 1/6 of the way.
- After you have added the syrup or honey, tip the glass slightly and pour an equal amount of the dishwashing liquid slowly down the side of the glass.

Does the dishwashing liquid float on top of the syrup or sink to the bottom?

- Mix a few drops of food colouring with water in one of the mixing cups.
- Colour the rubbing alcohol a different colour in another mixing cup.
- Be careful to add the next liquids VERY SLOWLY. They are less viscous (i.e., not as thick) and mix more easily than the previous liquids. We don't want them to mix.
- Tip the glass slightly, and pouring slowly down the side of the glass, add first the coloured water, then the vegetable oil, and finally the coloured rubbing alcohol.
- On a piece of paper, make a sketch of the glass and its liquids, labelling the position of each liquid in your glass.

Why do the liquids stay separated? Can you think of several ways that the liquids in the glass are different? Try to describe some properties that differ in each of the liquids in the glass.

How does it work?

One property that is different in all of the liquids is colour. Another property unique to each liquid is thickness (viscosity).

The property of the liquids that is responsible for the layering effect is density. Can you guess what the relationship is between the density of a liquid and its position in the glass?

Another property that keeps the liquids separate is that some of them are immiscible liquids, in other words they do not mix with each other. As you proved in the first experiment, oil and water are immiscible liquids. On the other hand, water and rubbing alcohol are miscible and will mix with each other. Water and the dishwashing liquid will also mix.

Stir up the liquids in the glass and watch what happens to the layers. Have any of the layers mixed (are they miscible in each other)? Wait a few minutes and look again. Have any of the other liquids separated?

Alternate procedure: Rainbow in a glass.

You will need:

four different colours of food colouring (e.g. red, yellow, green, and blue)
five tall glasses or clear plastic cups
¾ cup (180 g) of granulated sugar
a tablespoon for measuring
1 cup (240 ml) water

- In the first glass, add one tablespoon (15 g) of sugar.
- In the second glass, add two tablespoons of sugar, three in the third glass, and four in the last glass.
- Add three tablespoons (45 ml) of water to each glass, and stir until the sugar is dissolved. If the sugar in any of the glasses will not dissolve, add one more tablespoon (15 ml) of water to all of the glasses, and stir again.
- When the sugar is completely dissolved, add two or three drops of red food colouring to the first glass, yellow to the second, green to the third, and blue to the last glass.

In the remaining glass we will create our rainbow:

- Fill the glass about a fourth of the way with the blue sugar solution.
- Carefully add the green solution to the glass. Do this by putting a spoon in the glass, just above the level of the blue solution. Slowly pour the green solution into the spoon, raising the spoon to keep it just above the level of the liquid, until the glass is half full.
- Add the yellow solution, and then the red one in the same manner.

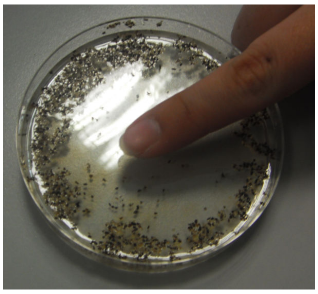
What do you notice about the coloured solutions?

How does it work?

The amount of sugar dissolved in a liquid affects its density. The blue solution has the most sugar dissolved in it and is therefore the densest. The other solutions are less dense than the blue solution, so they float on top of it. The densities of the solutions should be very close however, and the solutions are miscible, so you will see that the layers do not form well defined boundaries as in the first experiment. If done carefully enough, the colours should stay relatively separate from each other.

What do you think will happen if you stir up the liquids in the glass?

Runaway Pepper



You will need:

Bowl or a shallow dish
Pepper
Washing up liquid

What to do:

- Fill the bowl with tap water.
- Sprinkle the pepper on to the surface of the water.
- Stick your finger in (nothing should happen).
- Put a small amount of washing up liquid onto your finger tip and stick into the centre. What happens?

How does it work?

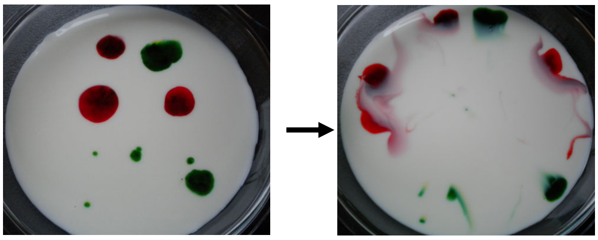
The surface tension of water is caused by the attraction of water molecules to each other, just as a magnet is attracted to things of metal. This attraction that the molecules have for each other is particularly strong on the surface or the top of the water, because the molecules have nothing above them to be attracted to and so they pull harder to the sides. This pulling creates a "skin" on the surface of the water. It is surface tension that allows insects to walk on water.

The surface tension on the water is what allows the pepper to float. When the detergent is dropped into the water, it dissolves into the water and makes the surface tension weak. The water’s surface tension force is stronger than the detergent and water mixture’s force, so the water pulls away from the soap and carries the pepper along with it!

This experiment can also be done with paperclips or any small items that will float on water.

Tie-Dyed milk

You will need:



Shallow bowl
Milk (enough to cover the bottom of the bowl)
Food dyes
Washing up liquid

What to do:

- Pour the milk into the bowl until the bottom is covered
- Put drops of the food dyes onto the milk
- Put a drop of washing up liquid into the centre of the bowl
- If nothing happens use several more drops.

How does it work?

This experiment uses the same principles of surface tension as the "Runaway Pepper" experiment.

At the start when the food dye is put on it isn't free to move around the milk. This is due to surface tension. Washing up liquid is a soap and soaps disrupt surface tension. So when you add the soap the food dye is free to move around creating the swirling effect that you see.

Where to find the supplies

Borax can be bought in pharmacies (you may have to ask them to order it in) for approximately €1.50 for 100g.

Iodine solution can also be bought from pharmacies.

All other supplies can be found in supermarkets or hardware shops.

Contact Details

If you have any problems or questions you can contact us by email at:

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We also have a website where you can find more information and variations on the experiments, along with an electronic copy of this booklet.

www.nuigalway.ie/kitchenchemistry

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