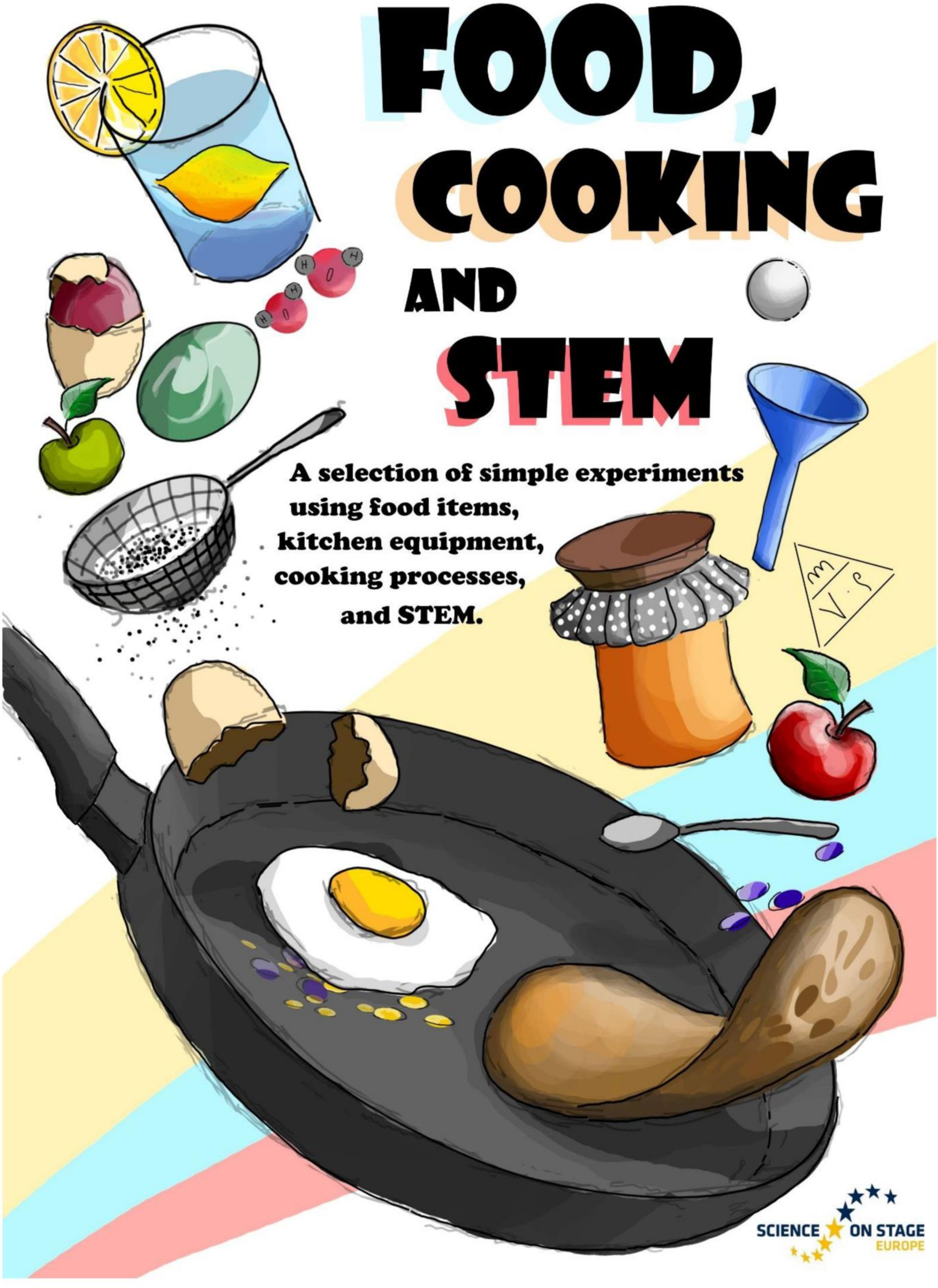
FOOD, COOKING AND STEM

A selection of simple experiments using food items, kitchen equipment, cooking processes, and STEM.



SCIENCE ON STAGE EUROPE

Foreword

FOOD, COOKING and STEM is the product of a brainstorming session at the Science on Stage Festival in Prague in March 2022, when around 15 teachers from all over Europe decided that sharing our ideas around the context of food would be useful, given that this is a common topic to us all.

Over the next year or so we will produce a series of experimental sheets, giving introductions to different areas of the science curriculum, using everyday “food” items and cooking processes. We have divided our posts into several sections so that each one will contain some material suitable to all stages of school education and STEM subjects.

The first section covers some simple experiments that use “food items”. Many of these are familiar experiments, which ordinarily would be demonstrated with science laboratory apparatus. However, we show how they can be performed with many items found in the kitchen and supermarket.

Our next section will be, “the chemistry in cooking and ingredients”. We hope then to look at some experiments which use everyday kitchen items such as pans, pressure cookers and microwaves. By then we hope that we will have thought of some more ideas, or inspired others to share.

Thank you for downloading this. We hope you find some inspiration in the following page and will possibly feel inspired to add some ideas of your own!

David (UK), Nuria (Spain), Rute (Portugal), Emma (UK)

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Science on Stage Europe brings together science teachers from across Europe to exchange best practice and teaching ideas and concepts with passionate colleagues from over 30 countries. Science on Stage Europe believes that the best way to improve science teaching and to encourage more schoolchildren to consider a career in science or engineering is to motivate and inform their teachers. The non-profit organisation was founded in 2000 and reaches 100,000 teachers Europe-wide.

Contents

Credits

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Cover illustration by Kristina Dovalova

Floating Fruit

Experiments exploring density
Science: Average density compared with water

FOOD, COOKING AND STEM

AGE RANGE
Primary /Secondary

SCIENCE PRINCIPLE
Average density, floating and sinking

EQUIPMENT/MATERIAL NEEDED
- Beakers and water
- Assortment of fruit

Description

The basic principle here is to use fruit (and/or pieces of fruit) to examine the way in which the fruit floats (or sinks).

1. Place an unpeeled and a peeled orange in water.
2. Place a lemon and a lime in water.
3. Place a conference pear and a apply in water.
4. Place half an orange in water.

Conclusion/Result

1. The unpeeled orange floats because of its thick pithy skin whereas the peeled orange sinks. The average (relative) density of the unpeeled orange is less than 1, whereas the relative density of the peeled orange in greater than 1 so it sinks. The orange peel floats, it acts like a buoyancy aid for the orange.
2. The lemon floats but the lime sinks. This is because a lemon has a fairly thick skin lowering its average density, whereas the skin of a lime is comparatively thin.


Oranges


Lemon and lime


Lemon and lime skin comparison

Floating Fruit

Experiments exploring density
Science: Average density compared with water

Floating apple and pear which has sunk

3. A conference pear sinks but an apple will float. Children seem to know this because of the game played with a floating apple at the end of October. A pear tends to be made of a much denser material and so it sinks.
4. The orange floats with the cut side downwards (upside down to some!) because this is the heaviest part of the orange.

Half orange, floating with the cut side downwards, held that way because of the less dense pith

Top Tips: Know your fruit before trying these experiments. Sometimes old fruit will have dried out which changes what happens. Fruit can vary depending on its age and variety.

Contributor: David Featonby, UK (da.featonby@gmail.com)

Floating and Sinking

Soda cans
Science: Increased density due to high sugar content

Age Range
Primary /Secondary

Science Principle
Average density, floating and sinking

Equipment/material needed
- Unopened cans of regular soda of different varieties
- Unopened cans of diet soda of different varieties
- Large aquarium or sink

Description

The basic principle here is to use different kinds of soda cans to examine the way in which they float (or sink).

1. Fill the aquarium or sink almost to the top with water.
2. Place a can of regular soda into the water.
3. Continue placing all the different cans of soda, the regular ones and the diet ones, into water in the same container.

Conclusion/Result

1. The cans of soda have exactly the same volume, or size. But their density differs due to what is dissolved in the soda. Regular soda contains sugar as a sweetener. If you look at the nutrition facts on a can of regular soda, you will notice that it contains sugar, a lot of sugar. In some cases, a 330 mL can of regular soda will contain 35 g of sugar.
2. Diet sodas, on the other hand, use artificial sweeteners such as aspartame. These artificial sweeteners may be hundreds of times sweeter than sugar, which means that less than a few grams of artificial sweetener are used in a can of diet soda.
3. The difference in the amount of dissolved sweetener leads to a difference in density. Cans of regular soda tend to be more dense than water, so they sink. Cans of diet soda are usually less dense than water, so they float.

Floating and Sinking

Soda cans

Science: Increased density due to high sugar content

Top tips: Make sure that no air bubbles are trapped under the can when you place it in the water. In case, you don't see very clearly the difference of density, you can always add some salt to the water in the container.

Fair test: Are you sure that the two cans are identical, i.e. are both made of the same material? How can you be sure that the same volume of drink is in each can?

Warning: Manufacturers often change the specification of cans and content.

Internet links: https://web.physics.ucsb.edu/~lecturedemonstrations/Composer/Pages/36.34.html

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Smarties – Dissolving and Melting

Is there a difference?

Science: Latent heat needed for a solid to melt

FOOD, COOKING AND STEM

AGE RANGE

Primary /Secondary

SCIENCE PRINCIPLE

Latent heat for a solid to melt

EQUIPMENT/MATERIAL NEEDED

- Sugar coated chocolate mini sweets (Smarties)

Description

Take a chocolate sweet and let it slowly “dissolve” in your mouth, noting the temperature you think that the sweet “feels” as it softens.

Smarties! On the right showing half eaten sweet with chocolate inside

Conclusion/Result

At first the colouring of the sweet dissolves off and the sweet turns white.

The sugary coating then dissolves leaving the chocolate. At these stages the sweet and mouth appear to be at the same temperature. The sweet feels neither warmer nor cooler.

The chocolate then starts melting, (mouth temperature approx. 38° C, melting point of chocolate about 31° C). In order to melt, the chocolate needs to take in heat from its surroundings, known as latent heat. So, the chocolate draws heat from your mouth and so the mouth senses that the chocolate is cool.

Top Tips: The sweets must “dissolve” slowly to get the best effect. The apparent temperature drop is small so some children will find it difficult to detect.

An alternative is to use “chocolate buttons”, discs of solid chocolate, and just rest them on your tongue. An extension is to try different types of chocolate and see if you can relate the “feel” to any differences in the melting points

Internet links: This experiment is included in Ruth Wiltshire’s and Alison Alexander’s IOP food experiment sheets

https://nustem.uk/wp/wp-content/uploads/2016/07/Food-Sheets-Combined.pdf

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Marshmallows - Air Pressure

Demonstration of pressure effect

Science: Effect of changes in pressure on volume

AGE RANGE

Primary /Secondary

SCIENCE PRINCIPLE

Boyle's Law

EQUIPMENT/MATERIAL NEEDED

- Coffee saver vacuum container (or a standard vacuum pump)
- Marshmallows

Description

The new marshmallows from the packet are placed inside the vacuum container and the pressure is reduced, and we observe what happens. After a while the air can be let into the container again and once more, we observe what happens.

A variation is to join and decorate several of the marshmallows as shown in the photograph. This inevitably leads to greater interaction with young students.

Marshmallows in packet and on bench beside the kitchen vacuum pump

Marshmallows modelled into a bear shape

Conclusion/Result

Marshmallows are sugar and air! The air is in bubbles inside the sweets. You can remove a lot of the air from the container using the pump, but the air in the bubbles stays trapped, however the external pressure on them is reduced. Therefore, the bubbles enlarge, making the marshmallows themselves get bigger.

Marshmallows - Air Pressure

Demonstration of pressure effect
Science: Effect of changes in pressure on volume

Normal pressure

Normal pressure

Low pressure, marshmallows have expanded

When the pressure is increased again by letting air return to the container the marshmallows shrink once more, often beyond their original size.

What else could you put inside this container to demonstrate interesting effects?

Could you work out the reduction in pressure from the change in size of a marshmallow?

Extra: What happens when you put marshmallows in a microwave oven? The mallows will expand again, but for a different reason. Moisture in the mallow evaporates and increases more gas into the bubbles which consequently expand. The bubbles have more gas inside and so are bigger at normal atmospheric pressure.

Internet links:
www.scientificamerican.com/article/puffing-up-marshmallows

www.youtube.com/watch?v=bWd31AefKns

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Spinning Eggs

Raw and hard-boiled, what is the difference?
Science: Inertia and rotation, solids and liquids in a container

FOOD, COOKING AND STEM

AGE RANGE
Primary /Secondary

SCIENCE PRINCIPLE
forces, conservation of angular momentum, vector products

EQUIPMENT/MATERIAL NEEDED

- Raw and hardboiled eggs

Two fresh eggs, but one has been boiled so that it is solid inside. Which one is raw, and which is hard-boiled?

Description

1. How can you tell the difference between fresh and hard-boiled eggs without breaking them? The answer is to place them on a horizonal smooth surface and spin them, and then stop the spin by touching the egg gently and releasing immediately.
2. Can you spin a hard-boiled egg so that it stands on its end? The answer is yes, by spinning it as fast as you can when lying horizontally on a slightly rough surface, so that it erects itself!

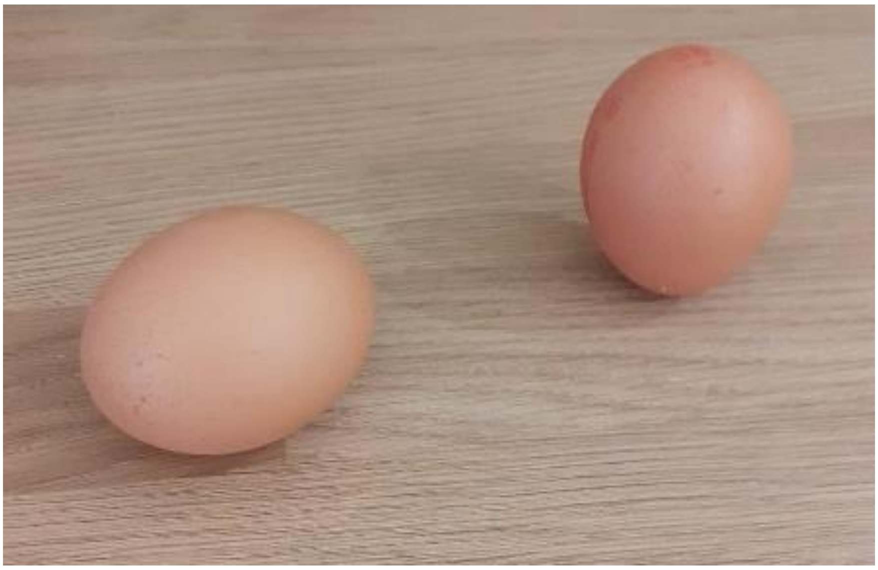
Conclusion/Result

The hard-boiled egg is much easier to spin because it is solid compared with the raw egg. However more noticeable is that after being stopped the hard-boiled egg remains stationary but the raw egg starts moving again. That is because the raw egg contains fluid, which continues to move even when the egg is momentarily stationary.

Spinning an egg shape horizontally so that it erects itself and stands on its end is harder to explain and follows the theory similar to the "tippe top". A combination of the spin of the egg and the frictional couple between the egg and the surface leads to an erecting couple which can stand the egg up as it continues to spin rapidly. An interesting discussion on the conservation of angular momentum can follow.

Spinning Eggs

Raw and hard-boiled, what is the difference?
Science: Inertia and rotation, solids and liquids in a container



A spinning hard boiled (solid) egg is able to erect itself. It needs to be spun rapidly on a slightly rough surface.

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Pepper and Detergent - Surface Tension

Get away with dirt and bacteria/viruses

Science: Reducing surface forces using detergent

AGE RANGE

Primary /Secondary

SCIENCE PRINCIPLE

Varying surface forces on a liquid

EQUIPMENT/MATERIAL NEEDED

- Plate
- Water
- Pepper
- Dish detergent

Description

1. Fill up a dish with water.
2. Sprinkle some pepper in it, so it spreads over the surface
3. Drop a drop of dish detergent into the centre of the dish and observe what happens to the pepper.

Conclusion/Result

When you drop a single drop of dish detergent the pepper will be pulled away to the edge of the plate, leaving a clear patch in the centre of the dish. The dish detergent modifies the surface of the water.

The skin on the surface of water is quite strong (surface tension) but the soap solution weakens this strength thus the water on the edge of the dish pulls the soap out into that thin layer, taking with it the pepper. This explains why washing in soapy water is more effective when cleaning as the reduced surface tension allows the water to penetrate more easily as the surface tension is lowered.

Pepper and Detergent - Surface Tension

Get away with dirt and bacteria/viruses

Science: Reducing surface forces using detergent

Top Tips: A great experiment to help explain why and how we should keep our hands always clean.

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Sunset in the Kitchen…

…with milk and cookies

Science: Dispersion of light

Age Range

Primary /Secondary

Science Principle

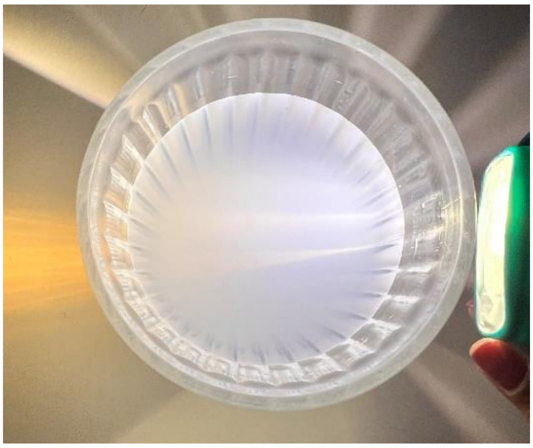
Dispersion of light

Equipment/material needed

- Clear glass cup (or transparent plastic box)
- Tap water
- A few drops of milk
- Flashlight
- Biscuits (to eat)

Description

1. Fill the clear glass cup (or the transparent plastic box) with tap water.
2. Switch on the flashlight and shine the light on one side of the glass.
3. Add a few drops of milk and stir until it is possible to see a beam shining through the mixture.
4. Look at the beam from the side, the top and from the end of the cup.



Conclusion/Result

When we look from the side, we see the bluish-white mixture of water and milk. When we look at the opposite side of the flashlight, we see the mixture with an orange colour.

In the kitchen

Sunset in the Kitchen…

…with milk and cookies

Science: Dispersion of light


In the lab

The mixture of water and milk is serving as a model of the atmosphere. The white light (consisting of red, orange, yellow, green, blue, and violet light) passing through a mixture of water and a few drops of milk is scattered. The shorter the wavelength of light, the more it is scattered. Thus, blue light is much more scattered than the orange and yellow light. The red light is the least scattered and continues its original direction.

When we look at the sky, we see blue, the light that suffers the most dispersion.

At sunset, when the light crosses a greater layer of the atmosphere until it reaches our eyes, most of the colours of white light have been scattered, except red, orange and yellow. That is why at sunset we see the sun in red-orange colours.

Top Tips: We can do this activity, watching the sunset, while drinking a glass of milk and enjoying some cookies.

Internet links: https://youtu.be/9v6nE887R18

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Secret Messages with Jelly

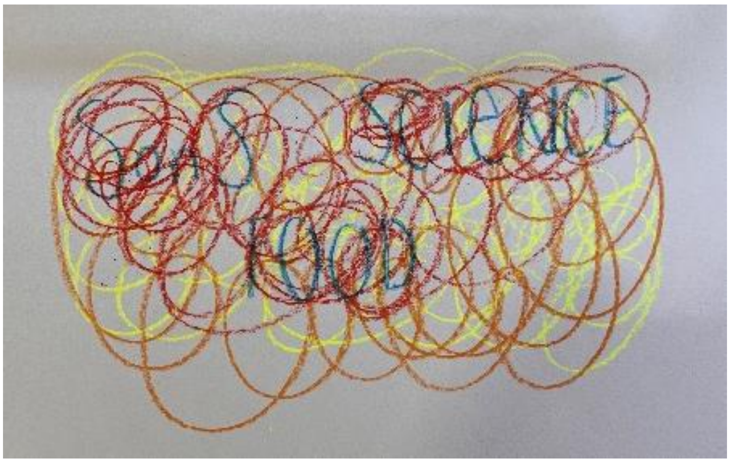
Absorption of light with different colours
Science: Using jellies as filters

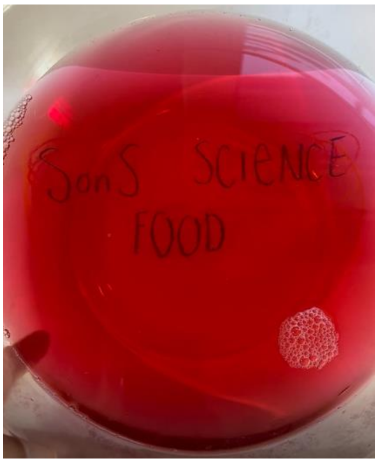
AGE RANGE
5+ to senior
SCIENCE PRINCIPLE
Absorption of light

EQUIPMENT/MATERIAL NEEDED
- Red jelly (strawberry or raspberry)
- White sheet of paper or card
- Different coloured pencils/crayons (at least red and blue)

Description

1. Prepare the strawberry jelly as described on the package and place it in a transparent container.
2. Draw a picture or write a message on a white sheet of paper/card using a blue pencil or crayon.
3. Hide the drawing or message by colouring over it with red pencil/crayon, using circular movements (do not paint evenly, as the result will not be the same).
4. Use the jelly to reveal the hidden pictures or message placing the container with the jelly on top of the message.


Secret message



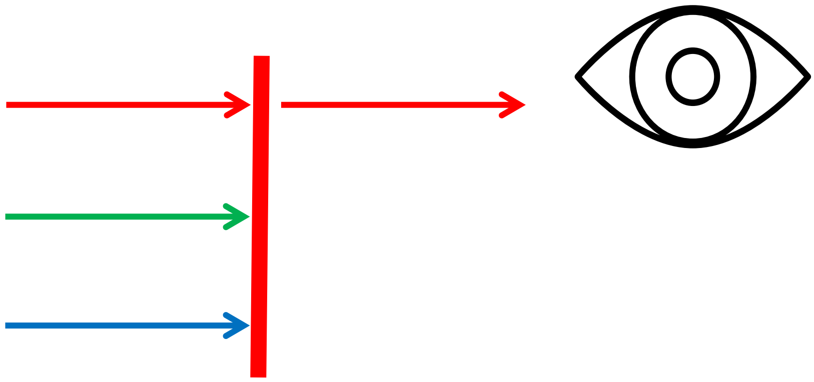
Message through the jelly

Conclusion/Result

Primary colours of light are red, green and blue. When these three colours are mixed, we have white light. It is the colour of the reflected light which determines the colour of the object. In our eyes we have cones sensitive to red, green and blue. When we see a shiny, red apple, the red we see is just how our brain understands the light bouncing from it. When the light in the kitchen shines on the apple, the red light bounces off toward our eyes. The blue and the green are absorbed.

In our eyes we have cones sensitive to red, green and blue. When we look at a red apple, it makes the cones sensitive to red excited! And when excited, they send a message to our brain that says, "This is red".

When the light shines on a blue plate the blue light bounces off toward our eyes. The red and green light are absorbed. The strawberry jelly acts like a filter, a transparent material that absorbs some colours and allows others to pass through. Using filters (like the jelly) to observe objects causes them to be seen in different colours. The red jelly transmits only red light and absorbs all other colours, i.e. it blocks green and blue light and only red light can get through to our eyes. Our message written with blue pencil and hidden with red pencil will be revealed through the jelly. With our message the white paper and the red scribbles looks red, and the blue message looks black, so it's very easy to see.



Top Tips: A great activity for summer days, for Valentine's Day and any time you want to surprise someone or have some jelly to eat.

Important: Always adhere to health and safety rules of your school!

Internet links: https://youtu.be/bdJlNM52MNs

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Tissandier with Tomatoes

Exciting experiment from the past (and present!)
Science: Moments and Inertia

AGE RANGE
Primary /Secondary

SCIENCE PRINCIPLE
Moments and Momentum

EQUIPMENT/MATERIAL NEEDED

- Long bread stick
- Tomatoes
- Fresh eggs for extension

Description

This is an experiment made famous by Gastov Tissandier using a wooden rod and wine glasses. Here we have the option of using squashy tomatoes or eggs.

A long bread stick is balanced between two large tomatoes with two small tomatoes balanced on the top. You will have to cut out a little bread to get everything balanced. You then need either a stick to break the bread or you can karate chop it with your own hand.

Smash the bread at its centre and watch what happens to the tomatoes. Will the big ones be squashed with the force of your stick/hand?

The experiment can also be demonstrated with other items, for example a thin wooden rod balanced on fresh eggs in egg cups. To be sure to get a clean break it may be helpful to weaken the rod at its centre by making a small half saw notch).

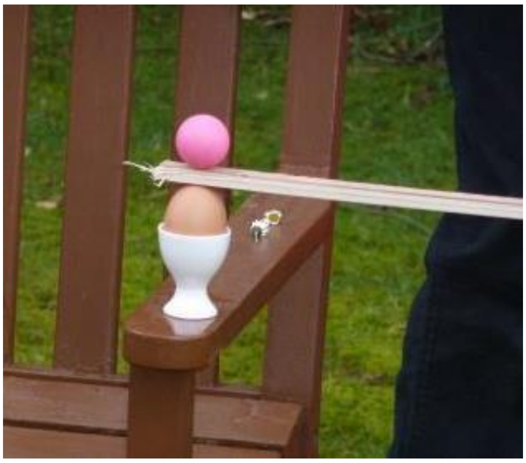
Conclusion/Result

The force is not transmitted to the ends of the bread/rod if they are broken quickly, i.e give a sharp strike!

The bread /rod is broken in two at its centre and each half thereafter acts independently, rotating about its own centre of mass. Thus, when the central part moves downwards the rod/bread rotates about the (new) centre of mass thus the ends lift off the tomatoes/eggs. So the eggs/tomatoes are unbroken. The items on the upper surfaces of the half rods/bread are therefore projected upwards to add to the effect.

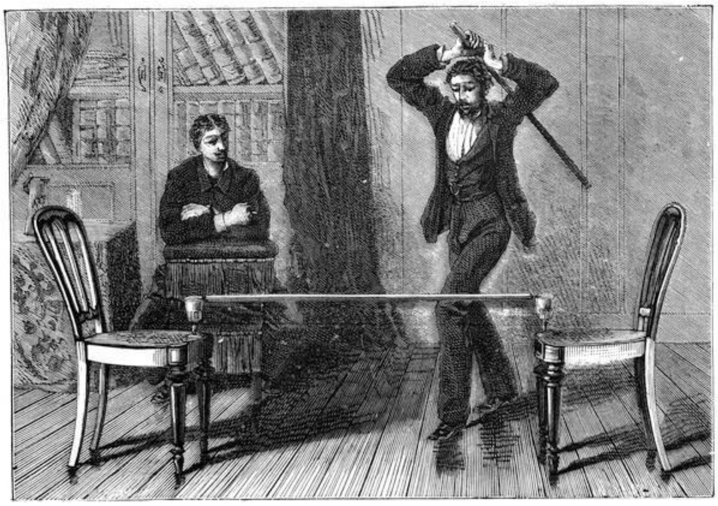
Tissandier with Tomatoes

Exciting experiment from the past (and present!)
Science: Moments and Inertia



Above, repeating the experiment using eggs. I usually make a small saw cut at the midpoint of the thin wooden rod to ensure a successful break at the centre.

Another way to do it, without using eggs, tomatoes etc is using thin threads to suspend the rod.



Internet links: For a short discussion of the historic experiment see Gaston and Albert Tissandier's historic experiment
https://commons.wikimedia.org/wiki/File:Scientific_amusements(1890)_Experiment_to_illustrate_inertia.jpg

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Spaghetti Challenge

Science: Pressure and pressure transmission

AGE RANGE
Primary /Secondary

SCIENCE PRINCIPLE
Forces

EQUIPMENT/MATERIAL NEEDED

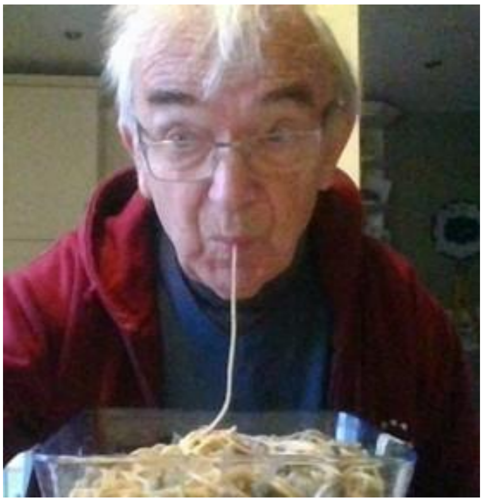
- Raw Spaghetti
- Some cooked for an extra

Description

It is almost impossible to bend a single strand of raw dried spaghetti and snap it into two separate pieces by bending it as shown in the photograph. Inevitably the strand breaks into three pieces. Two larger and one small piece that comes from the centre.

Taking a single strand of spaghetti and attempting to snap it into two pieces by bending the strand

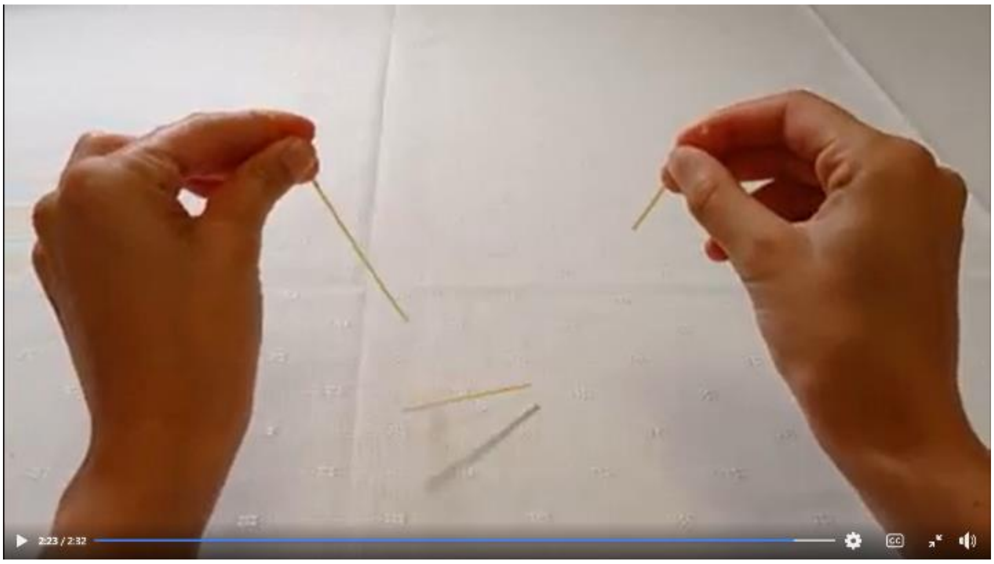
In a second totally unrelated experiment, except that it uses spaghetti, here is a question. How can it be that you can "suck" cooked spaghetti covered in lubricating tomato sauce into your mouth. I was always taught that we shouldn't use the word "suck". When drinking with a straw, it is the atmosphere that, for example pushes liquid up a straw when the pressure in your mouth is reduced. So, we have all done this, but how does it happen with spaghetti, the atmosphere cannot be pushing on the end of the spaghetti, it is flexible?



Taking a single strand of spaghetti and "sucking" it into my mouth!

Conclusion/Result

The raw spaghetti is under “bending” tension all the way along its length, but most noticeably near the centre where it is most curved. Even so it never seems to break at the exact centre where is most curved, but a centimetre of so away from the centre, immediately followed by a reaction back of the longer piece which causes a second break, leaving the strand in three pieces, not two.



Spaghetti broken into three pieces

The difference in pressure across the length of the cooked spaghetti between the inside and the outside of the mouth accounts for the movement of the spaghetti length.

Internet links:

Facebook group “What Happens Next Experiments? Dates 28.7 Q 29/7 A

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Cola Roller

Science: Forces

AGE RANGE
Primary /Secondary
SCIENCE PRINCIPLE
Forces

EQUIPMENT/MATERIAL NEEDED
- Unopened carbonated drinks can
- Concave shaped ramp

Description

First you need your ramp. You can use thin plywood fixed at its centre to a second piece of thicker rigid wood. The flexible plywood is raised at its ends with books to create the concave surface.

Ramp and cola can ready to roll

Place the can at one end of the ramp and let it roll back and forth counting the number of times it oscillates. You then give the can a good shake and ask what will happen if you repeat the experiment, counting the oscillations.

Conclusion/Result

The can makes approximately half the number of oscillations the second time as the first. Most people may get that right but when it comes to an explanation there can be many theories, most of which are incorrect.

1. The mass of the can changes because of the bubbles now formed inside. (INCORRECT; how can the mass change, nothing has gone in or out!)
2. The increase in pressure inside the can because of the shaking increases any resistance. (INCORRECT: Contrary to what is expected the pressure inside does NOT change, what we have done is make it more likely that bubbles will form, and the dissolved carbon dioxide is released)

3. The bubbles inside the can produce a greater drag on the liquid inside slowing it down. (CORRECT)

Top Tips: The experiment can be performed with a small clear plastic bottle and the bubble will be seen. Using the can does however add mystery to the experiment.

This can be great fun with younger children by getting them to count the oscillations out loud. Try different languages to for some cross curricular work!

Internet links:

See “What Happens Next Experiments” group on facebook. “Rolling Cans” 13th/14th June 2020

Physics Education Rolling cans—the question D Featonby and F Vitkoczi 2017 Phys. Educ. 52 037001 also Rolling cans—the answer D Featonby et al 2017 Phys. Educ. 52 047001

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