

# Make perfume like TAPPUTI-BELATEKALLIM

Tapputi-Belatekallim was the world's first recorded **CHEMIST**. She lived in Mesopotamia, in modern-day Iraq, and worked as a royal perfume-maker. We know about her because she is mentioned in an ancient piece of writing, known as a cuneiform tablet, which was written around 1200 BCE!

To make her perfumes, Tapputi would mix flowers, natural oils, herbs and tree sap with water and other liquids, before 'distilling' the mixture. Distilling is when you separate out different substances by boiling a mixture until it evaporates (turns into a gas) and then cooling it so that the water vapour turns back into a liquid. The equipment you need to do this is called a 'still', and Tapputi used, and possibly even built, the first ever documented still for this process.

Tapputi's perfumes weren't just for smelling nice. Ancient people believed that these beautiful scents could travel up to the gods and make them happy. They also used perfumed ointments to heal injuries and illnesses.

Tapputi needed a deep understanding of chemistry to do her job. A lot of the equipment and ingredients for the perfumes were originally used in the kitchens, and by women. It is likely that most early chemists were women.

Tapputi was revolutionary in her methods, even creating a new technique to make her perfumes last longer and smell brighter than before. Today, chemical engineers use many of the same techniques that Tapputi used 3,000 years ago.



## NOW IT'S YOUR TURN!

### What you will need:



Flower petals such as rose or honeysuckle



Herbs such as lavender or rosemary



Muslin or cheesecloth



A small colander



A cooking pot with a domed lid



**1** Place your flower petals and herbs on a piece of muslin or cheesecloth. Ask a grown-up to help you crush them with a rolling pin or mallet, then cover the petals up with the rest of the muslin or cheesecloth.



**2** Add a small amount of water to the cooking pot (around five centimetres deep) and place a colander inside the pot so that the water level sits just below the bottom of the colander.



**3** Place the muslin or cheesecloth parcel inside the colander and then put a small glass bowl on top of it.



**4** Put the lid on top of the pot, upside down so that the domed lid is directly on top of the small glass bowl.

**5** Ask your grown-up to help you heat the pot on a low heat. As the water heats up, it will evaporate and condense (turn back into liquid) when it touches the upside-down lid.

**TIP:** Place ice in the middle of the upside-down lid to speed up the condensation!



**6** Your perfume will drip from the upside-down lid into the small glass bowl. When all the water in the pot has evaporated, turn the heat off and leave everything to cool.

**7** Transfer your distilled perfume into a small bottle or jar and enjoy!



# Make a rainbow like KAMĀL AL-DĪN AL-FĀRISĪ

Kamāl al-Dīn al-Fārisī was a Persian **ASTRONOMER**, born around 1267, who used a special object called a camera obscura to study rainbows.

A camera obscura is a dark room, or box, with a small hole in one wall or side. Because the light comes in from the hole, an upside-down picture of what is outside is created on the opposite wall.

Al-Fārisī used a camera obscura to look very closely at how a rainbow is formed. Previous scientists thought that rainbows were made from sunlight reflected by clouds. Al-Fārisī thought differently – he believed that a ray of light from the Sun would bounce from raindrop to raindrop and become bent, creating the rainbow.

Al-Fārisī carried out an experiment to prove his theory. He filled a large spherical vase with water, and placed it in a camera obscura, to create rainbows.



It is possible that camera obscuras date back to before 400 BCE, and they have helped us understand how light travels, as well as how our eyes work.

But he wasn't able to work out exactly why this happened, nor explain why or how the bending of light could make the colours in the rainbow.

Before Al-Fārisī, people thought you could get different colours of light by mixing light and dark, whereas Al-Fārisī went on to prove that the colours were formed by mixing and bending the light on a dark background.

## NOW IT'S YOUR TURN!

What you will need:

A small mirror



A glass



A piece of white paper



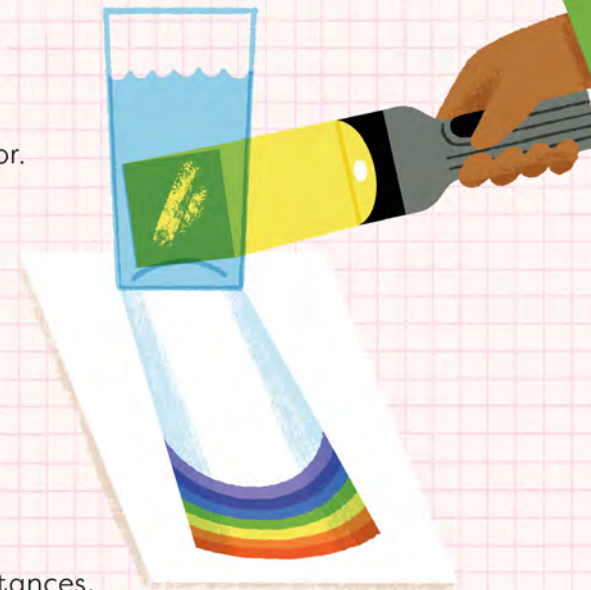
**1** Fill a glass with water and put the mirror in the water.

**2** Take the glass and the paper to a place where there's not much light. Shine the torch toward the centre of the mirror.

**3** Hold the glass above the paper or place it on the paper.

**4** Watch the torch light pass through the glass, bending the light and forming rainbows on the paper.

**5** Experiment with different distances, heights and angles to see if you can make better rainbows.



# Create a pendulum like GALILEO GALILEI

Galileo Galilei was born in 1564 in Pisa, Italy. When Galileo was 19, he was at the cathedral in Pisa watching a chandelier swinging. He timed it using his pulse and realised that, as the chandelier swung, it always kept the same time. Back then, clocks were not very reliable. As Galileo watched the chandelier, he realised how he could make a clock keep time much better: by adding a pendulum!

Galileo was working as a **MATHS** professor when he heard about the invention of the telescope. He decided to make his own, bigger version, with better magnifying power. It allowed him to see objects in space in ways that no one had ever been able to! In 1610, Galileo saw Jupiter and its four largest moons. He saw craters on the Moon, and the stars of the Milky Way.



The Roman Catholic Church, who held a lot of power and could act like the police, didn't agree with these ideas at all. They gave Galileo a strong warning, but he didn't change his mind, and he ended up being arrested for his views.

As he got older, Galileo became blind, but he continued his work until he died in 1642. It wasn't until 350 years after his death that he was pardoned by the church for supporting the fact that everything orbited around the Sun.

At this time, most people believed that all the planets moved around the Earth. Galileo disagreed with this. He had seen the moons moving around Jupiter through his telescope, and he loudly supported the views of an astronomer called Copernicus, who had declared that the planets, including Earth, move around the Sun.

## NOW IT'S YOUR TURN!

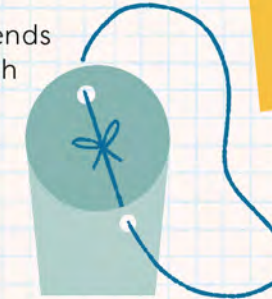
### What you will need:

- \* A paper cup
- \* Scissors
- \* String
- \* Sticky tape
- \* A broom handle or long stick
- \* 2 kitchen chairs
- \* Salt or sand (enough to nearly fill your cup)
- \* A clock or watch

1 Ask a grown-up to poke a hole on either side of the rim of the cup.



2 Cut a long piece of string. Thread the ends of the string through the holes then tie the ends together to make a large loop, as if it is a handle for the cup.



4 Fill the cup with salt or sand.

**TIP:** You could fill the cup with paint and poke a hole in the bottom of the cup, and as the pendulum swings, it would create pendulum paint art beneath! Just make sure you lay paper all over the floor!



3 Slide the stringed cup onto the stick or broom handle and balance the stick or broom handle across two chairs.



5 Push the cup gently so it swings from side to side, and try to measure if the swing of the pendulum keeps to time!



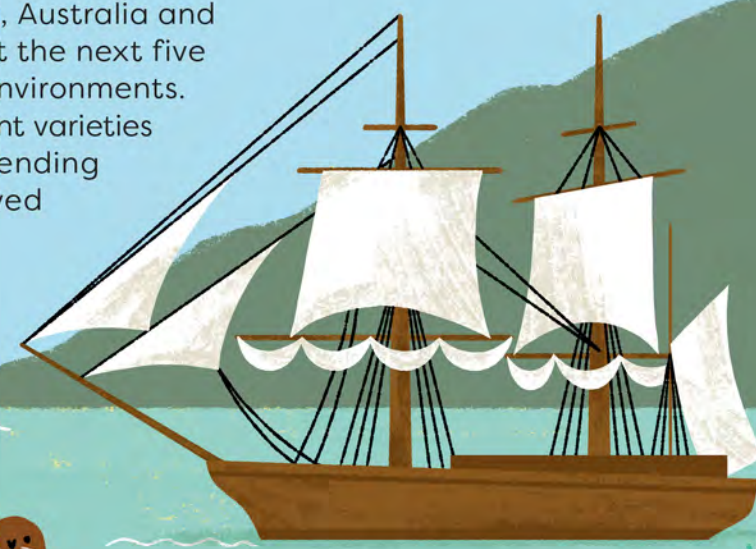
# Explore evolution like CHARLES DARWIN



Charles Darwin is famous for his theory of evolution, which is the idea that living things, including humans, have changed over millions of years to survive on our planet. He became an important **EVOLUTIONARY BIOLOGIST**.

Darwin was born in 1809 in Shropshire, UK. As a boy, he didn't do very well at school. His father wanted him to become a doctor, but Darwin didn't enjoy medical school, so instead he studied theology (religion) at the University of Cambridge, spending much of his time there learning about plants, animals and nature.

In 1831, Darwin set sail on the HMS *Beagle* to South America, Australia and South Africa as part of a marine-survey expedition. He spent the next five years studying how animals and plants survive in different environments. While he was in the Galápagos Islands, he noticed that different varieties of a bird called a Galápagos finch had different beaks depending on what food they ate. The finches that liked fruit had curved beaks, while those that liked insects had pointed beaks!



Some years after he returned to the UK, Darwin wrote a book called *On the Origin of Species*, which explained his theory of 'natural selection' – the idea that all animals and plants have slowly changed, or 'evolved', over millions of years to adapt to where they lived.

At this time, most people believed that God had created humans, animals and plants as they were. These people were shocked by Darwin's ideas and his book was banned in many different countries. But over time, it became scientifically proven that all living things evolve – including humans!

Darwin has over 250 species named after him!



## NOW IT'S YOUR TURN!

### What you will need:

A flat, green surface, such as a patch of grass or a green rug



**1** Place your toilet roll tube on the scrap paper and draw around it with your black pen or pencil to create a circle. Do this 15 times, then use the scissors to cut each circle out.



**2** Colour 7 of your counters orange and 8 of your counters green. Then draw a beetle shape on top of each one with your black pen or pencil. Now you have 7 orange beetles and 8 green beetles!



**3** Lay out 7 of the orange beetles on your green surface. This is your 'starting population' of beetles. Now add 1 green beetle. This beetle has a 'gene mutation', which made it a different colour to the rest.



**4** Imagine you are a predator, such as a bird. You, as a predator, will pretend to eat the beetles that stand out the most – so take away 4 of the orange beetles.

**5** The beetles that are left have babies! Give each beetle a baby that looks like it. You will now have 6 orange beetles and 2 green beetles.



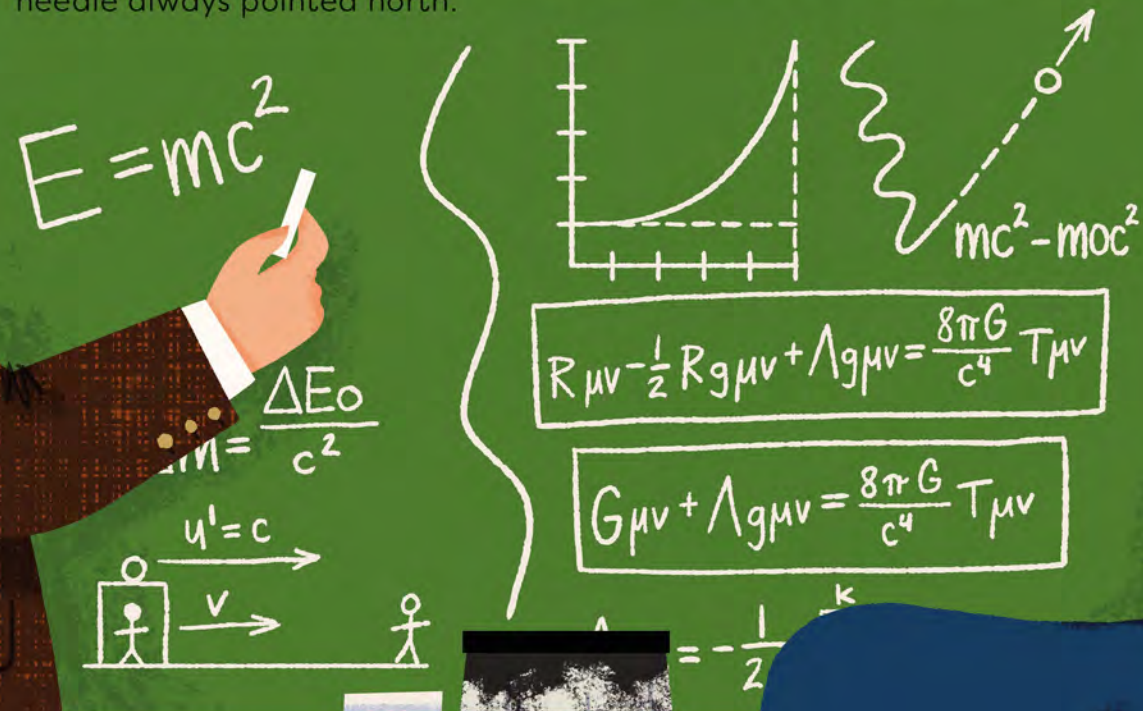
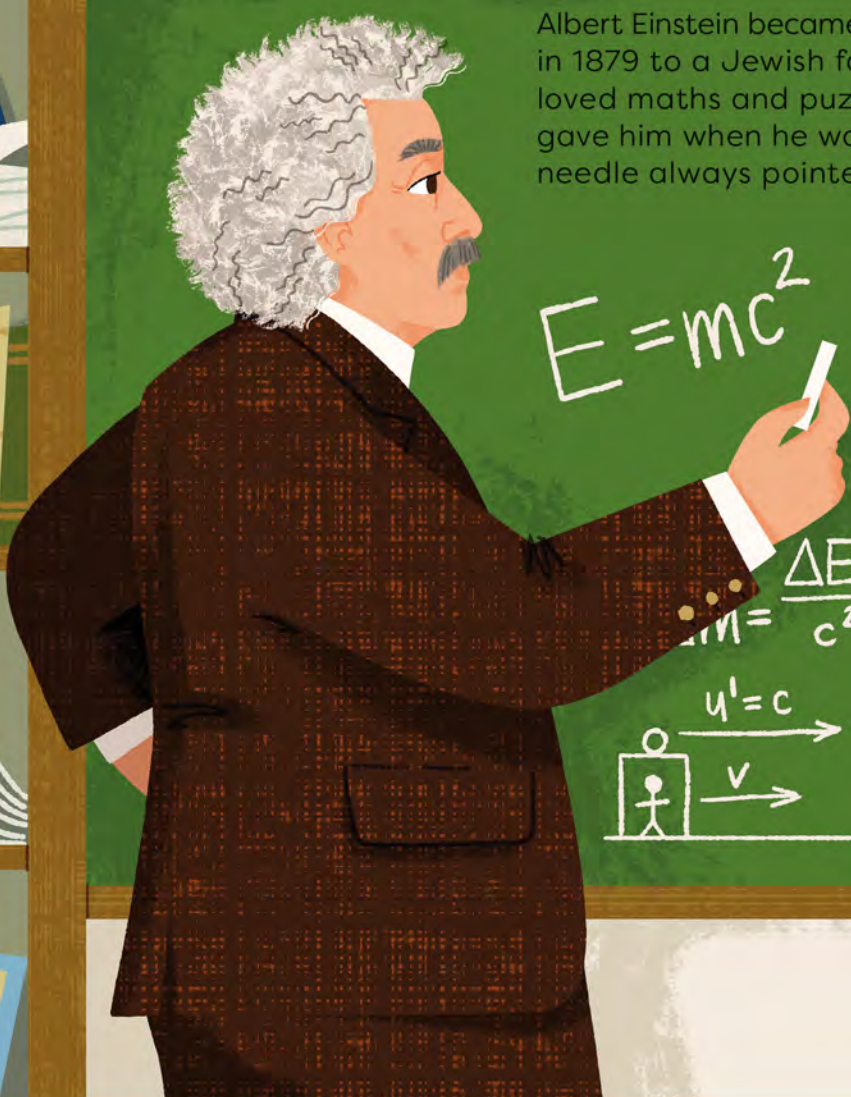
**6** Repeat steps 4 and 5! How many orange and green beetles are there now?

**7** The green beetles blend in with the grass background, so they are more likely to survive the predator! Over each repetition, the green beetles increase in number.



# Measure the speed of light like ALBERT EINSTEIN

Albert Einstein became a world-famous **PHYSICIST**. He was born in Germany in 1879 to a Jewish family. Einstein didn't do very well in school, but he loved maths and puzzles. He was fascinated by the compass his father gave him when he was five - Einstein wanted to know why the magnetic needle always pointed north.



By 16, Einstein had written a scientific paper and got a place at university to study physics and maths. He wanted to become a teacher, but no one would give him a job, so he ended up working at a patent office in Switzerland, where he recorded other people's inventions and developed some of his own, too.

Einstein shared his ideas about energy and mass with the world when he was 26. He believed that anything we see and touch can be turned into energy. His famous equation  $E = mc^2$  explained how mass, which is related to how heavy something is, can be turned into energy. Energy (E) equals the mass (m) of something multiplied by the speed of light (c) multiplied by the speed of light again ( $c^2$ ).

## NOW IT'S YOUR TURN!

### What you will need:

- \* A bar of chocolate
- \* A microwave
- \* A ruler
- \* A calculator
- \* A microwaveable plate



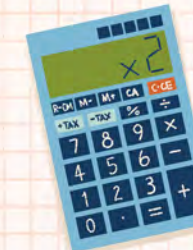
- 1 Remove the turntable from the microwave. Place your chocolate bar on the plate and put it in the microwave.
- 2 Run the microwave for about 10 seconds. Carefully remove the plate and check whether there are any melted spots of chocolate.



- 3 Repeat in 10-second bursts until melted spots appear. Make sure you don't overdo it and burn the chocolate!

**TIP:** To work out c (the speed of light) you need to multiply the wavelength by the frequency of the microwave. Wavelength is the distance between two peaks in the wave of light. Frequency is how many times the light waves move up and down per second.

- 4 Carefully use a ruler to measure the distance in centimetres between 2 melted spots that are next to each other.



- 5 Multiply the distance by 2. This gives you the wavelength of light!



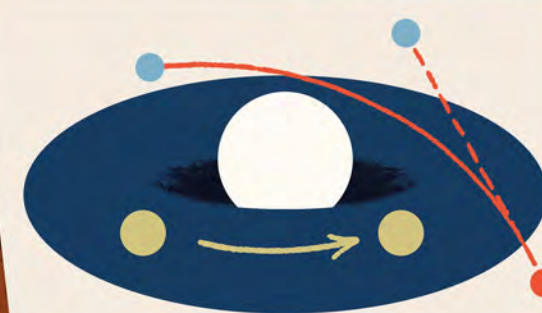
- 6 Check what frequency your microwave runs at. A standard frequency is 2.45 gigahertz. Multiply the wavelength in centimetres by the frequency in hertz, so if your microwave runs at 2.45 gigahertz, you multiply the wavelength by 2,450,000,000.

- 7 This gives you the answer in centimetres per second, but you need it in metres per second, so divide your answer by 100. The actual speed of light is 299,792,458 metres per second. What did you get? How accurate was your experiment? You may now eat the chocolate!



In 1915, Einstein published his theory of 'general relativity'. Einstein explained that gravity (the invisible force that pulls objects towards each other) was caused by massive objects in space, such as stars, bending space and time. Six years later, he won the Nobel Prize in Physics.

Sadly, in the 1930s, Einstein was forced to leave his country. The Nazis had taken control of Germany and wanted to get rid of all Jewish people. He escaped to the USA where he worked on his theories for the rest of his life. Einstein had changed how we understand space and the universe forever!



Einstein was able to show that as objects approach the speed of light, distances squash and time actually stretches!