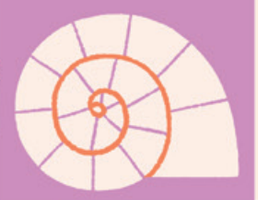
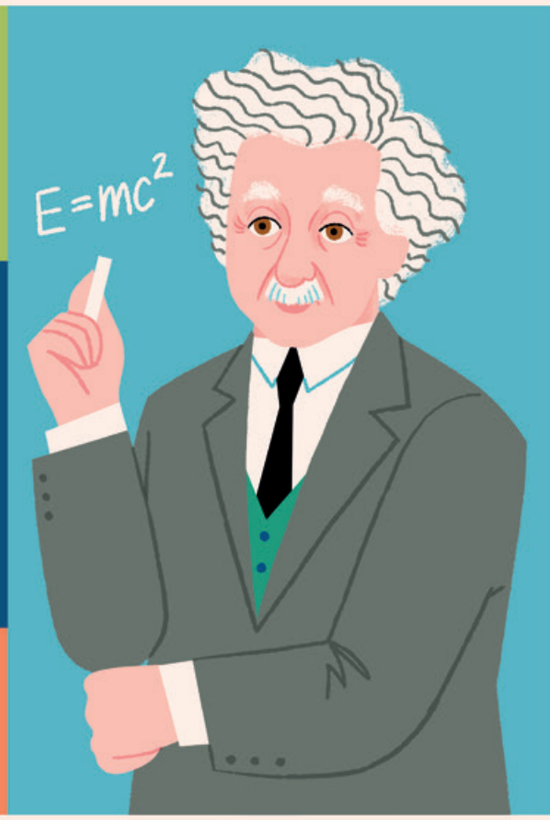
UNIVERSITY OF CAMBRIDGE

THIS BOOK WILL MAKE YOU A SCIENTIST





Try your very own science experiments inspired by 25 amazing scientists

WRITTEN BY
Dr Sheila Kanani

ILLUSTRATED BY
Ellen Surrey

nosy crow

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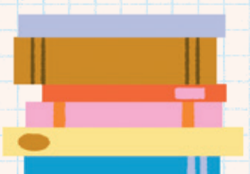

To the children of the world. You are all scientists! Engineer your own happiness and change the world with kindness.
S. K.

For all the future scientists, may this book inspire you.
E. S.

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INTRODUCTION

THIS BOOK WILL MAKE YOU A SCIENTIST! YES, YOU!

As you turn the pages, you will meet scientists from the past and the present, from different cultures, locations and places in the world. Discover biologists, chemists, physicists, astronomers, astronauts and more, who have all invented, created or discovered incredible science!

But how did they think up their exciting experiments? When did they start to wonder about how the world works? And why did these people become so fascinated by dinosaurs, birds, volcanoes and black holes? Asking questions is the first step to becoming a scientist, and finding out some of the answers might even give you some ideas to create your own experiments!

You will discover what makes a good scientist and what different scientists do. You will learn about what inspired them to study their area of science – whether that is making crystals, hunting for fossils, investigating unusual places all over the world, or even taking trips into space! Whether these scientists studied nature, chemicals, light or electricity, you can be sure of one thing: all scientists are curious and love to discover new things!

Scientists are very good at working together in teams. This is called 'collaboration', and sometimes, without teamwork, the science just can't get done! So perhaps you might like to use this book, and the experiments in it, to work with your friends and family in a team.

There are many different types of science. Some of the people in this book were the first to do their experiments. Others took what previous scientists had learned and expanded their knowledge. Some will have worked together, and others worked alone.

You may have learned about some of these ideas before, but you will also discover brand-new theories and concepts. Some of these words might be new to you, but this book is here to teach you the terms and language that scientists use!

Most importantly of all, this book will let you learn about science through doing it! After meeting each of the scientists in the book, you will be able to conduct your own experiments to create electricity like Nikola Tesla, extract DNA like Rosalind Franklin, design an aeroplane like Christine Darden, and much, much more!

Now it's your turn!
Be inspired by this book and become a scientist . . .

GETTING STARTED IN YOUR LABORATORY

From lying in the bath to soaring through space, the scientists in this book have worked anywhere and everywhere. In this book, you will meet Tapputi-Belatekallim who made herb perfumes in ancient Mesopotamia, Katia Krafft who studied volcanoes around the world and Jane Goodall who spent months in the jungle with chimpanzees!

Throughout history, many scientists have also worked from a special place called a laboratory, or lab. Inside this space, a scientist can carry out experiments on their own, or with others.

Scientists might do small experiments on the laboratory desk, or need giant computers to help them with their calculations. They might use different equipment, such as pipettes, electrical wires or magnets, or they might need nothing more than a pencil and some paper. Sometimes scientists will spend weeks on their work, and sometimes their experiments will take them a lifetime, hidden from the world until they feel that they've found the answers to all the questions they can think of! A lab can be anywhere – even in your bedroom or kitchen.

In a laboratory, scientists will usually keep their equipment, tools, books and other useful objects. They might also have personal items to keep them motivated, such as photos of the people who inspire them. What else do you think a scientist might keep in their laboratory?

WHAT WILL YOU NEED TO DO YOUR SCIENCE EXPERIMENTS?

In this book, you will read about all sorts of different things that you can use for your experiments, from toothpicks and toilet roll, to strawberries and seashells!

For many of the activities in the book, you will only need a few items, most of which can be found in the kitchen. However, you will also need some tools and materials like those on this page.

Some tools and materials you might need:

Glass cups and jars

Scissors

A pen

Colouring pencils

Card

paper

Erase

A microwave

String

A chocolate bar

Marbles or ping pong balls

A watch or stopwatch

A plastic ruler

A mirror

Keeping clean

Science experiments can be messy sometimes! It's a good idea to have an apron or old T-shirt to cover your clean clothes, and some newspaper or a wipe-clean tablecloth to protect your home.

Keeping safe

When you do your experiments, it's important to keep yourself and others safe. So, follow instructions exactly as written, make sure you tie long hair back and avoid wearing anything that might dangle down or get in the way. If you feel doubtful or worried about trying anything, ask a grown-up to help you!

And remember, you should always have a grown-up with you to complete any experiments that involve cooking, or hot or boiling water, as there is a risk of burning. Scientists need to be careful as well as clean: never eat or drink during your experiments, clean up well after they are done and always be careful with chemicals, such as surgical spirit (page 25 and 45), that can irritate your skin.

TRY, TRY AND TRY AGAIN!

Many of the scientists in this book have had to try many times to get their experiments to work successfully, making mistakes and learning from them along the way. And sometimes, just sometimes, it is the *mistake* that ends up becoming the incredible scientific discovery. You will read about one scientist who forgot to tidy up his lab before going on holiday, only to come back and realise he had created a miracle drug!

Some scientists have had to try again and again to have their ideas and experiments taken seriously. You will read about scientists who were not believed at first because of their gender or skin colour, and you will read about scientists whose findings were so incredible or unusual that people couldn't believe they were correct.

So, if you'd like to become a scientist, you will need to have the patience, confidence and determination to believe in yourself and try, try and try again!

Before you start the experiments in this book, you can practise some basic science skills. These are the building blocks for becoming a better scientist.

1 Exploration and observation

Take a walk through nature and explore your surroundings. What can you see? What can you hear? What can you smell? Use your senses to explore where you are. Everywhere is a laboratory, and this is a great way to start training your brain to think scientifically.

2 Measuring and pouring

Use different objects and ways of measuring and pouring. You could pour water from a bottle into a cup. You could weigh some food and compare it to other objects. How tall are you? How tall is a tree? Using numbers to measure is a good way to practise using scientific language!

3 Using tools

Hands-on experiments are great practice for scientific thinking. What tools might you need? Rulers, weighing scales, paperclips, pencils – these are all scientific tools!

4 Asking questions

Spark your curiosity by asking lots of questions! Think about the 'why' and the 'how' when you look at something. There are so many questions out there to ask! Why is the sky blue? How deep is the sea? Why do we dream? How clever are animals?

5 Predictions and estimations

Can you find patterns in things (such as animal prints or leaves) and then use those patterns to work out what might come next? Could you look at something and estimate how big it is, or how much of it there is? How long do you think it might take water to boil? Can you make a guess, then have a go and find out? Practise these skills and think like a scientist!

6 Gathering and recording information, or 'data'

Information is often known as 'data'. How will you gather the data you've found out? Will you write it down? Or can you draw it? Can you group different things together by colour or type, or look for the odd one out?

7 Communicating

Sharing your science helps others learn too! And words aren't the only way to communicate – you could draw pictures and charts too. What about a short video explaining what you've discovered?

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:

- Fresh water
- Flower petals such as rose or honeysuckle
- Herbs such as lavender or rosemary
- Muslin or cheesecloth
- A rolling pin or mallet
- A small colander
- A small glass bowl
- A small bottle or jar
- 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.

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

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.

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!

Measure volumes like ARCHIMEDES

Archimedes was born in an ancient Greek state called Syracuse around 287 BCE, located in present day Sicily, Italy. He began inventing machines from an early age and went on to become one of the most famous **ENGINEERS** in ancient Greece.

One day, Archimedes was asked by King Hieron II of Syracuse to solve a difficult problem. The king had given a craftsman some gold to build him a crown. However, the king wanted to check that the craftsman had really used all the gold for the crown and hadn't mixed it with cheaper silver (a common trick at the time).

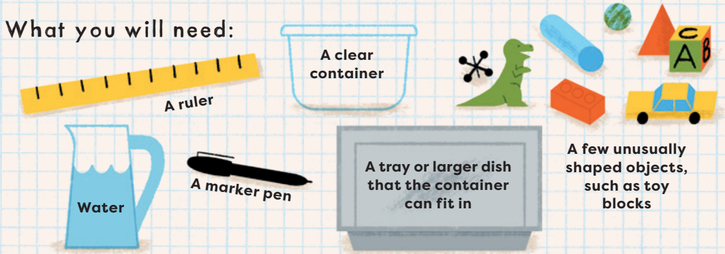
Archimedes knew that gold and silver had different densities – this means that a lump of gold weighs almost twice as much as a lump of silver of the same size, or 'volume'. But how could he calculate the volume of a crown, which doesn't have a regular shape?

Archimedes was puzzling over this when he got into the bath and noticed some water slipping over the edge. The water that had left the bath, he realised, must have the same volume as his body, an irregular shape! He could use this method to find the volume of the crown. Archimedes was so excited, he is said to have jumped out of the bath and run through the streets shouting "Eureka!" ("I have found it!")

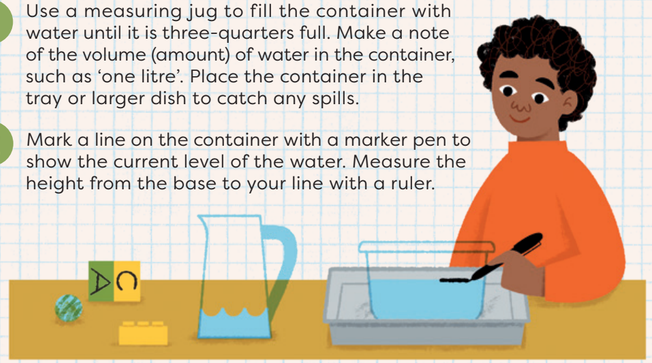
Using his knowledge of levers and pulleys, Archimedes created weapons and defences to protect the people of Syracuse from the Romans. Sadly, though, he was killed aged 75. In some stories, Archimedes was drawing mathematical pictures in the sand when a Roman soldier snuck up on him. It is said that his last words were "Don't disturb my circles!"

NOW IT'S YOUR TURN!

What you will need:



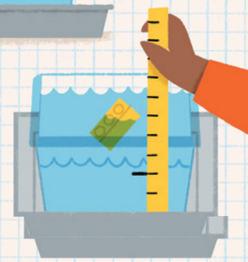
1. Use a measuring jug to fill the container with water until it is three-quarters full. Make a note of the volume (amount) of water in the container, such as 'one litre'. Place the container in the tray or larger dish to catch any spills.



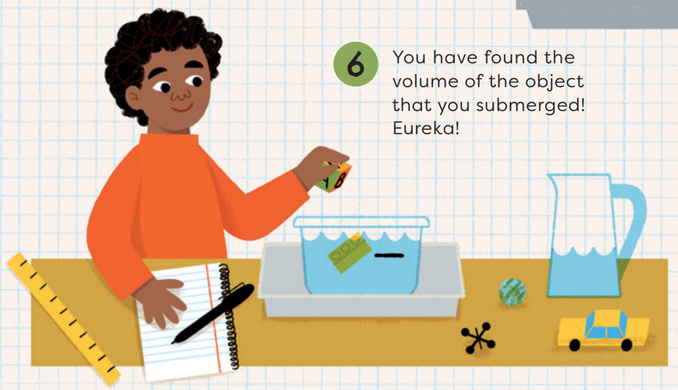
2. Mark a line on the container with a marker pen to show the current level of the water. Measure the height from the base to your line with a ruler.

3. Submerge your object in the water.

4. The water level will have risen! With a ruler, measure the distance between the new water level and the marker line you made. This is the amount of water displacement.



5. Now that you know the water displacement, you can find out what the volume of the object is with this sum: multiply the displacement by the volume of water you put in the tub, and divide that by the height you first measured.



6. You have found the volume of the object that you submerged! Eureka!

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.

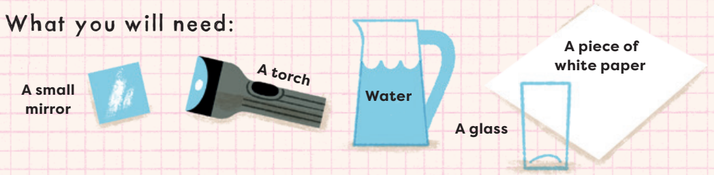
It is possible that camera obscuras date back to before 400 BCE, and they have helped us understand how light travels, as well as how our eyes work.

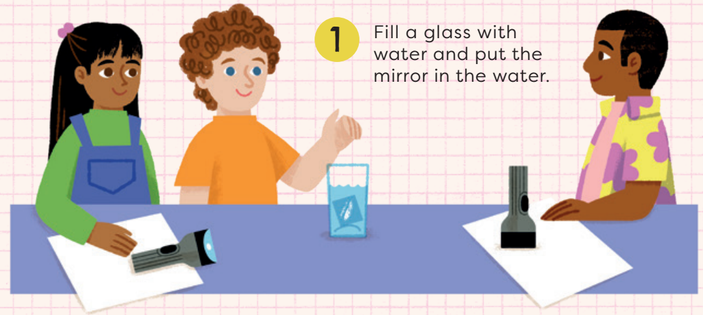
But he wasn't able to work out exactly why this happened, nor explain why or how the bending of light could make the colours in the rainbow.

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!

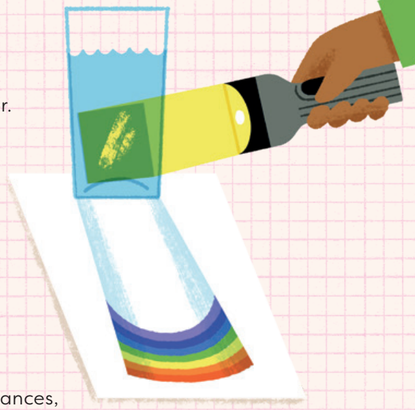
What you will need:





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

2 Take the glass and the paper to a place where's 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.