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Written by

Anna Claybourne

Illustrated by

Adam Larkum

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Many early people lived on fertile plains where it was easy to grow crops. So the world probably did seem like a flat disk, surrounded by hills or seas.

The Earth is round!

As you probably know, our planet, the Earth, is a giant sphere. No one falls off because Earth's powerful gravity pulls us towards it, wherever we are on its surface. But a long time ago, such an idea wouldn't have made any sense to most people. They thought the Earth was flat.

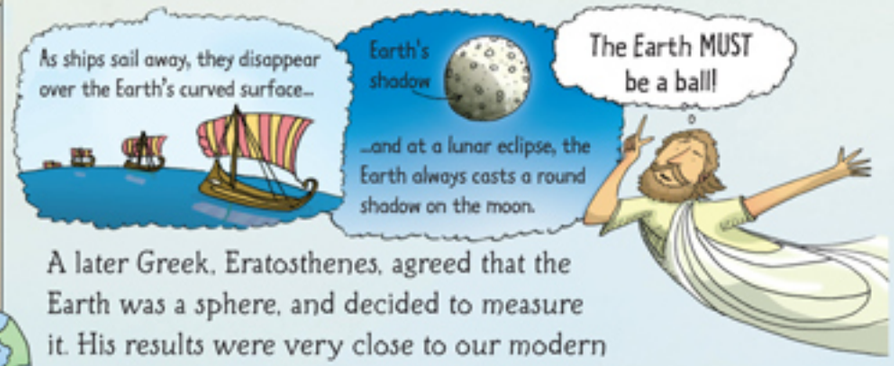
The flat Earth

Many early people, such as the Sumerians and the ancient Egyptians, saw the Earth as a giant flat disk (or, for the ancient Chinese, a square). They thought the sky must be a huge dome, with the stars, Sun and moon attached to it. No one was sure what lay at the "edges", because in those days people rarely moved long distances.



Could it be round?

However, around 2,400 years ago, the ancient Greeks began to question this idea. The great Greek thinker Aristotle, for example, saw various things that suggested the Earth was actually a ball floating in space.

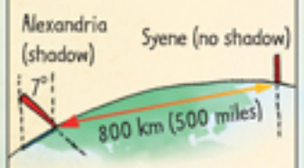


A later Greek, Eratosthenes, agreed that the Earth was a sphere, and decided to measure it. His results were very close to our modern measurements, which show that the Earth has a circumference of about 40,000km (25,000 miles).

How Eratosthenes measured the Earth

Eratosthenes didn't have a giant tape measure, so how did he measure the Earth?

He knew that in Syene in Egypt, in the middle of summer, the Sun was right overhead, and a stick stuck in the ground would cast no shadow.



At Alexandria, about 800km (500 miles) north, there were shadows. By measuring them, Eratosthenes could tell how much the Earth must curve between the two cities.



From this segment, he could calculate the size of the whole Earth.

Ideas and arguments

By medieval times, almost everyone agreed that the Earth was a sphere. But a few didn't. Some Christians didn't want to believe the world could be round, as the Bible said it had "four corners". Others worried that if the Earth was a ball, you could fall off it. They wondered if people could possibly live on the other side of the Earth, and what they might be like.

Of course, one problem was that the Earth was so big, no one had ever explored all of it to find out its shape once and for all. But that was about to change.



Some writers imagined that the people living on the opposite side of the world from them must be strange, monstrous beings.

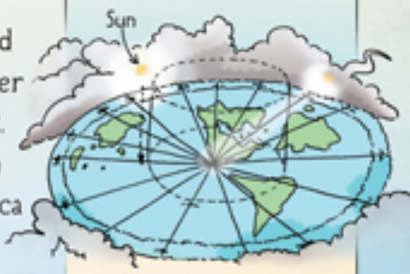
Flat-Earthers

Someone who believes the Earth is flat is known as a "Flat-Earther". Despite the evidence for a round Earth, English writer Samuel Rowbotham started a new Flat-Earth movement in 1849 to promote this outdated belief.

Around the world

During the 1400s, Europeans began to explore more and more of the world. One of them, Italian-born Christopher Columbus, set off west across the Atlantic Ocean in 1492. He was hoping to sail right around the world to eastern lands such as China – but he didn't manage to, as America was in the way.

But not long afterwards, in 1519, Portuguese explorer Ferdinand Magellan led an expedition that did complete a journey around the world. Other explorers pieced together more and more of the planet, and people began to make realistic world maps and globes.



This flat-Earth map from 1931 shows a flat disk with the North Pole in the middle and a ring of icy mountains around the edge.

The first pictures

By the time spaceflight began in the 1950s, it was obvious that the Earth was a sphere. But it was still amazing to see the first ever photographs of the Earth from a distance. Russian astronaut Aleksei Leonov described the view of Earth from space like this:



From alchemy to chemistry

Chemistry is the science of how substances behave, join together and break apart. It helps people to make all kinds of things we use every day, such as medicines, washing powder and shampoo. But did you know that modern chemistry grew out of a mystical world of secret codes and magic spells, which was known as alchemy?

The philosopher's stone

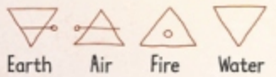
Alchemists spent many years searching for, or trying to create, a magical substance called the philosopher's stone. They believed it could turn other metals, such as lead, into gold just by touching them. Many also thought that the philosopher's stone could give a person eternal youth or make them live forever. Despite many efforts, no one ever seems to have found it...

What is alchemy?

People have been doing things like heating up rocks to get useful metals out of them for more than 5,000 years.

But long ago, nobody understood how things like this worked. If a precious metal such as gold could come from stones, they reasoned, maybe you could make it out of anything. These ideas led to the practice of alchemy. Alchemists experimented with all kinds of substances to try to make something valuable.

Like the ancient Greeks, most alchemists believed everything was made up of just four basic elements: Earth, Air, Fire and Water.



Alchemists used code-like symbols to stand for the four elements and many other substances too.

Many alchemists wanted to make gold out of cheaper "base" metals.

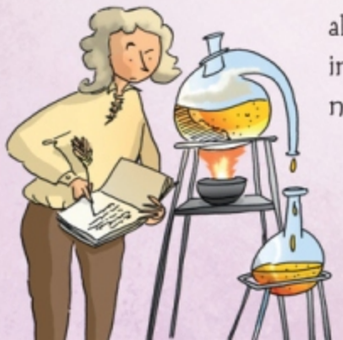


Others hoped to create a magic medicine called the Elixir of Life, which could cure all illnesses.



Alchemy was like chemistry, but less scientific. Instead of carefully studying the facts, many alchemists thought that things like magic spells, secret signs or the position of the stars could help them. And a lot of them were cheats, who made fake gold and drugs to sell. Over time, though, some alchemists' experiments led to useful inventions, such as inks, porcelain and effective medicines. This practical, non-magical side of alchemy became known as "chymistry".

We now know that a lot of alchemy was nonsense, but some alchemists were very clever. The great physicist Isaac Newton, for example, was a keen alchemist.



To mix, heat and process their chemicals, alchemists invented many types of equipment that are still used in chemistry labs today.



Arabian alchemy

The word alchemy comes from *al-kimiya*, which means the "transmutation" or "changing" of things in Arabic.

Arab alchemists were among the first to do proper carefully recorded experiments. One of the most famous was Abu Musa Jabir ibn Hayyan, also known as "Geber", who lived around the year 800. He found out how to make many useful chemicals, such as hydrochloric acid, and invented better ways of making steel and glass. He also said: "The first essential in chemistry is that you must perform practical work and conduct experiments."

Boyle's *Skeptical Chymist*

One of the most famous chemists was Irish-born Robert Boyle. He discovered several gases, and saw that there must be many different elements. In 1661, he wrote a book, *The Skeptical Chymist*, which argued that the mystical, magical aspects of alchemy were nonsense. Like Geber, Boyle said "chymists" should test ideas with experiments, and use a clear, simple system for naming chemicals.

The origins of modern chemistry

A hundred years later, French chemist Antoine Lavoisier followed these ideas and changed the way chemistry was done (see box), paving the way for modern chemistry. These changes are often called "the chemical revolution".

Lavoisier's revolution

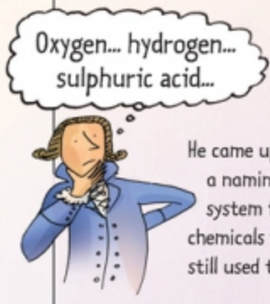
Lavoisier set up new ways of doing chemistry experiments and measurements.



He discovered and listed many new chemicals and elements (see page 45).

He used experiments to find out what really happens when things burn.





He came up with a naming system for chemicals that is still used today.

He declared that chemical reactions can change substances, but not create or destroy matter.



Lavoisier even helped to invent the metric measuring system.

Metric measuring flasks are a common sight in today's chemistry labs.





Vaccination

You've probably had at least one vaccination, an injection that protects you from a dangerous disease. But how does it work, and how was it first discovered?

Safe survivors

People knew long ago that some diseases can only be caught once. If you get chickenpox, measles or mumps, you probably won't get it it again. Your body becomes "immune" to that disease, meaning it learns how to fight it off.

This also happens with smallpox, a disease that used to kill millions of people. In ancient Greece, those who had already survived smallpox would care for smallpox sufferers, because they didn't catch it again.

Over 2,000 years ago in ancient China and India, people tried to make themselves immune to smallpox. They took a scab or some pus from a person with a mild case of smallpox, and scraped their skin with it. If it worked, this gave them the same mild form of the disease. Afterwards, they were protected from catching smallpox ever again. This process is called inoculation.

Smallpox facts

Smallpox was a very dangerous disease caused by a virus, which killed up to a third of people who caught it. It caused pus-filled blisters to form all over the body and face, and people who survived could be left with hundreds of deep scars, or "pock marks".

Smallpox spread from one person to another through coughs and sneezes, saliva, or infected clothes or bedclothes.



Lady Mary Wortley Montagu

Lady Mary Wortley Montagu knew how serious smallpox could be. She had had it herself as a child, and had scars on her face – and her brother had died from it.

On her travels in Turkey, in 1718, Lady Mary Wortley Montagu, an English writer, saw smallpox inoculations taking place. The practice had spread there from the Far East. Seeing how well it worked, Lady Montagu had her own children inoculated. She took her new knowledge with her back to Britain, and gradually, smallpox inoculation began to spread around Europe and North America.



Jenner's jab

The problem with inoculation was that it could go wrong, and cause a deadly bout of smallpox. It also helped to spread smallpox around, which was dangerous.

However, there was another disease, cowpox, that was very like smallpox but much less serious. People who worked with cows knew that no one who caught cowpox from a cow ever seemed to get smallpox.

During the 1700s, several people tried using cowpox to protect against smallpox. But the one who made a difference was Edward Jenner, an English doctor and naturalist. Having heard how cowpox could protect against smallpox, he decided to test it. In 1796, he took some pus from the skin of a milkmaid with cowpox, and scratched it into the arm of his gardener's eight-year-old son, James Phipps.



Milkmaids were known for their clear complexions. This was because most of them had caught cowpox, so they never caught smallpox.



Jenner's test wasn't very fair on James Phipps! He survived – but doing a dangerous medical test on a child wouldn't be allowed today.

It worked!

James caught cowpox, as expected, and recovered. Then Jenner tried to infect him with smallpox several times – but James was immune to it. Jenner named the new method "vaccination", from *vacca*, the Latin for cow.

Jenner announced his results and, after a slow start, smallpox vaccination spread around the world. Millions of lives were saved, and by 1980, smallpox was wiped out. Today, smallpox germs only exist in a few science labs.

Vaccinations today

After Jenner, scientists developed vaccines for many more diseases, using dead or weakened disease germs that don't cause serious illness. Today, most of us are vaccinated against measles, polio, TB and several other diseases.

What's in a word?

"Vaccination" and "immunization" both mean using a weakened or milder form of a disease to make you immune. "Inoculation" really means using the same full-strength disease germ that you are protecting against – but doctors also sometimes use it to describe vaccinations, which are also often called "jabs".