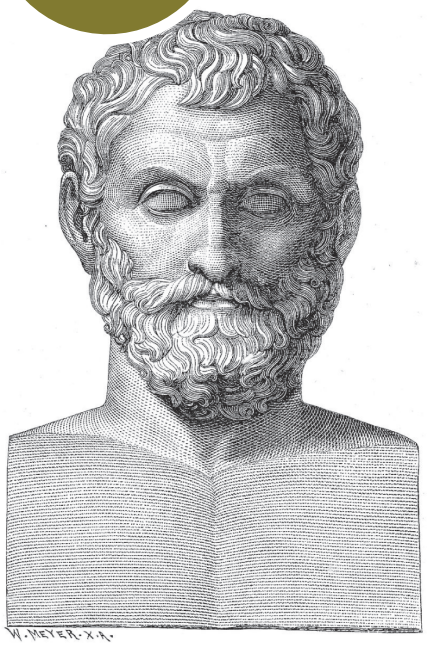
The Ogden Trust

making physics matter

Age 7-11 years

Research cards

Thales of Miletus



About

Thales of Miletus was a Greek philosopher, mathematician and astronomer who was born in 624BC. Thales lived in Miletus in Asia Minor, today Milet in Turkey. Thales was part of a new generation of philosophers who began to use science and reason instead of mythology to explain the world around them. He lived until 546BC when he died of heat stroke at the age of 78 while watching the games at the 58th Olympiad.

Working scientifically

Thales made predictions and carried out experiments, making careful observations of the phenomena he was investigating. He had a particular interest in what materials were made from so he carried out many tests to explore the properties of different materials and compare them.

In one of his experiments, Thales investigated amber (fossilised tree sap) and discovered that if he rubbed it with a piece of animal fur, the amber would attract lightweight objects such as feathers. In another experiment he noticed that lodestone (magnetic iron ore) attracted pieces of iron. Thales compared the similar way in which lodestone and amber behaved – they could both attract other materials and objects. He had in fact discovered magnetism and static electricity, but at the time he thought they were the same phenomena.

As all good scientists do, Thales thought carefully about the observations he had made and began to draw conclusions and make predictions to explain the behaviour of the materials he had observed. Thales came to the conclusion that lodestone and amber must have a soul! At the time it was generally believed that any sort of movement was due to life, soul or the gods.

Thales must have written down his observations and ideas somewhere, although there are no examples of his work to be found. Historians have managed to piece together the life and work of Thales because of the many philosophers who followed him, and who discussed his ideas and the experiments he carried out.

The early Greek word for the Sun was ‘hlector’ (pronounced ‘elector’) and this was also used to describe the material amber because its colour reminded people of the Sun. In many ancient Greek writings that describe Thales’ work and ideas, amber is called ‘electron’, which would become the root of the word electricity that we use today.

Thales didn’t have the equipment needed to find out more about these strange material behaviours and it would be over 2,000 years before anyone was able to learn more.

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William Gilbert

About

William Gilbert was born in Colchester on the 24 May 1544. Part of a reasonably wealthy family, Gilbert was fortunate enough to be educated at St John's College, Cambridge – becoming a Doctor of Medicine in 1569. He moved to London to work as a doctor and then travelled widely around Europe eventually returning to become President of the Royal College of Physicians. In the final years of Queen Elizabeth I's life, Gilbert was her personal physician and when she died he became physician to King James I. William died of the Bubonic Plague on 30 November 1603.

Working scientifically

As well as his medical career, William Gilbert was a curious scientist, always reading the work of philosophers and scientists who had gone before him and questioning their ideas. William had a particular interest in magnetic objects and electrical attractions. He carried out years of research to develop a greater understanding of these areas of science. He wrote a book *De Magnete, Magneticisque Corporibus, et de Magno Magnete Tellure* which means 'On the magnet, magnetic bodies and the great magnet of the Earth' to share his work and ideas with the world.

In his book, Gilbert correctly concluded that the Earth had a magnetic core made from iron and this was the reason that compass needles behaved as they did. He also described his experiments with amber, which he called 'elektron', originating from its Greek name. He recognised that a force was present after he rubbed the amber and called it 'electric force' and he invented the first electrical measuring instrument – the electroscope – so that he could collect data to help him get a better understanding of static electricity.

Gilbert argued that electricity and magnetism were not the same thing because in his tests static electricity disappeared from materials when they were heated but the magnetic effects of materials didn't appear to change.

Some of William Gilbert's peers were critical of his work and ideas because they were so different to the current beliefs about the world and how it worked. There were many others, however, who praised his work, as all of his findings and conclusions were based on facts from experiments that he reported in extreme detail so that they could be repeated.

William Gilbert was the first person to use the word 'electricity' to describe the phenomena that he observed and today he is known as the 'Father of Electricity and Magnetism' because his work became the platform upon which the whole area of electrical engineering was built.

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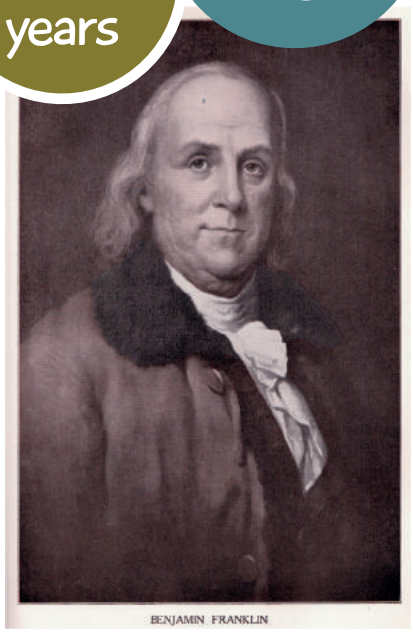
Age 7-11 years

Research cards

Benjamin Franklin



images: wikipedia, creative commons

About

Benjamin Franklin was born on 17 January 1706 in Boston, Massachusetts. His family had travelled by ship from England to live in the colonies of the New World. Benjamin, the fifteenth child in the Franklin family, only went to school until he was 10 years old. Benjamin continued his education by being an avid reader at the same time as becoming an apprentice in his older brother's printing company. He ran away to Philadelphia at the age of 17 and went on to be successful in a range of careers including author, printer, politician, scientist, inventor and diplomat. Franklin became one of the Founding Fathers of the United States of America as well as a significant contributor to the world of science with his discoveries in the areas of electricity, light, meteorology and oceanography. Benjamin Franklin died of pleurisy on 17 April 1790, three years after signing the US Constitution. Over 200,000 people attended his funeral in Philadelphia.

Working scientifically

In the 1740s there was a huge interest in electricity because it was used by magicians for tricks – creating shocks and sparks. Other than this, our ideas about electricity hadn't changed for over a hundred years. Benjamin Franklin was very curious about electricity and wanted to understand more about it. Observing the world around him, Franklin noticed similarities between the electricity used by magicians and lightning. He observed that they both created light, they both made loud cracking noises when they exploded, and they always attracted to metal objects. He had also noticed a similar smell. Based on these observations Franklin predicted that they were in fact the same thing.

Already a professional writer, Franklin wrote letters about his observations and ideas to scientists in England. The scientists who received the letters were very impressed with his ideas and published them in a book called *Experiments and Observations on Electricity*. His ideas were greeted with enthusiasm from the scientific community.

Franklin designed a test for his hypothesis that lightning was a discharge of electricity which he carried out in 1752 by flying a kite in a storm. Attached to the top of the silk kite was a foot long, metal point and at the bottom of the string a ribbon and a metal key with a wire attached to it that linked it to a Leyden jar (used at the time to 'store' electrical charge). Franklin kept himself safe by standing in a barn which also kept the end of the string dry to insulate him. When the storm passed over, the metal point pulled electric charges from the cloud, which then travelled down to the Leyden Jar. Franklin got a shock when he moved his hand near the jar. From this experiment he concluded not only that lightning was electricity but also that there were two types of electrical charge and he was first to call them positive and negative.

Franklin's work on electricity led to his invention of the lightning rod to protect buildings from lightning strikes. Of all of his amazing achievements, he thought that this was the most important.

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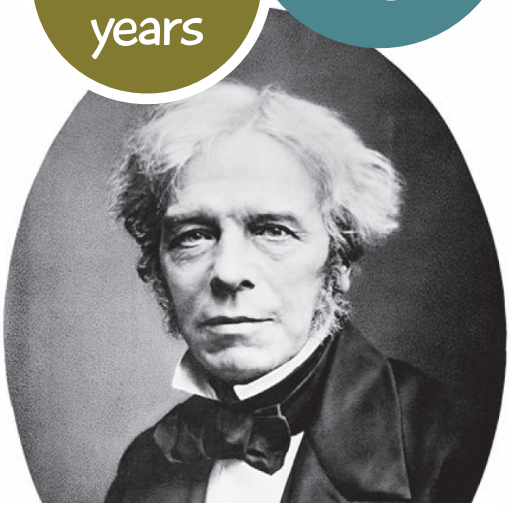
Age 7-11 years

Michael Faraday



About

Michael Faraday was born on 22 September 1791 in London. He didn't come from a wealthy family so only had a very basic education. At the age of 14, he became an apprentice to a bookbinder and over the following seven years he educated himself by reading all of the books he was binding. Having attended one of his lectures, Faraday wrote to the famous chemist Humphrey Davy asking to be his assistant. Davy managed to get Faraday a job as a chemist's assistant at the Royal Institution which lead to a lifetime's work studying electromagnetism and electrochemistry. Faraday died on 25 August 1867 at his home in the grounds of Hampton Court.

Working scientifically

Faraday helped many scientists with their experiments at the Royal Institution as well as carrying out many of his own. He mostly worked on chemistry experiments, but Faraday was fascinated by electric circuits and electromagnetism. At this point in history, scientists had a much better understanding of electricity and electric circuits due to the work of many talented physicists including Alessandro Volta and André-Marie Ampère whose work overlapped with that of Faraday. Faraday's first recorded experiment was building a battery from halfpenny coins.

In 1821, Faraday published a paper on his work on the invention of the electric motor, a device that would change the world for ever, allowing electricity to be used to power vehicles and moving machinery. There was some controversy around this discovery of Faraday's. His mentor, Humphrey Davy, had been working on the development of a device to use electricity to create movement for some time but had been unsuccessful. Faraday's discovery came about as he built on Davy's experiments, learning from the mistakes he had made. When Faraday finally discovered how to make an electric motor he was so excited he published his findings quickly and forgot to acknowledge the work of Davy. Davy was furious, and Faraday was punished by not being allowed to work on the electricity and magnetism experiments for several years.

Faraday worked at the Royal Institution all of his life and made many amazing discoveries involving electromagnetism as well as chemistry. His work not only allowed us to use electricity to create moving machines, he also discovered how to generate electricity and he even invented the first balloon. To make science accessible to the public, he started the Royal Institutions Friday Night Lectures and Christmas Lectures – these still go on today.

As his work continued, Faraday had some difficulties with his mental health and memory loss which some think may have been due to his regular use of mercury vapour in the laboratory. When he eventually retired he was given a grace and favour house at Hampton Court Palace. During this time, he was asked to give advice to the government on chemical weapons for the Crimean war but refused to help for ethical reasons.

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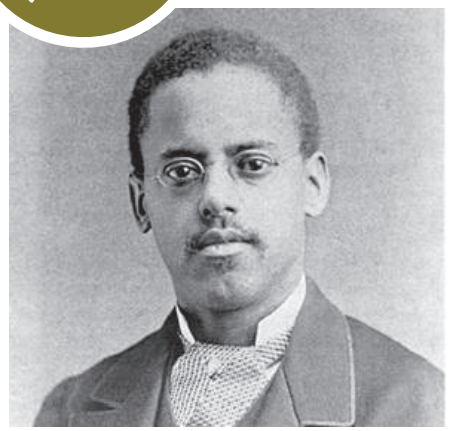
Age 7-11 years

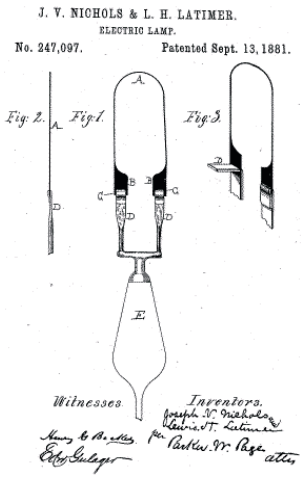
Lewis Howard Latimer



Queens Borough Public Library

About

Lewis Howard Latimer was born on 4 September 1848 in Massachusetts; not an easy time to be a black child in America. His parents had escaped from slavery in Virginia only six years before his birth. Their slave owner traced them to Boston to bring them back to Virginia as they were his property. At the time, there were a growing number of important people in Boston who were in favour of the abolition of slavery. Although the court ruled that Latimer's parents should return to Virginia to be slaves, these important people raised the funds to buy their release and freedom. Lewis wasn't educated for long. When the American Civil War began, Lewis joined the Union Army and served on a gunship for four years. Following the war, Lewis began working at the US Patent Office which led him into a career in electronic engineering where he became influential in bringing electric lighting to the world. He died in Queens on 11 December 1928 at the age of 80.



US Patent Office

Working scientifically

Lewis was so skilled at technical drawing while he worked at the US Patent Office that he became Chief Draftsman for 11 years – he had great accuracy in measuring and labelling his scientific diagrams. He was so highly talented that he was eventually employed by Alexander Graham Bell to help develop the patent for his telephone invention.

Lewis then moved to Connecticut where he began work with Hiram Maxim, an inventor who was working on designs for the first filament bulb. Unfortunately, another inventor called Thomas Edison solved the filament bulb problem before Maxim and received the patent. There was, however, a problem with Edison's design – the filament burnt out in only a few hours. This was when Lewis began experimenting with materials, and the design, to try and improve it. Through his experiments, he eventually discovered the design could be improved by covering the filament within a cardboard envelope. This prevented the carbon from breaking up and therefore provided a much longer life to the light bulb. This made the light bulbs less expensive and more efficient. In 1881, Lewis received the patent for the improved manufacturing technique of carbon filaments for the light bulb, and suddenly light became affordable for all.

Lewis' skills in electric lighting became well known as more key cities began wiring their roadways for lighting, Lewis was sent to lead the planning team and began travelling all over the world.

It wasn't long before Lewis began working for the Edison Electric Company. While working there he wrote a technical manual called *Incandescent Electric Lighting – A practical description of the Edison system*. The book got great reviews and became a standard text in the world of electrical engineering as the electric lighting industry grew into a worldwide success. Whilst working for Edison, Lewis invented all sorts of other machines including one of the first air conditioners, a lockable coat and hat rack, and a number of different light fittings. He received special recognition for the impact he had made on the electric revolution by being named one of the 28 Edison Pioneers.

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Age 7-11 years

Research cards

Mildred S Dresselhaus

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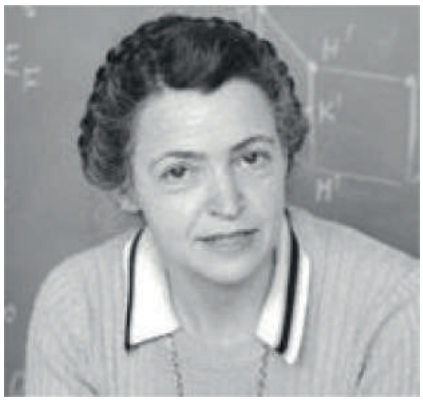

Credit - Georgia Litwack

About

Mildred S Dresselhaus, a Polish-Jewish immigrant, was born in the Bronx in 1930 during the Great Depression. Her family, having fled from Poland, worried about the tensions with the Nazi Party in Germany and the rising anti-Jewish attitudes in the region at the time.

As a child she read National Geographic magazines and developed a love of science. She was also a talented musician who won free violin lessons which allowed her to meet some more wealthy and advantaged New York families. Her new friends convinced her of the importance of education and helped her get a place at a girls' private school in New York City. Mildred became an amazing scientist and went on to study physics at university.

As well as raising her four children, born between 1959 and 1964, she became a world-famous materials scientist, fondly known as the 'Queen of Carbon'. She eventually became one of the first female professors at the prestigious Massachusetts Institute of Technology (MIT). Mildred received the Presidential Medal of Freedom in 2014 from President Obama, in recognition of her huge contribution to the world of science. She went to her lab every day until she was taken into hospital two weeks before her death in 2017.

Working scientifically

Mildred was very interested in the properties of materials – particularly in how they behaved when electricity or heat passed through them. She asked lots of questions about how we might change materials to give them different properties. Mildred decided to focus her work on carbon because nobody else was investigating it at the time.

Mildred developed techniques to create unique samples of materials, particularly carbon, that were only one atom thick; she designed and carried out tests to see how those materials behaved. Mildred made accurate measurements and reported her data, drawing conclusions about what she had discovered. Mildred's conclusions made her think of even more questions and she made further predictions about how materials might behave differently if she made more changes. She created new materials from thin pieces of graphite (a form of carbon) alternated with other materials only one atom thick. Mildred repeated her tests to explore the electrical and thermal properties of these new materials and made some amazing discoveries.

Although her findings were very complex, what she had learnt about the new materials made them very useful in the development of new electrical technology. Her findings led to the invention of the Lithium-ion battery, a rechargeable battery used in most home electronics today. In fact, all of today's electronic devices including smart phones, computers and renewable energy generators exist because of the work that Mildred did in developing new materials. She will also be remembered for the huge amount of work that she did to support female physics students to forge successful careers in physics.

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Writing framework

Name ..... Research team .....

Who or what are you researching?	
Where were they from/ where did this project take place?	
Between what years were they alive/when did this project take place?	
What was most significant about the discovery/project?	
What working scientifically skills did the scientist(s) show in making their discovery/ working on the project?	
Why was this discovery/ project important?	
What other interesting facts did you discover about this person or project?	
What else would you like to know about this person or project?	