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SCIENTISTS
MATHEMATICS

By Harry Jivenmukta

PYTHAGORAS 572-495 BC

Pythagoras was born on the Greek island of Samos. His father, Mnesarchus, was an Ionian. Very little of his early life has been recorded but it is known that he travelled widely in Egypt and Babylonia while still a young man. When the tyrant Polycrates came to power, Pythagoras, who disagreed with his ideas, fearing for his life, fled into the mountains where he hid in a cave. Some of his loyal students made the climb regularly so that they could continue to listen to his teachings, but eventually Polycrates forced Pythagoras to leave Samos altogether.

He went to Croton, a Greek settlement in southern Italy, where he began teaching again. Pythagoras believed, and taught that:

Numbers were the essence of all things and were thus the language of nature and the universe;

The spirit was purified by study;

The study of nature (and therefore numbers) could be a 'way of life', or a religion.

The fame of Pythagoras' school and teaching spread and the wealthy and famous sent their sons to be taught by him. Unfortunately, his ideas became so widespread that they amounted to a political force which was disliked by those in power at the time. He suffered from an attack led by a man called Cylon and many of his followers were killed. Other attacks followed and within two centuries none were left of the Pythagorean Brotherhood.

Meanwhile, Pythagoras continued working at his numbers and calculations. His most famous discovery was that , 'the square on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides'.

There are several ways to prove this theorem, but it was said of Pythagoras, that he was so pleased with his own proof that he gave the muses, the Greek goddesses of the arts, one hundred oxen as a sacrifice.

Pythagoras also investigated the harmony of sounds with vibrating lengths of string. We don't know how he died but it is believed that he was about seventy-nine, a great age for those times.

Activities.

There is an easy way to prove Pythagoras' theorem.

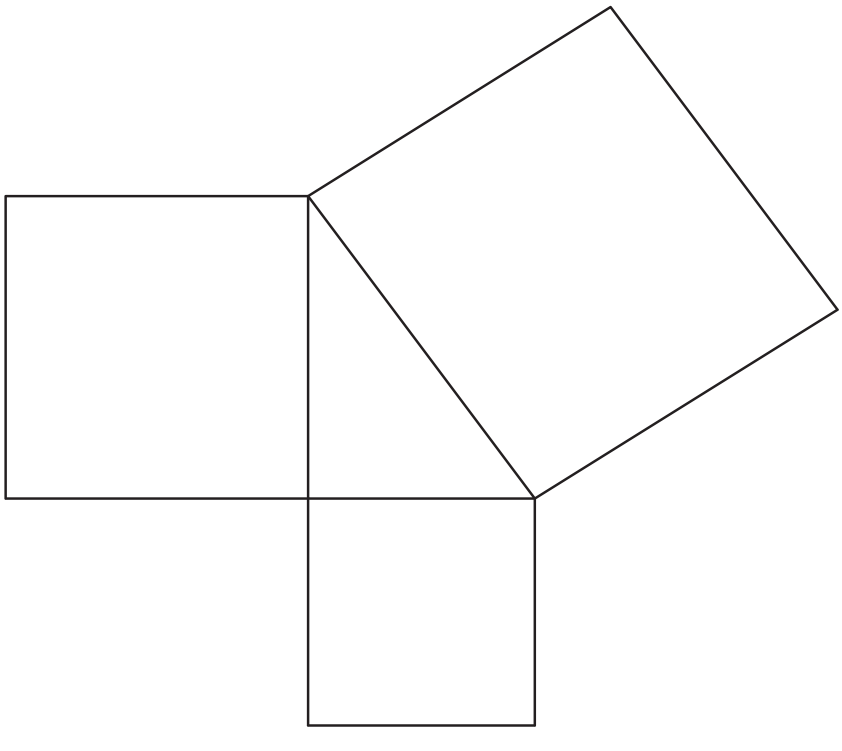
1 Draw a right angled triangle with the length of the sides in a ratio of 3:4:5. Try 6, 8,and 10 cm.

2 Draw an accurate square on each of the sides using each side as a base.

3 Calculate the area of each square.

4 Does the sum of the areas of the two smaller sides equal that of the hypotenuse?

5 Can you find other lengths of sides which do not follow the ratio of 3:4:5 but still obey the theorem of Pythagoras?



EUCLID 325-270 BC

The actual dates of Euclid's birth and death are unknown. Historians have deduced that the dates given are the nearest approximation that they can make from other writers and events of that time.

Where he was born is still a mystery, but it is known that he received his training in mathematics at the Platonic School in Athens, in Greece. In 306 BC, Ptolemy I built the first modern type of university in Alexandria and he appointed Euclid as its first Professor of Mathematics in 300BC. Another Greek mathematician, Pappus, wrote that Euclid was a modest and considerate man; he was certainly an industrious one.

We know that Euclid wrote at least ten books on mathematics, only five of which have survived to the present day. We know something of the others from different writers who mentioned them or quoted from them. The most famous of Euclid's books was the thirteen volume, 'Elements'. This was probably written while he was still very young and less than twenty-five years old. It was probably the fame from this book which encouraged Ptolemy to appoint him as a professor.

Euclid's Elements covered all aspects of the known mathematics of that time and not just geometry as most people would think. The whole book encompassed four hundred and sixty-five different theorems. It told mathematicians how to construct plane figures such as squares, triangles and other plane figures using a straight edged tool and a pair of compasses. It included details of different number systems and the properties of many solid shapes.

The famous Pythagorean Theorem about the square on the hypotenuse of a right-angled triangle is proposition number forty-seven in the first volume of Euclid's Elements.

Euclid also wrote a book called the 'Data' which was intended to help his students understand the 'Elements'. In science, he wrote a book on optics called, 'Optics', and another called, 'Phaenomena' which was used by astronomers for many centuries.

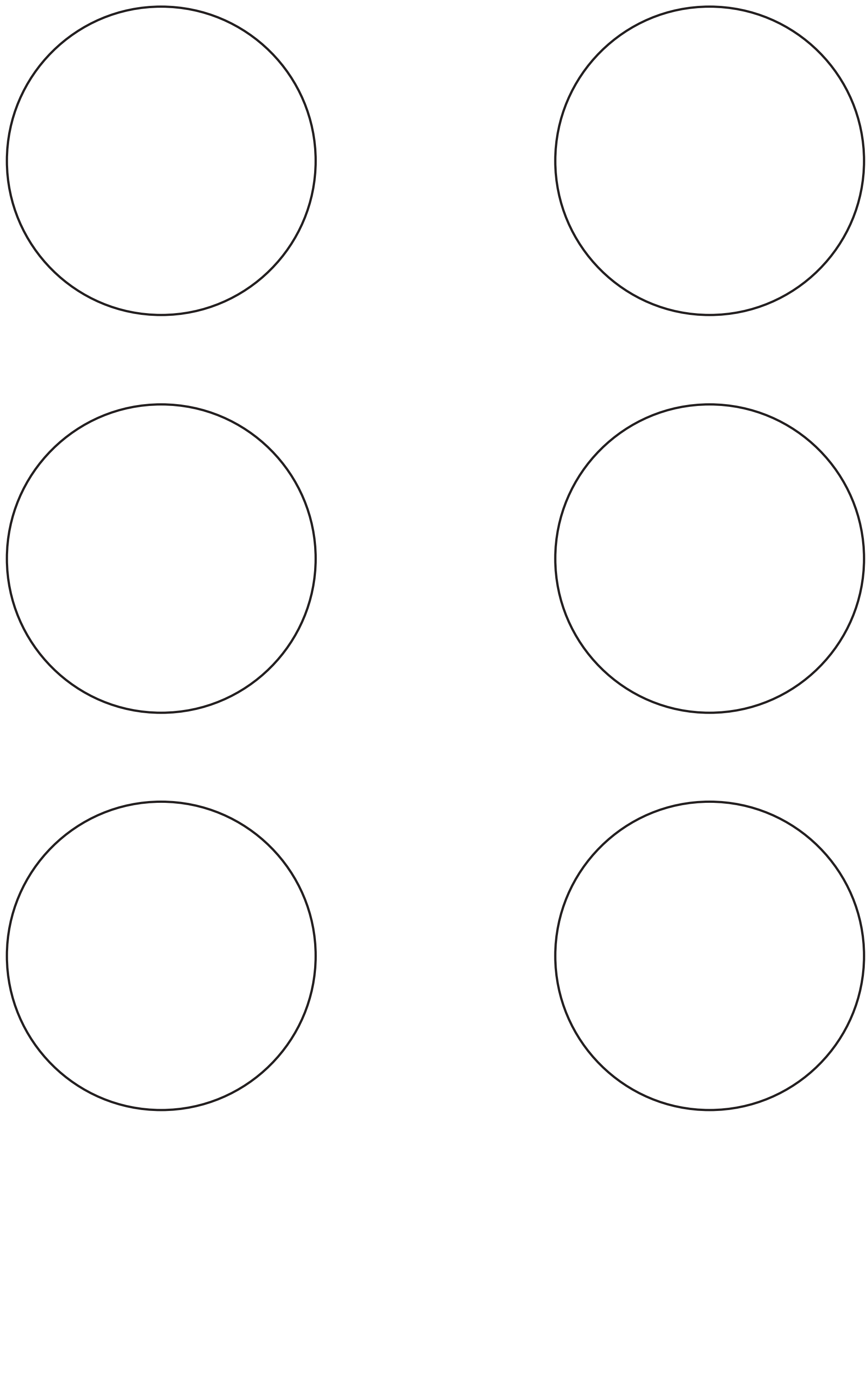
We do not know how Euclid died. Other mathematicians have long since surpassed him but many young students begin their foray into the study of geometry with some of Euclid's Theorems. Nowadays, non-Euclidean geometry is also a school and college subject.

Activities.

Using a set of compasses and a ruler, inscribe each of the following regular polygons into one of the circles:

TRIANGLE, SQUARE, PENTAGON,

HEXAGON, OCTAGON, DECAGON.



ERATOSTHENES 276-194 BC 5

Eratosthenes was writer, scientist and mathematician. His birth and death dates are not known exactly. The dates given are the nearest historians can manage and are based on the evidence of other writers and events of that time.

We know that Eratosthenes was born in Cyrene on the Libyan coast. The city of Cyrene was founded by the Greeks about four centuries earlier. It was ruled by Ptolemy I of Egypt.

Eratosthenes was educated by his father, Aglaos, until he was old enough to be sent to school in Athens. His education was by the Socretean method which meant that he went to listen and argue with the masters of the different subjects that he wanted to learn.

By the time he was thirty, Eratosthenes had become famous in the ancient world of learning. He was so famous that Ptolemy asked him to come to Alexandria and tutor his son. Ptolemy, as an added incentive, awarded him the position of the Chief Librarian of the famous library of the University of Alexandria.

Eratosthenes was an extremely clever man, but unlike many other scholars, he never specialised in one subject. He was truly a 'Jack of all trades'. He wrote at least twelve literary criticisms on the Greek Comedies of his time, a lengthy poem on astronomy and he made a valiant effort to place known events in some sort of chronological order using the Olympic Games as a key as well as listing the names of many of the ancient winners. He began his calendar with the Siege of Troy and correctly worked out the need for leap years.

He wrote a book on ethics, or the goodness of particular actions and a treatise on astronomy which included a scientific description of the known constellations as well as the mythological method of naming each group.

In mathematics, he wrote works on geometry, current mathematical problems such as the measurement of the circumference of the Earth and the numerical systems. By recognising the differences in the angles of the sun's rays at noon in Aswan and Alexandria, he was able to calculate the circumference of the Earth and the angle of the tilt of the Earth on its own axis. However, he is best known for his method of finding prime numbers which is still called the Sieve of Eratosthenes. In his method all the known composite numbers are discarded. The remaining numbers are prime numbers.

Anatole Lucas, a French mathematician worked out the largest prime number so far, without using a calculator or a computer in 1876, (2 to the power of 127-1). With the help of computers, the known number of prime numbers has exceeded three hundred and fifty. Eratosthenes stayed in Alexandria studying and working for many years. As he grew older his eyesight failed and he became blind from opthalmia, or inflammation of the eye. Tradition tells us that, in despair over his increasing disability and helplessness, Eratosthenes committed suicide by slowly starving himself to death when he was about eighty years old.

HYPATIA 370-415

Hypatia was the first female mathematician of any importance. She was also a Neoplatonist philosopher. Neoplatonists tried to ensure that the thinking of the Greeks, such as Plato, Aristotle and Socrates were not lost in the onslaught of Christianity.

Hypatia was born in Alexandria, in Egypt. Her father was Theon, an astronomer and mathematician who ran his own school of scientific studies. As she grew up, Theon passed on everything he knew to his daughter and she helped him in his school.

When Theon died, Hypatia took over the teaching and running of the school. She became so well known for her sound knowledge and ability that scholars flocked to listen to her expounding mathematical theory. In her spare time, she wrote new editions of the writings of ancient mathematicians such as Appollonius and Diophantus.

She was a very practical person, providing instructions on how to make an astrolabe and a hydroscope. Some said that she was so clever that she surpassed nearly all the men of her time. She was beautiful and serene and was, “never abashed in coming to an assembly of men”.

Sadly, living in Alexandria at that time was not easy. It was a hotbed of religious fanaticism, with newly converted Christians fighting against each other’s sects and all of them fighting against the old Roman and Greek ways of worshipping many gods.

After one particularly nasty riot, a mob led by a man called Peter, who was a lay preacher, stopped her as she was returning to her home. They took her to the church of Caesareum where they stripped her of her clothes. They murdered her by slicing off her flesh with the sharp edges of the tiles which had fallen from the roof and broken. She was only forty-five years old.

Women of great learning were a rarity in those days. Most women were tied to home duties. Theon must have been an enlightened man to both recognise and allow his daughter’s ability to develop. Women do better today.

Activities.

1. Find out what an astrolabe was. How was it made and used? What instrument is used today in the same way?

2. Hypatia lived in Alexandria. Who founded the city and when?

3. Egypt is famous for its pyramids. Using card or stiff paper, construct a four-sided pyramid on a square base. Decorate it with Roman numerals or Egyptian hieroglyphs.

FIBONACCI 1170-1240 7

Leonardo of Pisa, or Leonardo Fibonacci, was the son of a wealthy merchant who lived in Pisa in northern Italy. Leonardo's father's business was based in Bugia, a port in Algeria.

Leonardo joined his father in Bugia as soon as he was old enough to leave his mother and be educated. Leonardo was sent to an Arab tutor for his schooling. It was the Arab scholars and Medieval monks who were largely responsible for keeping learning and classical study alive during this period. The Arab scholars especially, were renowned for their ability in mathematics Leonardo was fascinated by the 'art of the nine Indian figures' or numbers as taught in the Arab world.

When he had reached adulthood, Leonardo travelled to Rome, Greece, Egypt and Syria to discover as much as he could about numerical systems. He became convinced that the Hindu-Arabic system was the best because it used a place holder, the 'zephirum', or zero, to order the numbers instead of stringing huge numbers together in rows as the Romans did. The use of a zero made all forms of computation and calculation far simpler and more efficient than other systems. Leonardo is credited with being the first European to use the Hindu-Arabic system, but it shouldn't be forgotten that it had already been in use for many centuries in the Middle East and India.

In 1200, Leonardo returned to Pisa and began writing up all that he had learned. Two years later he published his four volume book, 'Liber Abaci' or the Book of the Abacus, or Calculator.

In this book, Leonardo maintained that arithmetic and geometry are not only connected but that they also support each other. With his mixed numbers he wrote the fractional number before the whole number and he enjoyed breaking fractional numbers into their fractional parts.

Leonardo is probably best known for his investigations into number sequences. The sequence that is named after him is;

1 1 2 3 5 8 13 21 34 55 89

Leonardo found this sequence occurring naturally in many spheres of plant life and other biological forms. Much of Leonardo's spare time was taken up with the solving of the fashionable mathematical puzzles and conundrums that exercised the brains of the wealthy and educated, but he also continued working and published his second book, 'Practica Geometriae' in 1220. Some say that this book was based on the lost works of the ancient mathematician, Euclid. Leonardo's third book was called 'Flos' or blossom and contained many of his solutions to the fashionable puzzles of the day.

Leonardo was awarded a State pension for his work in setting up an efficient accounting system for the city and surrounding areas. He died in about 1250. He had no rival as a mathematician in Europe and is rightly famous for his ability to bridge the gap from Classical times to the Renaissance and in making known the work of Arab mathematicians.

Activities.

Leonardo's greatest claim to fame is the number sequence known as the Fibonacci sequence. The Fibonacci sequence starts with '1' and continues in this way:

1 1 2 3 5 8 13 21 34 55

1 Work out the next ten numbers in the sequence.

2 How did you find them? Try putting your method into a formula.

3 Using a calculator, can you discover several interesting relationships between the numbers in the sequence?

4 Leaving out the two 1s, try adding the next three numbers in the sequence and divide your answer by the fourth number:

e.g. 2 add 3 add 5 divided by 8 =

then 3 add 5 add 8 divided by 13 =

Continue doing this several times. What happens? Is there a pattern to your results? Try to find other patterns using a different set of combinations.

NAPIER 1550-1617

John Napier was the son of a Sottish laird. He was born at Merchiston Castle, near Edinburgh. His parents died and he became the laird when he was still very young. John had a private tutor until he went to St.Andrew's University at thirteen years old. He left the university without completing his degree and it is believed that he travelled in Europe with a tutor. He returned to Merchiston when he was twenty one.

John was a close associate of John Knox and he became very involved with the problem of who would succeed Elizabeth I to the throne of England. The Scots, including John, strongly backed the claim of James VI providing that he did not revert to Catholicism.

In 1620, John wrote a book called the, 'Plaine Discovery of the Whole Revelation of St. John'. The dedication of this book was in the form of a letter to the king, in which he urged the king to purge his family and household of 'all suspicion of Papists and Atheists'. When James I gained the crown, he spent the early years of his reign undoing all Elizabeth's good work. They were troubled times.

John became interested in the tools of war. He invented a chariot which had a metal front full of holes for firing shot at the enemy (an early tank?). He also produced a prototype for some artillery and two types of mirrors for signalling. As the country settled down, John turned towards the study of mathematics. He enjoyed the different ways in which numbers could be computed and investigated the huge numbers and their computation in the science of astronomy. Astronomy required prodigious feats of mathematics and John sought ways by which these tedious tasks could be made more efficient and quicker.

John began working on what he called, 'Logarithms'. His logarithms were tables from which he could quickly determine the roots, products and quotients of numbers. He wrote a book, publishing his investigations and results in 1614. H. Briggs, another scientist who later carried on John's work, visited him and together they discussed how John's logarithms could be used in astronomical study and calculations.

In 1620, a Swiss mathematician Burgi, claimed that John had stolen his work, and that he had discovered 'logarithms'. This was unlikely as John had published his work six years before, but it was an unpleasant episode in John's life. John Napier is also credited with being the first person to use a 'point' to separate an integral and fractional number. However, John's greatest claim to fame was his invention of calculating 'bones' or rods by which he could multiply numbers very quickly. These bones were an early type of calculator and were later developed into the slide-rule.

John, Baron Napier of Merchiston, died where he was born when he was sixty-seven years old.

DESCARTES 1596-1650 10

Rene Descartes was born near Tours in France. His father was a lawyer and a member of the lesser nobility. Rene was still an infant when his mother died and he was cared for by a nurse.

Rene was a frail and sickly little boy. He was only given a few lessons at home so as not to tax his strength too much. When he was eight, his father sent him to be taught at the new Jesuit College at La Fleche, near Touraine. The principal, Father Charlet, allowed Rene to remain in bed in the mornings until he felt well enough to get up and participate in the activities with the other boys.

Rene used this time to work on problems and trying to solve mathematical puzzles. He learned Latin, Greek, and studied the works of great Classical writers. He also studied 'logic' based on the ideas of Aristotle, some Physics, Astronomy and Mathematics. By the time he was fourteen, he was experimenting with different methods of proving mathematical principles and theorems. At eighteen, Rene went to the University of Poitiers to study law. He obtained his degree in two years and then he travelled to Paris.

Rene was tired of studying and determined to enjoy himself he went to parties and balls, he rode for pleasure and drove a fine carriage about the place. He lost most of his money gambling and soon found that he had to move to poorer quarters. However, it wasn't too long before he found this frivolous lifestyle boring. He began mixing with more intellectual young men and returned to discussing mathematical and other philosophical problems with them. it was during this period of his life that he probably formulated his famous saying, 'cognito ergo sum', meaning 'I think, therefore I am'.

By 1619, Rene had outgrown much of his frailty and joined the army. He fought in the Thirty Years War and in the Battle of Prague in 1620. Sometime during this time, Rene had three vivid dreams which were to change his life. He was scared and decided to devote the rest of his life to investigating the nature of science and mathematics. He travelled around Europe meeting other scientists and mathematicians but failed to meet with Galileo as he had hoped.

Eventually he returned to Paris to work and study. He made many friends and became famous for his investigations, but he also made many enemies for arguing against the Church and other long-held beliefs. At one time he was accused of the punishable crime of being an atheist.

Following his sickly childhood, Rene was a complete hypochondriac. He would retire to bed at the glimmer of a sniffle or stomach ache. Regardless of this, he still managed to publish his works, books and treatises. There were many controversies about some of his work with various other mathematicians claiming it was stolen from others or just incorrect. Nevertheless he received many honours and was invited to Sweden by Queen Christina. Within six months of his arrival, Rene caught a chill and ten days later he was dead at the age of fifty-four.

PASCAL 1623-1662

Blaise Pascal was born in Claremont in France. His father was an important official who presided over the judges of the taxation court. His mother died when Blaise was four years old.

Blaise was frail and sickly from birth and not expected to live to be an adult. When he was seven, his father moved the family to Paris. His two sisters went to school but Blaise was taught at home by his father. Blaise was clever and very quickly learned Latin and Greek, but his father refused to teach him any science or mathematics fearing that it would be too strenuous for his frail son. Blaise worked hard and secretly found out as much as he could about the forbidden subjects, but it wasn't until he was twelve that his father gave in and began teaching him.

Blaise loved mathematics. He immediately grasped the properties of plane figures and at twelve years old he had discovered the rules concerning the internal and external angles of triangles before he had received any tuition!

Two years later Blaise persuaded his father to let him attend weekly lectures in mathematics. Sadly these excursions were short lived and ceased when his father incurred the wrath of the great Cardinal Richelieu. Blaise's father was banished from Paris and he took his family with him to the city of Rouen. The country air was good for Blaise, he grew stronger and was able to study more diligently. It was during this period that Blaise first described what is now termed, 'Pascal's Theorem' whereby intersecting points on a conic section fell in a straight line. Two years later, he had produced a form of calculator that went further than John Napier's Bones.

Sadly Blaise's ill-health returned and halfway through his eighteenth year he became so ill that he was paralysed and his family thought his death was imminent. However, he slowly recovered and began working again.

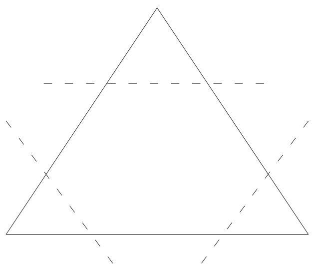
In 1648, Blaise's father received a pardon and the family returned to Paris. Blaise began experimenting again, but he was often so weak that he had to have an assistant to help him. Rene Descartes visited him and couldn't believe that he had achieved all that was said of him. Descartes accused him of copying his own work and especially that on the properties of cones. They parted company, angry and jealous of each other.

After his father died, Blaise was kept busy supervising the running of the family estate, this occupation and the freedom from his father's prohibitions, did wonders for Blaise's health in the short term. For three years he led the life of the young man about town, enjoying his freedom and the wealth he had inherited. In 1654, Blaise was out driving when suddenly the horses bolted, their traces broke and they plunged over a bridge. The carriage with Blaise was left safely at the edge of the broken bridge. Blaise claimed this was a miracle. He changed from a frivolous young man into a serious philosopher who praised God for His wonders, and spent his time working on mathematics. Four years later, Blaise one night suffered from a series of severe convulsions. He died that night from a brain tumour and stomach ulcers. He was thirty-nine years old.

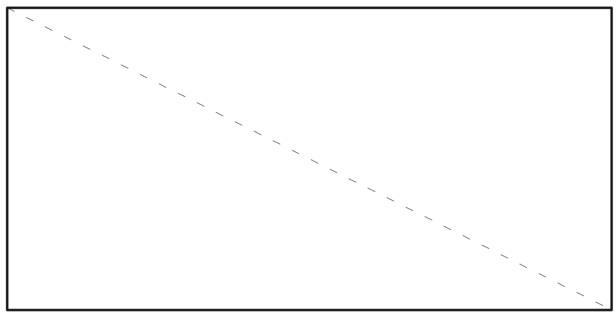
Blaise Pascal was twelve years old when he discovered that he could calculate and prove that the sum of the internal angles of a triangle equalled two right angles.

1 Can you prove that the sum of the internal angles of a triangle equal two right angles?

2 Do it in two ways: with the angles of a triangle removed and rearranged on a piece of paper; using a rectangle.



TRIANGLE



RECTANGLE

3 Find out about Pascal's Triangle. Copy it out and use it to explain the theory of probability.

4 Blaise Pascal also looked at the curve called a cycloid. Find out what a cycloid is and draw a picture of it.

5 Why do you think it is called a cycloid?

6 Try attaching a small pea lamp to a wheel when it is dark. Turn the light on and move the wheel. What shape does the light move in as the wheel moves along?

LEIBNIZ 1646-1716

Gottfried Wilhelm Leibniz was born in Leipzig, in Germany, two years before the end of the Thirty Years War which left Germany in ruins. Both parents of Gottfried were fervent Lutherans and he was brought up according to very strict religious practices.

Gottfried did well at school and entered university when he was fifteen. He finished all his degree work quickly and was absolutely furious when the university refused to award him his degree because he was too young! He transferred to the University of Altdorf, presented another treatise and was given his degree. They were so impressed with Gottfried's ability that they offered him a professorship, which he angrily declined.

Instead, Gottfried accepted a position as lawyer to a famous statesman (von Boyneburg) and worked closely with other famous leaders of that time. When he wasn't busy with official business, Gottfried found time to begin investigating some of the problems pertaining to the time and his situation. Gottfried was a lonely man. He was only just medium height and suffered from extremely bowed legs, possibly caused by poor nutrition in childhood. He never married.

After five years, von Boyneburg died and Gottfried went to London to try and sell a primitive calculating machine that he had invented. Unsuccessful, he found that with money running out, he had to find a position. He became the librarian to the Duke of Braunschweig-Luneborg and began investigating what was later to be called 'integral' and 'differential calculus'. He also studied the laws of motion and introduced new theories which he called, 'Dynamics'.

Gottfried was never idle, he worked on ways to improve water pumps, on making clocks more accurate, lamps safer and even on the idea of making a submarine. He developed the method of using multiples of two in a number system which became known as the Binary System, he investigated the properties of a circle and a square within a circle.

Gottfried was also caught up in the political turmoil in Europe at that time, but none of these terrible events prevented him from continuing his investigations. Towards the end of his life, he was imprisoned for two years for travelling abroad without permission. By this time Gottfried suffered terribly from gout. He obtained permission to travel to the spa of Bad-Pyrmont to take the healing waters. There he met Peter the Great of Russia and enjoyed many discussions with him. He stayed at the spa for two years without any of his pain being improved. His suffering became so great that he took to his bed and died there in 1717 at the age of seventy.

LIEBNIZ 1646-1716

Liebniz worked with numbers. There are many different groups or types of numbers.

1 Write a short sentence to explain or define the following types of numbers:

EVEN	SQUARE
ODD	TRIANGULAR
PRIME	RECTANGULAR
COMPOSITE	FIBONACCI
PERFECT	

Palindromes are words which are the same backwards as forwards. Numbers can also be palindromic; e.g. 121, 9779.

Take this number 129

reverse it 921

add the two 1150

reverse it 0511

add these two 1661 - a palindrome!

Do the same with any numbers you like and see if you always end up with a palindrome. Can you account for this?

GAUSS 1777-1855

Karl Friedrich Gauss was born in Brunswick in Germany. He was the only son of the foreman of a gang of bricklayers. His mother was the clever daughter of an artistic weaver. The family was poor and they had a struggle to survive. Karl was amazing. He taught himself to read and calculate numbers when he was three years old and by the time he was five, he was able to correct and calculate the wages that had to be paid to his father's bricklayers.

Karl was nearly lost to the world when he fell into a nearby canal. He was saved by the bravery of a passing labourer on his way home. Karl's father wanted him to be a bricklayer like himself and their were many rows in the home until his mother prevailed and he was allowed to go to school. The teacher at Karl's school was one who believed that thrashing children was good for them. Learning was a painful business but Karl persevered and by the time he was ten, his Latin and Greek were so good that the teacher allowed him to attend classes in arithmetic!

Then Karl went to the secondary school in Brunswick. By this time both his parents realised how clever he was and they sacrificed a great deal to keep him at school. Fortunately for the family, the local Lord, the Duke of Brunswick heard about Karl and was so impressed that he paid Karl's school fees.

At fifteen, Karl went to a type of Sixth Form college where he stayed until he entered the University of Gottingen at eighteen. On completing his first degree, the Duke of Brunswick awarded Karl a pension so that he could continue with his own studies and investigations.

Karl investigated algebraic equations, elliptic functions, polygons, statistics and probability. He also worked on the properties of numbers, and the geometry of curved surfaces. In these investigations, he worked out how a curved lens could be used to correct some eye focusing defects. He studied the magnetism of the Earth and correctly predicted exactly where the South Pole would be found. He also invented the heliotrope which has been used for signalling until modern technology improved on the system.

Karl was one of the first mathematicians to doubt some of the proofs in Euclidean geometry. He kept his own theories to himself because he wasn't prepared to face the barrage of opposition that the rebuttal of Euclid's work would ensure. One of the items he investigated was that 'the sum of the interior angles of a triangle COULD be less than 180 degrees.' This type of calculation was associated with the geometry of curved surfaces.

With an associate, Weber, Karl began working on magnetism and electric telegraphy. Their work was almost identical with that of Samuel Morse in America. They sent their first telegram in 1833 and then discarded the work in fear of the consequences of having worldwide communication so quickly. Karl was a deeply religious man and hated the political turmoil in Europe during his lifetime. He hated teaching and had very few students. Instead, he wrote over one hundred and fifty papers on his theories, proofs and treatises. He died suddenly one night when he was seventy-seven years old.

Can you make a working Heliotrope? You will need a friend to help you do this. You will need two mirrors, two pieces of card to cover the mirrors and copies of the Morse Code. Make sure it is a sunny day.

1 Each of you should take a mirror, a piece of card, and a copy of the Morse Code.

2 Stand about 200 metres away from each other.

3 Try flashing messages to each other using the sun's rays on the mirrors. NEVER flash the mirror into anyone's eyes.

4 Use the card to cover the mirror and produce longer and shorter flashes.

You should spend some time learning the Morse Code. Why is this method better than using flags as they did before the heliotrope was invented. What method is used today?

INTERNATIONAL MORSE CODE

A .-	J .---	S ...
B -...	K -.-	T -
C -.-.	L .-..	U ..-
D -..	M --	V ...-
E .	N -.	W .--
F ..-.	O ---	X -..-
G --.	P .--.	Y -.--
H	Q --.-	Z --..
I ..	R .-.	

1 .----	6 -....
2 ..---	7 --...
3 ...--	8 ---..
4 ....-	9 ----.
5	0 -----

BABBAGE 1791-1870

Charles Babbage was born in Walworth, Surrey. His father was merchant, banker and goldsmith. The family were wealthy enough to have a permanent nanny for Charles and his brother.

When Charles was nine he became seriously ill with a high and prolonged fever. As soon as he was well enough, he was sent to Devon to recuperate, where he also attended a small private school. He learned the usual Latin and Greek, and also the mathematics required for navigation skills. Navigation mathematics was almost a compulsory subject in Britain's coastal schools. While he was there he met an astronomer who was to become a friend and teach him the mathematics associated with space as they knew it. Charles attended Totnes Grammar School before going to Cambridge to achieve his degree at Trinity College.

On his way to Cambridge, Charles bought a copy of Lacroix's book on integral and differential calculus. He poured over it for months trying to grasp its principles. When he asked his tutors about particular points, they told him not to worry, "it wouldn't be in the examinations!" Even the senior lecturers had little idea of the subject so Charles struggled on by himself. he worked extremely hard, but he was also a fun-loving, lively young man who was able to charm others and have lots of friends.

Charles studied the work of many of the famous French mathematicians and was labelled as a dangerous liberal when he supported the French against Newton. These accusations prevented Charles being awarded a university teaching position which made him extremely impoverished when he married his wife, Georgina.

They moved to London, where they managed to live on his allowance of four hundred and fifty pounds a year. Charles set up his own study and began working on his own at mathematics. He achieved important investigations into algebra and the theory of functions, and began work on his idea for an analytical engine.

In 1819, Charles went to France and met many of the French mathematicians he had admired and emulated. He met De Prony, who had been commissioned to formulate a new set of logarithmic and trigonometric tables to accompany the new Revolutionary metric system. Charles used these table to help him with his analytical engine.

On his return to London, Charles began working on a machine which would enable sailors to plot their positions with greater accuracy and prevent many unnecessary shipwrecks. It took several years to perfect, but in 1822, Charles, using cog wheels instead of the more usual metal strips, had made a six-wheel machine that operated accurately.

At its demonstration everyone was so impressed that Charles was awarded a grant of one thousand pounds to improve his 'Differential Engine' for government use. This was followed by fame and many honours. His fortunes also improved when his father died and he no longer experienced financial difficulties.

Charles continued to work and travel for many years, reaping honours and meeting with the masters of mathematics and science. He continued to develop his machine, improving its performance and enlarging its capability. Charles died quietly in his sleep just before his eightieth birthday. He will always be remembered as the man who built the forerunner of the computer.

ABEL 1802-1829

Niels Henrik Abel was born on the island of Finnoy in Norway. His father was a poor Protestant minister and his mother was a vivacious lady who did her best to raise seven children and help with parish work. When Niels was tiny, the family moved to Gjerstad in southern Norway. Like many others in Norway at that time, the Abel family were so poor that some of the time they were close to starving.

Niels was sent to the local school until he was thirteen when he went to the Cathedral school in Oslo. One of his teachers was a Bernt Holmboe who was to have a great influence on young Niels. Holmboe instilled a love of mathematics into the boys and soon realised that Niels was especially talented. Holmboe gave Niels the writings of other great mathematicians to study as well as extra coaching in material beyond that given to the other boys. By the time he was sixteen, Niels had begun to discover flaws in some of the theories and reasoning of these mathematicians.

In order to gain a place at university, Niels began to investigate some these flawed problems and set up his own proofs. Sadly, his father died and the burden of supporting his mother, brothers and sisters fell on Niels' young shoulders. Niels left school and took in private students as a way of earning enough money for the family. A career in Mathematics was now in the distant future, if ever.

His friend and teacher, Holmboe, came to the rescue. Holmboe told as many as he could about the plight of this brilliant young mathematician, and enough money was collected to support the family and send Niels to the University of Christiana in Oslo. He finished his preliminary degree the following year and returned home to earn money again.

In 1825, the government awarded Niels a travelling scholarship which took him to France and Germany. He visited many scientists and discussed his mathematical theories with them However, he refused to meet Gauss because, when he had been seeking help, he had sent Gauss one of his treatises. Gauss, when he received it, had shouted, "Another of these monstrosities!" and had torn it up and thrown it away without reading it. Niels' main area of investigation concerned algebraic function, functional equations and theoretical mechanics.

Whilst in France, Niels caught a heavy cold which he was unable to throw off. Seeking the help of a doctor, he was told that he had contracted tuberculosis. His money was running out, Holmboe did what he could to help but when the scholarship money failed to arrive, Niels was destitute and forced to return to Oslo.

He failed to obtain a university post that was vacant - it was given to Holmboe. Niels struggled on by taking in students until the university finally gave him the money they owed him, but it was all too late. Niels started bleeding from his lungs. He fought against the killer disease as long as he could but he died four months later at the age of twenty seven. Two days after he died he was awarded a professorship at the University of Berlin and it was announced that he had won the Grand Jacobi Prize for mathematics. It all came too late to save him.

RIEMANN 1826-1866

Georg Friedrich Bernhard Reimann was born near Hanover in Germany. He was the second of six children in the family of a Lutheran minister. As soon as he was old enough, Georg was sent to secondary school at the Lyceum in Hanover. Here he did well and excelled at mathematics so much so that his teachers said that they had taught him all they knew long before he was old enough to leave and go to university.

Georg went to Gottingen University. His father wanted him to study theology and become a minister like him, but Georg, although he tried, hated it and did badly in his exams. His father gave in and allowed Georg to study mathematics instead. One of his teachers was the great Karl Gauss. Georg worked on defining Euclidean geometry and paved the way for later investigations into non-Euclidean geometry.

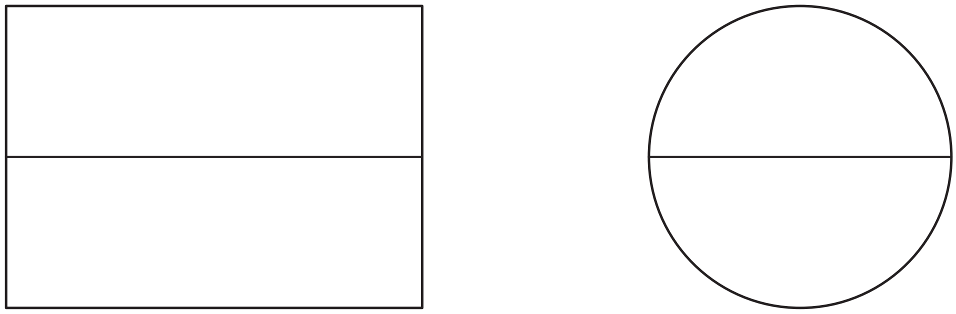
This work gave Georg the necessary qualifications to enable him to teach at university level. He was given a university post but no salary; instead it was stipulated that he could only lecture to students who were willing to pay him!. During the following year, Georg was awarded a small salary which was just enough to live on without suffering real hardship. It freed him from being totally dependent of fee-paying students and gave him the opportunity and time to pursue his own investigations.

Georg married in 1862. Soon after his wedding, he became ill with a high fever and severe pains in his chest. he was diagnosed as suffering from pleurisy. He never really recovered from this which was worsened by the discovery that he had contracted tuberculosis. In an effort to overcome this terrible scourge, he moved to the warmer climate of Italy. He died there at Selasca within a few months of his fortieth birthday.

In his short life, Georg did not have the time to reach his full potential as a mathematician. Modern mathematicians owe much to him and his work on the theory of functions, vector analysis, topology and particularly to his instigation of non-Euclidean geometry. Tuberculosis was a terrible scourge before the middle of the twentieth century; doctors thought it was almost wiped out, but recently it has become prevalent again in many areas.

Georg Riemann did a lot of work on Topology. Topology is a very interesting branch of mathematics that deals with geometric properties which are unchanged by twisting or stretching.

1 Two objects are said to to be topologically equivalent if one can be stretched and distorted to look like the other.



Examine the letters of the alphabet and see which letters are topologically equivalent to the other.

2 Another interesting topological problem is the mobius strip. Take a strip of paper about 3cm wide. put a twist into it and join the ends with tape or glue. Draw a line down the middle of the strip and continue all along the length of the strip. What happens? You should come back to the point where you started. This shows that the strip has only one side; you did not have to cross any edges when drawing the line.

3 Cut along the line right round until you come to the point at which you started. What happens?

4 Taking another strip joined as before, cut into thirds lengthwise. What happens? Why?

KOVALEVSKAYA 1850-1891

Sofya Kovalavskaya was born in Moscow. Sofya had a normal education for a girl of her class. At fifteen she began to go to parties and other social activities for enjoyment and as preparation for finding a husband, but Sofya had already discovered a fascination for mathematics and all her spare time was taken up with reading everything she could on the subject. In spite of all her social activities, Sofya still managed to pass the exams for entrance to university. Her nearby University of St. Petersburg was still refusing to admit women so Sofya became determined to find another which would accept her.

Her family were both angry and distraught; it was absolutely unheard of for a gently reared, aristocratic, single girl to go to university, let alone to one in a foreign land. Sofya was adamant. Her family refused all means of support if she persisted. Sofya found her way to freedom by marrying a young palaeontologist, Vladimir Kovalevski. They travelled to Germany and Sofya attended Heidelberg University.

Sofya studied physics, but her main study was on elliptic functions in mathematics. She also found time to write a novel about her childhood in Russia which was only published after her death. All her life, her beauty and vivacity prevented her from being considered a serious student. It is said that she wore ugly clothes and a huge floppy hat to hide herself when she sought entrance to Berlin University to continue her studies in mathematics. The university refused her entrance - no woman could possibly work on mathematics at the same level as men! However, Professor Weierstrass was impressed enough with her ability to offer her private tutorials. Their association continued for five years in spite of many ultra-conservative scientists warning the professor about letting a woman learn so much beyond her intellectual capacity!

It was the University of Gottingen that finally awarded Sofya her degree. In spite of this qualification Sofya was unable to obtain a teaching or research position. Discouraged she returned to Russia. No one would employ a woman mathematician. Angrily, she returned to the social whirl. She neglected her studies until after the birth of a baby girl. With her husband and daughter, she moved back to Moscow and resumed her work on mathematics.

In 1882, Sofya moved to Paris. In the following year her young husband died. She was so devastated by his death that she refused to eat or drink for five days, on the sixth day she recovered her senses and asked for pens and paper. She wrote masses of mathematical formulas. Then she attended a conference in Odessa where she met many scientists from all of Europe. Finally she was offered a position at the University of Stockholm in 1884. Four years later she was awarded the Bordin Prize for her work on the ‘Rotation of a Solid Body about a Fixed Point’. She had sent in her treatise on plain paper and in an unmarked envelope so that the examiners wouldn’t know that they were dealing with the work of a woman. They were so impressed that the prize was increased from three to five thousand francs. Early in the following year Sofya was awarded the position of Professor of Mathematics for life. Her future was at last assured.

Tragically, two years later, Sofya was a victim of the terrible influenza epidemic which swept through Europe. She was forty-one when she died.

Sofya worked on elliptic functions. You can make an ellipse in several ways. Try these two.

1 To see what an ellipse looks like simply fill a glass beaker with some coloured water. Tilt the glass slightly. The shape you see is an ellipse.

2

a. Stick two nails or pins through a piece of paper, securing them firmly, (back onto a board).

b. Tie a knot in a piece of string to form a loop.

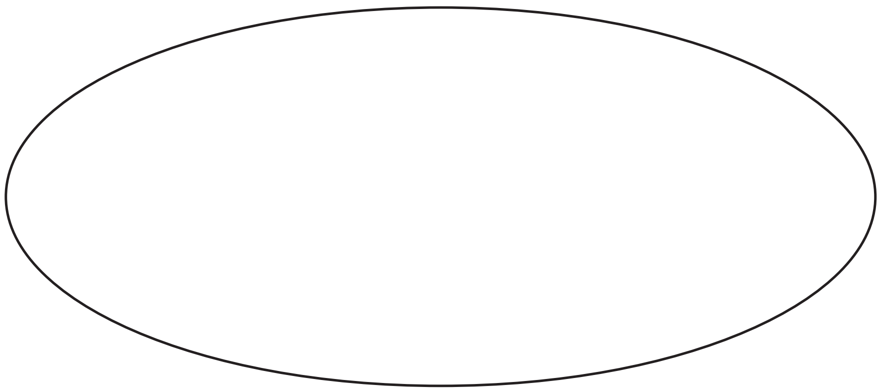
c. Place this loop around the pins.

d. Hold the point of your pencil inside the string and pull until the sting is taut.

e. Move your pencil around the two points making sure that the string is taut all the time.

f. You should have drawn an ellipse.

g. If you move the pin around ten degrees to the right and continue in this way until you have completed the 360 degrees you will have a very interesting pattern.



AN ELLIPSE

WIENER 1894-1964

Norbert Wiener was born in Columbia, Missouri, in the USA. His father was an immigrant who became professor of Slavonic Languages at Harvard University.

Leo Wiener, determined that his son should succeed, taught him to read and write before he was three years old. He then went on to teach his son mathematics and science. Norbert went to Secondary school when he was nine years old.

In 1906, when he was almost twelve, Nobert entered college to study for his degree. At nearly fourteen Norbert had a degree in mathematics but was obviously far too young to teach. So he went back to university, to Harvard, to study zoology. Unfortunately, he hated the practical work so gave up after the first year. Chopping and changing again, Norbert spent a year at Cornell before returning to Harvard to study for his Master's degree in mathematics. Within a year he had this and his doctorate. Harvard still considered him too young for a university position so they gave him a travelling scholarship. He went to Cambridge in England and Gottingen in Germany.

At the outbreak of World War I, Norbert tried to join up but he failed the eyesight test. Disappointed he returned to America to teach and write books on a variety of subjects. He was one of the staff writers for the Encyclopaedia Britannica and he also wrote for the Boston Herald.

In 1919, Norbert obtained a position teaching mathematics at the Massachusetts Institute of Technology, (MIT). He stayed there, progressing up the ladder of promotion until he became a professor and head of mathematics. He worked on several mathematical problems, publishing treatises on, 'Differential Space', 'Harmonic Analysis', 'Tauberian Theorems' and what is probably his most famous work named, 'Cybernetics'.

During World War II, Norbert worked on gunfire control and range-finding. After the war, he spent leave travelling in Mexico, France, Italy and India. He finally retired from Harvard in 1962. Two years later he set off on his travels again. He reached Sweden in the spring. He was enjoying meeting and talking with other mathematicians and scientists in Stockholm when he suddenly died at the age of seventy.

NEUMANN 1914-1971

Hanna Neumann was born in Germany. Her father was an aristocrat, who instead of becoming an army officer, became a historian. In 1914, he dutifully joined the army but was tragically killed during the first days of the war when Hanna was just a baby. In spite of their wealthy background, Hanna's mother was very poor and had only her army pension with which to support herself and bring up two daughters.

Hanna entered university in 1932. She studied mathematics as her main subject, with philosophy, physics, history and religion as extra subjects. Hanna did well in her studies and enjoyed discussing her work with other mathematicians and scientists. She met her husband Bernhard at a discussion session. In 1932, the Nazi Party was manoeuvring to gain power. Germany was becoming a very dangerous place for Jewish people and those of partly Jewish descent. Bernhard was Jewish and he realised that Germany was unsafe. He left for England and was followed by Hanna in the following year where she became secretly engaged to Bernhard, (Germans were not allowed to marry Jews after 1933 when the Nazis came to power). Then Hanna returned to Berlin to continue her studies.

Some of the finest lecturers and professors in German universities were Jewish and Hanna joined a group of students whose aim was to protect these learned Jewish people. They accomplished little more than the prevention of some harassment before the Nazis ruled that no Jew was allowed to attend or teach in a university. Hanna decided to stay on after completing her degrees and achieve her doctorate, but she was warned that the Nazis refused to grant degrees until the student had answered political questions correctly. Hanna's association with the protection of Jews group did not augur well for her chances. However, just before her 'finals', Hanna caught scarlet fever. In spite of being ill, she still achieved distinctions in physics, and mathematics with credits in her other subjects.

After the Anschluss in 1938, Hanna decided that it was time to leave. She travelled to England and secretly married Bernhard in Cardiff. They couldn't marry openly as they feared reprisals on their families still in Germany.

After the beginning of the World War II, Bernhard was interned as a German National, he was released when he volunteered to join the army. Hanna moved to Oxford where she lived in a caravan, brought up three small children and continued her studies. After the war, Bernhard was offered a post in Hull and Hanna was offered a temporary post in lecturing in mathematics. Then they were offered better positions in Manchester so they moved again.

Slowly, Hanna's work was recognised and she began to receive honours and accolades. Bernhard was offered a research post in Australia and left in 1963, with Hanna and the children following in 1964.

In Australia, Hanna's qualities as a lecturer and teacher were desperately needed as they worked on upgrading the standard of mathematics in both students and teachers. Both Hanna and Bernhard received many more honours in recognition of their contribution to mathematics. They travelled at the invitation of many countries. In Canada towards the end of 1971, Hanna suddenly felt very ill. She took herself off to the local hospital where she was put to bed. She lapsed into a coma and died two days later. She was fifty-seven years old.